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The Challenges and Opportunities of Sustainable Education in the Arab Region

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Foreword

Ahmed A. Zayed

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The Challenges and Opportunities of Sustainable Education in the Arab Region

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Foreword

Over the years, Education for Sustainable Development (ESD) is gaining the attention of all stakeholders, not only because sustainable development goals is at the core of the global agenda, but also because ESD is an essential contributor to the efforts to achieve the Sustainable Development Goals. ESD aims to empower learners with the skills and knowledge to take informed and responsible actions and decisions at different levels.

We, at the Bibliotheca Alexandrina (BA), see that nourishing the minds with the values that embrace sustainability and promotes sustainable present and future is our ultimate goal. The BA serves to be a center of excellence in the production and dissemination of knowledge, and to be a place for dialogue, learning, and understanding between cultures and people. Here at the BA and through the World Academy of Sciences for the Advancement of Science in Developing Countries Arab Regional Partner (TWAS-AREP) which we host since 2005, our working agenda is paying special attention to promote awareness on different topics related to sustainable development.

From this perspective, we are delighted to present in this booklet the outcome of the online lecture entitled “Education for Sustainable Development”, organized by TWAS-AREP, on 2 November 2022. This booklet aims to shed light on the topic Education for Sustainable Development in the Arab region, by providing an overview of the challenges faced by Arab countries in areas associated with quality education, and will suggest a set of potential solutions for the presented challenges.

We hope that bringing forward this booklet can positively contribute to the regional and global efforts of promoting the awareness on sustainable development and education.

Prof. Ahmed A. Zayed
Director, Bibliotheca Alexandrina

The Challenges and Opportunities of Sustainable Education in the Arab Region

Education for Sustainable Development in the Arab region is facing a complex set of challenges that require immediate attention. One of the main issues is the large population of young people under 25 in the region, which has put a strain on the existing education system and has led to a shortage of quality education options. This is further compounded by the limited economic opportunities available to graduates, making it difficult for them to find meaningful employment and support themselves financially. As a result, many Arab students who have the opportunity to study abroad choose not to return to the region after graduation, which only intensifies the problem. In addition to these challenges, the quality of pre-college education has remained stagnant, with a lack of sufficient quality teacher training and investment in educational resources. Higher education is also becoming increasingly unaffordable for most people, increasing social and economic inequality.

We aim to provide the context for the challenges of sustainable education in the Arab region, by describing the progress that has been made so far and identifying the sources of the challenges faced by Arab countries in areas associated with quality education. It also suggests potential solutions that can improve access to and quality of education in the region, highlighting the importance of using evidence-based decisions in the process. Specifically, we focus on the potential solutions that can help alleviate these challenges and increase opportunities for improved access to and quality of education, to support sustainable development for the region.

Context of Sustainable Education

The Sustainable Development Goals (SDGs) are a set of 17 Global Goals adopted by the United Nations in 2015 as part of the 2030 Agenda for Sustainable Development. These Goals are designed to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity by 2030. The SDGs include the following 17 Goals:

- Goal 1: No Poverty
- Goal 2: Zero Hunger
- Goal 3: Good Health and Well-being
- Goal 4: Quality Education
- Goal 5: Gender Equality
- Goal 6: Clean Water and Sanitation
- Goal 7: Affordable and Clean Energy
- Goal 8: Decent Work and Economic Growth
- Goal 9: Industry, Innovation, and Infrastructure
- Goal 10: Reduced Inequalities
- Goal 11: Sustainable Cities and Communities
- Goal 12: Responsible Consumption and Production
- Goal 13: Climate Action
- Goal 14: Life below Water
- Goal 15: Life on Land
- Goal 16: Peace, Justice, and Strong Institutions
- Goal 17: Partnerships for the Goals.

Each Goal is accompanied by specific targets and indicators to measure progress. These Goals are intended to be integrated and indivisible and balance the three dimensions of sustainable development: Economic, social, and environmental. In line with the emphasis of the United Nations on developing "a plan of action for people, planet, and prosperity", Sustainable Development, Goal 4[1] focuses on education and aims to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all." This Goal has the following sub-goals by 2030:

1. Ensure that all girls and boys complete free, equitable, and quality primary and secondary education leading to relevant and effective learning outcomes.

