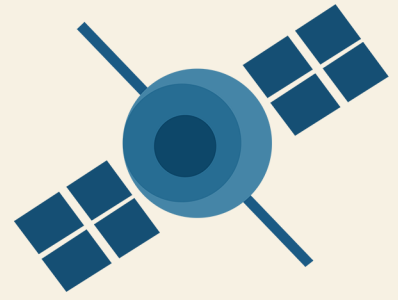




Towards a Human-Centered Scientific Culture in the Arab World

from crisis-driven science
to visionary renewal



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Short Summary

Rethinking scientific culture A roadmap for regional transformation in the Arab World

What if science in the Arab world could again be a cause for wonder, critical thinking, civic engagement, and citizenship? This report explores how scientific culture can be re-humanized and re-enchanted so that it confronts the most urgent challenges facing the Arab world today. It transports the reader from the jolts of the COVID-19 pandemic to the fast-rising age of AI. It asks: what type of science culture is demanded-not just for technological advancement, but to nurture empowered and inclusive societies from Tangiers to Baghdad?

Despite education and research investments, scientific engagement remains weak across the majority of the Arab world. Developed as part of UNESCO's Management of Social Transformation (MOST) Programme, the report identifies deeply-rooted obstacles: illiteracy, disengagement, low trust, and mobility restrictions and urges an interdisciplinary and holistic solution that places science within the cultural and social experience of Arab cities.

2,000
*researchers per
million peo-
ple in the Arab
world - over
5,000 in
Europe*

With cities as incubators of imagination, and Arab-Arab collaboration as a strategic necessity, a new science culture can be constructed: pluralistic, mobile, socially embedded, and emotionally resonant.

From libraries and museums to public media and art, the report offers a vision for galvanizing scientific interest and civic participation. Readers are invited to imagine how this transformation can occur, and to become part of building a future where Arab science touches the soul as much as the mind.

Towards a Human-Centered Scientific Culture in the Arab World

from crisis-driven science
to visionary renewal

Foreword

Science and technology have skillfully demonstrated their adaptive capacity to address the socio-environmental challenges of the Arab world, from water desalination systems to technological innovation.



Yet, as in other regions, there is an enduring paradox: despite increasing investments in science, the public remains disconnected from science. However, the role of scientific research is key to combating disinformation and is an indispensable tool for strengthening public trust. The COVID-19 crisis highlighted the essential role of science in building societal resilience, echoing the urgent need for an overhauled scientific culture built on ethics, inclusivity, and accessibility. The pandemic underscored the paramount role of cooperation and the necessity to reiterate the unity of the human family.

Higher education and research entities in the Arab world are central to this endeavor. In order to reinforce the prime role of scientific institutions, R&D expenditure must increase, gender inequality in STEM fields should be addressed, and interdisciplinary collaboration should be strengthened as a matter of urgency. The Arab world has 2,000 researchers per million inhabitants (Egypt 686 per million; Iraq 111; Oman 281; Qatar 577; Morocco 1,070 and Tunisia 1,772) and 41% of them are women, despite the increased women's representation in Arab countries like Tunisia and Egypt. To face those challenges, 1,000 to 1,200 full-time researchers per scientific field are needed to sustain national innovation systems, a threshold that some of the Arab countries fall short of. These shortfalls call for an urgent institutional shift to build societies in which science is embraced as a public good. This report, *Towards a Human-Centered Scientific Culture in the Arab world: From Crisis-Driven Science to Visionary Renewal*, is part of UNESCO's general mandate and broader mission to leverage science, technology, and innovation for sustainable development and cultural

renewal. It builds on previous foundational UNESCO frameworks like the Charter of Ethics of Science and Technology in the Arab Region (2019), Recommendation on the Ethics of Artificial Intelligence (2022), and Culture: Urban Future; Global Report on Culture for Sustainable Urban Development (2016). This report, through a social and ethical lens alongside an urban-cultural approach, offers a comprehensive guide to re-enchant and re-humanize scientific culture with consideration for the Arab world's own social, cultural, and institutional settings.

The publication draws on robust survey evidence, expert insights, and regional case studies to furnish policymakers, educators, scientists, and community leaders with practical strategies and ideas. Interdisciplinary action, urban science nodes, larger Arab-Arab collaboration, and embracing popular culture are encouraged to make science user-friendly and inspiring. From leveraging AI to enhance Arabic-language scientific literacy to paying tribute to the legacy of literary legends like the late Ahmed Khaled Tawfik, who popularized science through his fictional works, the report envisions a future where science is part of Arab identity and aspirations.

We are thankful to all the participants who made this report possible. Your commitment to supporting a healthy culture of science is an inspiration for all of us.

This report is a call for action to build inclusive, innovative, and ethical science environments. Collectively, we have the power to build a future where all Arab citizens, regardless of gender, age, and background, can approach science as a source of development, empowerment, and hope that fuels constructive change and peaceful ventures across the region and beyond.

Dr. Nuria Sanz

Director

UNESCO Regional Office for Egypt and Sudan

Liaison Office with League of Arab states

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1. INTRODUCTION

This initial draft of this report was concluded at the twilight of the pandemic era and was shaped accordingly. It was therefore decided to update the report without losing the foundational, robust, rigorous, and methodological work that went into it. Moreover, the pandemic is still considered recent, and its lingering effects remain strong. Despite the global fatigue with the mere mention of COVID-19 or those harrowing days spent indoors – let alone the unimaginable death toll that gripped the world – the lessons it imparted were profound, as it is uncommon for everyday reality to be confronted with science in such a dramatic and existential manner.

The reason for the update was driven by the need to expand the report beyond the crisis-driven science of the pandemic era and shift toward a longer-term strategy that brings scientific culture into the broader Arab landscape. The report consciously addresses the era in which it is written ; it also seeks to address both the enduring and profound shifts that have occurred in the regional contexts in relation to science. Furthermore, the advocacy component repositions science away from a technical endeavor into a cultural force that enriches and empowers Arab peoples' lives, identities, and experiences, which need to be factored into the development of scientific culture and therefore emphasizing the human value of science.

Accordingly, the report's primary guiding question will be:

***How can we re-enchant and re-humanize
scientific culture for the Arab world?***

This human-centered approach in reframing the driving question intentionally uses the word choice of “re-enchant,” to not only invoke a sense of wonder and curiosity, but also to align with a cultural renewal and to reconnect with historical achievements such as the Islamic Golden Age, and positions science as part of an intellectual revival in the Arab world. The “re-humanize” element brings social sciences, humanities, and the arts into dialogue with scientific culture to make it more relatable to the public and to emphasize the question of ethical advancement in science. Social justice and the public good cannot, and should not, be

divorced from the pursuit of science. Any ethical framework developed needs to draw from local cultural traditions and remain morally grounded, while science and research results need to move beyond the confines of the scientific community and into society. This is not only to spread scientific awareness, but to “uplift people’s lives, protect human dignity, and promote cultural and ecological sustainability.”¹

Moreover, the conflicts in the region showed how the dark side of science and technology obliterates the hopeful side of science and technology, by hindering “research and innovation” and eliminating “scientific, intellectual and societal progress.”²

While this report advocates for science policy reform, it also draws on the insights of urban studies, sociology, philosophy, and popular culture to promote a human-centered vision of science – one that is accessible, inclusive, and responsive to the needs of the Arab world. It does this accordingly through five thematic tracks:

- *Cities as Scientific Hubs: Explores the potential of urban areas to become centers for scientific engagement and education.*
- *Arab-Arab Collaboration and Mobility: Examines how regional partnerships can enhance scientific culture by addressing the question of mobility and visa regimes.*
- *Interdisciplinary Approaches: Discusses the value of social sciences, humanities, and the arts in making science accessible.*
- *Popular Culture: From science fiction to social media, popular culture offers a relatable entry point for the public to explore scientific concepts.*
- *AI and Emerging Technologies: Addresses the impact of AI and new technologies on public perception and engagement with science.*

Section One critically analyzes the scientific culture in the Arab world through the existing principal opportunities and challenges in science communication and public engagement. Drawing on comparative case studies, expert interviews, and survey data, it maps the structural and societal drivers that underpin science engagement in the region.

¹ Sabine Dorpmüller, interview by Amro Ali, 15 November 2024.

² Amr Rageh, “Gaza’s science and tech experts targeted in assaults,” (16 April 2024). <https://www.scidev.net/global/news/gaza-s-science-and-tech-experts-targeted-in-assaults/>.

The report points to the persistent obstacles to scientific mobility, deficits in interdisciplinary research, increasing significance of science communication on the internet, and ambiguous degrees of public trust in science regulation. These insights are still strongly valid, but the post-pandemic environment and the rapid advent of new technologies have introduced new complexities that necessitate an expanded framework. Section Two responds to this need by augmenting the preliminary findings by five thematic streams proposing a more human-centered, interdisciplinary scientific culture. It integrates sociology, philosophy, urban studies, and arts viewpoints with an emphasis on city-centered action, narrative, ethics, and Arab-Arab collaboration. These tracks are designed not to replace the conventional paradigm but supplement it with focused empirically based responses to render science more attractive, accessible, and responsive to Arab societies' needs.

2. PROBLEM STATEMENT

In the Arab world as a whole, there has been extensive investment in science, technology, and innovation; and a majority of governments have ranked these fields of research as priority areas in national development plans. However, these are often focused on institutional research output and global competitiveness rather than being geared towards science understanding, appreciation and interaction with society at large.

Despite such advancements, Arab scientific culture remains fragmented, non-accessible, and weakly integrated into everyday life. There is a gap between scientific institutions and society, in which science is seen as elitist, overly technical, or irrelevant. Structural problems – e.g., poor scientific literacy, institutional lack of trust, ineffective science communication, and barriers to interdisciplinarity – are still hindering successful public participation.

This disconnection, if not alienation, has far-reaching consequences as it limits the ability of science to spark interest, influence public policy, and address social issues. Accordingly, it risks widespread exclusion of much of the public, especially women, children, rural communities, and minorities, from becoming involved in, or benefiting from, scientific progress. Moreover, the acceleration of new frontier technologies like AI is outpacing public awareness and ethical preparedness, further widening the gap between innovation and society.

The problem crosses education systems, cultural institutions, public debate, and regional mobility. Both formal science education and informal science outreach belong to the described problem, while mostly excluding purely technical or commercial research frameworks that are not designed for broad civic engagement.

This report seeks to fill this gap by reimagining scientific culture as a civic, cultural, and human project. It aims to foster a more socially responsive, interdisciplinary, and inclusive science – one that is rooted in Arab realities, captures public imagination, and contributes to knowledge-based resilient societies.

SCOPE

This discussion paper focuses on five selected and identified pillars for promoting scientific culture: science communication, science and public engagement, public cognition of science, public accountability for science, and ethical oversight of science. The five pillars will be addressed in this review and the different tools scientists have tested in measuring them.

Science communication is the practice of informing, educating, raising awareness of science-related topics, and growing the sense of fascination about scientific discoveries and arguments. Diversity in ethnicity, culture, language, gender, sexuality, class, religion and disability are the main factors affecting the choice of communication methodology. Promoting science communication has different goals³ such as: (i) sharing recent findings and exciting news about science, (ii) increasing public appreciation of science, (iii) increasing knowledge and understanding of science, (iv) influencing opinions, policy preferences or people's behavior, and (v) ensuring that a diversity of perspectives about science held by different groups is considered when solutions to societal problems are pursued⁴.

3 Illingworth, Sam; Allen, Grant (2020), Effective science communication: a practical guide to surviving as a scientist (2nd ed.). Bristol, UK; Philadelphia: IOP Publishing. pp. 1–5. doi: 10.1088/978-0-7503-2520-2ch1. ISBN: 9780750325189. OCLC: 1172776633.

4 National Academies of Sciences, Engineering and Medicine (2017): Communicating Science Effectively: A Research Agenda (978-0-309-45102-4).

The main prerequisites to achieve such communication are: trust; presenting scientific content in simple and attractive ways; serving public needs, and choosing the adequate communication approach.

The terms **“public awareness of science”, “public understanding of science”, and “public engagement with science and technology”** refer to attitudes, actions, views and activities that make up the public’s overall relationship with scientific knowledge and organization⁵.

Different tools are used to measure science communication and public awareness of science; some studies have been prepared to measure public awareness of, interest in, and attitude toward science, as well as the public’s participation in science programs through surveys (e.g., the 2019 Public Awareness of Science, Technology, and Innovation (STI) Malaysia study⁶; the Department for Business, Energy and Industrial Strategy; and the Department for Business, Energy, and Industrial Strategy United Kingdom⁷). Other studies were designed to create Key Performance Indicators (KPIs) for measuring and assessing quality of science communication in general, in journalism, social media and museums.⁸ Additionally, some studies were designed to measure its impact in changing the general public’s views, knowledge, attitudes or behavior regarding science or scientific results in order to determine whether and how this influence is being reached (Leiden University, Netherlands).⁹

5 Savaget, Paulo and Acero, Liliana (2017), “Plurality in understandings of innovation, sociotechnical progress and sustainable development: An analysis of OECD expert narratives”. “Public Understanding of Science” 27 (5): 611–628. doi: 10.1177/0963662517695056. PMID: 29298581. S2CID: 3179006.

6 Malaysian Science and Technology Information Center (MASTIC) (2019), “Public Awareness of Science, Technology & Innovation (STI) Malaysia” <https://mastic.mosti.gov.my/storage/2024/06/BI-Full-Report-STI-2019-as-of-21-January-2022.pdf>

7 Department for Business, Energy & Industrial Strategy, 2019, “Public Attitudes on Science”, Research Paper Number 2020/012, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/905466/public-attitudes-to-science-2019.pdf

8 Xiufeng Liu, Lei Fu Shao and Hui Chi, 2014, Measuring University Students’ Science Communication Efficacy in Middle and High Schools, Annual meeting of the NARST, Pittsburgh, PA, USA, https://www.researchgate.net/publication/301920378_Measuring_University_Students'_Perceived_Self-efficacy_In_Science_Communication_in_Middle_and_High_Schools

9 NWO - Nationale Wetenschaps Agenda (Dutch Research Agenda), 2022, Measuring science communication impact, https://www.nwo.nl/sites/nwo/files/media-files/nwa_-_all_factsheets_en.pdf

Public cognition of science directly reflects public attitude and acceptance of science. This contributes to individuals' cultural values and perceptions of scientific consensus. On the other hand, the percentage of population involved in S&T activities - males or females - is strongly linked to a "better informed" society and one that is "more tied" to science applications and emerging technologies. Better understanding of STI in other words (STI literacy) helps communities better utilize technology outcomes, hence, leading to a better, healthier and safer lifestyle. Moreover, there is a rising need to draw the interest of societies - especially Arab society - towards scientific studies and scientific careers. The number of scientists and researchers engaged in research and development (R&D) in the Arab world indicates an urgent need for coaching efforts. The numbers of R&D researchers in Arab countries, averages about 2,000 per million according to 2019 reports (Egypt 686 per million; Iraq 111; Oman 281; Qatar 577; Morocco 1,070; and Tunisia 1,772) compares poorly to numbers of nearly and above 5,000 per million in European countries (Sweden 7,537; Germany 5,211; and UK 4,603).¹⁰

According to Dr. Hassan Nazar, UNESCO Senior Expert on Science and Engr. Education; Energy and STI for Sustainable Development, it is a well-known secret that a threshold of 1,000 to 1,200 FTEs (full-time equivalent researchers or technical workers) is required in each science field to support the national innovation system. Lemarchand (2016) indicated that any production "system" needs a critical mass of experts and investment to start showing earnings, at which the impact of the STI activities become visible within the economy. When a country has around 1,000 to 1,200 FTEs per million inhabitants, this will scale a gross expenditure on R&D (GERD) investment of around 1% of GDP. When countries have more than 1,200 FTE "researchers" per million inhabitants in any given science field, the result is that the critical mass of researchers, working in the country, are spreading their knowledge into society. One will also witness that when a country is reaching the 1,200 FTEs researchers per million inhabitants' milestone, the shares of the private sector investment in STI activities starts to match the public sector investment.¹¹

10 World Bank Data, 2021, <https://data.worldbank.org/indicator/SP.POP.SCIE.RD.P6>

11 Lemarchand, G.; Empirical Assessment of Critical Mass of Researcher; Personal Communication; 2016.

Globally, a clear gap persists between male and female involvement in S&T-related studies and jobs. According to UNESCO's UIS data, less than 30% of the world's researchers are women. The US reported significant improvement in percentage of females involved in such jobs as engineering and computer science, doubling their numbers between 2003 and 2017, yet women¹² represent only 29% of the total labor force.¹³ An unexpected revelation is that female researchers constitute over 41% of total researchers in the Arab world. This number does not reflect the actual status in all Arab countries, as three leading countries Tunisia, Egypt, and Algeria, have more than 55% of female researchers. This percentage drops to less than 30% in a considerable number of Arab countries. More in-depth regional analysis is needed through the portioning of Arab countries for a more accurate analysis of this vast difference.

Public accountability to science is related to responsibility, integrity and accountability of citizens to the state for implementing the science agenda. It depends primarily on society's awareness and understanding of scientific policies, strategies and roadmaps with specific timing and goals. In literature, there is no specific method that can be relied upon in measuring accountability, but the reference in this case is the process of accountability which is carried out by Parliaments in terms of accounting for expenditures or some of the achievements made by governments. To summarize, this review focuses on research made to examine these four main pillars upon which societies' scientific culture is built.

The review will first address the different adopted policies to strengthen science community interaction such as studies evaluating awareness and interaction with science within different communities. It will then present studies conducted in two countries around the same time frame (2019); it will briefly discuss and compare adopted methodologies and tools; and examine reported surveys and studies on responses to the pandemic (COVID-19) – at the regional and global levels. Finally, there was special focus on efforts exerted in the Arab world to promote scientific culture.

12 Women in science, UNESCO UIS 2019. <https://unesdoc.unesco.org/ark:/48223/pf0000370742>

13 National Science Board Science & Engineering Indicators, 2020, The State of U.S. Science & Engineering. NSB-2020-1, <https://nces.nsf.gov/pubs/nsb20201/assets/nsb20201.pdf>

Ethical Oversight of Science might seem redundant given the previous pillar on the public accountability for science, they are, however, distinct and play complementary roles but not interchangeable ones, hence the reason to maintain the two pillars parts in the report.

The public accountability strategy in the Arab world is supposed to render the scientific processes subject to mechanisms of transparency and make them answerable to society's needs, but it is not necessarily intended to address the ethical dimensions of scientific practices. The most prudent part taken by ethical oversight would, therefore, relate to establishing systems and standards that guide scientific behavior with an overview of the areas experiencing rapid technological development such as AI, biotechnology, and data privacy. This has to do with the ethical dimensions of science practices in which moral values, protection of individual rights, societal welfare, and long-term impacts are ensured. In contrast, public accountability would imply an account of events about responsibility towards transparency and responsiveness to the expectations held by the public. Therefore, it is a means by which the public can observe and challenge the decisions and actions of a scientific institution.

To sum up, these two areas though they appear to be related, address different dimensions of science's relationship with society. Public accountability develops trust as science is made available and responsible to the public, therefore assuring that the needs of the community are met, especially when pursued with the assistance of public funding or policies. Ethical oversight gives an added important layer of guidance on responsible scientific practices; this is something public accountability cannot fully address, especially in areas where risks are very high and regulation is evolving. Thus, if public accountability to science and ethical supervision of science are brought together, they constitute a comprehensive approach towards transparency as well as efficiency in ethical integrity in building trust in science across the Arab region. Accordingly, this pillar adopts the framework of UNESCO's Charter of Ethics of Science and Technology in the Arab Region.

*This ethical framework is intended to help identify the means to: protect the contexts of science and technology, products thereof and scientific workers; promote science and technology and support their success, including through the provision of the required legislative and legal tools, human and material resources, as well as the enabling environments, such as state and societal support; guide science and technology towards the right course, steering them away from unethical trends and practices that are harmful to humans and the surrounding environment.*¹⁴

KEY DEFINITIONS

- “Scientific mobility” refers to the ease with which scientists, researchers, and students engage in cross-border exchanges, particularly within the Arab region.
- “Urban science hubs” denote cities that actively integrate scientific engagement through public spaces, city programs, and community initiatives.
- “Liberal Arts” covers the entire spectrum of the social sciences and humanities, such as sociology, philosophy, history, and the arts.
- “Interdisciplinary approaches” encompass methods that bridge science with the liberal arts.
- “Popular culture” involves using media, literature, and social platforms to make science appealing and accessible.
- “Ethical oversight” addresses frameworks ensuring that scientific advancements align with public values and maintain accountability, particularly with the rapid rise of technologies like AI.

¹⁴ “Charter of Ethics of Science and Technology in the Arab Region,” UNESCO (2019). <https://unesdoc.unesco.org/ark:/48223/pf0000372169>

SECTION ONE

Introduction to Section One:

Diagnosing the Current Scientific Culture

The Arab world today faces a paradox: while investment in science and technology has steadily increased, public engagement with science remains fragmented, uneven, and often limited to formal academic settings. Section one seeks to understand this severing by analyzing the Arab world's scientific culture, including the structures, social dynamics, and communicative practices, that underpin it. Furthermore, it explores the five foundational pillars – science communication, public engagement, public cognition, public accountability, and ethical oversight – through surveys, expert interviews, and case studies to understand how science is perceived, accessed, and trusted across Arab societies.

This part recognizes recurring bottlenecks to include illiteracy, less access to trusted information, and public skepticism, generally. Such factors contribute towards hindering an inclusive Arab scientific ecosystem. Besides, it cites the increasing trend of digital media, politicizing science, and the uneven geography of gender and generational involvement.

The diagnostic framework that underpins section one eventually informs the transformative strategies that will be explored in section two which builds on the established insights to propose multiple pathways for re-enchanting and re-humanizing scientific culture in the Arab world. It will do so by emphasizing cities as scientific hubs, Arab-Arab collaboration and mobility, interdisciplinary approach to science promotion, role of popular culture in science promotion, and AI and emerging technologies. These measures seek to integrate science into the heart of Arab daily life and collective aspirations.

3. REVIEW OF INTERNATIONAL AND REGIONAL EFFORTS, RESEARCH AND PUBLICATIONS

As Dr. Nazar Hassan puts it, the 2030 Sustainable Development Agenda has called upon all stakeholders to support sustainable development through concrete Science, Technology and Innovation (STI) initiatives that would lead to the required high levels of innovation. However, innovation is not a decision, rather an ecosystem upon which knowledge societies and sustainable development are founded. STI is hence a core requirement to guarantee the transformation of the targeted nations towards scientific tempo and culture, which will eventually give rise to and establish the missing innovation ecosystems.

An innovation ecosystem is the evolving set of actors, activities, artifacts, and institutions and their relations, including complementary and substitute relations that are important for the innovative performance of an actor or a population of actors. In other words, an innovation ecosystem refers to a loosely-interconnected network of companies and entities that coevolve capabilities around a shared set of technologies, knowledge or skills, and work cooperatively and competitively to develop new products and services. These entities include, but are not limited to, academia, research centers, the production sector and well-equipped incubators in order to develop innovative ideas for commercialization. An innovation ecosystem hence consists of economic agents and economic relations as well as the non-economic components such as technology, institutions, sociological interactions and culture. Non-economic components or innovation structure can enable ideas to come to life, thus introducing and disseminating innovation within a given society.

A number of major factors could be attributed to the very low rates of innovation found within any national innovation ecosystem as a whole. These are namely the lack of a knowledge base required for sustainable development, the lack of qualified technical critical mass together with the lack of quality education and training support, misalignment between the labor market and graduates' skill, lack of awareness regarding entrepreneurship and how to become pioneers in seeking entrepreneurship opportunities.

The weakness of the National Innovation System (NIS) in any country could be also attributed to the absence of required partnerships between academia, research and the productive (public and private) sectors. Each of these three sectors could be functioning in separate silos in the absence of adequate policies and regulations, both of which could transform the current NIS status quo into a robust national innovation culture and deliver the necessary support to the current innovation system.

When considering the Arab region as an example and relating these factors to the main five pillars of any NIS, we discovered that academia is not effectively participating in producing graduates that possess the required market skills, and that Technical and Vocational Education and Training (TVET) is at its worst, whereby students at entry level fail to affiliate with classic higher education institutes. At research institutes, the staff had graduated from an education system that does not teach strong analytical and problem-solving skills or the creativity to innovate. The private production sector, on the other hand, does not really get the necessary boost from the government to be involved in the research and innovation sphere as an equal partner.

3.1. International policies towards science community interaction (SCI)

There are different policies that have been adopted by governments to generate and enhance the interaction between their communities and science. Some countries took steps forward in defining policies for science communication by way of institutionalization. One of these countries is The United Kingdom which has established the Science Media Centers (2012), where The UK SMC has played a key role in the creation of other SMCs around the world. Such centers are currently operational in five continents. Each SMC works primarily with national news media, and scientists in their respective countries¹⁵ have entered the field. As a result, we are witnessing growing networks in the science communication community (e.g., European Citizen Science Association, 2021; European Science Engagement Association, n.d.).

15 Science Media Center, 2021, London, <https://www.sciencemediacentre.org/international-smcs/>

Emerging technologies created novel ways for interaction with audiences, for example Twitch in Germany (which is actually a live streaming video portal that is mainly used by gamers whereby the idea of using the platform for science communication came to life because Twitch has a science and technology category).¹⁶ Augmented Reality for example “Up to Space” via augmented reality application is a special exhibition at the Universum Bremen that aims to bring closer the subject of space travel and research in space. It brought forth the concept of how the Science Center integrates partners from local space industry to the European Space Agency and why augmented reality is well suited to explaining rockets.¹⁷

Besides, a rising number of academic and political institutions formulate position papers on science communication (Ziegler and Fischer, 2020), and future directions of the field are debated.¹⁸

On the other hand, other countries adopted clear policies towards improving their communities’ scientific literacy. China, for example, has developed an Action Plan Outline for Improving People’s Scientific Literacy.¹⁹

The Civil Scientific Literacy in China (CSL) was reported to represent 1.4% of the population in 2001 and it reached 10% in 2020 as an outcome of these series of action plans. The CSL in females was almost 30% compared to male’s literacy in 2015. This number jumped to 80% according to 2018 statistics, which indicates that the action plans succeeded in bridging the gender gap in a huge country like China with its highly heterogeneous mixes of ethics and beliefs.