2. Ensure that all girls and boys have access to quality early childhood development, care, and pre-primary education so that they are ready for primary education.

3. Ensure equal access for all women and men to affordable and quality technical, vocational, and tertiary education, including university.

4. Substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs, and entrepreneurship.

5. Eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples, and children in vulnerable situations.

(1) Information and quotes about SDG 4 is adapted from, see "Sustainable Development Goal 4 (SDG 4)", *UNESCO. Global Education Cooperation Mechanism: Education 2030*, https://www.sdg4education2030.org/the-goal#:~:text=Sustainable%20Development%20Goal%204%20(SDG%204)%20is%20the%20education%20goal,lifelong%20learning%20opportunities%20for%20all.%E2%80%9D.

6. Ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy.

7. Ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship, and appreciation of cultural diversity and culture's contribution to sustainable development.

8. Build and upgrade education facilities that are child, disability, and gender sensitive; and provide safe, non-violent, inclusive, and effective learning environments for all.

9. Substantially expand globally the number of scholarships available to developing countries, in particular, least developed countries, small island developing states, and African countries, for enrolment in higher education, including vocational training and information and communications technology, technical, engineering and scientific programs, in developed countries and other developing countries.

10. Substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing States.

In the following sections, the author will discuss the progress in implementing the activities related to SDG 4 in the Arab region, the persisting challenges in implementing the activities, and implementing STEM programs successfully in Arab countries.

Table 1

Gross Enrolment Ratio of Primary and Secondary Education[2]

Country	Primary Education	Year	Lower Secondary Education	Upper Secondary Education	Year
Algeria	107	2019	NA	NA	NA
Bahrain	98	2019	98	96	2019
Comoros	100	2018	69	45	2018
Djibouti	75	2019	59	43	2019
Egypt	106	2019	101	78	2019
Iraq	NA	NA	NA	NA	NA
Jordan	82	2019	70	54	2019
Kuwait	88	2019	56	57	2018
Lebanon	NA	NA	NA	NA	NA
Libyan Arab Jamahiriya	NA	NA	NA	NA	NA
Mauritania	100	2019	46	29	2019
Morocco	115	2019	100	62	2019
Oman	103	2019	108	105	2019
Palestine	98	2019	98	78	2019
Qatar	104	2019	101	109	2019
Saudi Arabia	101	2019	106	118	2019
Arab Region Average	82	2019	70	54	2019
World Average	88	2019	56	57	2018

(2) Adapted from, see D. Liu, *et al*., *An Overview of Education Development in the Arab Region: Insights and Recommendations towards Sustainable Development Goals (SDGs)* (Beijing: Smart Learning Institute of Beijing Normal University, 2021).

Development and Persisting Issues with SDG 4 in the Arab Region[3]

A report entitled "Progress of SDG4 in the Arab Region: A Summary Review" published in 2022 by the United Nations Educational, Scientific and Cultural Organization (UNESCO) identified the following areas of progress in achieving SDG 4 in the Arab region:

1. National reports on SDG 4 indicate promising progress in early childhood education, with an emphasis on laws and policies, nutrition and healthcare for school-aged children, training for teachers and caregivers, and home-based care programs. Notably, some countries have reported positive results in creating stimulating environments for children under 5 in the home. However, fewer than 25% of 3- and 4-year-old children in the region are enrolled in early childhood education.

2. The Arab region has seen higher completion rates at the primary school level than at the lower secondary level. This indicates that students are dropping out of school after completing primary education. Moreover, data (Table 1) on enrolment indicate that the Gross Enrolment Ratio (GER)[4] of primary education ranges between 75% in Djibouti to around 100% in Algeria, Comoros, Mauritania, Morocco, Oman, Qatar, and Saudi Arabia, with an average of 82% for the Arab region as compared to 88% in the world. At the lower secondary level, the ratios range between a low of 46% in Morocco to around 100% in Egypt, Morocco, Oman, Qatar, and Saudi Arabia with an average of 70% in the

(3) Information about progress in the Arab region is adapted from the United Nations Educational, Scientific and Cultural Organization (UNESCO), *Progress of SDG 4 in the Arab Region: A Summary Review* (Paris: UNESCO, 2022), online e-book, https://en.unesco.org/sites/default/files/sdg4_progress_report.pdf.

(4) Total enrolment in a specific level of education, regardless of age, expressed as a percentage of the eligible official school-age population.

Arab world and a world average of 56%. Finally, at the upper secondary level, the rations are lower for most countries in Table 1 with a low of 29% in Mauritania, and a high of around 100% in Oman, Qatar, and Saudi Arabia.

3. International and regional assessments show that student proficiency levels in the Arab region are relatively low, calling for concerted efforts to improve them. For instance, data indicates that less than 50% of students who complete lower secondary school possess minimum proficiency in mathematics (refer to the sections entitled "Program for International Student Assessment (PISA)" and "Trends in International Mathematics and Science Study (TIMSS)" in this paper).

4. There has been a moderate increase in basic ICT skills, such as the ability to open and compose an E-mail and use the copy-and-paste function, in the region.

5. Despite serious efforts, most countries still struggle to conduct systematic literacy assessments to determine proficiency levels. Currently, there are attempts to create new common scales for measuring minimum proficiency levels.

6. The student-qualified-teacher ratio for primary and secondary levels for most countries of the region indicates that the teaching capacity has grown.

7. Other issues and challenges:

    a) Three key areas that require prioritization in policy and planning are education or training, disability and education, and enhancing data collection, monitoring, and accountability.

b) The Arab region has seen significant improvement in the topic of disability and education infrastructure, safe school environment, gender-sensitive infrastructure, etc.

c) The COVID-19 pandemic has had a significant impact on the Arab world, one of which is the loss of learning. It is necessary to evaluate this loss of learning so that effective "catch-up" programs can be implemented.

d) The proportion of youth not in employment, education, or training has increased for both young women and men since at least 2012. The rate in the region was estimated at 34.3% in 2020, compared to a global rate of 22.3%.

e) In 2016, 90% of youth aged 15–24 were literate, while only 53% of adults aged 65+ were literate. Additionally, the literacy rate among older females is more than 20 percentage points lower than that of older males.

f) It is important to note that to effectively monitor and track progress on Education for Sustainable Development (ESD) and Global Citizenship Education (GCED) in the Arab region, it is important to establish a common understanding among countries on the necessary competencies and implementation strategies, including policy and curriculum adjustments to align with regional standards for measuring ESD and GCED.

In addition to the above developments, there have been some positive developments in access to the Internet in schools and the availability of computers that are used for pedagogical purposes in schools. However, this development is lopsided with relatively rich countries with small populations, having more access to computers and the Internet. These developments are described below.

Access to the Internet

The Internet and social media have transformed the way education is delivered and accessed. These technologies have made it possible for educators to reach students beyond the physical boundaries of a classroom and for students to access educational resources and connect with peers and teachers. Social media platforms can be used to create online learning communities, share resources and information, and facilitate communication and collaboration among students and teachers. Additionally, the Internet and social media provide easy access to a vast array of multimedia educational content, such as videos, simulations, and interactive learning materials. However, it is important to note that the use of these technologies in education should be balanced with appropriate guidance and usage policies, to ensure that the focus is on learning and not on distraction.

The importance of the Internet was evident during the COVID-19 pandemic when schools had to make transition to online learning. The crisis presented an opportunity for Arab Governments to enhance e-services, but it also highlighted the technology disparities among Arab nations. For example, students in Gulf States and urban areas were at an advantage as they had better access to the Internet and computers for remote education. Data available at Internet World Stats: Usage and population statistics about the Arab countries (https://www.internetworldstats.com/stats5.htm) indicate that Internet penetration ranges from 27% in Yemen to 100% in Bahrain, United Arab Emirates and Qatar with an average of 79.7% in the Arab countries from which data are available. Data also show that a significant percentage of the population has access to one type of social media (Facebook).

Access to the Internet requires having the necessary tools such as computers. As can be gathered from Table 2, in primary education,

only six Gulf countries have full computer access, with Jordan and Mauritania having the lowest access at 13.4% and 14%, respectively. Lebanon has the highest access at 66.5%. For lower secondary education, seven countries have full access, with Comoros having the lowest at 40.5%. For upper secondary education, 8 out of 13 countries have achieved full access, with most countries having access above 90%.