16 Rebecca Winkels, 2020, A new, interactive live experience, Wissenschafts kommunikation, https://english.www.gov.cn/policies/policywatch/202107/07/content_WS60e51e8dc6d0df57f98dc841.html

17 Anne White Skull, 2020, Up to Space via augmented reality app, Wissenschafts kommunikation, <https://www.wissenschaftskommunikation.de/up-to-space-per-augmented-reality-app-43331/>

18 Ziegler Ricarda, Hedder Imke Ronja and Fischer Liliann, 2021, Evaluation of Science Communication: Current Practices, Challenges and Future Implications, Frontiers in Communication, VOLUME 6, DOI=10.3389/fcomm.2021.669744

19 Scientific literacy plan announced: https://english.www.gov.cn/policies/policywatch/202107/07/content_WS60e51e8dc6d0df57f98dc841.html

3.1.1. Measurement of public awareness of STI: International case studies

One of the most direct and effective tools of monitoring and evaluating success of governments' policies in improving public awareness of science are "surveys". Two significant surveys performed in the UK and Malaysia were chosen to be analyzed. The two countries have significant diversity in culture, heritage and traditions. Comparing the methodologies and outcomes of both surveys is very useful to highlight this context.

The 2019 Public Awareness of the STI Malaysia Study aimed to determine the Malaysian public's awareness of, interest in, and attitude toward STI, as well as their participation in STI programs. It showed that Malaysians' attitude towards science is generally positive and is not defined by gender, locality, age group, or ethnicity.²⁰

The numbers indicated a "well informed society", although more than half the sample agreed that STI causes our lifestyles to change too fast and that we depend too much on science, one third of the sample indicated that they do not rely enough on faith. These results prove that culture and religious beliefs are key players behind the scene.

Looking at the media's impact on public information, traditional media as a leading source of STI such as television (83.6%) and newspapers (76.8%) remain the two leading sources of STI information among Malaysians of all demographic backgrounds. However, the reliance on television and newspapers as a source of STI information had decreased when compared to 2014, at 97.3% and 86.7% respectively. Meanwhile, Malaysians are increasingly referring to social media (63.3%), e-News (52.5%) and science websites or videos (51.8%), as sources of STI information.

Comparing the media's effect on a western country, Kantar performed a study in the UK on behalf of the Department for Business, Energy and Industrial Strategy (BEIS) and found that people are unsure whether they can trust science reporting in the media. Only half of those polled believe

²⁰ MOSTI, 2019, Public Awareness of Science, Technology & Innovation Malaysia, Malaysia, <https://mastic.mosti.gov.my/storage/2024/06/BI-Full-Report-STI-2019-as-of-21-January-2022.pdf>

the information they learn about science is generally accurate, while one third are unwilling to comment. People were significantly more willing to trust online science information that they discovered on their own (81%) than information provided by social media personalities (30%) or friends (30%). People recognize that there are more reliable sources of science information available, even if they do not use it themselves. TV (52%), online news (38%), and social media (33%) were rated as the best sources for informing people about science, which corresponded to the sources people used most frequently. Science journals have a much lower share (25%), books (21%), and science blogs (16 %) and were regarded as reputable sources, despite the fact that they were rarely used in practice.

To conclude, it is clear that personal relevance is crucial to engagement. Science plays a crucial role in the extremely personal field of healthcare, alongside the enjoyment of nature and space-related TV shows, podcasts and family visits to museums, all being popular have brought science to life and grabbed people's interest. This shows that appealing to personal medical science experiences and showing the natural environment are both good approaches to raising public involvement with science. The key to this, however, is to present the science in a clear and engaging manner; nature documentaries being a great example thereof.²¹

3.1.2. International communities' responses and COVID-19 experiences: Lessons learned

One of the significant examples of communities' response to the pandemic is China, where people's adherence to control measures is affected by their knowledge, attitudes, and practices (KAP) towards COVID-19 during the period of the rapid rise of the outbreak. A study reported the results of knowledge questionnaire¹⁷ that consisted of 12 questions regarding the clinical characteristics and prevention of COVID-19. The survey was completed by 6,910 persons; 65.7% were women, 63.5% held a bachelor degree or above, and 56.2% engaged in intellectual labor. As most of the survey participants had a relatively high socioeconomic status, in particular women, were

²¹ Department for Business, Energy & Industrial Strategy, 2019, Public attitudes to science, Research Paper No. 2020/012, <https://assets.publishing.service.gov.uk/media/5f22cf7bd3bf7f1b1593c15c/public-attitudes-to-science-2019.pdf>

knowledgeable about COVID-19, held optimistic attitudes, and had appropriate practices on COVID-19.²² This survey compellingly illustrates that illiteracy and being isolated from science is one of the main issues that must be tackled to improve the scientific culture.

Brazil provided a raw model for science communication with the media as a conduit; media organizations collaborated with health professionals to create audio notifications that could be broadcast from cars all across the city.²³

Leaders' ability to lead and communicate during crises is critical for supporting and guiding citizens' actions and emotions. One successful example is the Australian government's crisis communication management during the COVID-19 pandemic. Communication delivered over a seven-month period, beginning with the first reported case of COVID-19 in Australia, was analyzed utilizing a coding process to identify central organization for crisis communication frames and themes. Ninety-one communiqués were analyzed using transcripts obtained from the Prime Minister's official website to assess changes in communication during the period of the pandemic with key epidemiological indicators and public health measurements being examined across time. These were compared to eleven main themes based on the World Health Organization (WHO) and the United States' Centers for Disease Control and Prevention's Crisis and Emergency Risk Communication (CERC) principles.²⁴

The public's trust and broad acceptance of response actions are essential for a government's pandemic control plan to succeed. A study looked into public opinions of the UK government's COVID-19 reaction incorporating

22 Zhong BL, Luo W, Li HM et al., Knowledge, attitudes and practices towards COVID-19 among Chinese residents during the rapid rise period of the COVID-19 outbreak : a quick online cross-sectional survey. *Int J Biol Sci.* 2020; 16(10):1745-1752. Published 2020 Mar 15. doi:10.7150/ijbs.45221

23 Thaís Cavalcante, 2020, How Brazilian favela journalists are raising awareness about COVID-19, Open Democracy, <https://www.opendemocracy.net/en/democraciaabierta/how-brazilian-favela-journalists-are-raising-awareness-about-covid-19/>

24 Natalie Reyes Bernard, Abdul Basit, Ernesta Sofija, Hai Phung, Jessica Lee, Shannon Rutherford, Bernadette Sebar, Neil Harris, Dung Phung, Nicola Wiseman, 2021, Analysis of crisis communication by the Prime Minister of Australia during the COVID-19 pandemic, *International Journal of Disaster Risk Reduction*, Volume 62, ISSN 2212-4209, <https://doi.org/10.1016/j.ijdrr.2021.102375>.

9,300 participants while focusing on the relationship between trust and perceived transparency. The results showed that the vast majority of respondents (95.1%) favored the government's enforcement of behavior change. Half of the respondents thought the government was making sound decisions. Positive attitudes on the government's decision-making process were linked to favorable attitudes on government transparency in terms of the COVID-19 pandemic response.²⁵

Five key themes emerged from a qualitative analysis of public perception of government transparency: (1) the justification of opacity as a result of the crisis, (2) generalized mistrust of politics, (3) concerns about the role of scientific evidence, (4) the quality of government communication, and (5) questions about political decision-making processes. The study showed that trust is not uniform among communities, and generalized mistrust concerns about the transparent use and sharing of evidence as well as insights into decision-making processes can all influence public impressions of a government's response to a pandemic. The study recommends targeted community engagement tailored to the experiences of various groups, as well as a renewed focus on accountability and transparency in the UK government's COVID-19 pandemic response.

Public accountability to science: COVID-19 a real-life test

A study conducted in The UK in 2020 investigating public trust during the COVID-19 pandemic emphasized that citizens in countries with a high aggregate level of trust in science, are more likely to be confident about vaccination, over and above their individual-level of scientific trust. Furthermore, it was discovered that societal agreement on scientific trust moderates these individual-level and country-level associations. The positive link between trust in science and vaccine confidence is stronger in nations with a high level of societal consensus regarding the trustworthiness of science and scientists than it is in comparable countries with a lower level of social consensus.²⁶

25 Enria L, Waterlow N, Rogers NT, Brindle H, Lal S, et al. (2021) Trust and transparency in times of crisis: Results from an online survey during the first wave (April 2020) of the COVID-19 epidemic in the UK. PLOS ONE 16(2): e0239247. <https://doi.org/10.1371/journal.pone.0239247>

26 Sturgis P, Brunton-Smith I, Jackson J. Trust in science, social consensus and vaccine confidence. Nat Hum Behav. 2021 May 17. Doi: 10.1038/s41562-021-01115-7. Epub ahead of print. PMID: 34002053.

On the other hand, the rapid development of COVID-19 vaccines is a remarkable feat, vaccinating the entire world has numerous hurdles, from production to distribution, deployment, and most critically, acceptability. The ability of governments to explain the benefits of vaccination and provide them safely and effectively is crucial to public confidence in vaccines. While only a small percentage of the public is antivaccination, there is apprehension about COVID-19 inoculation in many nations; recognizing that the scale of vaccination campaigns required is unprecedented, governments' efforts to build confidence will be critical to their success and the creation of more resilient societies following a crisis.²⁷

To conclude, public accountability relies on trust in governments, especially when individuals lack the science knowledge or cognitive frameworks that are necessary to form a judgment.

3.2. Public engagement and the cognition of science in the Arab world

There are many routes underway in the Arab world to communicate science to the public, such as scientific journalism (e.g., newspapers, magazines, television and radio), face-to-face interaction (such as public lectures in museums or universities, debates, science busking, “sci-art” exhibits, Science Cafés and science festivals) along with interaction via the Internet (websites, blogs, wikis, podcasts and other social media platforms). There is a wide array in Arab countries' adapted strategies to connect their communities with science. Some of the experiences were based on scientific institutional efforts to simplify science to the general public or through social activities, media involvement along with a number of community volunteer experiences.

Some countries such as the Kingdom of Saudi Arabia (KSA)²⁸ supported the dissemination of scientific knowledge translated into Arabic. Parallel

²⁷ OECD, 2021, Enhancing public trust in COVID-19 vaccination: The role of governments, https://www.oecd.org/en/publications/enhancing-public-trust-in-covid-19-vaccination-the-role-of-governments_eae0e-c5a-en.html

²⁸ Al-Arabiya net, 2019, The most important scientific communication experiences and initiatives in Saudi Arabia, <https://www.alarabiya.net/>

to the books that the Kingdom publishes it runs several magazines such as “Science and Technology”, “Science and Technology for Boys”, the Arabic “Nature” and “KAUST Discoveries”.

Other countries such as the United Arab Emirates (UAE) adopted science portals initiatives such as the Mostaqbal (Future) Portal to promote science, technology and research among the youth. It provides easy access to the latest technology and scientific news. In disciplines such as space science, health, artificial intelligence and virtual reality, the platform offers studies, essays, visual materials and infographics in plain Arabic.²⁹ Moreover, Popular Science Arabia Magazine targets Arab youth to evolve, adapt and learn to keep pace with a transforming world and restore Arab cultural superiority.³⁰

Some Arab countries such as Egypt chose international collaboration. The Fame Lab and the “Science Story” project are examples of collaboration with the Goethe-Institute and the German Academic Exchange Service (DAAD). The project aims to strengthen scientific journalism in Egypt and the Arab countries, make it more popular, and address the problem of fake news.³¹

Another significant event is The ASW (Arab Science Week), which is regarded as the most important scientific event in the Arab world because of the concerns and problems it addresses, as well as the opportunity to explore solutions that may help improve our lives. The Arab Science Week also provided citizens with the opportunity to participate in and watch events at home, given that all events were online thus empowering and encouraging individuals to engage in science and disseminate scientific information.³²

29 Dubai Future Foundation, 2021, <https://www.dubaifuture.ae/>

30 The United Arab Emirates governmental, 2021 Inspiration behind the advancement. <https://u.ae/en/about-the-uae/science-and-technology/inspiration-behind-the-advancement>

31 Goethe Insytut, 2021, Hunting Down Fake News; <https://www.goethe.de/prj/zei/en/art/22147824.html>

32 NAMES news, 2021, Arab Science Week, <http://namesnetwork.org/en/news/NewsDetail?Find=10370>

3.2.2. Science Communication and COVID-19 responses in Arab Countries

Valuable lessons that were learned from the global experience with the COVID-19 pandemic were communicated by governments around the world. A study on “Government Communication Strategies during Coronavirus Pandemic”³³ was conducted aiming to depict and explore the government communication scenario in the UAE in dealing with the COVID-19 pandemic and examine the types of strategies, information and messages delivered via digital mediums in order to effectively manage the challenges brought about by the pandemic via the Crisis and Emergency Risk Communication model. The study included a qualitative investigation of the digital platforms of two government agencies. Based on the findings, the UAE government adopted several communication goals and techniques to face the pandemic according to the risk management scenario. The significant diversity in nationalities of residents in the UAE was one of the distinguishing challenges in this study.

A cross-sectional survey that took place between April and July 2020 in KSA³⁴ with 6,000 participants, showed that 84.93% of the population were aware of the virus, 78.78% reported a belief that the virus leads to death, 89.47% reported a belief that 14 days is the incubation period, and 93.73% were aware of the possibility of asymptomatic carriers. The results reflect heightened fears at the early stages of the virus spread. Another study was performed to measure knowledge and attitudes towards the pandemic. The results suggest that 53.9% of the 712 participants were females, and the respondents' mean age was 39.43. Moreover, it was discovered that 75% of the participants identified television as the most trustworthy source of information. The majority of respondents had adequate knowledge of the COVID-19 pandemic evidenced by their correct responses to knowledge questions. Their educational level, age, marital status, parental status,

33 Ahmed Farouk Radwan and Sheren Ali Mousa, 2021, Government Communication Strategies during Coronavirus Pandemic: United Arab Emirates Lessons, Journal of Health Management, Volume: 22 issue: 4, page(s): 516-527

34 Almofada SK, Alherbisch RJ, Almuhray NA, et al. Knowledge, Attitudes and Practices Toward COVID-19 in a Saudi Arabian Population: A Cross-Sectional Study. Cureus. 2020; 12(6): e8905. Published 2020 Jun 29. doi:10.7759/cureus.8905

and the sector of their employment (private or public) were all essential determinants of their knowledge. The COVID-19 pandemic survey showed a 98.6% positive attitude among safety and security employees. The majority of those polled were adopting sound COVID-19 preventive practices that were both effective and safe.³⁵

Another cross-sectional survey (559 participants) in Egypt was conducted in March 2020 among adults who are not working in the medical field. The survey was conducted via a link published on social media sites as well as personal interviews, with the purpose of determining the Egyptian public's knowledge, perceptions, and attitudes on the COVID-19 pandemic. The bulk of their acquired knowledge appeared to be emanating from social media outlets (66.9%) and the internet (58.3%). Older and less educated participants with a lower income and participants living in rural areas were far less knowledgeable about the pandemic. The majority of participants (86.9%) were concerned about the possibility of infection, while 37.6% believed their income would drop if they become isolated and 68.5% stated that it should be maintained during this time. When the vaccination became available, about 73.0% said they were eager to be injected. Furthermore, participants had a strong understanding of the situation and a positive attitude toward preventive measures in general. This information is primarily obtained through novel media channels, which have both advantages and disadvantages. Although the government has taken significant steps to educate the public and slow the spread of the disease, more work is needed to educate and support the poor if and when vaccines or therapeutics are approved and made available. The study urges the government to equitably distribute the vaccines to protect the rights of the most vulnerable and those who are in need.³⁶

In discussing the surveys undertaken in different Arab countries, it has become evident that social media has become a landmark in science communication.

35 Maha M. AlRasheed,¹ * Abdullah M. Alsugair, Hala F. Almarzouqi, Gadah K. Alonazi, Fadilah S. Aleanizy, Fulwah Y. Alqahtani, Gamal A. Shazly, and Fowad Khurshid ,2021, Assessment of Knowledge, Attitude, and Practice of Security and Safety Workers Toward the COVID-19 Pandemic: A Cross-Sectional Study, *Front Public Health*.

36 Abdelhafiz AS, Mohammed Z, Ibrahim ME, et al.: Knowledge, Perceptions and Attitudes of Egyptians about the novel Coronavirus Disease (COVID-19). *J. Community Health*. 2020; 45(5): 881-890. doi:10.1007/s10900-020-00827-7

3.2.3. Arab Communities and Improving Public Accountability on Science

The importance of scientific literacy and the urgent necessity for it in generating conscientious, well-informed citizens in today's world is more evident than ever before. The argument over scientific content and information provided by media professionals is particularly relevant to science communication. New, open-source media is a new field through which knowledge and its processing are distributed to multiple audiences. Knowledge-sharing platforms are currently among the unique digital modes of communication. An exploratory study investigating communicating science in the new media environment in Egypt, and the advancement of science literacy discusses the varying levels of knowledge with the term "scientific literacy," which encompasses more than skill utilization. The goal of this research is to examine how Egyptians use new media tools, with a particular focus on scientific information and popular science themes. Furthermore, this research aims to examine the Egyptian public's opinion regarding "scientific literacy," and the multiple levels of science literacy that define a person as "scientifically literate". Unlike traditional media, this study used an online questionnaire to analyse motivation factors for new media prominence in science communication. The study also looked at elements that contributed to scientific literacy growth in Egypt as well as those that impaired the advancement of scientific literacy.³⁷

Arab countries took steps towards developing S&T agendas. These agendas are at different stages of maturity in promoting a scientific culture in each country, as discussed later.

3.2.4. Science and Technology agendas in Arab countries

Arab countries have endorsed a strategy to harness science, technology and innovation for development by improving science education, upgrading and reforming their universities; building research capacity and encouraging international collaboration. This strategy focuses on

37 Heba El Shahed, 2020, Communicating Science in the New Media Environment: The Advancement of Science Literacy, Arab Media & Society. <https://www.arabmediasociety.com/communicating-science-in-the-new-media-environment-the-advancement-of-science-literacy/>

improving science education at universities, increasing scientific research capacity, increasing financial support for research and development, and fostering regional and international scientific and educational cooperation.³⁸

To summarize, it can be concluded that most of Arab countries are concerned with scientific research, and a considerable number of them are developing S&T policies and agendas. Although no specific strategies are being developed yet, they are aiming to promote public engagement to science through various activities that are underway in Arab countries to link communities to science.

There is an urgent need to establish clear policies to address the undeniable high percentage of illiteracy in many zones through advanced technologies that reach out to all demographics. In addition, the need persists to emphasize quality education that leads to a generation more closely connected to STI.

4. ASSESSMENT PROGRAM FOR GAUGING SCIENTIFIC CULTURE IN THE ARAB WORLD

4.1. Introduction

The review of international and regional researchers' debates and suggestions to connect societies with S&T, emphasized the importance of an on-the-ground exploration of Arab society's connection to S&T.

4.2. Investigative tools and methodologies

In section one, online survey questions were prepared based on the marked pillars and were initiated in different Arab countries. Experts' meetings and workshops were held with officials representing different disciplines including governments, decision and policy-makers, academia, journalism and the media and social experts. Sessions were held in order to share opinions and reflections on proposed questions; others were held to

³⁸ Wagdy Sawahel, 2014, New Arab strategy for science, technology and innovation, university world news, <https://www.universityworldnews.com/post.php?story=20140ru31411375640>

document participants' opinions to posed questions; looking for gaps and solutions. Final concluding sessions were held for experts to summarize their recommendations and proposed roadmaps to promote a scientific culture in our Arab world.

It is worth mentioning that we had to undergo two rounds of opening the survey to improve the diversity of responses from different Arab countries, however; the second round – although circulated directly in countries other than Egypt- did not change much of the countries' sharing percentages.

Section two draws on existing literature, current studies, literature reviews, desktop analysis, meta-analysis, published interviews, media monitoring, social media analysis and existing data sets to gather the needed insights. Moreover, it includes some interviews with academics who are members of, or connected with, the Arab-German Young Academy of Sciences and Humanities, and who are actively involved in AI and science outreach. These approaches enable a collection of the necessary qualitative evidence, updated statistics, and relevant policies to build up on the original report with up-to-date and useful information.

4.2.1. Online Public Survey

The aim of the survey is to assess the impact of the initiatives and efforts undertaken by Arab countries in science communication and respond to questions that are missing in desk research.

Although the adoption of an online survey facilitated reaching participants wherever they are located; however, it limited reaching individuals who possess sufficient literacy to respond to this type of online surveys.

4.2.2. Preparation of the Survey Form

The research team prepared the questionnaire for the discussion paper for the online survey by first reviewing the previous regional and international experiences and studies on promoting a scientific culture in different societies, prior surveys were briefly discussed and compared. This survey was hence prepared while taking into consideration recent

recommendations [16, 17 and 19] of literature and experts' discussions and challenged issues raised by researchers.

Expert panel workshops were held twice; once prior to launching the survey in an effort to challenge the vision we reached as a conclusion to the extensive literature survey, another was held to formulate an indicator of the experts' reflections on survey progress.

4.2.3. Survey design

At the onset of the study, the team conducted a review of the literature on science communication and awareness surveys to determine the latest developments in surveys. The online survey was designed by using Google Form and it was classified into five sectors: personal information of respondent sector, public cognition of science sector, science communication sector, science and public engagement sector and public accountability on science sector, covering a total of 29 questions.

Several meetings were held with experts and the UNESCO team to further refine the questionnaire with the view that it should reflect the issues of understanding the challenges of science communication in Arab countries. The questions of the survey were translated from English into Arabic language. The end product was a survey with questions both in English and Arabic to make it easily understood by non-expert respondents. It should be noted that the survey is not based on a previously accredited instrument but was developed contextually for the aims of this study. Specifically, to reflect the Arab regional context, drawing on expert consultations, literature on science communication and engagement, and tested indicators of public trust and perception.

4.2.4. Sample size and coverage

The target audience of the survey was experts and non-experts in the Arab region ranging in gender and age. In order to enable us to use the probability survey approach, the respondents were randomly selected using social, professional and scientific circles. The survey was completed by participants in 16 Arab countries, namely: Algeria, Bahrain, Egypt, Iraq, Jordan, KSA, Kuwait, Lebanon, Morocco, Oman, Palestine and Qatar.

After several revisions and modifications to the questionnaire, the link to the survey was sent to 610 participants in all Arab countries. The total number of respondents was 512 with an 83% response rate.

4.2.5. Demographic characteristics of survey participants

The number of females in the sample represents 36.8% of all respondents, while males represent 63.2% of the total number. Most of the respondents (28% of all respondents) were between the ages of 20 to 29, while the age of respondents from 30 to 39 ranged about 21.5% as shown in the figure 4.1.

Females aged between 30 and 39 represent the highest share of females in this survey. Moreover, most of the respondents in rural areas were males and in the same age range. This gives an indication of an expected future change in rural areas where the population believes in the importance of science, and a more gender balanced interest in S&T exists.

As for social status, more than half of the respondents have children (59%). 45% of the surveyed households were comprised of 4 to 5 members, on average.

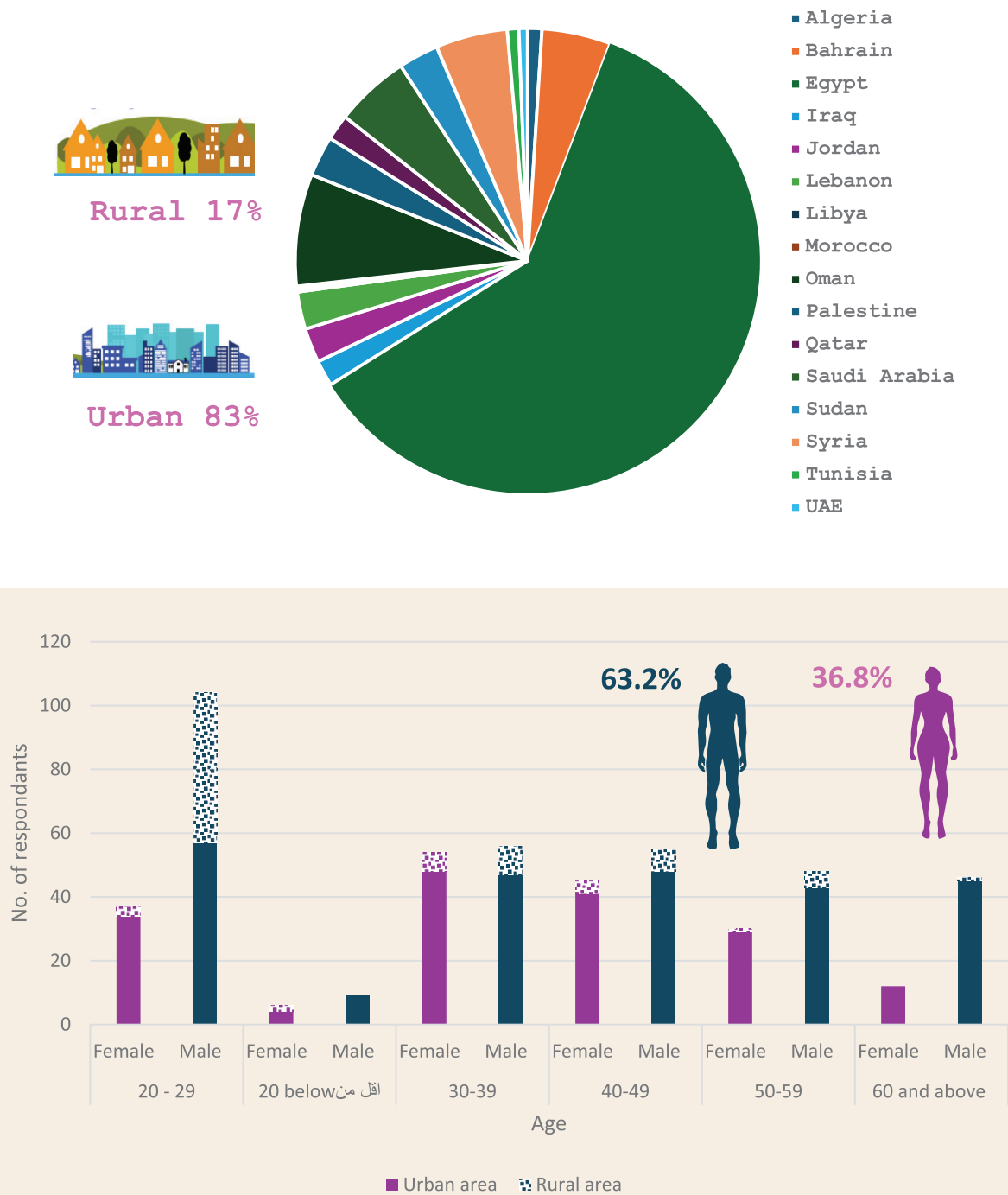


Figure 4.1: Demographic Characteristics of Survey Participants

Figure 4.2 displays the educational and professional background of the participants. The educational level of the participants was almost evenly divided; one third were university graduates, another third were PhD holders, and 20% were undergraduate students.

Private sector employees represented nearly 25% of total participants, government employees at about 20%, while academia's share was 42%.

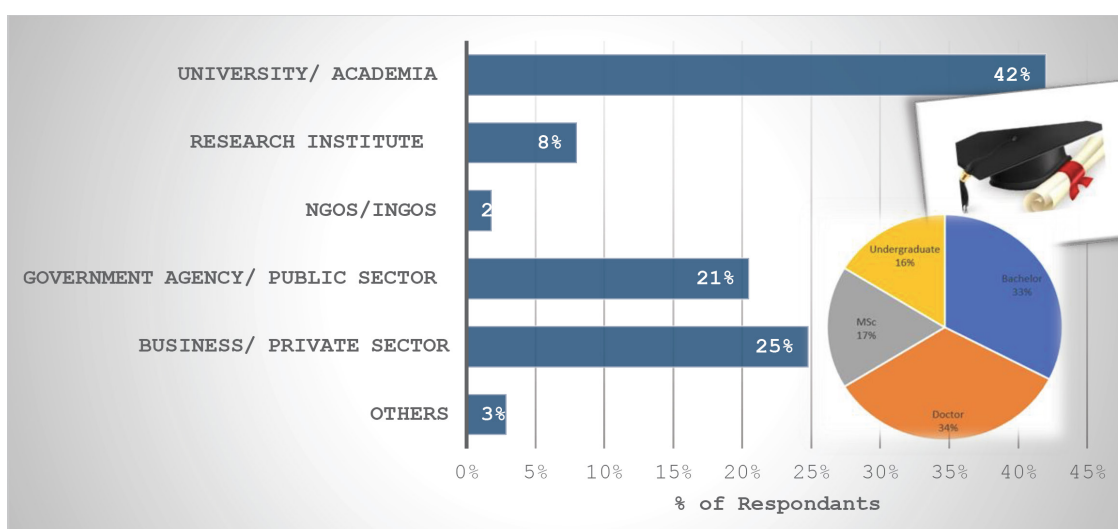


Figure 4.2: Education level & Employment Sector of Participants

4.2.6. Public cognition of science survey sector

The second section in the survey questions was dedicated to scouting Arab communities' cognition of science whereby the vast majority of respondents emphasized the benefits of science (98%). Although the survey delivered different outcomes in showing that the public had a false sense about science. Figure 4.3 indicates that most of the participants (85%) believed that science supports religious beliefs. Most of the participants (82%) were exposed to rumors during the pandemic (Fig. 4.4). Almost 31% acquired actual information from official sources with an equal percent searched for said information on their own. Social media did not significantly contribute to dispelling false information; rather, it was the primary source of rumors about the danger associated with vaccination

and propagated news in terms of untested and invalid medications, etc. It is worth noting that a considerable portion (21- 40) percentage of all age groups, relied on the government as a main source of rumor clearance.

The youth, less than 20 years of age, unexpectedly, seemed to make the least effort to investigate the accuracy of rumors, however this age group tends to depend on social media. In contrast, seniors, over sixty years of age, were the group that least relied on the media, yet surprisingly 29% of the group handled the provision of information on their own.

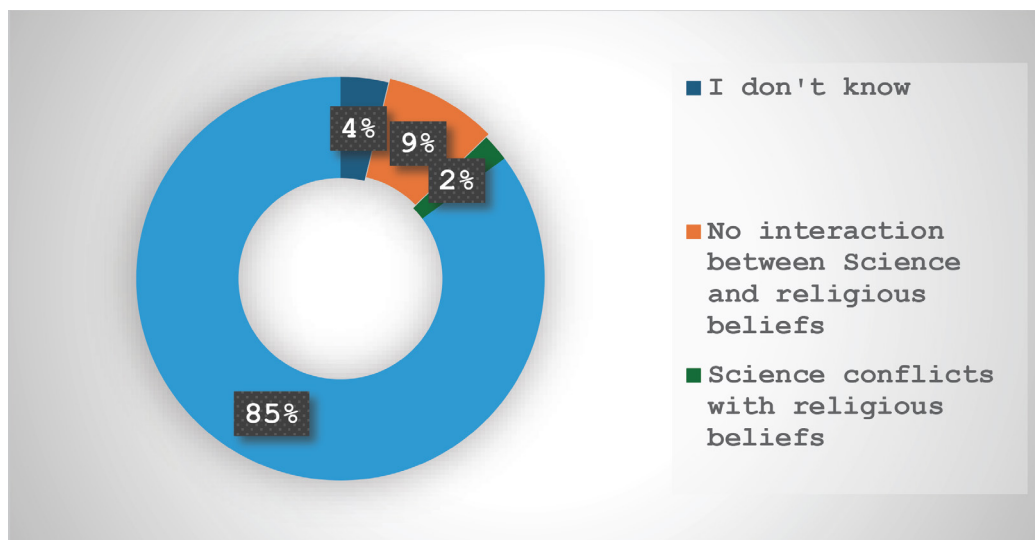


Figure 4.3: Religious beliefs and science

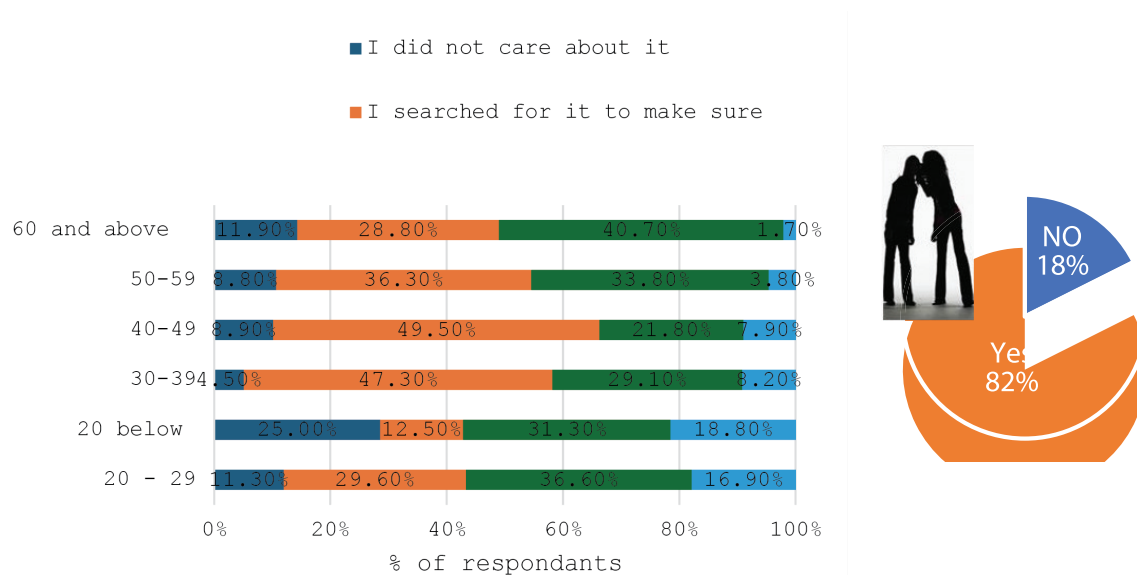


Figure 4.4: Exposure and responses to science-related rumors

Switching to trusted sources of scientific information (Fig. 4.5), the majority has a higher level of confidence in academia (universities and scientific journals) as a trusted source of scientific information. On the other hand, social media was not chosen by the majority as a reliable source for such information.

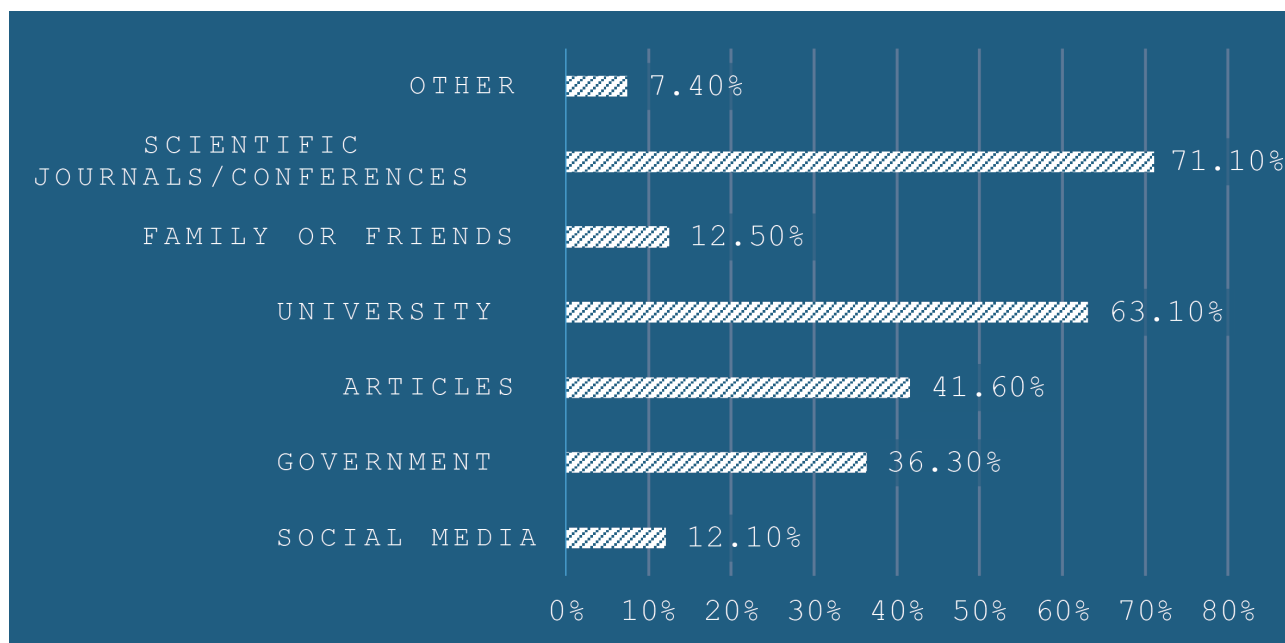


Figure 4.5: Trusted sources of scientific information

4.2.7. Science communication in the eyes of the public

Participants were asked to propose preferred methodologies that improve scientific communication through the media. Highest preference was given to professionally prepared videos and transmitted through social media as one of the most effective tools to deliver science to the public, followed by simplified TV shows or programs, then documentaries and simplified writing in magazines and newspapers.

As for the public's satisfaction with their governments' support during the pandemic, almost one third of the respondents believed that their governments succeeded in reducing the pandemic's impact on their personal lives and professions. About 44% of all respondents consider that governments did a fair job, while 22% believed that their governments did not provide them with adequate support during the pandemic.

4.2.8. Third survey section: Public opinion of science and public engagement

Participants were asked about the share of participation within their families in scientific activities/events (Fig. 4.6). 41% of the respondents' families shared in scientific events while 5% never participated in such activities. 18% can be encouraged to do so with some guidance.

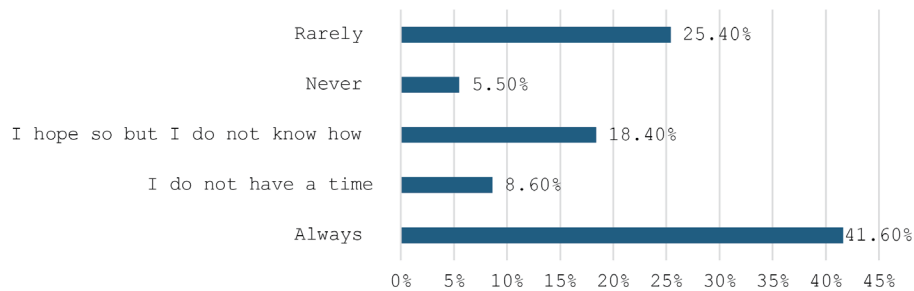


Figure 4.6: Families' involvement in S&T-related activities and events

Arab societies' sentiment on the COVID-19 pandemic in terms of whether the fear of the pandemic was real or overrated, participants were almost equally divided between agreeing or strongly agreeing that the pandemic was magnified in its scope (39%), (Fig 4.7). 28% of the respondents were neutral, and 21% strongly disagreed or disagreed. In terms of vaccine as a tool to slow the spread and its effectiveness, almost 45% believed in being vaccinated, while the neutral portion of respondents represented one third of the total.

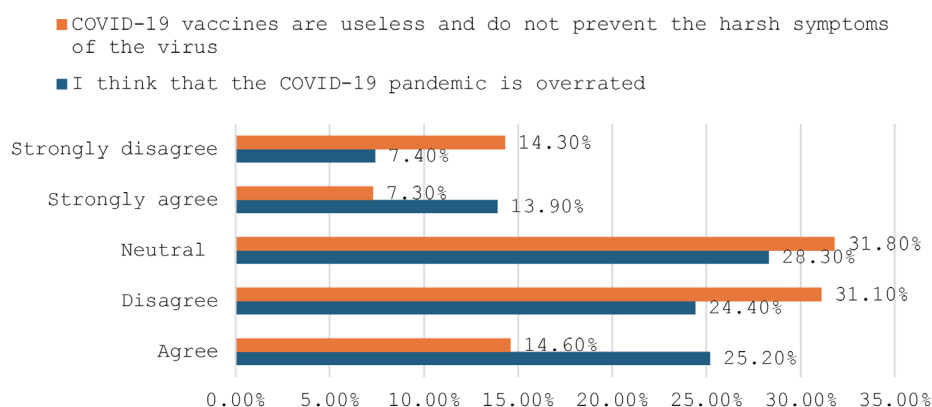


Figure 4.7: Public reflections on COVID-19 being overrated & importance of vaccination

4.2.9. Fourth survey section: Public accountability to science in Arab countries

Participants were directly asked if they were aware of the existence of a science agenda in their countries. About (35%) of all participants did not know whether their country had a science agenda, (12%) believed that there is no applied agenda at all, while (10%) had the opinion that one does exist but it is not applied. Participants who were aware of the fact that their countries had adopted a science agenda, and applied it to an acceptable or moderate extent, represented (22%).

Pressing ahead with asking the public about the level of interest in science that is exhibited by the general public in their countries, participants were divided between moderate (40%) and limited (38%). Only (18%) indicated a high level of interest, and a minority of (4%) believed that there is no interest at all.

Moreover, participants were asked whether some scientific findings are fabricated and not accurate (Fig.4.9). It was very interesting to learn that 44% of respondents do not have a specific opinion about their trust in scientific findings, though a considerable percentage had a solid educational background. Almost the same percent (45%) strongly agreed or agreed that some scientific findings are not accurate, leaving a minority of less than 11% who trusted scientific findings.

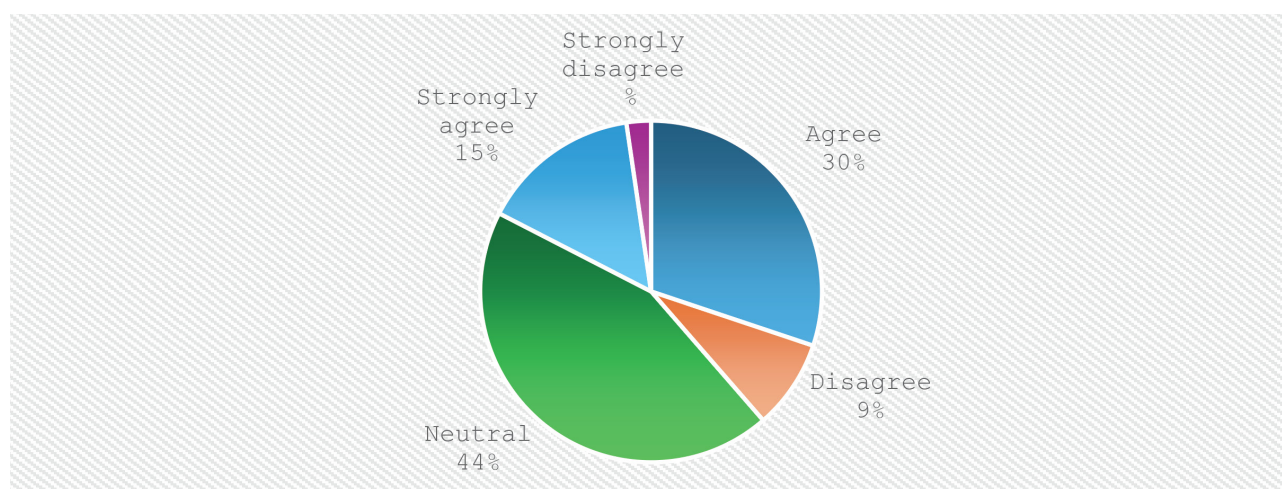


Figure 4.8: Participants' opinion of levels of trust in reported scientific findings

In order to monitor the way that the public interacts with science in real life, participants were asked to define the way that they act when they get sick or need a consultation (Fig.4.9a). The majority of participants (73%) reported that they seek professional help if they get sick. A small fraction preferred to search the internet for information, while only 8% relied on family and friends who had experienced similar situations.

To measure trust in females in sensitive professions such as medicine, the survey participants were asked how they felt about female doctors. The vast majority expressed their indifference in seeking a female doctor's help. (Fig.4.9b)

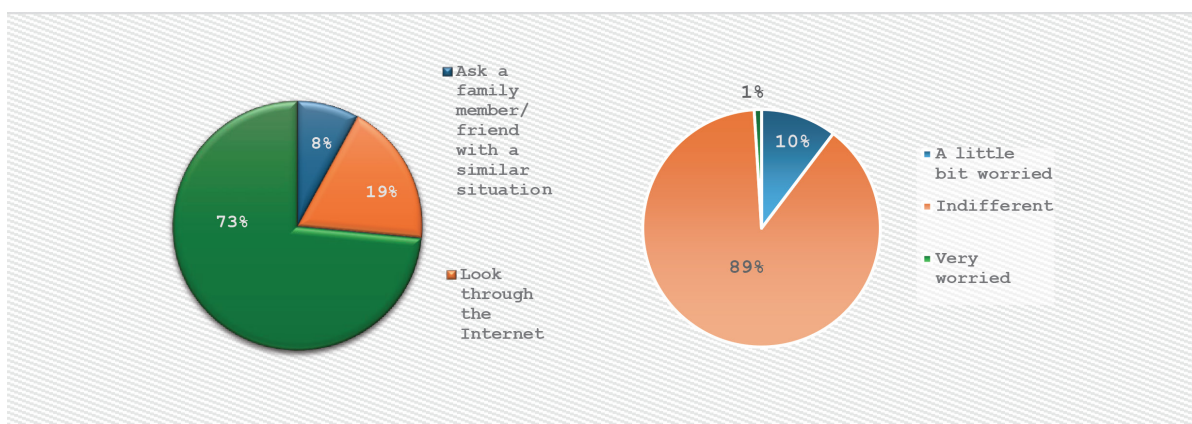


Figure 4.9: The public's response about seeking medical help

Figure 4.10: Participants' opinion on seeking the help of female doctors

Participants were asked about whether they believe they are smart enough to sufficiently understand technology and innovation (Figure 4.11a). A strong majority (82%) believes that they are intelligent enough to understand technology and innovation; while only (11%) expressed a lack of understanding thereof.

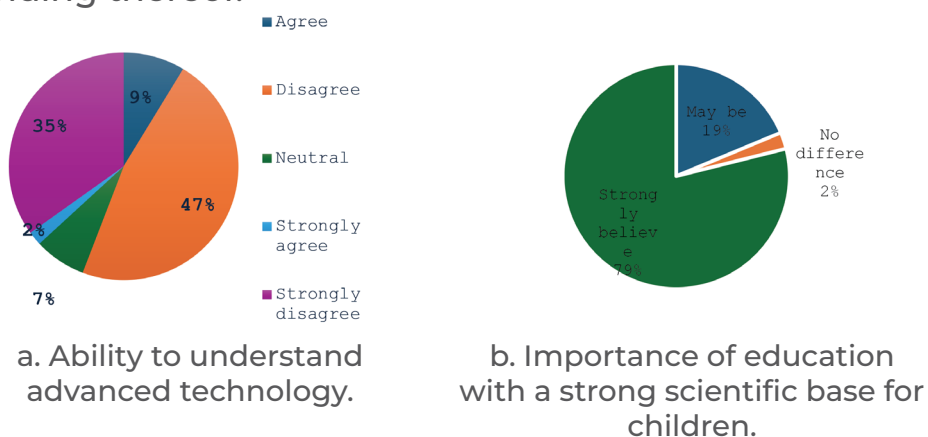


Figure 4.11: Public readiness for science engagement

There is a high level of awareness of the importance of providing children with quality scientific education for a better future and better jobs. A large majority of participants (79%) believe that providing a solid scientific education for their children means that their chances of securing a better professional career will significantly increase, while 19% are not certain and only 2% of respondents believe that it will make little to no difference (Fig.4.10b).

4.3. Experts' Meetings, Webinars, Agendas and Discussions

A series of expert meetings and webinars was conducted to exploit their opinion on the proposed four pillars to promote a scientific culture in the Arab world.

4.3.1. Views of Interviewed Experts on Science Communication in the Arab world

This part is derived from the results of the first expert webinar, which gathered 23 experts from across the Arab world – academics, media professionals, science journalists, government officials, and scientific culture experts. The gathering shared the rich experiences of countries such as Oman, Tunisia, Palestine, Bahrain, and Egypt. Rich case studies on the state of science communication in each country were presented through expert presentations by Palestine, Oman, and Tunisia.

One of the most prominent themes that emerged was the unprecedented global response to the COVID-19 pandemic, particularly the global panic and uncertainty among governments and the public. The lack of familiarity with the virus, coupled with the challenge of tracking and forecasting its spread, led to immense pressure on scientists to come up with immediate solutions. Experts were perturbed by the media's demands for rapid scientific solutions—e.g., vaccines or treatment protocols—without giving sufficient time for confirmation and peer review. The volume of published articles (thousands within six months) precluded the identification of established findings versus premature assertions, and calls were made for AI-based filters to help screen and authenticate scientific data.

One of the media professionals, representing a large Arab newspaper, discussed learning lessons in science journalism throughout the pandemic. He stressed that several media outlets published scientific claims without checking the accuracy or the date of the information and, often, quoting preprints without stating their preliminary status. The rampant promotion and subsequent prohibition of hydroxychloroquine were made a warning lesson on how speedy release of scientific information—often endorsed by major journals and governments—lost face for the people.

Surveys conducted during the session suggested that most of the experts were frequently exposed to misinformation and rumors and also looked for updates every couple of hours. Almost half thought that science news was uniformly distributed notwithstanding literacy problems in a few Arab countries, and around 67% was satisfied with the way the media handled the pandemic. Nonetheless, authorities highlighted the necessity for Arab countries to formulate clear science and technology policies, increase the budget for R&D, and establish institutional foundations dedicated to media science. Authorities further stressed the government's pivotal role in nurturing public confidence-building and science communication

4.3.2. Interviewed Experts reported the experiences of Arab countries in promoting public engagement and accountability to science

One of the models of institutional activities geared towards public engagement with science was displayed in Egypt. Practices and mechanisms of public engagement with science and engagement of the public in science were identified as: Road-mapping post COVID-19 strategies to connect society with scientists in an effort to attain a resilient level in times of hardship; to support the publishing of simplified science; to better communicate with children through a variety of social activities, such as displaying kids' university experience; and finally, to call on the community to support innovations and ideas in relation with the pandemic.

Palestine's Higher Council for Innovation and Excellence (HCIE) presented its experience in the matter. HCIE main objective was to search for talent and innovators in the community as a whole, by using different tools of interaction (workshops, forums, etc.). HCIE also exerted efforts to spread awareness in the community about emerging technologies, 4.0 industry, etc.

Most of the Arab countries benefited from digital solutions and technologies to continue with online educational activities and shopping. A number of countries such as Tunisia used robots to enforce lockdown measures, while others used drones.

Education experts stated that COVID-19 was a blessing because it forced them to change their ways of teaching after many years of resisting change. Most of them emphasized that they kept the online tools as a part of their teaching system after the lockdown ended.

Everybody emphasized that online communication will never compensate for face-to-face communication and that socializing is an essential element for all. Most of the experts said that they preferred their lifestyle before COVID-19.

TikTok and bloggers introduced successful models of science communication tools for the youth; at the same time, they created a bridge to public accountability on science. Moreover, it was evident that there is a need for governments to invent tools that create new jobs needed in order to cope with using electronic platforms. Additionally, a framework is urgently needed for Arab countries for public accountability on science. In addition, research conducted in close collaboration with the community is needed so that its direct impact becomes evident to the public. Finally, transparency and democracy concerning research budgets are major requirements to garner the public's accountability.

4.3.3. Experts' webinar session on enhancement of public engagement to Science

After launching the online survey, experts were invited for a new cycle of discussions in two online sessions on public engagement and the role of Academia in promoting said engagement.

Expanding Community Science engagement was presented by a management of change expert from Oman. The presentation emphasized that practice is not just changing ideas, rather through discovery, analysis and the transformation of the conditions of society and culture. The methods and ways in which this practice is carried out will not take place instantaneously, instead, it will happen gradually.

The panel's discussion concluded that raising the awareness of individuals and their passion for learning must involve the parents because they have a direct impact on their children and that strengthening the community network must include all segments of society to raise the level of interest in science and knowledge. Thus, access to the concept of the global citizen and the international ambassador for science and knowledge would be disseminated.

Academia shared their experience through the Egyptian Space Agency experiment in reaching out to the public and promoting societies' engagement in space science. The presentation outlined the different activities held by the Agency in order to simplify space sciences and deliver the concept to all segments of society, especially school children and university students by using the same methods of simplifying sciences used globally to communicate space sciences to the public.

Activities are organized for school children for early detection of their talents and train them by organizing space day activities, conducting workshops for teachers and holding competitions to assemble a simplified educational satellite by merging the activities of the College of Technology and Space Sciences with the activities of the Children's University.

Another presentation explored the experience of engaging university students in Space Day, summer training, graduation projects, as well as providing technical and financial support to the students. Master's scholarships are awarded to students with the use of the Agency labs and facilities during research being recently added initiatives. Community engagement is sought from national banks and NGOs to sponsor

different public engagement activities in collaboration with the Agency in organizing site visits, internships and camps. Contributing policy makers commented that the reaction of the Arab scientific community towards the COVID-19 pandemic has been satisfactory to a large extent given that a solid number of research works had been published in various Arab countries with a great leap in one of the research works in the last six months. However, validation remains a missing component from the presented research is validation whereby more developed countries had made strides in this aspect. Different efforts were reported for better public engagement targeting children such as science valleys and summer schools for children.