Table 2[5]

Proportion of Schools with Access to Computers for Pedagogical Purposes[6]

Country	Primary Education	Year	Lower Secondary Education	Year	Upper Secondary Education	Year
Bahrain	100	2019	100	2019	100	2019
Comoros	30.8	2017	40.5	2017	52.5	2017
Egypt	94.7	2019	94.8	2017	91.2	2017
Jordan	13.4	2019	61.5	2019	100	2019
Kuwait	100	2019	100	2019	100	2019
Lebanon	66.5	2019	81	2019	91.8	2019
Mauritania	14	2017	100	2016	100	2017
Morocco	76.5	2019	86.2	2019	89.9	2019
Oman	100	2019	100	2019	100	2019
Palestine	93.9	2019	97.9	2019	99.1	2019
Qatar	100	2019	100	2019	100	2019
Saudi Arabia	100	2019	100	2019	100	2019
Tunisia	95.6	2019	99.8	2018	98.4	2019
United Arab Emirates	100	2019	100	2019	100	2019

(5) The proportion of schools with Internet access for educational purposes is calculated by dividing the number of primary schools with Internet infrastructure by the total number of schools in a country. According to Table 3, six Gulf countries have full Internet access, while Comoros has an Internet access rate of less than 15% at all education levels. Jordan has limited Internet access at the primary and lower secondary level, but full access at the upper secondary level. Except for Comoros, Jordan, and Tunisia, all countries have more than 70% Internet access at primary schools, all countries except Comoros and Jordan have more than 85% Internet access at lower secondary schools, and all countries except Comoros and Egypt have more than 89% Internet access at the upper secondary level.

(6) Adapted from, see *Ibid*.

Table 3

Proportion of Schools with Access to the Internet for Pedagogical Purposes[7]

Country	Primary Education	Year	Lower Secondary Education	Year	Upper Secondary Education	Year
Bahrain	100	2019	100	2019	98.4	2019
Comoros	8.0	2017	9.9	2017	12.7	2017
Egypt	71.3	2019	91	2019	47.1	2016
Jordan	13.4	2019	61.5	2019	100	2019
Kuwait	100	2019	100	2019	100	2019
Lebanon	91.1	2019	94.4	2019	96.2	2019
Morocco	82.8	2019	86.8	2019	89.3	2019
Oman	100	2019	100	2019	100	2019
Palestine	90.8	2019	95.8	2019	98.3	2019
Qatar	100	2019	100	2019	100	2019
Saudi Arabia	100	2019	100	2019	100	2019
Tunisia	48.7	2018	99.5	2018	95.4	2018
United Arab Emirates	100	2019	100	2019	100	2019

Persisting Challenges in the Arab Region

One of the major issues facing Arab countries is that their education systems are not preparing students for the demands of the new knowledge economy, making it difficult for these countries to meet the targets of SDG 4 by 2030. This is a significant concern

(7) According to the International Telecommunication Union (ITU, 2021), the proportion of schools with access to the Internet for pedagogical purposes (%) is calculated by the number of primary schools with Internet infrastructure divided by the total number of schools in a country, see *Ibid*.

as failure to adapt could lead to even higher unemployment rates. With advanced manufacturing technologies such as robotics, digital twins[8], and 3D printing being implemented in developed countries, the demand for unskilled labor is decreasing in both developed and developing countries. Arab countries must ensure that their education systems provide young people with the necessary skills to succeed in this new world of work. Two indicators that illustrate the inadequate performance of education systems in Arab countries are the recent results of the Program for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS).

PISA is an international study conducted by the Organisation for Economic Co-operation and Development (OECD) that assesses the knowledge and skills of 15-year-old students in reading, mathematics, and science. The study is conducted every three years and provides data that can be used to compare the educational performance of participating countries. TIMSS is an international assessment of the mathematics and science knowledge of fourth grade and eighth grade students. The study is conducted by the International Association for the Evaluation of Educational Achievement (IEA) and is typically administered every four years. TIMSS provides data on student performance and curriculum, instruction and teacher characteristics, and school and system policies, which can be used to compare the educational systems of participating countries.