4.3.4. Experts closing session

Preliminary results of the public questionnaire were presented to the experts at this point and the comments regarding this phase were:

- The percentage of women's participation in the questionnaire is found to be close to reported percentage of women working in the science and technology sector, which is around 30%.
- The number of participants in the questionnaire and participating countries were discussed. It was agreed to appreciate the limited time allocated for the questionnaire. The participating numbers are considered acceptable, with the need to increase participation from the rest of the Arab countries other than Egypt until such time that the regional perspective of the study is completed at the level of Arab countries.
- The expert attendees participated in the experts' questionnaire, which addresses five questions of an advanced nature. The results were presented and discussed as follows:
 - The first question was about the vast gap between the efforts of scientific communication with the public. The opinions of experts underlined the weakness of cooperation between scientists and media experts, in addition to the fact that scientific material is not interesting.
 - The second question was about the challenges that scientists face in communicating information to the public.

The experts' opinions indicated the lack of communication skills, along with the skills of simplifying science, as well as funding and resources is one of the challenges.

- The third question was about developing the required skills; the experts' opinion was that the skills needed for television programs, video clips, lectures and public discussions should be developed further.
- The fourth question was about the ranking of obstacles facing the Arab community to engage in science. The experts' opinion was that the obstacles were stacked in terms of importance as: illiteracy, lack of logical thinking, lack of confidence, lack of awareness and lack of interest.
- The fifth question was about prioritizing the elements required to enhance public participation in science. The experts' opinion was that the most important element is information and awareness. The necessity of having qualified trainers, incentives for participation, and organizing training activities and workshops was also expressed by the experts.

A WHO expert commented that for the first time, there was a convergence in terms of the spread of a health pandemic and a storm of conflicting information about the facts surrounding the pandemic and the feasibility of using vaccines to contain it. This was the first challenge facing the authorities in controlling the pandemic and its spread, particularly once vaccines were made available. This inconsistency in information was exhibited at the start of the pandemic, and there were two challenges facing WHO and health authorities around the world; the spread of misinformation about this pandemic, which made confronting the health pandemic more difficult, and the lack of awareness role to clarify the facts, especially on social media, which is the most common source of misinformation. WHO uses social media, periodic bulletins, and weekly press conferences, which have continued thus far , to dispel these misconceptions and false news. WHO was keen to disseminate information especially any developments that occur during the spread of the pandemic and its multiple transformations.

There was constant communication with the Ministers of Health in the region for the purpose of exchanging advice on the basic means of

prevention and control of the pandemic. In addition to communication skills, the importance of technology had emerged, and digital health has become an essential means of communicating with the public and scientists without the need to move to direct communication in-person.

An entire department was dedicated within the WHO Regional Office to be specialized in media and communication, and it played a major role during the response to and control of the pandemic, in addition to continuous cooperation with regional scientific research academies as well as international organizations such as UNESCO.

The Egyptian Observatory for Science and Technology commented that one of the positive effects of the spread of the pandemic is the increase in society's interest in science and technology and the search for accurate and documented information. Worthy of note is the fact that the experts' responses to the questionnaire were consistent with the results of the full questionnaire that was conducted on different groups in society thereby confirming the need for direct mechanisms for scientific communication between scientists and the media.

A Scientific Research Ethics expert commented that a climate of mistrust in the news as well as in the licenses granted to vaccines. The spreading of false news on social media attributed to doctors' and university professors' mistrust and led to the reluctance of medical staff to accept the vaccine. Experts agreed that confidence in the outputs of scientific research which was rigorously put to the test during the pandemic period due to publishing houses that disseminating scientific papers without checking the veracity and credibility of such paper which were ultimately withdrawn as a result.

The main reason for the lack of trust is not illiteracy in its absolute sense, but it is the poor access to accurate information and the poor method of delivering it, and the evidence for this is the existence of a climate of mistrust even in educated circles such as medical staff. Thus, it is a problem of trust and transparency, as well as conflict of interests, especially for pharmaceutical companies, which are the largest beneficiaries of the pandemic directly.

It was concluded that there is an urgent need for expanding the ethics of scientific research to include any circulation of scientific information because it is not published by scientists until after verifying its credibility and in turn submission of same to the community in order not to destabilize confidence. The matter is not limited to the ethics of scientific research, but extends to the ethics of media outlets that published undocumented information, as they endeavored to raise their status and increase viewership rates.

5. GUIDELINES FOR THE FUTURE

5.1. Introduction

The conclusion and recommendations outlined in this section establish the survey results, expert panels' discussions, and webinars attendees' responses guided by the proposed four pillars to build communities with better understanding, interaction and communication of S&T.

An insight comparison was conducted between the responses obtained from other countries' surveys and the common questions in this survey. Gaps between policies and public responses are analyzed, recommendations to bridge these gaps are introduced to increase public interest in S&T. Tools are presented to influence public interest in science, and a framework is proposed for better science communication.

The ultimate goal is providing a vision for forming a society bound to science, one that understands its importance to Arab communities' social and economic wellbeing, and is confident about using it, all of which are reinforced with qualified scientists and researchers.

5.2. Evaluation of Arab communities' knowledge, perceptions, and interest in science compared to other international communities.

This section outlines the fact that knowledge leads to confidence, hence; raising public interest in acquiring essential scientific knowledge which shall increase trust in and acceptance of scientific outcomes (vaccines, medicines, etc.), and said knowledge would encourage S&T-related education, hence; creating a base for jobs and businesses in emerging technologies.

5.2.1. Assessment of public cognition of science in Arab communities

Responses to the first section of the survey questions which mainly focused on measuring public cognition of science, the first pillar, emphasized that there is significant awareness of the importance of science. The survey conducted in Arab communities indicates that the vast majority (98%) believe that science benefits their lives.

There is evident cognition of the importance of science on the part of webinar attendees, experts and survey participants. Almost 79% of the Arab survey participants believe that providing proper scientific education for their children will secure better jobs in the future.

The encouraging survey majority's (85%) confirmation that science interacts positively with people's prevailing religious beliefs, defied the fears of some experts that the Arab culture and religious backgrounds may yield some wrong beliefs about STI.

Comparing Arab participants' cognition of science to the Malaysian community conveyed that the 2019 survey responses with 82% of Malaysians' attitude towards science being generally positive, however; 14.5% were unsure of the benefits of STI.

5.2.2. Arab public interest in science compared to other regions

Raising Arab communities' interest in science is a vibrant tool to achieve better public engagement and accountability to science. Survey participants believe that 40% of their Arab communities have moderate interest in science, while 41% of the families did participate in different STI related activities and events. Both responses support the average interest in S&T in the Arab community (in countries participating in the survey) within the tested sample and the boundaries of limited resources.

A thorough examination of the age and gender aspects is presented in Figure 5.1; with a disturbing remark in the response of participants aged under 20, as both genders did not show an elevated level of interest in science. Moreover, they were divided between either limited or moderate interest. This limited interest did not show except for females in the over 60 section, which is understandable. This indicates the need for better communication to spread awareness of the importance of science among freshmen university students and high school students.

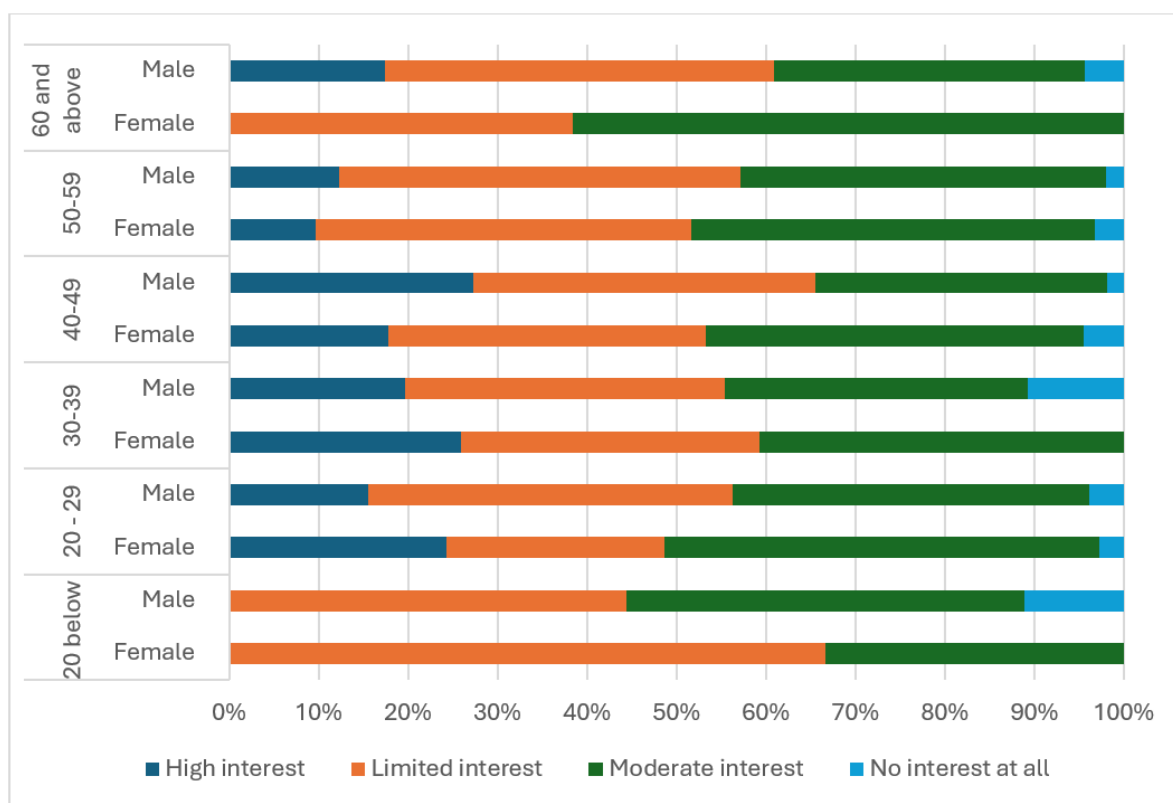


Figure 5.1: Interest of Arab communities' participants in science

On the other hand, when comparing with international experiences, we find that families' interest in S&T-related activities in nations like Malaysia, USA and China PRC was categorized in previous surveys as follows: in 2018, the United States of America and China showed that more than half of their citizens or residents do visit science related locations (50% USA and 58% China), while Malaysian's science-related interest in 2019 hovered about 44%.

5.2.3. Public confidence in science deliverables survey results versus international surveys

Survey replies indicated that there was a loss of confidence in science and scientists during the spread of the pandemic because of premature research results, unvalidated published data in reputable scientific journals were not validated, and the media's time-sensitive and deadline-bound approach to increase the circulation of updates to an eager audience, all of which played a significant role in shaking the public's confidence in scientific findings. As for participants' trust in reported scientific findings, 44% of the respondents do not have a specific opinion. Almost the same percentage (45%) strongly agree, or agree that some scientific findings are not accurate, which leaves us with a minority that trust scientific findings (less than 11%).

On the contrary in the UK 2019 survey, opinion was divided in terms of whether information that is obtained about science is generally true. Besides, the UK survey shows that people find science more accessible and feel better informed as reflected in the 2019 survey compared to the 2014 survey; people were more likely to feel very or fairly well informed about science (51%, up from 45%), while a tenth disagreed and one third said that they neither agree or disagree.

In addition to the standard reasons reported in previous research, illiteracy, poor access to accurate information, poor methods of delivering the information, transparency and possible conflict of interest were all the basic reasons for loss of public confidence.

5.2.4. Effectiveness of science communication tools

Although the majority of participants (71%) selected scientific journals and conferences as being the most trusted sources of scientific information; nonetheless, most of the participants proposed using visual tools such as videos on the internet, TV shows to be the easiest way to promote science communication (Fig.5.2).

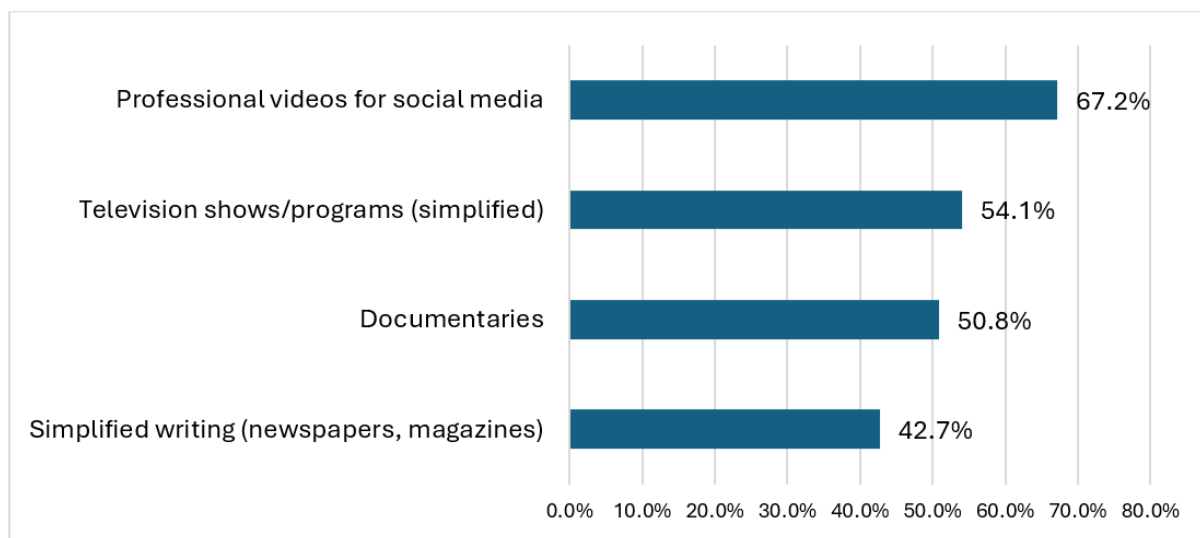


Figure 5.2: **Proposed tools by public survey for promoting science communication**

Arab public opinion reflected in the survey coincided with reported significant communication tools from different international surveys. The UK survey held in 2019 showed that British people still rely mainly on TV for science information. However, there was a shift between the surveys conducted in 2014 and 2019 from print to online; accessing newspapers to learn about science dropped to (13% from 28%), with a significant rise in online media being recorded. A majority of (71%) of UK participants believes that the media sensationalizes science and politicians are very easily influenced by media reporting on science. It is worth noting that British people have become more trusting of science reporting in 2019 compared to 2014.

As for the China 2018 survey, citizens who accessed S&T information through TV and the Internet/Mobile Internet every day represented 68.5% and 64.6% respectively, while citizens listening to the radio and reading newspapers every day represented 24.2% and 10.3% respectively. Less than 10% of surveyed citizens relied on books (8.1%) and journals (5.9%).

Finally, for Malaysians, television remained their primary source of STI related information in 2019 (83.6%). Moreover, internet sources were broken down into social media, e-News, science websites/videos, e-Books, e-Magazines and e-Journals, representing 63.3% of respondents.

5.3. Public accountability to science in the Arab world

Confidence in providing scientific information through different platforms was questioned, and the responses presented in Figure 5.3 with the highest level of trust assigned to scientific platforms. Social platforms got a moderate level of trust while governments appeared to have satisfactory levels of confidence concerning scientific information.

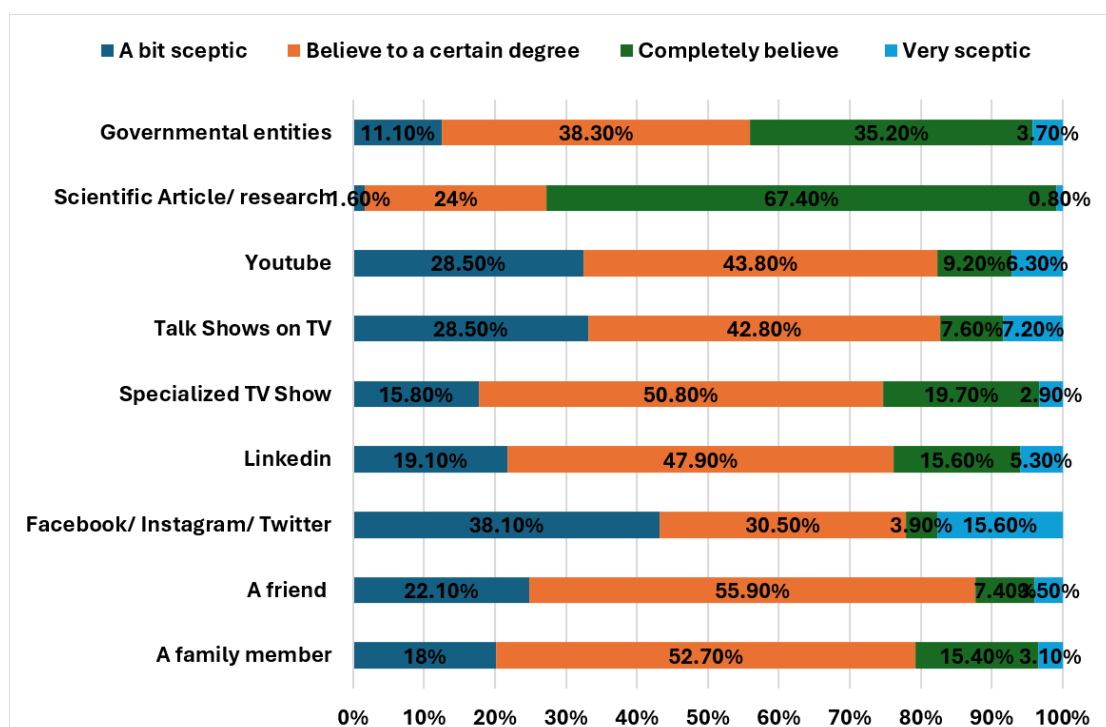


Figure 5.3: Confidence in sources providing scientific information

On the other hand, to measure the readiness of the Arab community to get engaged, hence the principle of accountability to science, a direct question was formulated to gauge the extent of their confidence in their own ability to understand S&T.

Responses of Arab participants (Fig.5.4) show that 11% believe they are not intelligent enough to understand science, in comparison with 28% in the UK 2019 survey. Almost half were less likely to feel that science and technology are too specialized for most people to understand (55%, up from 47%).

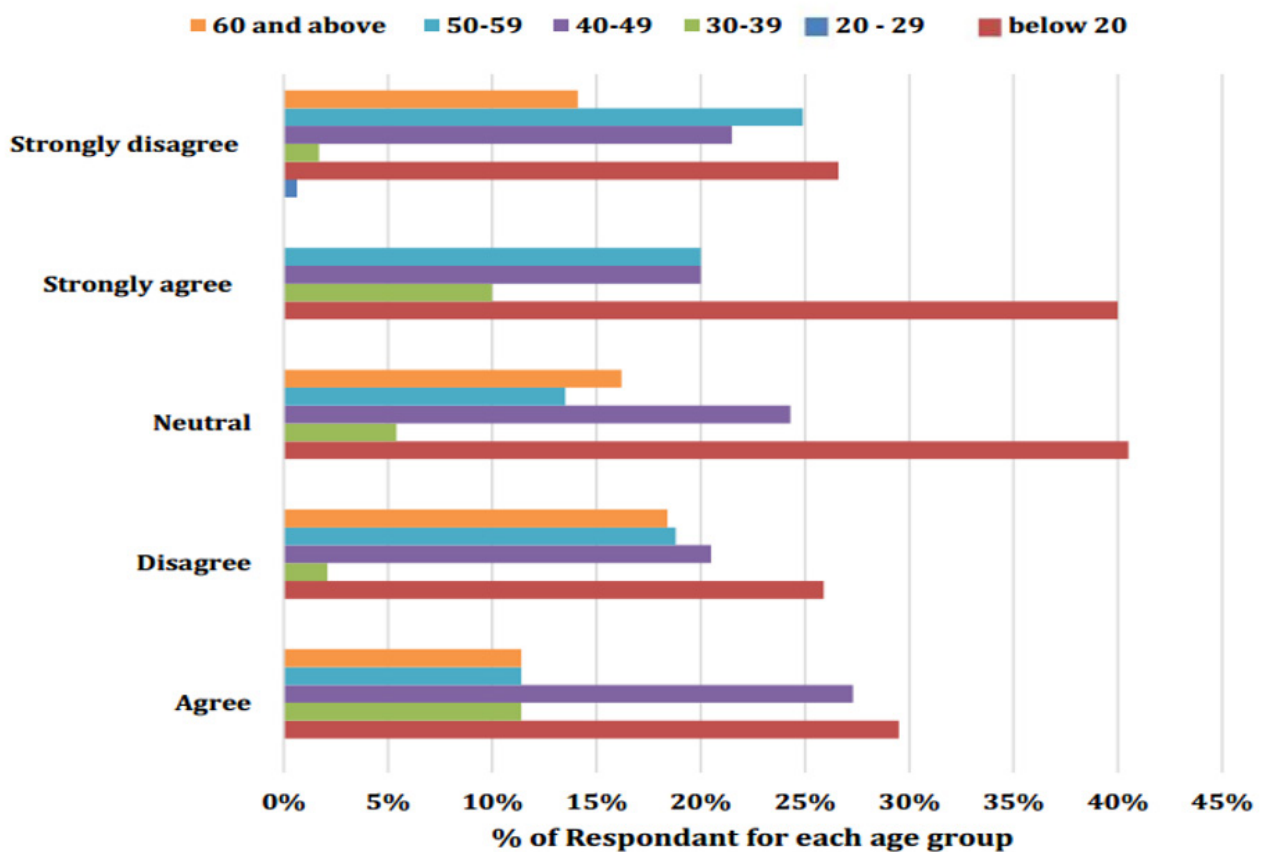


Figure 5.4: Participants' confidence in their own ability to understand advanced technology

5.3.1. Evaluation of Arab public responses to the COVID-19 Pandemic

Examining the COVID-19 experience, it was an unexpected real-life test for our Arab community. Many science-related rumors and fake news were spread on social media in the Arab region; the vast majority of respondents (82%) and interviewed experts were exposed to such rumors. Public trust in science was significantly impacted by such rumors at the start of the pandemic. This fact was realized within a few months after the spread of the virus. Serious efforts were made to recover the public's damaged trust; tens of scientific papers were retracted, and several premature recommendations were highlighted.

An in-depth analysis of the public's response categorized by age and gender is presented in Figure 5.5. The survey indicates that a considerable majority (48%) of male youth (20-29 years) strongly agree that the pandemic was overrated, while older male generations (40-49 years) were on the opposite side of the spectrum, whereby 45% strongly disagree that the pandemic was blown out of proportion. From a gender perspective, females had less tendency towards extremism, with those who strongly believed that the pandemic was overrated (40%) being of the older group (30-39 years). Females who strongly disagree about the overrating (37%) were in the age group (20-29 years).

Younger male generations seem to have a weaker sense of belief in the usefulness of vaccines compared to older generations. On the contrary, females aged between 30 and 39 expressed their strong belief in the importance of vaccines (42%).

Matching survey results and experts' discussion; it can be concluded that the vagueness surrounded the start of the pandemic, and the contradiction in news -even from scientific resources- had direct reflection on the confidence in the effectiveness of the manufactured COVID-19 vaccines. Off course, the fast release of the vaccines played a significant role in raising such worries.

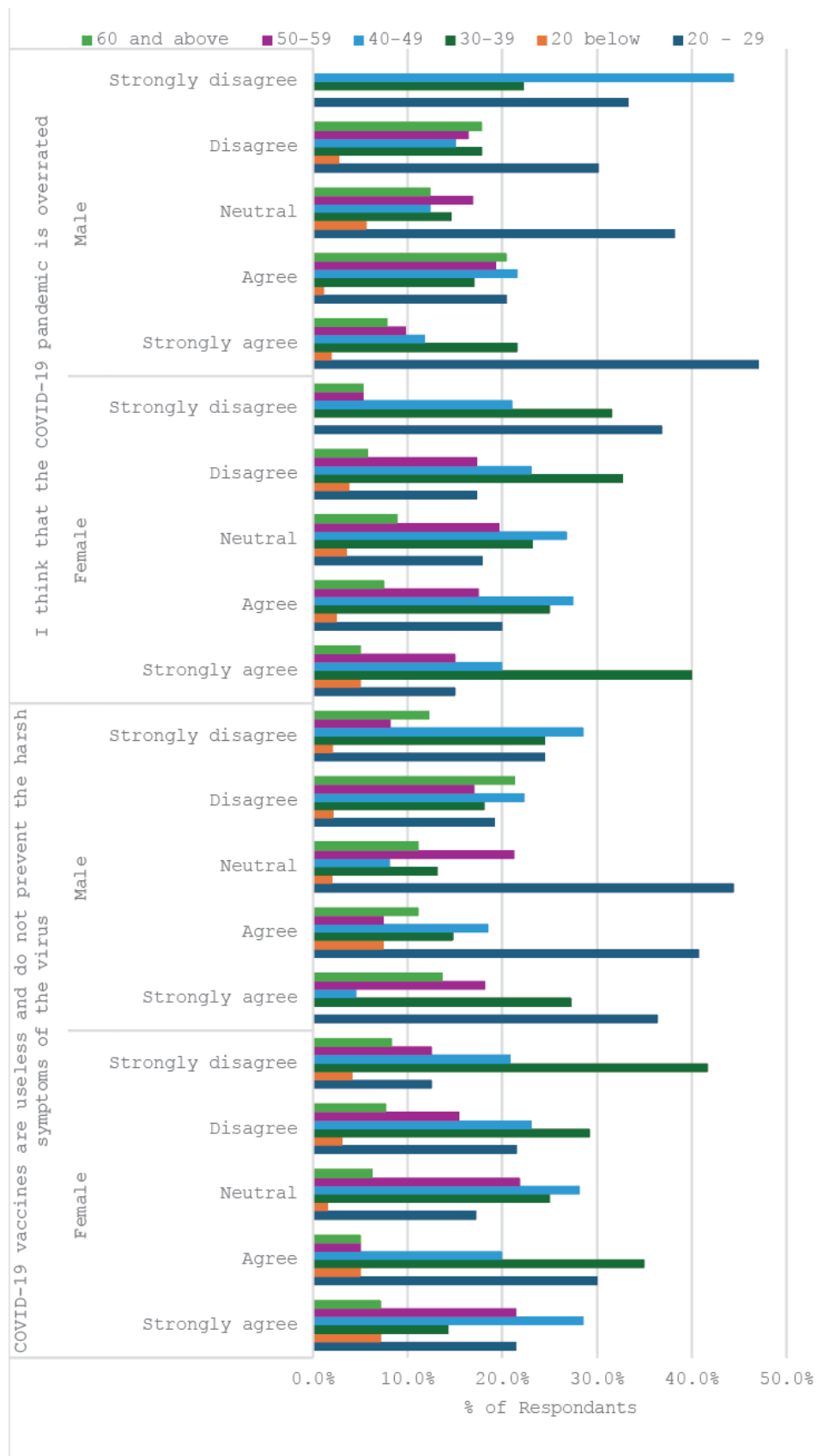


Figure 5.5: Survey responses on the COVID-19 Pandemic and vaccines

5.3.2. Trust and awareness of governments policies

The results of the conducted survey (Fig.5.6) showed that the majority of Arab participants are satisfied with their governments' performance during COVID-19, with a 22% minority expressing disappointment with their governments' performance.

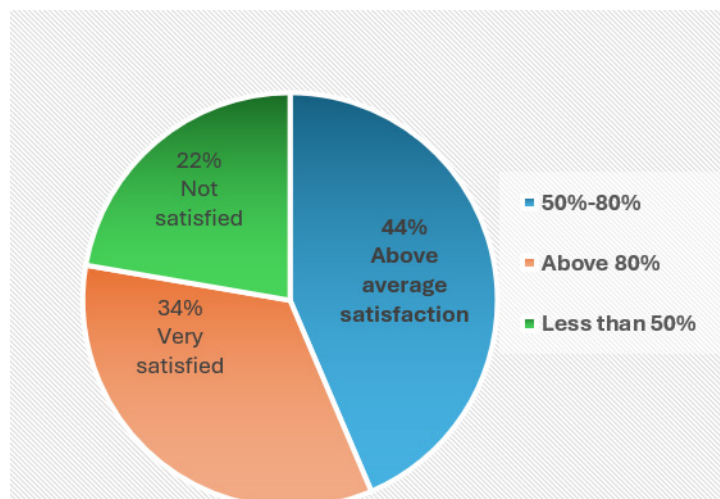


Figure 5.6: Public satisfaction levels with government performance during COVID-19

This matches the responses reviewed during webinars and experts' interviews, as they show that both interviewed experts and the public believe that governments in Arab countries dealt very well with the pandemic.

Looking back at the Malaysian 2019 survey, results indicated that 55-63% were aware of their government policies, whereas in the Arab countries survey, 35% were not aware of such science policies being adopted versus only 22% who were aware, to an acceptable or moderate extent (Fig.5.7).

Taking a closer look at the age distribution of respondents, a shocking fact emerges; 62% of the youth under the age of 20, and almost half of the youth of the 20 to 29 age category, did not know if such an agenda exists. This percentage declined to 20% in the 60+ age group most likely due to the type of professions of respondents in this age group.

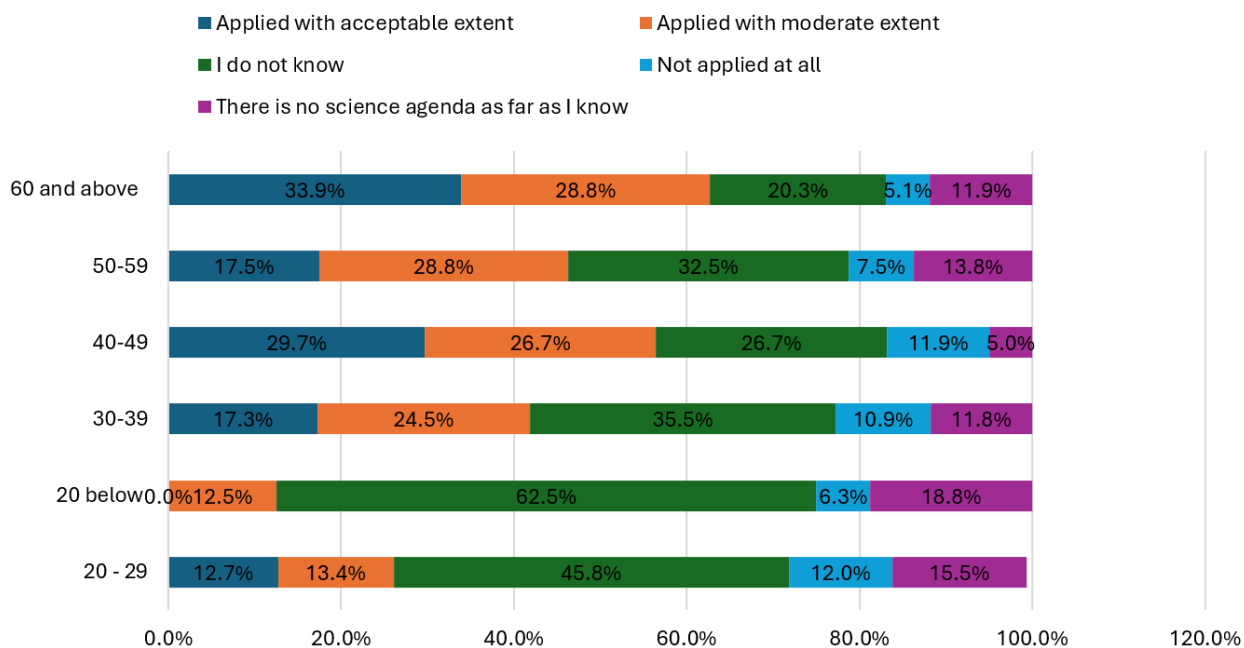


Figure 5.7: Public awareness of national science agendas

5.4. Gaps between policies and public response

Survey results, alongside webinars discussions and experts' opinions, confirmed that both the public and experts have an obvious shortage of awareness of governments' policies regarding this issue.

- Policy makers need to understand the importance and benefits of public engagement to science. On the other hand, scientists need to be encouraged to interact with policy makers.
- Some Arab countries have S&T agendas, but still lack a defined policy to promote scientific culture in their societies. This is emphasized by the limited interest in S&T related studies at the university level as reported by ALESCO (March 2022). Only four Arab countries rate above 30% in terms of the number of S&T university graduates.
- Science and technology strategies in the Arab world still need more initiatives and programs to bridge that gap.

Besides, expenditures on R&D in the Arab world (GERD) remain below expectations (according to the ALESCO Observatory -2018, GERD in Arab countries ranges between 0.12% and 1.5%).

- Most strategies are not communicated to the public and confined to decision-makers.
- There is an undeniable gap between public awareness and engagement to science.
- The COVID-19 experience highlighted the evident gap between urban and rural areas in both awareness and communication, although according to World Bank statistics (2020), rural areas host about 40% of the total Arab world populations.

In order to bridge previously defined gaps, improvement of existing policies is needed, basically by identifying public concerns, ideas and ambitions. This knowledge can be acquired by using different tools such as: surveys, workshops, consultations and new technological tools. This shall lead to a more engaged community, through the utilization of tools to be discussed in the following section

5.5. How to influence Arab public attitude and engagement with science

5.5.1. Creating platforms and spaces for engagement

In the last two decades, governments, mostly in developed countries, started funding sources for science and technology investments. Noteworthy is the fact that there is huge growth in informal public engagement in S&T activities through online spaces for science communication and engagement. Social media has shown enthusiasm for uncontrolled engagement among users interested in science. To the contrary, a weak level of attention on the part of academia has been noted regarding sites of engagement between the community and science outside framed policies.

5.5.2. Investing in Capacity-building of science communication

The provision of capacity-building in science communication to coach current and future scientists and STEM practitioners, and for the media to effectively communicate and engage the public to science would be practical measures. Moreover, there is a need to assist teachers in increase student interest in STEM by taking them from theory in the classroom to science applications. This training can be provided through assigned agencies such as academies of sciences, research institutes and universities. More focus on available and required tools is displayed in the following section:

5.5.2.1. Proposed tools for enhancement of science communication in the Arab world

In terms of Arab communities, governments need to adopt a defined framework to promote:

- Directing research centers, and institutes towards more research programs that serve public related problems, hence, efforts will be felt and appreciated by the public.
- Training researchers on how to communicate with the public as well as paying attention to scientific journalism.
- Simplifying science and communicating with children to instil the value of science in them.
- Creating a unified Arab initiative to simplify science to be taught in Arabic to facilitate communication along with an increase in television programs.
- Utilizing social media and modern technologies to simplify science and create community dialog in simple language for scientific problems which can be valuable during crises such as COVID-19.

5.5.2.2. Promoting science communication in rural areas

Strengthening digital resources availability in rural areas

A wide gap still exists between rural and urban communities in terms of the availability of internet sources and facilities. Hence, improving rural inhabitants' interest in and knowledge of STI remains one of the aspects that need to be addressed when planning strategies, if the urban rural digital divide were to be bridged. Digital technologies have changed how, where, and when we learn. The internet, and many more innovative teaching approaches, do require stable and reliable internet connections. During the COVID-19 crisis, most of the Arab countries relied on online teaching to varying degrees. This digital divide became clearly evident and addressing it became more crucial by providing stable and reliable internet connections and easy access to information and ICT to the public.

Development of special TV programs for rural areas.

Develop special television programs that would be of interest to rural areas, taking into consideration their interests and needs; they should be conveyed in a simpler language, one that they can accept and appreciate.

Promoting science teachers' skills in rural schools

Special training and workshops focused on making science lessons more interesting and interactive by using different kits and experiments are required measures. Students should be encouraged to practice in class and not be focused on theory only. These workshops can be initiated in collaboration with universities and science-based societies.

5.6. Gender context and its impact on scientific culture in Arab communities.

- There is significant awareness of and engagement with science in female youth, which was indicated in ALESCO's published statistics on gender equality at different education stages in the majority of Arab countries.
- The survey shows rising confidence in professional females, as most of the survey participants (89%) were

indifferent about being treated by female or male physicians. Participants in the online survey represent the educated sector of their communities, which can translate directly into an advancement of the Arab scientific culture.

- Expert panel discussions emphasized the need to attract women to some fields related to S&T, particularly emerging technologies. This is aligned with the survey responses (Fig.5.8) which indicated that males were more confident than females in strongly rejecting the idea that they might not be smart enough to understand advanced technologies (36% compared to 32%).
- Though women in some Arab countries are very enthusiastic about certain medical fields such as community health.

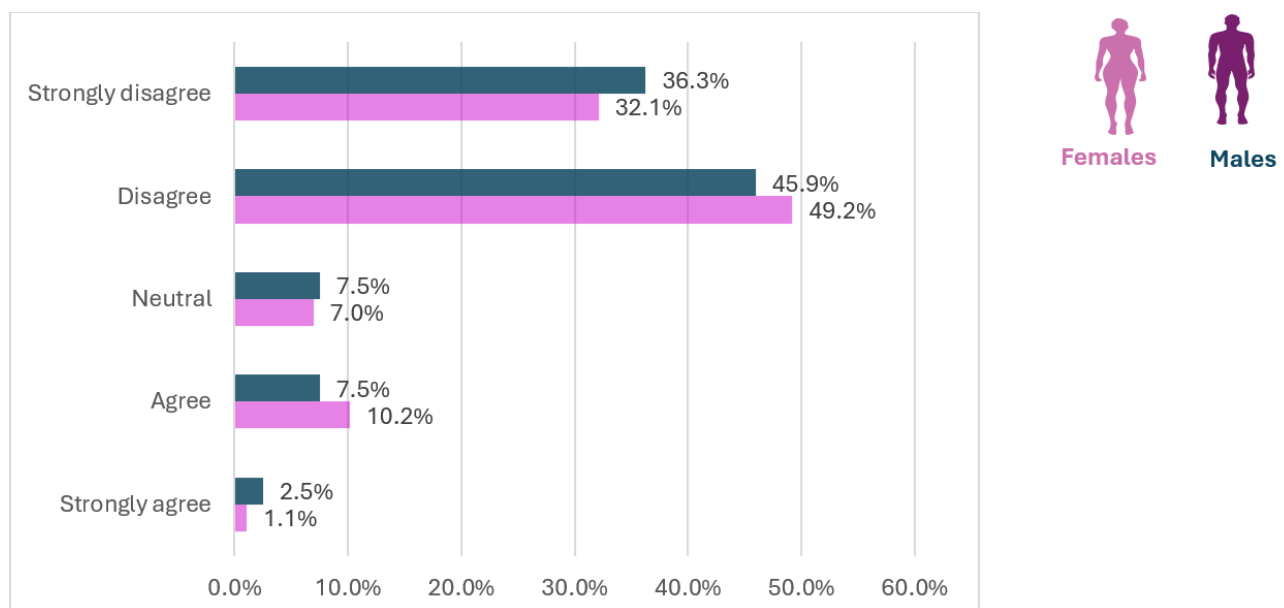


Figure 5.8: Participants' confidence in their ability to understand advanced technology

Experts' recommendations regarding gender are strongly supported by the Global Gender Gap Index report (2020) . Reported statistics show that closing the gender gap in the Middle East and North Africa (MENA) region stands at (61%), compared to about (77%) in Western Europe and the USA. The report focused on seven promising future jobs, some are S&T based such as data, artificial intelligence, cloud computing and engineering. Moving from low skill jobs to these jobs, by gender, is reported as follows: the percentage of males in engineering jobs is double that of females (8.2% to 4.7%); in cloud computing, the percentages stand at (22.4%) for males versus (9.3%) for females, while the ratio of transfer to data and artificial intelligence jobs was nearly the same for both genders, at (48%).

5.7. Proposed roadmap for bridging the science gap in Arab communities.

Based on the outcomes of this research, the following tracks are proposed as a roadmap for governments to bridge the science gap in our communities:

- Microscopic studies and surveys are needed, at the national level, given that diversity in lifestyle, economic and educational levels among Arab countries may affect the accuracy of the results.
- Enabling two-way links and inspiration between science and research on the one hand, and real-life needs and communities welfare on the other. Adopting different tools to inspire new generations to embrace STI.
- Putting the development and use of new knowledge to work on resolving the urgent economic and social challenges while converting pressing issues into a source of opportunities. The Ukrainian war raised famine fears in some countries due to an expected shortage in vital grains, such as wheat, validates this very point.

- Encouraging stakeholders to become partners in new investments thereby generating a suitable ecosystem for a university-society interface; motivating entrepreneurial universities; supporting public and private partnerships in education, research and innovation; and developing Citizen Science;
- Supporting public utilization of technology incubators and science parks by both governments and academia (universities and research institutes);
- Shifting the role of government from doer to enabler to allow, leaving space for professional private service providers to support small and medium-sized STI enterprises;
- Carving out niches that build on unique Arab values and assets, while countering herd behavior and loss of the unique Arab identity;
- Investing in quality education and becoming more open to the outside world through knowledge and ideas exchange. This requires adopting open science policies by developed countries.
- “Train the Trainers”, including government officials, university management, teachers and other key professionals to achieve a required mindset for change in the community.

SECTION TWO

Introduction: Expanding the Framework

Section one necessitated a critique of Arab scientific culture in light of the structural and societal factors that continue to limit public engagement with science. The previous section noted how barriers from illiteracy to low trust in scientific governance trust have hindered efforts to build a pluralistic, participatory, and robust transnational scientific ecosystem. While these findings help to understand today's landscape, the post-pandemic world has been confronted with an accelerated pace of emerging technologies not seen since the introduction of the world wide web into the home and workplace in the 1990s, therefore what is required is a broader framework and visionary perspective to address this new era.

Section two meets this imperative by expanding the report's analytical and strategic scope. It elaborates five thematic streams: cities as scientific hubs, Arab-Arab collaboration and mobility, interdisciplinary approach to science promotion, role of popular culture in science promotion, and AI and emerging technologies. These five tracks offer new or revitalized entry points for remobilizing, re-enchanting, re-humanizing science with the everyday life of the Arab world. All in all, this section expands and advocates for a human-centered science from Tangiers to Baghdad, one that is culturally embedded, socially grounded, emotionally resonant, and politically responsive to the changing needs of Arab societies.

6. CITIES AS SCIENTIFIC HUBS

Arab cities have long been the most familiar geographical site of understanding that has spurred innovation, culture, change, and public curiosity. Cities strongly oppose the distant and bureaucratic image of the state that characterizes much of the Arab world. The energy and diversity of cities produce a cultural resource that enables science to be anchored into civic identity and urban life. This, of course, is not a phenomenon unique to Arab cities. As the late Steve Rayner, former professor of Science and Civilization at Oxford University and Director of the Institute for Science, and Michele Acuto, Professor of Urban Resilience in the School of Geographical Sciences at Bristol University, noted, “A common mistake often made in sensationalist reiterations of the ‘urban age’ mantra is to represent the proactivity of cities today in terms of novelty.”³⁹ Historically, Arab cities performed as the unit that advanced science through birthing scientists, and becoming synonymous with scientific discoveries, be it in astronomy, medicine, and mathematics.

Emphasis on cities enables promotional activities to be executed at the local level with a degree of flexibility not possible at the state level. While national operating programs are restricted by a unified policy and strong bureaucracy, the city-based ones can be more adaptive, responsive, and in tune with the needs and interests specific to the communities. A form of “city diplomacy” in which cities “constitute mediated ‘international’ relations between rightful representatives of polities.”⁴⁰ A science program in Dubai, UAE, for instance, could focus on innovation and technology reflecting what the city stands for a modern, futuristic hub while, on the contrary, a program in Fez could be based on the rich historical heritage of astronomy and mathematics of the Moroccan city. This flexibility can enable each city to have its unique narrative that ties together its history, its culture, and aspirations toward promoting science a much more resonating effort to the local population. This does not mean city-based

39 Steve Rayner Michele Acuto, “City networks: breaking gridlocks or forging (new) lock-ins?,” *International Affairs* 92, no. 5 (2016), <https://academic.oup.com/ia/article-abstract/92/5/1147/2688095?redirectedFrom=fulltext&login=false>, <https://onlinelibrary.wiley.com/doi/abs/10.1111/1468-2346.12700>. p. 1147.

40 Michele Acuto, “City networks: breaking gridlocks or forging (new) lock-ins?” 1148.

initiatives have not taken place; rather, they happen but oftentimes disconnected from the backdrop of the city.

A good example of this, and which is in many respects the paragon of misaligning the science and the respective city, is the Bibliotheca Alexandrina (BA) Science Festivity in the Egyptian city of Alexandria which has been one of the well-entrenched activities annually conducted since 2007.⁴¹ It aims to bring science closer to people, and it is targeted mainly at the segments of schoolchildren and young people. Events are centered at the BA Plaza, which houses the “Science Village” featuring hands-on exhibits, interactive activities, and science shows.⁴² It is a festivity characterized by diversified programming: lectures, workshops, and thematic events, such as “Science in Ancient Egypt,” highlighting historical scientific achievements such as “medicine, engineering, mummification, agriculture, ancient industries, hieroglyphic writing, and papermaking,” as well as interactive shows such as “Egyptian Queens”, “The Journey”, “King Ahmose”, and a virtual tour inside the tomb of king Tutankhamun.⁴³

41 “Science Festivity,” Bibliotheca Alexandrina, 2025, <http://bibalex.org/psc/en/getinvolved/sciencefestivity.aspx>.

42 “Science Festivity.”

43 “Science Festivity 2024,” Bibliotheca Alexandrina, 2024, <https://www.bibalex.org/psc/en/getinvolved/eventdetail.aspx?i=7438&s=sciencefestivity>

BIBLIOTHECA ALEXANDRINA
مكتبة الإسكندرية

العالمية

SCIENCE FESTIVITY

Science in Ancient Egypt العلوم في مصر القديمة

يومي الخميس والجمعة، ٢٦-٢٧ سبتمبر ٢٠٢٤، من الساعة ١٠ صبا إلى ٤ مساءً.
بمكتبة الإسكندرية، الساحة الخارجية (البلد).

Thursday and Friday, 26-27 September 2024;
10:00 am - 4:00 pm, Bibliotheca Alexandrina, Plaza.

*الدخول مجاني ولكن من خلال الحجز المسبق.
التسجيل الإلكتروني من يوم الأحد، ٨ سبتمبر ٢٠٢٤، من خلال الرابط التالي
<http://www.bibalex.org/psc/sciencefestivity>

*Entry is free of charge upon prior reservation.
Online registration starts on Sunday, 8 September 2024, through the following link:
<http://www.bibalex.org/psc/sciencefestivity>

For inquiries, please contact the Planetarium Science Center
+203 4839999 Ext.: 2350-2351 +203 4820464 +203 01012307772
psc@bibalex.org www.bibalex.org/psc BAPSC

مركز الفلك المتاحف
Planetarium Science Center

مكتبة الإسكندرية
BIBLIOTHECA ALEXANDRINA

Figure 6.1: Science Festivity 2024

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Figure 6.2: Science Festivity 2023

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Figure 6.3: Science Festivity 2018

© Bibliotheca Alexandrina



Figure 6.4: Science Festivity 2017

© Bibliotheca Alexandrina

However, with the partial exception of the Science Festivity 2018 that focused on marine life, the event does not align with the social geography of Alexandria let alone position it as part of the event narrative. While it takes place in the prestigious BA, occasionally touching upon Alexandria's historical role in science, such as in the case of specific exhibits about ancient scientists like the Eratosthenes Festivity (held since 2003), which runs every June in Alexandria and Aswan with a "series of activities that revolve around the methodology Eratosthenes applied in measuring the Earth's circumference 2000 years ago."⁴⁴ Yet, the festivals do not have that driving impulse to put the whole event into the context of Alexandria's unique scientific heritage and its potential as a modern urban science hub.

The Science Festivity could also have a much stronger thematic focus on Alexandria itself. The *longue durée* from the ancient Library of Alexandria to its modern reincarnation, and the city's contemporary role in culture, should be a natural decision for the festival to place a stronger thematic focus on the city itself, while Alexandria would provide a compelling backdrop and synergy to the event. In capitalizing on the identity and history of Alexandria, it would profoundly nurture more local engagement and pride, positioning the city as a locale in which science and culture conjoin.

For example, the event can be celebrated by increasing science-related activities or themes across the city, where a relevant theme can run at the Greco-Roman museum, Roman Amphitheater, Citadel of Qaitbay, Pompey's Pillar, corniche, and even in less developed urban areas. Thus, enveloping the city within the festival narrative. This would mutually work well as it would further enrich the event and feed into Alexandria's self-branding as an abode of science, knowledge, and innovation in the Arab world.

SciFest Dubai has been one of the annual major science festivals in the UAE; it tends to foster STEAM education through an interdisciplinary approach both creatively and innovatively. The event is organized with various

⁴⁴ "Eratosthenes Festivity," Bibliotheca Alexandrina (2023). <https://www.bibalex.org/psc/en/getinvolved/eratosthenes.aspx>

activities that include, albeit not limited to, science shows, stargazing events, interactive exhibits, and workshops.⁴⁵ In an attempt to escape the perception of Dubai as a city of global consumerism, SciFest Dubai reframes the Gulf city's transnational hub from global capitalism towards scientific innovation and progress. The event's mandate and the activities undertaken overlaps with a wider strategy that Dubai is pursuing in its efforts to become a smart city and attain technology-driven growth. In one respect, SciFest Dubai aligns with the city's vision as a global hub of innovation by integrating with the city's smart infrastructure.

The event ticks off several of the recommendations of this report. For example, it has an interdisciplinary and popular culture element, "To bring culture back into science and make science fun and exciting through music, dance, poetry, theatre, debates, conferences, movie screenings and science fiction writing." A public element, "To bring science out of the narrow confines of classroom curriculum and academic circles and into mainstream culture" and "to encourage scientific literacy among the general public."⁴⁶ For these reasons, it should be commended. However, the event still lacks local cultural narratives that would make the event deeply rooted in the city's identity, and thus create a more inclusive and culturally connected urban science festival. It does modestly address this through an initiative called Project Tesseract for "Promoting Third Culture conversations," but this seems more targeted at Dubai's intelligentsia than the general public.⁴⁷ Nonetheless, the festivity should be explored further as a case study and encouraged to form partnerships with other Arab cities who could learn from its model.

In Saudi Arabia, the yearly large and comprehensive STEAM Festival in Riyadh showcases the fields of science, technology, engineering, art, and mathematics. The host is King Salman Science Oasis, and tens of thousands of visitors have been coming to this event since its inception in 2022: from students and families to amateur science enthusiasts.⁴⁸ The wide audience has been attracted to the enjoyable event that features interactive displays, hands-on workshops, and live demonstrations.

45 "SciFest Dubai," (2024). <https://www.scifestdubai.com/about>.

46 "SciFest Dubai."

47 "Project Tesseract," (2025). <https://www.project-tesseract.com/about>.

48 "Steam Festival 2024 in Riyadh," (2025). <https://platinumlist.net/event/item/94743>.

In 2024, it had a “Fun Chemistry” theme, showcasing both the traditional Arab scientific heritage and advances in the field of modern times.⁴⁹ While the STEAM Festival has successfully exploited the infrastructure provided by its venue, there is an even greater opportunity to be more welcoming of more local elements that could refer to Riyadh’s cultural and historical identity. The brand for this festival is currently pitched at a national level, rather than being used to highlight Riyadh as a specific urban scientific locus, with the aim to “align with the country’s research, development, and innovation priorities.”⁵⁰ Thus, it is to the event’s benefit to further integrate the city’s heritage sites and local cultural narratives in order to create a far richer and more place-based experience. The ticket prices are set around 10 US dollars, which raises the question if this might bar less privileged demographics from attending the festival.

The KAUST (King Abdullah University of Science and Technology) Science Fun Fair is also organized yearly. It targets both the KAUST community and the wider public in Saudi Arabia. The event is held at Thuwal Beach and showcases several exhibits and activities on food science, environmental sustainability, and digital technology. There are daily science shows, mental math competitions, and STEAM challenges targeted toward families and young learners. While carrying localized elements, the focus of the event still has strong linkages to KAUST as an institution, rather than to an emphasis on the broader Thuwal area’s cultural and historical identity. Although it does note the welcoming of the “wider community” and “school students from outside of KAUST,”⁵¹ a stronger inclusion of more community-driven projects or collaboration with local schools and other cultural organizations would add a layer of depth in engagement and a framing of Thuwal as something more than just a venue, but indeed a participatory scientific hub.

49 “King Salman oasis hosts global chemistry talent event,” (23 July 2024). <https://www.arabnews.com/node/2555106/%7B%7B>

50 “STEAM Festival 2024 Starts in Riyadh,” (2 September 2024). <https://spa.gov.sa/en/N2164473>.

51 Enrichment Program Office, “Science Fun Fair,” (2025). <https://www.kaust.edu.sa/ar>

The proposed approaches on city-driven initiatives are not meant to ignore or bypass national governments; rather, it is to complement national efforts through the highlighting of uniqueness, strengths, capacities, and history of individual Arab cities. The problem has been highlighted in UNESCO's Global Report on Culture for Sustainable Urban Development (2016) which argues that that "Local authorities are marginalized, despite the fact that the process of decentralization has begun in most countries. Cities are still largely dependent on transfers from the central government for their economic resources."⁵² Yet just as "heritage is emerging as a key issue of urban citizenship in the Arab world",⁵³ it must be added that science needs to be latched onto this heritage as a continuing story of the Arab city in question. Decentralization also means the city acquires an agency to incorporate scientific culture into the city's historical and contemporary narratives that would achieve stronger and meaningful public engagement.

Undoubtedly, national policies often play an instrumental role in funding, creating regulatory frameworks, and giving support to large-scale science initiatives. However, localized nature of city-level activities enable tailored outreach strategies that are in harmony with the specific features and identity of each urban locus. In many instances, successful science engagement will need a multi-layered approach entailing collaboration between city councils and national agencies with local organizations.

7. ARAB-ARAB COLLABORATION AND MOBILITY

At a conference in Sicily that this author had attended in the summer of 2022, a young Libyan scholar made a statement that shocked the room: "It is easier for a Libyan academic to get Schengen visa to attend a conference in Europe than it is to get a visa to attend a conference in Morocco." His irony masked the frustration that he seems to have been accustomed to. His experience encapsulated a widespread problem across the Arab world

⁵² Culture: urban future; global report on culture for sustainable urban development, (UNESCO, 2016), <https://unesdoc.unesco.org/ark:/48223/pf0000245999>. P. 47.

⁵³ Culture: urban future; global report on culture for sustainable urban development. P. 50.

in which mobility is hampered by visas which has become “important tools of modern regimes to control human mobility.”⁵⁴

Visa restrictions pose a substantial problem that extends beyond individual inconveniences; they are a systemic barrier that undermines regional scientific cooperation. When Arab scholars are unable to travel freely for conferences, workshops, and collaborative research projects, the region loses out on opportunities for shared learning, knowledge transfer, and joint innovation. A young scientist in Tunisia, for instance, may have limited access to the groundbreaking work being done in UAE’s advanced research centers, while an environmental researcher in Lebanon may struggle to collaborate on climate resilience projects with counterparts in Morocco. This lack of mobility creates silos of expertise, with knowledge and innovation stagnating in isolated pockets rather than flowing freely across borders, where it can be enriched and adapted from diverse perspectives.

It also causes layers of discrimination and skews research outcomes. For example, if an Arab is known to hold dual citizenship (Egyptian and French), he or she is invited to a conference not so much because of their merit, but their mobility poses less headache from both ends. There have been cases of institutes when a scientist, for example, in Iraq, had their visa to Tunisia rejected or delayed, the institute calls up a scientist with a privileged passport but living in the Arab world, to be rushed to speak on a panel that should have been for the Iraqi scientist, who no doubt would have exerted effort preparing for the event. Even when the visa is granted, often on the last minute, the flight tickets have increased surpassing what the institution’s budget allows. If the consulate requires proof of flight tickets beforehand and then the visa is denied or not granted in time, it causes the more wasted time for the institute to seek a refund. This visa requirement before an Arab national can set foot in a different country is a notorious form of “remote control”⁵⁵ and “pre-emptive mobility

54 A. K. M. Ahsan Ullah, Diotima Chatteraj, and Arju Afrin Kathy, “Mobility in a globalised world: How countries regulate mobility with passports and visas,” *Journal of Public Affairs* 24, no. 3 (2024), <https://doi.org/10.1002/pa.2932>, <https://onlinelibrary.wiley.com/doi/abs/10.1002/pa.2932>.

55 Aristide R. Zolberg, *A Nation by Design: immigration policy in the fashioning of America* (Harvard University Press, 2006). 443. in Ullah, Chatteraj, and Kathy, “Mobility in a globalised world: How countries regulate mobility with passports and visas.”

governance.”⁵⁶ Furthermore, as is often the case, an institute’s personal relationship with the ambassador, consul-general, or consulate staff members that are nurtured for the sake of fast-tracking visa processes are not a sustainable and equitable approach.

Indeed, Arab visa policies are shaped by national security, economic stability, and illegal migration. While not taking away from the validity of these concerns, a balanced approach needs to be taken to address these constraints as well as the urgent need for more open mobility. As Marwa Helmy, a cultural policy researcher and cultural manager, argued that there is a need for Arab governments to be involved in “simplifying application processes, providing clear guidelines, and establishing dedicated visa categories or streamlined visa pathways.”⁵⁷ While the author was referring to barriers faced by Arab artists, it also applies to the science field. However, there is a need to go even further than easing what amounts to the problematic status quo.

The below lists eight ways this matter can be realistically addressed.

7.1. Introduce an Arab Scientific Mobility Visa

Similar to the European Union’s researcher visa which emphasizes the importance of science and innovation while maintaining necessary security measures, Arab governments could develop a region-specific visa tailored for scientists, researchers, and students. This would cover academic exchanges, conferences, or collaborative projects. This visa would be valid for short-term stays across participating Arab countries, open to scientists with institutional endorsements or event invitations. As well as standardized fees and predictable processing times to ensure equitable and timely access. Overall, it would streamline the application processes, reduce paperwork, and offer fast-track approvals for eligible individuals.

56 Dennis Broeders and James Hampshire, “Dreaming of Seamless Borders: ICTs and the Pre-Emptive Governance of Mobility in Europe,” *Journal of Ethnic and Migration Studies* 39, no. 8 (2013/09/01 2013), <https://doi.org/10.1080/1369183X.2013.787512>, <https://doi.org/10.1080/1369183X.2013.787512>. in Ullah, Chatteraj, and Kathy, “Mobility in a globalised world: How countries regulate mobility with passports and visas.”

57 Marwa Helmy, “Cultural and artistic mobility in the Arab region: Priorities of funding strategies in light of the political, security and economic context (2024-2026),” (2024). https://on-the-move.org/sites/default/files/inline-files/mobility-arab-region-funding-priorities_EN.pdf

7.2 Regional Visa Exemptions for Science-Related Travel

Visa exemptions can be applied for specific events, projects, programs, or institutions. The waiving of visa requirements for specific participants or institutions would increase engagements, and benefit, regionally significant science fairs, conferences, and collaborative research projects. To do so, Arab governments would need to establish agreements to exempt scientists from specific categories of travel restrictions. There are several models that can serve as inspiration, including the Mercosur Residence Agreement which furnishes freedom of movements, work permits, and temporary residencies in the Latin American states of Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru and Uruguay.⁵⁸

7.3. Utilize Available Infrastructure for Streamlined and Smooth Approvals

Countries with developed centers or regional offices that process visas can develop specific units for scientific mobility within these centers. Such a unit should provide prioritization in processing scientists and academics, with sufficient human and material resources. For example, the UAE's Golden Visa program for scientists could inspire similar fast-track services across the Arab world. Even though this is targeted at established foreign talent, rather than aspiring talent.

7.4. Encourage Science Diplomacy Initiatives

Engage Arab countries in dialogue and partnerships emphasizing the importance of mobility for scientific progress. Science diplomacy, driven by regional organizations like the Arab League or supported by global partners like UNESCO, could promote the harmonization of visa policies and greater regional collaboration.

⁵⁸ "MERCOSUR Residence Agreement," Labour Migration Branch (International Labour Organization) (15 November 2017), https://webapps.ilo.org/dyn/migpractice/migmmain.showPractice?p_lang=en&p_practice_id=187.

7.5. Host Annual Regional Science Events in Rotating Cities

One compelling method could include the rotation of cities annually in the Arab world that host science festivals. Part of this event would include the relaxation of visas restrictions for participants, setting the precedent for further liberalizing changes in this area. There are similar models such as “Arab Capital of Culture” initiative which was established by the Arab League under the auspices of UNESCO which aims to celebrate Arab culture through a designation of a different city each year to host cultural events.⁵⁹ In 2013, Baghdad was selected as the Arab capital of culture and it went out of its way to upgrade its cultural infrastructure, including science and education.⁶⁰ However, science is not central to this annual initiative. Furthermore, the event has been instrumentalized for political purposes and has struggled following budget cuts. Other similar models include the Arab Capital of Media, although this is more focused on the Arab media landscape. However, a subset of this festival cannot be studied to understand the potential for science being promoted through different Arab media outlets, and if science promotion can act as a criteria for awarding a city to be the Arab Capital of Media. Currently, Kuwait holds the title for 2025.

7.6. Facilitate Arab Science funding with travel support

Due to COVID-19 and security measures, financial support for scientific endeavors has been scaled back in the Arab world. What is needed is more dedicated grants that explicitly cover travel and accommodation expenses for Arab scientists, thus establishing a base minimum to ensure that mobility and engagement is not scuttled by financial constraints. While it is admirable that funding arises in emergency relief situations, a framework is needed to create more permanent or long-term funding mechanisms to ensure the sustainability of scientists and scientific endeavors. Private sector investment and philanthropic foundations

⁵⁹ “Capitals of Arab Culture,” Arab League Educational, Cultural and Scientific Organization. <https://www.alecso.org/nsite/en/mn-culture-2/projects-and-programs/capitals-of-arab-culture>

⁶⁰ “Bagdad project as the capital of Arab culture 2013,” UNESCO (2018). <https://www.unesco.org/creativity/en/policy-monitoring-platform/bagdad-project-capital-arab-culture-2013>.

should contribute to funds. Perhaps a website or app dedicated to grants management to simplify funding and reporting, as well as a feature that establishes benchmarks to assess the effectiveness of a particular funding stream and the success it has had on mobility and collaboration. Furthermore, successful funding models, even outside the Arab world such as Horizon Europe, that support cross-border scientific mobility should be regularly studied in order to adopt best practices that meet an international standard and help to improve young and emerging Arab funding bodies.

One good example is the Arab-German Young Academy of Sciences and Humanities (AGYA), a bilateral academy that supports early-career researchers from both Germany and Arab countries, and between Arab countries. Dr. Sabine Dorpmüller, AGYA'S managing director, notes: "Regional collaboration [in the Arab world] receives less support and is often not part of the countries' strategic goals. Furthermore, research centers or clusters tend to focus on national strategic interests instead of taking the regional opportunities and strengths into account. AGYA has recognized this need and connects centers of expertise in the region and pools research capacities in order to create interregional competence networks to inspire a new kind of collaborative, interdisciplinary research practice in the Arab region."⁶¹

7.7 Mutual Recognition of Qualifications

One way to simplify visa approvals is to develop or strengthen a unified accreditation system that would not only ensure consistency in academic qualifications across Arab countries, but would help facilitating movements by instantly recognizing qualifications without redundant verification processes. While bilateral and sub-regional agreements exist, their lack of universality does not enable smooth collaboration between different Arab scientists and exchanges and only makes bureaucratic hurdles the norm. For this reason, UNESCO's "Revised Convention on the

Recognition of Studies, Diplomas and Degrees in Higher Education in the

⁶¹ Dorpmüller, interview.

Arab States” (2022) should be followed through.⁶² Part of the preamble pushes for the “mutual recognition of higher education studies, certificates and degrees by all authorities and institutions would constitute a major step towards facilitating the mobility of students, teaching staff, specialists and researchers.”⁶³ Some of the relevant convention aims include:

(a) Facilitate the recognition of studies, certificates and degrees awarded by other States Parties in order to allow students to begin or continue their higher education.

(b) Promote the possibility of having confidence in measures designed to frame, recognize and ensure the quality of qualifications and promote their integration, and to build the capacities needed in order to facilitate mobility between States Parties and regions.

(c) Enhance the quality of higher education, promote the credibility of certificates of higher education in States Parties, increase the competitiveness of higher education at the regional and international levels, and encourage the creation of a quality control body to facilitate the process of accreditation.

Unfortunately, to date, only nine Arab countries are signatories: Egypt, Jordan, Lebanon, Mauritania, Morocco, Oman, Qatar, Yemen, and Palestine.

7.8. Create an Online Visa Monitoring Mechanism

A small UNESCO initiative could include a centralized website or portal that tracks and publishes data and updates on visa policies and barriers in the Arab world. It would be a platform that is marked by transparency and accountability to the mobility welfare of Arab nationals. Features of this portal could include:

⁶² “Revised Convention on the Recognition of Studies, Diplomas and Degrees in Higher Education in the Arab States,” UNESCO (2 February 2022). <https://www.unesco.org/en/legal-affairs/revised-convention-recognition-studies-diplomas-and-degrees-higher-education-arab-states>.

⁶³ “Revised Convention on the Recognition of Studies, Diplomas and Degrees in Higher Education in the Arab States.”

- Country profiles that are regularly updated for visa policies, with a specific focus on researchers and students.
- Milestones and success stories in which the portal highlights easing of visa challenges in specific Arab countries. Moreover, the body administering the portal would send a public letter of gratitude to the foreign ministry of the respective Arab country that took the decision in easing visa restrictions. This would hopefully set a precedent by spotlighting the route Arab countries should take in regards to cross-border mobility.
- A challenges section that documents real-time issues and barriers reported by scientists and students. Accordingly, if the problem was exacerbated, the body running the portal would send privately a letter of concern to the respective foreign ministry in question.
- Interactive tools that enable users to compare visa policies and annual visa changes. This would also provide invaluable insights to encourage governments to address challenges while celebrating milestones achieved.

A combination of the above suggestions could also enhance the thematic streams in this report by bolstering city-to-city partnerships and interdisciplinary approaches. The often default method to address visa rejections is to resort to Zoom and video conferencing. This method should be treated with caution, as it will undercut initiatives to address the mobility problem. Scientific events require networking, which is often equally important, if not more, than the speaker's presentation. Networking is usually carried out during coffee breaks and conference lunches and dinners. The time frame that video conferencing is obviously not privy to. As Helmy rightly asks, "How the intimacy and importance of the physical encounter can be protected in light of this technological brutality?"⁶⁴ Promoting scientific mobility within the Arab world should not be reduced to easing visa restrictions, rather, the question is how can UNESCO help nurture an ecosystem of shared learning and regional scientific solidarity? That in itself would indeed embed within it the relaxing of visa regimes.

64 Helmy, "Cultural and artistic mobility in the Arab region: Priorities of funding strategies in light of the political, security and economic context (2024-2026)."

8. INTERDISCIPLINARY APPROACH TO SCIENCE PROMOTION

Historically in the Arab world, science was always in dialogue with philosophy, culture, and the arts. An interdisciplinary approach to science promotion would create a more meaningful experience of science, and in some respects, restoring the disciplines to their traditional constellation. This approach can reinvigorate public engagement by making science more relatable, contextual, accessible, and connected to the lives of Arab citizens in everyday ways.

8.1. The Role of Sociologists

The integration of social sciences such as the sociological discipline in the promotion of science adds another important perspective through which science can be made more relevant and compellingly make a link to everyday experience. Science writer Sheeva Azma highlights a problem that is not unfamiliar in the Arab world, “As a science communicator advocating for science communication as an established part of undergraduate and graduate science programs, I find it tough to fight against a tide that wishes to keep scientists separate from society and “too busy” to engage with the people who are supposed to benefit from scientific understanding the general public.” She goes on to add “One way...to humanize science [is] by understanding the sociology of science.”⁶⁵ This is a severely underutilized field, let alone being heard of before. Sociologists who engage in the sociology of science can shed light on why scientific ideas are perceived and adopted by the public as the role of the sociologist in general is to study societies and how people interact with each other through cultural norms, social structures, and social behavior. Luciano d’Andrea and Andrea Declich argue that a sociological approach to science communication is required to make science socially relevant and transparent, “scientific research (including that developed in the field of sociology) has a social nature and it is therefore open to sociological analysis.”⁶⁶

⁶⁵ Sheeva Azma, “Science as a Human Activity: Understanding ‘Sociology of Science,’” Fancy Comma, LLC (29 July 2023). <https://fancycomma.com/2023/07/29/sociology-of-science/>.

⁶⁶ Luciano d’Andrea and Andrea Declich, “The sociological nature of science communication,” JCOM-Journal of Science Communication 4 (06/01 2005), <https://doi.org/10.22323/2.04020202>. 7.

A sociological perspective can mediate scientific progress with the acceptance or lack of it by a culture that, more often than not, has its traditional social values in conflict with new ones inspired by modern science. For example, a sociologist's informed perspective on knowing what different societal factors affect attitudes about vaccination or climate change can help design better science communication strategies.

Sociology is the study of human behavior and society.



Science focuses on asking questions about the world and answering them through research.



Science is performed by humans in society.



Therefore, science is also a product of society.

To learn more, visit www.fancycomma.com

Figure 8.1: Illustration by Sheeva Azma

Community concerns and misconceptions in the Arab world towards science can be addressed and accommodated by sociologists who bring in their studies of cultural narratives, social norms, and collective behaviors, which can shape public perceptions. The interdisciplinary and public-oriented sociologist moves beyond the simple dissemination of information and can hold a dialogue with the public by taking on-board their beliefs, anxieties, and hopes, while employing the instruments for understanding social obstacles to scientific engagement such as gender biases, educational disparities, and economic inequalities. This is vital as it can otherwise prohibit scientific resources and opportunities from

reaching marginalized groups, especially women, minorities, and rural communities in the Arab world. In this manner, the role of sociology enables scientific culture to become a collective undertaking that is informed by the contribution and feedback of the very society it aims to serve.

8.2. The role of Philosophers

An interdisciplinary approach has the key advantage in which the ethical and philosophical issues resulting from scientific practice may be addressed. Given that the Arab world is awash with rich traditions of philosophical inquiry, the tradition for philosophers to enter into debates with scientists is well-laid. Philosophers can make very significant inputs into the ethical aspects of scientific research, as most of the new technologies border on the unthinkable, particularly AI, data privacy, biotechnology, and genetic engineering.⁶⁷ Take for example, in the fields of AI and data privacy, it is unfathomable that ethical considerations should not be driving the contentious subject. As the Harvard Gazette stated that AI presents “the deepest, most difficult philosophical question of the era, the role of human judgment.”⁶⁸ Philosophers are best positioned to help mediate and steer conversations on questions that involve, although not limited to, the respect for individual privacy, risks of surveillance technologies, and the pervasive effects of automation on societies as a whole. To have ethical conversations are not merely debates but have a real-life consequence on policy-making, public perception, and the direction of scientific research. By embedding ethical considerations into the scientific process from the very start, we can cultivate a culture of science that makes social good and moral responsibility its guiding principles, which are quite in tune with Arab cultural values centered around community, respect, and collective well-being. The outcome is that the dizzying speed of emerging technologies will be guided by reflective innovations and responsible policies. Albert Einstein lamented the separation of philosophy from science.

67 Christina Pazzanese, “Ethical concerns mount as AI takes bigger decision-making role” The Harvard Gazette (26 October 2020). <https://news.harvard.edu/gazette/story/2020/10/ethical-concerns-mount-as-ai-takes-bigger-decision-making-role/>.

68 Pazzanese, “Ethical concerns mount as AI takes bigger decision-making role.”

“So many people today and even professional scientists “seem to me like “somebody who has seen thousands of trees but has never seen a forest. A knowledge of the historic and philosophical background gives that kind of independence from prejudices of his generation from which most scientists are suffering. This independence created by philosophical insight is – in my opinion – the mark of distinction between a mere artisan or specialist and a real seeker after truth. (Einstein’s letter to Robert Thornton, 7 December 1944, EA 61–574).69”

In a nine-authored article titled “Why science needs philosophy,” the authors argue for the need to maintain “a close allegiance with philosophy [that] will enhance the vitality of science.”⁷⁰ They make a plea to restore the historical links between science and philosophy, and to break the perception of present-day scientists who often perceive philosophy as completely separate, different, and, in some cases, hostile to science.

The Arab philosophers, such as Al-Farabi, Ibn Sina (Avicenna), and Ibn Rushd (Averroes), represent the historical interpenetration of science and philosophy. Al-Farabi made the logic of science a basic ingredient of scientific reasoning; to him, rationality is linked with structured investigation. Ibn Sina synthesized metaphysics and medicine into one single frame in *The Canon of Medicine*, wherein scientific practices are related to wider humanistic interests. Ibn Rushd supported the compatibility of faith with reason and advocated for the use of reason in understanding both nature and the things of heaven. These titans made philosophical standpoints that have traditionally humanized and placed scientific developments in context, and this offers many valid lessons on modern science promotion in the Arab region.

Nevertheless, there is a tiring overuse of these same philosophers. As if the contemporary period has nothing to offer. To tie it in with the city-based approach, famous or not-so-famous thinkers and scientists can

69 Don A. Howard and Marco Giovanelli, “Einstein’s Philosophy of Science,” *Stanford Encyclopedia of Philosophy* (2004). <https://plato.stanford.edu/entries/einstein-philsience/>.

70 Lucie Laplane et al., “Why science needs philosophy,” *Proceedings of the National Academy of Sciences* 116, no. 10 (2019), <https://doi.org/doi:10.1073/pnas.1900357116>, <https://www.pnas.org/doi/abs/10.1073/pnas.1900357116>.

be brought to the forefront into the discourse of science promotion. For example, a scouring of the archives of Aleppo or Agadir, can bring up notable historical figures that can be employed for that respective city in question.

Also, the multi-authored article by Laplane et al recommends simple approaches to overcome the division between philosophy and science which include: Make more room for philosophy in scientific conferences, host philosophers in scientific labs and departments; co-supervise PhD students in which the supervision is carried out by a science researcher and a philosopher; create university curricula that is balanced in science and philosophy so as to foster a genuine dialogue between them; science and philosophy should be read together in class or journal clubs; develop new sections in science journals that are devoted to philosophical and conceptual issues.⁷¹ The authors point out that reconnecting philosophy and science is more desirable and realizable than “decades of estrangement” would lead to suggest. They also make a robust case in which science should take note:

“Philosophy and science share the tools of logic, conceptual analysis, and rigorous argumentation. Yet philosophers can operate these tools with degrees of thoroughness, freedom, and theoretical abstraction that practicing researchers often cannot afford in their daily activities.”⁷²

8.3. The role of Psychologists

The psychologist comes armed with cognitive insights related to learning, perception, and responses to scientific information. There is a necessity to understand the cognitive-emotive processes that shape the Arab populace in their relation with science, and through that very understanding, to assist the communicators of science tailor messages in a more functional manner. For example, there is evidence from psychology that people are more likely to engage with scientific concepts when they are presented in a narrative format that appeals to emotions and personal experiences,

⁷¹ Laplane et al., “Why science needs philosophy.”

⁷² Laplane et al., “Why science needs philosophy.” 3950.

rather than as dry statistics or technical jargon. Distinguished scientist Dean Keith Simonton wrote “Without the addition of a psychological dimension, I believe, it is impossible to appreciate fully the essence of the scientific imagination. And without this appreciation, the origins of science, the emergence of new ideas about natural phenomena, must escape our grasp. Psychology is mandatory if we wish to comprehend the scientific genius as the generator of science.”⁷³ Moreover, American psychologist Gregory J. Feist who focuses on the psychology of science as a sub-discipline argues that “psychologists of science bring unique methodological and theoretical tools to the studies of science. Only psychologists, for instance, can bring a true experimental design to the study of scientific thought and behavior.”⁷⁴

Therefore, science promotion needs to be aware of the psychological drivers of skepticism that varies from mistrust of authorities, fear of the unknown, or cognitive biases, thus science communicators can create empathetic and persuasive messages. The psychologist, in concert with the rest of the liberal arts, focuses on establishing trust and emotionally touching the audience, thereby making science not just intellectually appealing but also personally relevant.

8.4. Toward a More Human and Accessible Science

The interdisciplinary approach is undertaken here in a way that contributes to the development of an interdisciplinary science, more humane, more accessible, and deeply situated within the Arab cultural context. In this way, promoting science through philosophy, sociology, arts, literature, and even psychology will help to go beyond the limited, purely technical view of science to a diversified one filled with different perspectives and creative expressions.

This is not to say these methods are not being employed, rather, it is that they are often treated as incidental, an afterthought, or utilized for branding purposes. The above holistic approach needs to rigorously inject values, ideas, and stories into the scientific spectrum of facts and data, if

73 Gregory Feist, “Why the Studies of Science Need a Psychology of Science,” *Review of General Psychology* 10 (06/01 2006), <https://doi.org/10.1037/1089-2680.10.2.183>. 183-184.

74 Feist, “Why the Studies of Science Need a Psychology of Science.” 183.

science is going to shape a new or different understanding of the world. The Arab world does not require the rebuilding of a scientific culture as much as it requires an inclusive scientific culture that is set within ethical considerations and integrated with its rich cultural traditions. This would require an interdisciplinary model that fundamentally changes the way science is taught, learnt, communicated, and experienced, thus producing a science that is an integral constituent of everyday life and a source of inspiration for individuals irrespective of age or background. Thus, telling the public that science is both intellectually stimulating and culturally meaningful.

Massimiano Bucchi and Brian Trench present a framework for understanding the three major ways in which science is communicated to the public (figure 8.2). These three broad categories are dissemination, dialogue, and participation.⁷⁵ Dissemination is the traditional manner of sharing scientific knowledge which is formal and hierarchical and aligns with technocracy in which experts should decide what is best for society, while the public is a passive actor. The Dialogue is a more open approach that represents two-way communication that engages the public and enables the questioning of science. Finally, the participation category encourages active involvement of the public to co-create knowledge and shape science itself. Science communication in the Arab world has largely hovered between the closed dissemination, most noticeable during COVID-19 in which governments limited public debate, and allowed modest form of dialogue. In most case, and depending on the context, Dialogue and hopefully Participation should be aimed for.

75 Massimiano Bucchi and Brian Trench, "Rethinking science communication as the social conversation around science," *Journal of Science Communication* 20, no. 03 (2021), <https://doi.org/10.22323/2.20030401>, https://jcom.sissa.it/article/pubid/JCOM_2003_2021_Y01/.

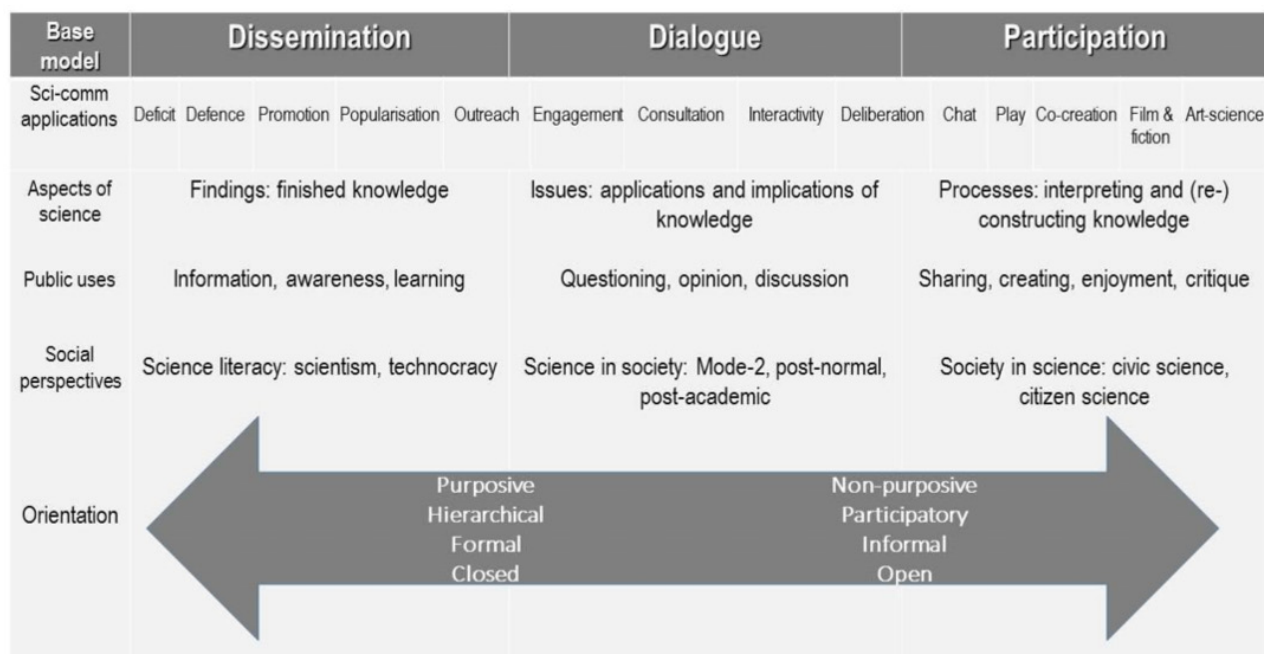


Figure 8.2: Framework of the social conversation around science

The diagram also signals that the liberal arts have long had the ability to express ideas and make them digestible to the general public and thus would enable science communication to flourish in the dialogue and participation categories. Arab thinkers, artists, and writers are in a position to translate abstract scientific concepts into emotionally resonant experiences. An interdisciplinary dialogue that utilizes art installations, sociology, poetry, philosophy, psychology, literature, storytelling, among others, will be able to, in one way or another, touch on the pulse regarding the implications for humanity when it comes to science and progress. This should not be a difficult undertaking in light of the fortunate reality in which the Arab world boasts a rich tradition of cultural forms and thus can be harnessed for making both science appealing and exposing Arab publics to different cultural mediums from other Arab cities. American microbiologist Carl Woese once sounded a warning:

“a society that permits biology to become an engineering discipline, that allows science to slip into the role of changing the living world without trying to understand it, is a danger to itself.”⁷⁶

⁷⁶ Laplane et al., “Why science needs philosophy.” 3951.

9. ROLE OF POPULAR CULTURE IN SCIENCE PROMOTION

Popular culture has long been a potent channel in making science accessible for all over the past of couple of decades. Scientific concepts have seeped, intentionally or not, through literature, media, films, and lately, digital platforms. The intervention of science in familiar mediums and entertaining contexts is capable of demystifying complex scientific ideas, inspiring curiosity, and reaching diverse audiences; thus making science a part and parcel of Arab daily life.

9.1. Ahmed Khaled Tawfik and the Possibilities of Science Fiction

A strong example of popular culture driving science promotion in the Arab region is the late Egyptian writer Ahmed Khaled Tawfik who pioneered the Arabic science fiction genre in literature in the 1990s. Tawfik's series of pulp fiction-style pocketbooks, titled *Ma Waraa al Tabiaa*, or Paranormal, enthralled a young generation. What distinguished Tawfik's work was the intervention of scientific themes and characters drawn from real historical figures. Through his stories, Tawfik introduced young readers to famous scientists like Albert Einstein and Jabir Ibn Haiyan, considered the father of Arab chemistry.

This series of novels, as well as being amusing, introduced a whole generation of young Arabs to the world of science and, indirectly, scientific inquiry, which ran from 1993 to 2014.



Figure 9.1:
Tawfik's pulp fiction novels being sold on the street by a used book seller. Alexandria, Egypt (14 October 2020).

Many readers have identified Tawfik's works as a major inspiration for pursuing careers in science; popular culture can impress on young minds their future direction in science. "This was another smart move on the part of Ahmed Khalid Tawfik, both scientifically and artistically. He was trying to popularize science and get lots of scientific and historical facts into popular usage among the young. You can find young people saying that we learned more about science and the world from reading his pocketbooks than from school!"⁷⁷

Tawfik's novels reflected an unorthodox yet compelling and indirect manner of science promotion. American science fiction writer Isaac Asimov wrote that "science fiction writers foresee the inevitable, and although problems and catastrophes may be inevitable, solutions are not."⁷⁸ Accordingly, the genre in the Arab world is concerned with multiple possible futures and therefore its relevance is tied to present-day concerns and anxieties, as a popular quote attributed to English author Adrian Anthony Gill "science fiction is never about the future, in the same way history is rarely about the past: they're both parable formats for examining or commenting on the present." Science fiction modestly addresses the problem in which the traditional approaches and the educational system in the Arab world have failed to engage students in the scientific realm. Every object, person, or event in the science fiction text, is rooted in reality in one way or another, it enables readers to rethink how they would impact society and even bridge the gap between the underlying concept in novels and films and their actual use in the world. Therefore, science fiction is an alternative and viable route worth considering.

There needs to be a conscious approach to continuing Tawfik's legacy of science-inspired novels which merges engaged story telling with accessible forms of science to inspire curiosity and learning. The suggestions below are not taken to mean they are not currently being applied, but that they need to be part of a structured approach towards continuing the ideas behind his work.

⁷⁷ Emad El-Din Aysha, "In Memoriam: Ahmed Khalid Tawfik, the Man and the Mission," *Arablit & ArabLit Quarterly* (21 November 2018). <https://arablit.org/2018/11/21/in-memoriam-ahmed-khalid-tawfik-the-man-and-the-mission/>.

⁷⁸ A. Aguirre, B. Foster, and Z. Merali, *How Should Humanity Steer the Future?* (New York: Springer International Publishing, 2015). 1.

9.1.1. Science Fiction for Young Adults

- One method is to pick up on Tawfik's Paranormal by encouraging and, or spotlighting an ongoing, initiative that creates a series of science-based novels targeting young Arab readers. The themes of these stories could explore AI, space travel, gene editing, and other emerging technologies within Arab contexts.
- The novels can introduce contemporary, rather than only medieval, Arab scientists as characters or inspirations that can connect their achievements with hope and possibilities for the future of the Arab world.

9.1.2. Graphic Novels and Illustrated Stories

- Although this approach is quite common, it bears mentioning there can always be room for improvement. That is, to adapt science themes into graphic novels and comic books that has been a proven medium that resonates strongly with younger audiences. This could involve a young protagonist who is armed with STEM knowledge and deploys it in the story to solve mysteries.
- The stories could also feature interactive elements such as puzzles and experiments that readers can replicate.

9.1.3. Interactive Digital Storytelling

- Scientific themes and concepts can be taught through interactive e-books and mobile applications where young readers can make choices that shape the story's outcome. For example, a story set in the future in which climate change in the Gulf has taken an even worse devastating toll and readers are required to decide how to manage the dwindling resources, enabling them to learn the principles of ecology and sustainability, as well as teaching them logic and critical thinking skills in the process.

9.1.4. Science-Themed Anthologies

- Publish anthologies of science and technology-inspired short stories by modern Arab authors. These anthologies could include interdisciplinary viewpoints in how science intersects with culture, ethics, and daily life in the Arab world.

- The umbrella genre of Speculative fiction that covers all the subgenres of fantastical fiction (e.g. supernatural, fantasy, utopian, apocalyptic, alternate history, futuristic etc.) should be encouraged as the spearhead to invigorate debate on current topics such as climate change and AI.

9.1.5. Collaborative Efforts with Schools

- Create a curriculum-linked book series for schools where stories align with scientific topics taught in classrooms. For example, a novel about a student discovering the secrets of ancient fossils in Algeria to accompany lessons on paleontology.
- Adventures in renewable energy or physics through relatable characters and real-world scenarios.

9.1.6. Incorporating Science into Popular Media

- Collaborate with television networks or online streaming platforms in producing serialized shows, interactive episodic content, or science-themed novel adaptations, such as Paranormal on Netflix.
- An initiative could involve inviting Arab scientists into the production to assist in maintaining accuracy regarding the science in question while keeping the material entertaining.

9.1.7. Updating the Pulp Fiction Format

- Reissue Tawfik's pocket-book format with a new series of available, reasonably priced books for urban and rural readership.
- Recurring characters can be used, young scientists or inventors, who solve real-life problems for societies in the twenty-first century.
- Such pulp fiction format books could be sold in schools, supermarkets, local bookshops, and koshks (kiosks) that sell printed material.

9.1.8. Science Festivals with Storytelling Themes

- An initiative could include organizing workshops and festivals where aspiring writers and scientists come together to create science-inspired narratives. An example could involve a festival theme based on “The Future of Arab Cities,” calling for stories that apply urban planning, technology, aesthetics, and sustainability.
- A straight forward initiative could involve a competition for young writers to produce science fiction inspired by Arab culture, history, and contemporary challenges.

9.1.9. Short Films or Animated Content

- Create short films or animated series from the science-themed stories. These could be highly shared on social media and video-on-demand sites.
- Concentrate on themes related to robotics, AI, or climate science that would interest a younger viewer.

9.1.10. Virtual Reality (VR) Experiences

- An initiative could involve creating immersive VR storytelling experiences that merge science and entertainment. For example, a VR time travel adventure that teleports back to medieval Baghdad to explore the work of Arab scientists and their contributions to today’s discoveries.
 - Interactive experiences that simulate space or underwater explorations.
- The above approaches, separate or combined, enable the literary tradition of Tawfik’s science promotion to evolve into a modern and multi-faceted strategy of stimulating scientific curiosity in the Arab world. These efforts would be complementary to UNESCO’s role not only in science promotion but assisting with its part in the unfolding narrative of historical and contemporary contributions to Arab science.

9.2. Digital Media and Rise of Scientist Influencers

Despite the doom and gloom that has been associated with the rise of digital media and social media platforms, they have been used to

promote science. In recent years, YouTube, X (formerly Twitter), Instagram, and TikTok, among other platforms, have played a leading role in the dissemination of science communication. Content creators, particularly scientific influencers, have delivered science in an engaging, fun, and accessible way. It has, therefore, given birth in the Arab world to a new generation of science communicators who use digital media to reach audiences who may have previously not been exposed to scientific information.

One notable example is Egyptian YouTuber Ahmed El Ghandour, known as “El Da7ee7.” Through his popular YouTube channel which has over two million subscribers, El Ghandour blends humor, storytelling, and scientific explanations to captivate millions of viewers.⁷⁹ His videos cover a wide range of topics, from “General Relativity” to “Speech Perception.” Including tongue-in-cheek videos like the “Benefits of Smoking.” El Ghandour’s approach not only underlines how digital media democratized science communication, but he used it to present complex ideas in an understandable and engaging way in bite sized videos (rarely going beyond ten minutes) for a wide Arabic speaking audience.

Other science influencers include Algerian astrophysicist Nidhal Guessoum who promotes astronomy and physics to the Arab public, Egyptian virologist Islam Hussein who educates Arabic-speaking audiences about viruses and pandemics, Kuwaiti engineer Mohamed Qasem who promotes the science of electronics and electrical engineering, and Egyptian physician Alyaa Gad who breaks taboos regarding certain health topics in the Arab world. Their videos go viral, spread scientific knowledge quickly, and reach those who do not normally look for educational content. The informal, conversational style of their YouTube and TikTok videos break the icy barriers to make science approachable.

⁷⁹ Da7ee7, YouTube. <https://www.youtube.com/@Da7ee7/>.

9.3. Films and Documentaries as Vehicles for Science Education

Movies and documentaries, the most well-known arena of popular culture, have played a significant role in the promotion of science. Hollywood productions have long been associated with the use of science as a central theme, and yet there has been a growing Arab interest in creating films and documentaries that focus specifically on the scientific achievements of the Arab world. Take for example the documentary “Science in a Golden Age” (2015) presented by Al Jazeera, the show summary reads “From satellite-enabled GPS to hi-tech medical procedures much of today’s modern science builds on the work of great thinkers from the past. But while the names Newton, Galileo and Copernicus are well known, just who were the scientists who came before them in the Golden Age of Islamic Science?”⁸⁰ The series ranges from Al-Khwarizmi, “The Father of Algebra,” to medieval chemists such as Jabir ibn Hayyan, Al Kindi, and Al Razi, and their influence on the modern world. The documentary series is an example of an informative and entertaining medium that illustrates the rich scientific heritage of the Arab world and thus instilling in Arab viewers a prideful connection to science.

There is an unappreciated role of Arabic films in the promotion of science. Although geared towards science fiction, such films have included *The Spider* (1965), *A Man Under Zero* (1966), *Journey to the Moon* (1959), as well as Palestinian filmmaker Larissa Sansour’s sci-fi trilogy: *A Space Exodus* (2008), *Nation Estate* (2012), and *In the Future They Ate from the Finest Porcelain* (2015). The Egyptian movie *Hepta: The Last Lecture* (2016) integrated psychological and scientific insights into its plot, thereby narrating concepts related to human behavior and emotions.⁸¹ The success of the film can be garnered in how it managed to stir public interest in psychology as a science; thus, it shows how popular cinema introduces audiences to scientific ideas through a common and entertaining format.

⁸⁰ “Science in a Golden Age,” Al Jazeera (15 September 2015). <https://www.aljazeera.com/program/science-in-a-golden-age/2015/9/15/about-science-in-a-golden-age>.

⁸¹ “Hepta - The Last Lecture (Film),” Arab Cinema Center (2016). <https://acc.film/listing/hepta-the-last-lecture.php>.

9.4. Social Media Campaigns and Science Popularization

Social media campaigns have played a significant role in the promotion of science within the Arab world, especially via the great reach of networks like X, Facebook, Tik-Tok, and Instagram. The use of hashtags has spearheaded science-based campaigns to bring awareness to a particular subject. One successful awareness campaign included the early detection of breast cancer in women in Algeria and the UAE. “Though simply a label marked by a hash symbol (#), the hashtag has transformed language and communication for millions,” argues Randa Saadi, “beyond organizing content on the internet and social media, hashtags now carry broader social implications. Their role and impact have evolved from simply gathering related posts under a topic to becoming a ‘ubiquitous symbol’ that drives discussions and influences dynamics within and beyond digital spaces.”⁸²

The Algerian scholar Randa Saadi, who undertook her doctoral research in marketing management, notes the successful spread of the #OctobreRose in Algeria due to the fact that it was bolstered by Pink October, a global initiative to raise awareness about breast cancer and Algeria was encouraged to play its role in the initiative. The UAE used the hashtag #PinkRibbon for breast cancer awareness and was popularized due to the coordinated efforts across government ministries, effective use of social media, and heightened engagement from the diverse local communities within the UAE.

⁸² Randa Saadi, “Hashtags as a Tool to Support Digital Marketing Campaigns International and MINA (Middle East and North Africa) Hashtags of the Breast Cancer Awareness Campaigns,” *Economic Researcher Review* 12, no. 2 (16 December 2024), <https://asjp.cerist.dz/en/article/258040>. 243.

There are various ways that UNESCO can utilize hashtags. It could, for example, launch #AskAnArabScientist campaign in which murky topics can be cleared up by the respective expert in their field while countering misinformation. A timeframe can be added to give it structure, an example could be #RamadanScience in which users spotlight the achievements of Arab and Muslim scientists, or on the topic of how to eat well and stay healthy while fasting. It should be noted that hashtags are not the driving force they once were, and their relevance has declined. However, when used strategically within a limited duration, they can frame discussions and heighten engagement.

9.5. Popular Culture and its Gateway to Science

No matter what approach is taken, storytelling needs to be at the heart of science communication initiatives, and it is also the most compelling means to frame popular culture's role in science promotion, if science communication is to be effective with audiences. Unfortunately, the digital age has fragmented the idea of narratives, as German-Korean philosopher Byung-Chul Han argues, society has gone from storytelling human beings to information-processing human beings.⁸³ This can be partially redeemed by enabling storytelling to be the driver of science communication in the adaptability of popular culture and understanding the tools that can effectively promote it. Fortunately, the foundation is already there. The traditions of storytelling in the Arab world are embedded and widespread enabling audiences to be reconnected with cultural narratives while highlighting that the present-day links up in a centuries long story of Arab science. The interdisciplinary approach will spawn heterogeneous links between science and the public's perception of it; inculcating a sense of wonder, curiosity, and affection for science in Arab daily life.

83 Byung-Chul Han, *The Scent of Time: A Philosophical Essay on the Art of Linger*, trans. Daniel Steuer (Cambridge: Polity, 2017). 17.

10. AI AND EMERGING TECHNOLOGIES

It is the AI wave that has revolutionized STEM and will have ramifications for humanity for generations to come, let alone for how scientific culture will be undertaken. When the World Wide Web became available and popularized in the mid-1990s, it saw a surge of young people enrolling in computer science and information systems at universities. Similarly, today, AI and emerging technologies are bringing new recruits to science subjects, which have now expanded to data science, machine learning, robotics, and cognitive science. AI can be defined succinctly in the following:

Artificial intelligence (AI) is the theory and development of computer systems capable of performing tasks that historically required human intelligence, such as recognizing speech, making decisions, and identifying patterns. AI is an umbrella term that encompasses a wide variety of technologies, including machine learning, deep learning, and natural language processing (NLP).⁸⁴

AI has emerged as one of the most powerful and celebrated phenomena in modern scientific culture. Like the rest of the world, Arab countries are in the midst of a major shift as AI, robotics, and big data reshapes, once again, the relationship between science and society. While the interviewees I spoke with were optimistic arguing that these technologies will revolutionize scientific engagement, promote innovation, and simplify complex scientific concepts for the public, they did however acknowledge the profound ethical, societal, and regulatory questions.

UNESCO has taken a clear stance on AI and has stated that it would be supporting Arab states in developing AI competencies; one prime example was among students and teachers through a series of regional seminars. The first seminar, held in April 2024, saw participation from 400 individuals across 80 countries, including 19 Arab States. The initiative was aimed at creating competency frameworks on AI for educators and

⁸⁴ “What Is Artificial Intelligence? Definition, Uses, and Types,” Coursera (20 December 2024). <https://www.coursera.org/articles/what-is-artificial-intelligence>.

learners that would later be launched during Digital Learning Week in September 2024. Several countries like Egypt and Qatar also shared in the development of AI use within their educational systems. The seminar also discussed ethics related to AI use. Furthermore, UNESCO stated that it hoped to continue these seminars in facilitating dialogues and knowledge sharing with regards to digital and AI competencies.

These actions are in line with UNESCO's comprehensive report *Recommendation on the Ethics of Artificial Intelligence*:

101. Member States should work with international organizations, educational institutions and private and non-governmental entities to provide adequate AI literacy education to the public on all levels in all countries in order to empower people and reduce the digital divides and digital access inequalities resulting from the wide adoption of AI systems.

102. Member States should promote the acquisition of “prerequisite skills” for AI education, such as basic literacy, numeracy, coding and digital skills, and media and information literacy, as well as critical and creative thinking, teamwork, communication, socio-emotional and AI ethics skills, especially in countries and in regions or areas within countries where there are notable gaps in the education of these skills.⁸⁵

The report is intended to create regulation and ethical frameworks, enhance workforce readiness, promote critical thinking, facilitate AI's integration into education, foster transnational cooperation, improve information literacy on AI, and support lifelong learning initiatives. The question arises: how will AI benefit and hinder scientific culture in the Arab world? Particularly regarding the themes that have been discussed.

⁸⁵ UNESCO, “Recommendation on the Ethics of Artificial Intelligence,” UNESCO (2022). <https://www.unesco.org/en/articles/recommendation-ethics-artificial-intelligence>.

10.1. Cities as Urban Laboratories

For cities, AI will power the smart science infrastructure that is part and parcel of the smart cities that automate research hubs and heighten the interactivity of science parks. Public engagement is geared towards making science more accessible via the AI driven museum exhibitions and urban installations. It can also power urban planning for cities that are seeking tech-driven sustainable environments, which by its very nature will also promote scientific activity and personalize science communication rooted in the local urban fabric. Even the science festivals discussed could see AI enhance the experience with tracking real-time data on audience attendance and engagement with tailored content.

On the other hand, AI will widen the digital divide as the most likely scenario will see AI-powered science festivals and hubs being concentrated in the wealthier cities of the Arab world. This is not to mention the high costs of AI-powered infrastructure that will inevitably exclude lower-income demographics from benefiting. The surveillance, data collection, and violation of privacy would be concerning given the track record of illiberal governments not addressing this concern, albeit it may be in their interest not to do so. Moreover, while AI could enhance the local identity of a city, the erosion is more likely given the focus may be on global narratives over local scientific heritage, and which may also marginalize indigenous, historical, and contemporary ways of approaching and appreciating science in the Arab world.

10.2. Arab-Arab Mobility and Collaboration

AI has the ability to improve transnational research quality by enabling scientists to collaborate remotely between cities in the Arab world. The ability to share data more efficiently, utilize translation and communication capabilities more effectively, and analyze regional scientific trends, can help build up or bolster the transnational Arab scientific community. If political will and policy are favorable to mobility, AI can streamline visa applications for scientists, researchers, and students.

Yet the harm AI can do is self-evident. The wealthier Gulf will dominate AI research, leaving a form of catchup politics to characterize the less wealthier Arab nations. The overreliance on new forms of AI-powered virtual collaboration will reduce networking, in-person scientific exchanges. Visa approvals and research funding, even under favorable policy conditions, might reflect existing inequalities as well, as one author noted, “data entry errors, algorithmic bias, and lack of human oversight can lead to rejections.”⁸⁶ In fact, the notion of AI-driven mobility decisions has a dehumanizing effect by depersonalizing and bureaucratizing scientific exchanges. Furthermore, increased reliance on AI networks can make research and personal data vulnerable to cyberattacks.

10.3. Interdisciplinary Approaches

AI interdisciplinary research presents a wide range of possibilities that include the bridging between STEM and the liberal arts by generating simulations and models, reformulating ethical frameworks that can analyze ethical dilemmas in scientific research and propose policy solutions, tailor interdisciplinary curricula based on student interests and skillset, and process vast quantities of data between STEM and liberal arts to produce new insights.

In light of what AI can do, it is likely to overshadow non-stem fields, and its data-driven nature may marginalize humanities-based scientific discourse, let alone the liberal arts itself. Ethical blind spots will arise when there is an overreliance on AI-generated insights that reduces critical human intuition to address complex matters and accordingly may see the oversimplification of interdisciplinary issues which lead to problematic or superficial conclusions. Moreover, to date, AI conferences have been largely tech-driven and lack the presence of the vital voices of sociologists, philosophers, and ethicists. Yet the problem is much worse as it is a societal challenge. Tammy Mackenzie argues in a country like Canada, the missing voices at AI conferences include people who are marginalized such as the physically challenged, young people, temporary foreign workers, prisoners, people in poverty, and the indigenous.

86 Benjamin Anyamele, “The Hidden Pitfalls of AI-Based Visa Applications (And How to Avoid Them),” Vocal Creators (10 February 2025). <https://vocal.media/education/the-hidden-pitfalls-of-ai-based-visa-applications-and-how-to-avoid-them>.

“AI is complex, far-reaching. It’s too much for only a few groups or experts to manage. That’s the nature of society-wide situations,”⁸⁷ she emphasizes an important point that is worth noting.

10.4. Popular Culture

As it has been noted before, AI can play a role in popular culture that creates science content in documentaries, films, and interactive storytelling. AI can potentially analyze historical texts from the Islamic golden age and recreate lost scientific stories for modern Arab audiences. As well as tapping into the past, AI can generate futuristic science fiction narratives to inspire and galvanize young Arab audiences.

Yet with AI will possibly come the loss of authenticity in science narratives as generated science content may lack depth and originality. It may also spread unverified or misleading scientific information, as well as algorithmic bias might push Western scientific narratives over Arab ones. The other risk would be to depersonalize science communication in which influencers, even AI-generated influencers, could replace human scientists as trustworthy and authoritative voices. Such a scenario would also give more credence to viral trends over genuine scientific education, resulting in science’s over-commercialization and commodification.

10.5. The prevailing blind spots of AI in the Arab world

There are two major challenges that need to be considered: the language bias and whether AI is producing a technological gluttony at the expense of traditional methods of learning.

The Arabic language, the fifth most spoken language in the world, is underrepresented in AI. Despite ChatGPT and other LLMs having Arabic-language capabilities, they were mostly trained on the English-saturated internet and datasets. Palestinian-German Shadi Albarqouni, professor of Computational Medical Imaging Research at the University of Bonn and member of the Arab-German Young Academy of Sciences and Humanities, argues that the problem is not just language, but an

⁸⁷ Tammy Mackenzie, “The missing voices at AI conferences,” Policy Options (19 January 2024). <https://policyoptions.irpp.org/2024/01/ai-more-voices-needed/>.

Anglophone bias that generates stereotypes and orientalism regarding Arabs and Muslims.⁸⁸ Fortunately, Arab countries have been quick to catch up. Although nowhere close to the level of English AI, the milestones have been impressive. The UAE appointed a minister of AI, the first ministerial portfolio of its kind in the world, and launched the language model named Jais, named after Abu Dhabi's highest mountain, in 2023.⁸⁹ What makes this a tremendous boon for Arab science is that Jais is open source and geared towards not only understanding dialects of Modern Standard Arabic, often used in formal texts and situations, but it also comprehends local Arabic dialects which dominate social media.⁹⁰

Jais reduces the dependency on the English language to access global scientific developments while supplementing Arabic scientific terminology and localization of complex topics. It can also build up the transregional Arab science community, facilitate exchanges and interdisciplinary collaborations, and open more doors for young aspiring scientists. It can also aid Arab scientists in exploring topics relevant to the Middle East and North Africa such as water scarcity, energy solutions, agriculture, and climate change. Jais and emerging models like UAE-based Falcon can enable Arab scientists to communicate their work with clarity to the general public, while being able to fine tune their work towards the cultural nuances of the Arab world. Moreover, the Arabic language platform can attract and engage younger generations to pursue STEM careers.

UNESCO centered AI on World Arabic Day in 2024 with the title “Arabic Language and AI: Advancing innovation while preserving Cultural Heritage.”⁹¹

88 Shadi Albarqouni, interview by Amro Ali, 27 November 2024.

89 Tiernan Ray, “Cerebras and Abu Dhabi build world’s most powerful Arabic-language AI model,” (1 September 2023). <https://www.zdnet.com/article/cerebras-and-abu-dhabi-build-worlds-most-powerful-arabic-language-ai-model/>.

90 Aimee Look, “Arabic AI could help open doors for other languages,” CNN (4 October 2023). <https://www.cnn.com/2023/10/04/middleeast/jais-arabic-ai-open-doors-spc-intl/index.html>.

91 “World Arabic Language Day 2024,” UNESCO (18 December 2024). <https://www.unesco.org/en/articles/world-arabic-language-day-2024?hub=66745>.

This is in line with UNESCO's Charter of Ethics of Science and Technology in the Arab Region that advocates for the promotion of "scientific publishing in Arabic" and the publication of "research in Arabic, in addition to foreign languages, if and as necessary to ensure the wider dissemination of the outputs of science and research."⁹²



Figure 10.1: World Arabic Day 2024, UNESCO

The basis of the event sought to rectify the discrepancy in which Arabic is spoken "by over 450 million people and holding official status in nearly 25 countries... and yet only 3% of online content is available in Arabic, restricting access for millions."⁹³ While reports and findings have yet to come out of this seminal event, the timing of it and the gathering of scholars, industry experts, and cultural leaders signals the imperative to address how AI can bolster Arabic representation.

Compared to the slow start that the Arab world took to the internet in the 1990s, (Saudi Arabia only enabled public access to the internet in 1999), AI is making rapid strides. The entry of Deepseek has inspired a rethink in Arabic AI. Faisal Al Bannai, the UAE's presidential advisor on advanced technologies, argued: "What happened with DeepSeek was another

⁹² "Charter of Ethics of Science and Technology in the Arab Region." 21

⁹³ "World Arabic Language Day 2024."

proof that small teams, agile teams, agile countries, can move fast and can make an impact... So we are learning...and we will be also launching other models in this regard...I think (DeepSeek gives) a serious sense of encouragement that you can punch way above your weight in this game, because the game is still starting.”⁹⁴

According to nature india in 2025, in their feature titled “As AI giants duel, the Global South builds its own brainpower”, Large Language Models (LLMs) are rapidly growing across the Arab States. Furthermore, there is an institutional and governmental commitment to adopting these models for the native language: Arabic. In the UAE, Jais was launched in 2023 by MBZUAI and Cerebras Systems; this model was trained on extensive Arabic and English datasets to better serve bilingual users. Additionally, the Technology Innovation Institute introduced the Falcon family of models in 2023, which quickly gained international recognition for its scale and performance. In Saudi Arabia, a bilingual Arabic-English model called ALLAM was launched in 2024 by relevant national entities. ALLAM is designed to better capture the linguistic nuances of Arabic through specialized tokenization techniques. Meanwhile, Qatar developed its own model, Fanar (2024), through a collaboration between QCRI and Hamad Bin Khalifa University, focusing on Arabic dialects and culturally appropriate AI-generated content. As for Egypt, the country collaborated with Huawei on its Arabic LLM (2024) to produce the PanGu ecosystem. Collectively, these initiatives demonstrate a strong regional commitment to prioritizing the development of AI systems that reflect local culture and language.⁹⁵

LLMs are also growing Saudi Arabia, Qatar, and Egypt (see figure 10.2). According to Nature, “For many countries in the Global South, the stakes are geopolitical as well as linguistic. Dependence on Western or Chinese AI infrastructure could mean diminished sovereignty over information, technology, and even national narratives. In response, governments are pouring resources into creating their own models.”

94 “UAE to launch DeepSeek-inspired AI models: senior official,” (12 February 2025). <https://www.france24.com/en/live-news/20250212-uae-to-launch-deepseek-inspired-ai-models-senior-official>.

95 Sibusiso Biyela, Amr Rageh and Shakoor Rather, “As AI giants duel, the Global South builds its own brainpower,” Nature, (20 May 2025). <https://www.nature.com/immersive/d44151-025-00085-3/index.html>

AI is at a high risk of drawing societies into techno-fundamentalism: “The belief that technology is ‘not only the means and will to triumph over adversity through gadgets and schemes, but the sense that invention is the best of all possible methods of confronting problems. At its essence, techno-fundamentalism sidesteps politics in favor of taking on social problems and translating them into technical solutions.”⁹⁶ In light of this, recent studies are pointing to a worrying sign.

Michael Gerlich at SBS Swiss Business School in Kloten, Switzerland, examined 666 individuals in the UK and discovered a noteworthy relationship between regular use of AI and diminished critical-thinking abilities. “Younger participants exhibited higher dependence on AI tools and lower critical thinking scores compared to older participants.” Although the former could be offset with higher education that imparted critical thinking. Moreover, Gerlich argues that “over-reliance on these tools can lead to cognitive offloading. Cognitive offloading occurs when individuals delegate cognitive tasks to external aids, reducing their engagement in deep, reflective thinking.”⁹⁷

A research project by scholars at Microsoft and Carnegie Mellon University in Pittsburgh, Pennsylvania, conducted a survey involving 319 knowledge workers in jobs that utilize GenAI weekly. While it expectedly enhanced their efficiency, it stifled critical thinking and encouraged long-term dependence. The researchers also noted: “A key irony of automation is that by mechanizing routine tasks and leaving exception-handling to the human user, you deprive the user of the routine opportunities to practice their judgement and strengthen their cognitive musculature, leaving them atrophied and unprepared when the exceptions do arise.”⁹⁸

96 Amro Ali, “Re-envisioning Civil Society and Social Movements in the Mediterranean in an Era of Techno-Fundamentalism,” *European Institute of the Mediterranean* 25 (2020), https://www.academia.edu/49551586/Re-envisioning_Civil_Society_and_Social_Movements_in_the_Mediterranean_in_an_Era_of_Techno_Fundamentalism.

97 Michael Gerlich, “AI Tools in Society: Impacts on Cognitive Offloading and the Future of Critical Thinking,” *Societies* 15, no. 1 (2025), <https://www.mdpi.com/2075-4698/15/1/6>.

98 Hao-Ping Lee et al., “The Impact of Generative AI on Critical Thinking: Self-Reported Reductions in Cognitive Effort and Confidence Effects From a Survey of Knowledge Workers” (Proceedings of the 2025 CHI Conference on Human Factors in Computing Systems, Association for Computing Machinery, 2025). 1.

Finally, the most recent and widely discussed MIT study aptly titled “Your Brain on ChatGPT: Accumulation of Cognitive Debt when Using an AI Assistant for Essay Writing Task.” The study divided 54 participants from the Boston area into three groups who were asked to write several essays. One group was tasked with using ChatGPT (the LLM group), the second group used the Google search engine (the Engine group), and the third was the “brain only” group that was not assisted by either technology. The researchers found the brain-only group displayed a “more extensive and stronger connectivity network” and an increased state of “internal coordination, engaging memory and creative thinking.”⁹⁹ The Engine group while still being cognitively active and able to perform the complexity of essay writing, showed “less activation of the brain’s long-range memory circuits”¹⁰⁰ as this was in part due to the offloading of some cognitive demands, for example, “instead of remembering facts, they could find them, and instead of internally cross-referencing knowledge, they could verify those via web sources.”¹⁰¹ The LLM group fared the worst, neurologically and linguistically, and produced homogeneous essays. By session three, 33% of LLM users reported difficulty in quoting their essays. Compare this to the other two groups both the engine group and brain-only group who scored 100% when it came to quoting their essays. Most LLM participants could say they felt a sense of partial ownership of the essays they were writing.¹⁰²

These studies are far from being against AI, as they do acknowledge its productive uses. Gerlich addressed the claim that AI helps with “cognitive offloading” on the assumption that users would be freed to take up creative pursuits. Rather than using that free time, using that free time to write a poem or a short story, users were engaged in the passive

99 Nataliya Kosmyna et al., “Your Brain on ChatGPT: Accumulation of Cognitive Debt when Using an AI Assistant for Essay Writing Task,” arXiv [cs.AI] (2025), <http://arxiv.org/abs/2506.08872>.

100 Kosmyna et al., “Your Brain on ChatGPT: Accumulation of Cognitive Debt when Using an AI Assistant for Essay Writing Task.” 97.

101 Kosmyna et al., “Your Brain on ChatGPT: Accumulation of Cognitive Debt when Using an AI Assistant for Essay Writing Task.” 97.

102 Kosmyna et al., “Your Brain on ChatGPT: Accumulation of Cognitive Debt when Using an AI Assistant for Essay Writing Task.” 138.

consumption of entertainment such as watching Netflix.¹⁰³ In the MIT study, they argued for the “strategic timing of AI tool introduction following initial self-driven effort may enhance engagement and neural integration.”¹⁰⁴ When the brain-only group were given AI tools in the final session, they were able to perform even better. Hence their claim that “early AI reliance may result in shallow encoding” and “Withholding LLM tools during early stages might support memory formation.”¹⁰⁵

10.6. Key Implications for Arab Science

While these findings take place in a Western context, there is little reason to believe they would not have relevance in the Arab world, given the even more difficult educational challenges faced. While a systematic study has yet to be undertaken on the effects of AI in the Arab world, already this report finds concerns from the interviewees. For example, Dr. Hanene Boussi who specializes in medical AI at the University of Tunis El Manar, and praises AI’s contribution to her field, worries about the impact AI will have on cognitive development among students who are using a variety of AI tools. She raises concern about how AI is altering the way young Tunisians are thinking and learning, and if this could potentially alter brain development processes. She argues that “my concern is not about laziness and using AI to do things for them but making parts of the brain work more.”¹⁰⁶ In other words, it goes beyond a student misusing ChatGPT for their assignment, it is the subcontracting of the human brain to AI and the cognitive functions that will inevitably be reshaped. Boussi stated there was a debate in AI about delaying young people from using it until they have reached a certain level of cognitive maturity. These are questions that require UNESCO, regional bodies, policy makers, and ethicists to tackle and cannot be simply left to the AI-tech industry

103 Ross Pomeroy, “Is AI eroding our critical thinking?,” Big Think (27 January 2025). <https://bigthink.com/thinking/artificial-intelligence-critical-thinking/>.

104 Kosmyna et al., “Your Brain on ChatGPT: Accumulation of Cognitive Debt when Using an AI Assistant for Essay Writing Task.” 139.

105 Kosmyna et al., “Your Brain on ChatGPT: Accumulation of Cognitive Debt when Using an AI Assistant for Essay Writing Task.” 140.

106 Hanene Boussi, interview by Amro Ali, 28 November 2024.

to address. In light of these, four critical points should be noted, if not reemphasized.

1- AI may undermine the core cognitive skills needed for scientific inquiry

The report emphasizes re-enchanting science by nurturing critical thinking, creativity, and public engagement. Yet these studies suggest that AI overreliance may dampen these very faculties, particularly among young people whom this report is aimed at.

2- Vulnerability of Arab youth and early-career scientists

In Arab contexts that is known to have large youth demographics and digital adoption is rising, this could result in a generation that is efficient but less reflective, curious, or independent-minded, unless guided otherwise.

3- The atrophying of scientific culture

If intellectual labor is increasingly offloaded by Arab scientists to LLMs without the agency of reflection or validation, then the region's scientific output risks becoming ethically compromised, if not derivative and uncritical.

4- The new invisible inequality: cognitive debt

The Arab world's education systems have long been confronted with the problem of rote memorization, educational inequity, and digital divides. The findings from the series of studies could introduce a new layer of cognitive stratification, that is to say, between those trained to think with AI, and hopefully beyond AI, and those passively shaped by AI. Overall, AI is not only altering what we learn but how we think.

AI should not be promoted as a universal solution. The proponents of scientific culture in the Arab world must resist framing AI as a shortcut or route to scientific excellence. Rather, it should be re-positioned as a tool that complements and aids in human reasoning, not replace it.

Policymakers and educators have a responsibility to rein in the hype of AI, and to contextualize its usefulness within pedagogical models that preserve human cognitive engagement, especially in science education. Arab educational and scientific institutions must develop AI literacy frameworks that balance usage with cognitive development. UNESCO's two reports, Recommendation on the Ethics of Artificial Intelligence and Charter of Ethics of Science and Technology in the Arab Region, offer comprehensive frameworks and guidelines for developing AI literacy.

While this report acknowledges the cognitive risks, it is not intended to fearmonger, but to argue for a holistic approach to science education that factors AI fluency into the equation with human judgment. When thought through carefully, AI can work wonders from boosting productivity to enhancing mundane tasks, freeing up mental space for scientific pursuits and higher-order thinking. This can only be done with an intentional design and philosophical approach in which AI should serve as a cognitive partner, and in no way should it become a substitute for intellectual labor. This is an opportunity for Arab science to showcase to the world the construction of an AI-augmented scientific culture that is rooted in ethics, creativity, and the collective good.

The findings on AI reinforce the imperative need of the central question of this report: "How can we re-enchanted and re-humanize scientific culture for the Arab world?" as well as reinforce the report's endeavor towards a human-centered, interdisciplinary, and ethically conscious scientific culture in the Arab world. It also validates the emphasis on arts, philosophy, sociology, and storytelling as tools to protect the integrity of how science is imagined and practiced. At the heart of scientific pursuits happens to be the idea generation that is under threat from AI. The misuse or excessive dependency on AI can potentially spell the destruction of intellectual fulfilment that might discourage young Arabs from pursuing

science careers and worsen an already fragile engagement in the scientific field.

AI's usurpation of science's idea generation would erode human creativity and scientific curiosity, thus switching scientific pursuits from a human imaginative-driven quest to a mechanical one. The Arab world needs more critical thinking and scientific confidence, not less which AI would reinforce with passivity. This would also risk alienation, as divorcing scientists from the meticulous process of discovery will torpedo deeper intellectual and emotional engagement that would be necessary to re-enchant science.

This is not to take away from AI's mammoth positive contribution, but it needs to be disciplined within a framework that accommodates human will and flourishing. It needs to ensure that Arab science and scientists have human agency in which AI should provide the tools to assist their work, not replace it, and certainly not in idea generation if possible. While AI aids in brainstorming, it should be left up to the Arab scientists to decide the direction of inquiry. Similarly, for a distinct scientific Arab voice to be enhanced, AI's role should be limited to processing vast amounts of data, identifying patterns, translating, and contextualizing scientific work, while interpretation and theoretical framing should be led by Arab scientists.

CONCLUSION

The strategy of the first section identified opportunities and challenges when it comes to scientific culture's public engagement and science communication. The comparative case studies, interviews with experts, and survey responses charted structural and public drivers of science engagement across the Arab region. The findings uncovered hindrances that choke scientific mobility, gaps in inter-disciplinary research, doubtful levels of confidence towards the governance of science, and the greater potential of science communication. All this was wrapped up at the tail end of the pandemic. The relevant findings carried on into the post-pandemic Arab world that came with new but connected challenges.

The second section built up on the findings in the first section through five thematic tracks to drive the re-enchantment and re-humanization of the scientific culture in the Arab world so as to heighten its appeal, accessibility, and inclusivity. Yet this whole report is also an invitation to scholars, students, policy makers, experts, educators, community leaders, civil society, and the general public to rethink the current approaches, or lack of, to science and consider innovative creative strategies to bridge the gap between science and Arab publics while not descending into forms of techno-fundamentalism. It is an appeal to continually draw from Arab history, cultural heritage, and modern realities to craft inspirational narratives that offer hope and direction for the young Arab generation with practical solutions – long-term investment in public science engagement, science education, and policy reform – to bolster the vision that permits scientific culture to crystalize possible different futures. All of which attract young Arab recruits and spreads the love of science far and wide, from Tangiers to Baghdad.

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ANNEX A: Workshops

ANNEX B: Science and community in the Arab world

ANNEX C: Statistics of participants by gender-age

ANNEX A

WORKSHOPS



Scientific Culture in Arab World
Regional Experts Discussion Webinars

SATURDAY, October 30, 2021,

7:00 pm – 8:00 pm (Cairo Local Time)	Webinar 1 Science Communication
8:15 pm – 9:15 pm (Cairo Local Time)	Webinar 2 Science and Public Engagement Public Accountability in Science

Zoom invitation will be sent by Thursday 28th October, 2021



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Scientific Culture in Arab World

Regional Experts Discussion Webinars

Second Round

SATURDAY, December 4, 2021,

5:00 pm – 6:00 pm Webinar 1

Scientists and Society

Gender and Scientific Culture

Expert Panel polling and survey

6:15 pm – 8:00 pm Webinar 2

Experts panel discussion on polling and

Survey results



Zoom invitation will be sent by Thursday 2nd of December, 2021

Contact US

Dr Hala Elkady, UNESCO Consultant

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Expert Panels Members

- Professor Sherief Kandil, Alexandria University, Academy of Scientific Research and Technology (ASRT)
- Professor Essam Kamis, Alexandria University, Former vice Minister of High Education and Scientific Research
- Dr Ayad Galol, AIDMO, Arab industry development and mining organization, Arab League Council.
- Dr. Abdel Aziz, UNESCO.
- Dr. Ahmed Farag, Society communication program, Egyptian space agency.
- Professor Eman Halawa, Head of Mechanical Eng Dept., British University in Egypt.
- Dr Gasser E. Hassan, City of Scientific Research and Technological Applications, Specialized councils ASRT, Egypt
- Dr Mohamed Ramadan, Supervisor of The Egyptian Observatory, Academy of Scientific Research and Technology (ASRT).
- Dr Ahmed Mandil, Coordinator, Research & Innovation, WHO/EMRO.
- Prof Mohamed Labib Salem, Prof. of Immunology, Faculty of Science, Tanta University,
- Dr Ahmed Abdelfattah Hussein. Associate Professor of Chemistry. college of science University of Bahrain
- Dr Rabab El-Sherif professor of physical chemistry faculty of science Cairo University

- Dr Heba Ahmed Hassan, Associate Prof. Cairo University, Faculty of Engineering, Electrical Power Engineering Dept. (Former Dean of College of Engineering Dhofar University Oman.
- Dr Maysoun Ibrahim, President of the Palestinian Information Sciences and Technology Syndicate, member of board of directors at the Higher Council for Innovation and Excellence in Palestine.
- Tarek Kapiel, B.Sc., M.Sc., Ph.D. (Plant Biotechnology), Assistant Professor, Botany and Microbiology Department, Faculty of Science, Cairo University, Giza, EGYPT.
Sonya Mohamed Sayed Ahmed Azab, Professor, Faculty of Medicine, Ain Shams University
- Rashid Al Abri, Hydrogeologist, Oman Water Society and visitor professor at Sultan Qaboos University, Oman
- Ashraf Amin, Head of Science Department, Al-Ahram Newspaper.
- Dr Wael A. Amer, Associate Professor of Physical Chemistry, College of Science, University of Bahrain.
- Noha Taymour, Lecturer faculty of Dentistry, Prosthodontics and materials science, Imam Abdulrahman Bin Faisal University, Saudi Arabia
- Mohamed Samir, Lecturer Assistant, Institute of Graduate Studies and Research, Alexandria University.
- Marie HANNA- UNESCO Cairo team.
- Dr Rania Khalil, Zagazik University

- Dr Mona Taman, international lecturer and consultant in education technology and education development
- Dr Nasser METWALLY, Department of mathematics, College of Science, University of Bahrain
- Mr. Rashid Al Abri, Assistant Director General for water Resources Assessment, Ministry of Regional Municipalities and Water Resources, Muscat, Oman
- Nabil HAMDI, Director Ministry of Local Affairs and Environment, Tunis, Tunisia

ANNEX B

SCIENCE AND COMMUNITY IN THE ARAB WORLD

ONLINE SURVEY

Thank you for your participation in the survey underlying the UNESCO discussion paper “Scientific Culture in Arab Countries” that aims at measuring the link between science and Arab communities.

This field survey aims at measuring the interconnectivity and interaction between communities and science and technology, in order to inform recommendations on promoting science communication as a major stepping stone towards advancing communities.

We kindly ask you to take part in achieving this aim by answering the following questionnaire.

Demographic section

Please provide the following particulars about yourself

1- Name (optional):

2- Gender ☐ Male ☐ Female

3- Email (optional)

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4- Age

- Under 20
- 20 - 29
- 30 – 39
- 40 – 49
- 50 - 59
- Over 60

5- How many people live in your household? (including you)

- a. 1
- b. 2
- c. 3
- d. 4
- e. 5
- f. 6
- g. >6

6- Are there children living in your household?

- a. Yes
- b. No

7- Which country are you a national of?

- ☐ Algeria
- ☐ Morocco
- ☐ Tunisia
- ☐ Mauritania
- ☐ Libya
- ☐ Egypt
- ☐ Sudan
- ☐ Lebanon
- ☐ Palestine
- ☐ Jordan
- ☐ Syria
- ☐ Iraq
- ☐ Kuwait
- ☐ Saudi Arabia
- ☐ Qatar
- ☐ Yemen
- ☐ Oman
- ☐ UAE
- ☐ Bahrain

8- What best describes the place you live in?

- a. Urban area
- b. Rural area

9- Your Title:

☐ Doctor ☐ MSc ☐ Bachelor ☐ Undergraduate ☐ Other

10- What type of Job do you hold and in which sector? Please select the most appropriate option.

- Business/ Private Sector
- Research Institute
- NGOs/INGOs
- Other, please specify
- University/ Academia
- Government Agency/ Public sector

11- Field of expertise:

Medical
Engineering and mathematic
Agriculture
Social and Human Sciences
Political Science and public administration
Economics
Business
Environmental studies
Languages and Arts
Other:

P1) Public Cognition of Science

Science is defined as observation, definition, identification and investigation, all of which are based on experiments and putting theories to the test. Community cognition of science is a milestone to achieving its welfare and advancement.

1- To what extent, in your opinion, science can be beneficial?

☐ Yes, to large extent ☐ to limited extent ☐ I do not know ☐ Nothing

2- How does science interact with religious beliefs?

- Science supports religious beliefs
- Science conflicts with religious beliefs
- No interaction between science and religious beliefs
- I don't know

3- Have you been exposed to any science-related rumors and fake news on social media, especially in times of crisis like the COVID-19 pandemic?

☐ No ☐ Yes

If yes, how did you know it was a rumor or fake news?

☐ It was denied through official sources ☐ It was denied through social media

☐ I searched for it to make sure ☐ I did not care about it ☐ It was later denied

4- What are your sources for scientific information? For each source, how do you rate your trust level?

• Social Media	High	Medium	Low
• Government	High	Medium	Low
• Articles	High	Medium	Low
• University	High	Medium	Low
• Family or Friends	High	Medium	Low
• Scientific journals/Conferences	High	Medium	Low
• Other (please specify)	High	Medium	Low

P2) Science Communication

1- How can we further enhance scientific communication through the media?

- Simplified language (newspapers, magazines)
- Television shows/programs (simplified)
- Professional videos for social media
- Documentaries
- Other

2- In your opinion – how far did your government succeeded in reducing the impact of COVID-19 on your life and profession ?

Above 80%

50%-80%

Less than 50%

P3) Science and Public engagement

1- Do you or any of your family members participate in any scientific activities/events?

- Never
- Rarely
- Always
- I hope so but I do not know how
- I do not have the time

P4) Public Accountability in Science

1- Does your country have a science agenda to be applied in the national development plan to serve future generations?

- ☐ There is no science agenda as far as I know
- ☐ I do not know
- ☐ Not applied at all
- ☐ Somewhat applied
- ☐ Applied to an acceptable extent

2- In your opinion, what is the level of interest in science shown by the general public in your country?

- No interest at all
- Limited interest
- Moderate interest
- High interest

3- Do you think that some scientific findings are fabricated and not accurate?

- ☐ Strongly agree
- ☐ Agree
- ☐ Neutral
- ☐ Disagree
- ☐ Strongly disagree

4- Do you think that the COVID-19 pandemic is overrated?

- ☐ Strongly agree
- ☐ Agree
- ☐ Neutral
- ☐ Disagree
- ☐ Strongly disagree

5- Do you believe that COVID-19 vaccines are useless and do not prevent harsh symptoms of the virus?

- ☐ Strongly agree
- ☐ Agree
- ☐ Neutral
- ☐ Disagree
- ☐ Strongly disagree

**6- When sick or needing a consultation, I usually:
(other economic dimension) (add question)**

- ☐ Seek professional help
- ☐ Ask a family member/friend who has experienced a similar situation
- ☐ Look on the Internet.

7- If you get sick, and your choices were limited to a female doctor, how do you feel about it?

- ☐ Indifferent
- ☐ A little bit worried
- ☐ Very worried
- ☐ You will postpone till a trusted doctor is available.

8- I don't think I'm smart enough to understand medicine or engineering

- ☐ Strongly agree
- ☐ Agree
- ☐ Neutral
- ☐ Disagree
- ☐ Strongly disagree

9- When I hear these sources talk about science, I	Completely believe it	Believe it to a certain degree	Am a bit skeptical	Very skeptical
A family member				
A friend				
A University professor				
Facebook/ Instagram/ Twitter				
LinkedIn				
Specialized TV Show				
TV Talk Shows				
YouTube				
Scientific paper/ research				
Governmental entities				

10- To what extent do you believe that providing scientific and technological education for your kids could provide them with better job opportunities in the future?

- ☐ Strongly believe
- ☐ May be
- ☐ No difference

ANNEX C

Statistics of participants by gender-age

Participants		20-29	Under 20	30-39	40-49	50-59	Over 60	Total
Female	Count	37	6	54	46	31	13	187
	%	26.1%	37.5%	49.1%	45.5%	38.8%	22.0%	36.5%
Male	Count	105	9	56	55	49	46	320
	%	73.9%	56.3%	56.3%	54.5%	61.3%	78.0%	62.5%
Total	Count	142	16	110	101	80	59	521
	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%



Towards a Human-Centered Scientific Culture in the Arab World

from crisis-driven science to visionary renewal

This report charts a visionary roadmap for rethinking scientific culture in the Arab world. Moving beyond a crisis-driven model of science, it advocates for a human-centered and socially embedded approach that promotes civic engagement, inclusivity, and cultural relevance. Grounded in empirical research, expert consultations, and regional data, the study identifies barriers to scientific participation and offers interdisciplinary strategies to revitalize public trust, communication, and ethical oversight. By positioning cities as hubs of innovation, fostering Arab-Arab mobility, and integrating science with the arts and popular culture, the report calls for a collective re-humanization and re-enchantment of science – one that inspires curiosity, informs public policy, and enriches daily life. UNESCO presents this publication as a call to action for policymakers, educators, and civil society to build a pluralistic, resilient, and ethically grounded scientific future across the region.



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