(8) A digital twin is a digital replica of a physical object or system used to simulate its behavior and optimize performance. It is used in various industries to improve design, operation, and maintenance.

Program for International Student Assessment (PISA)[9]

PISA 2018 found that the ability of 15-year-old Arab students to apply their knowledge in reading, mathematics, and science to real-life challenges is generally weaker compared to their peers in Cyprus, Israel, Malta, and Turkey. These Arab students also scored below the average for OECD countries. Although the study only included six Arab countries (Jordan, Lebanon, Morocco, Qatar, Saudi Arabia, and UAE), which are also considered to have relatively stable education systems, the findings suggest that the reality of Arab education systems may be worse than the results indicated. Additionally, a small percentage of Arab students were considered top performers (3%), and a high percentage were considered low performers (ranging from 30% to 60%), compared to the average of 16% and 13% respectively for the OECD and neighboring countries. The problem with this distribution of scores is that it is skewed to left, meaning that there are more low scores than high scores. Skewed left distributions can be caused by a variety of factors, such as poor teaching, a difficult exam, or a lack of preparation by the students. It is important to identify and address the cause of the skewness to improve student performance in the future. A left-skewed distribution can be a signal that something is amiss in the learning process and requires further investigation and action to improve student outcomes especially since it involves 15-year-old Arab students who are supposed to be preparing to enter universities and succeed in the scientifically and technologically rich world in the twenty-first century.

(9) Refer to, see "PISA 2018 Results", *OECD*, https://www.oecd.org/pisa publications/pisa-2018-results.htm.

Trends in International Mathematics and Science Study (TIMSS)[10]

The 2019 Trends in International Mathematics and Science Study (TIMSS) revealed a similar trend as the PISA study. It evaluated the performance of fourth-grade and eighth-grade students. None of the seven participating Arab countries (Bahrain, Egypt, Jordan, Kuwait, Oman, Saudi Arabia, and UAE) achieved a score above the 500 benchmark, which represents the 20th percentile. However, Bahrain and UAE scored higher compared to the other five countries.

Scarcity of Top-Tier Researchers in Arab Countries

According to the chapter on Arab countries in the 2021 "UNESCO science report: The race against time for smarter development"[11] world-class researchers are in short supply in Arab countries. Currently, the boundaries between the virtual world and reality, services, and industry are becoming obscured as biotechnology, nanotechnology, informatics, and cognitive sciences merge to create new fields such as bioinformatics, bionanotechnology, and nanorobotics. This is now known as the "Fourth Industrial Revolution". These new scientific fields are typically created in universities' basic science laboratories. This means that countries aiming to develop these new technologies must have a strong capacity for both basic and applied research. However, this poses a problem for Arab countries, in which there is a shortage of world-class researchers. According to the UNESCO science report,

(10) Refer to, see "TIMSS 2019", *TIMSS & PIRLS*, https://timssandpirls.bc.edu/timss2019/.

(11) Refer to United Nations Educational, Scientific and Cultural Organization (UNESCO), "The Arab States", chap. 17 in *UNESCO Science Report: The Race against Time for Smarter Development* (Paris: UNESCO, 2021): 422–465, online e-book, https://unesdoc.unesco.org/ark:/48223/pf0000377472/PDF/377472eng.pdf.multi.

out of almost 6100 highly cited researchers worldwide in 2018, only about 90 were based at universities in the Arab world, mostly in Saudi Arabia, and just six of those are from the region, according to a study of publications in the Web of Science database. However, the positive news is that despite this, many Arab countries are investing in higher education and recruiting top researchers as indicated in the 2021 UNESCO science report: The race against time for smarter development, which indicates that countries such as Qatar, Saudi Arabia, and the UAE that "have been recruiting top scientists for their universities and research institutes".

Recommendations for Implementing STEM Programs Successfully in Arab Countries[12]

To increase the opportunities for success in introducing STEM programs in Arab countries, it is crucial to base the implementation on solid principles from educational research. According to Resnick (2000), nine principles, derived from a combination of psychological and educational research, are key to defining successful education in the 21st century and can help improve student learning. These are: 1) organizing for effort, 2) clear expectations, 3) fair and credible evaluations, 4) recognition of accomplishment, 5) academic rigor in a thinking curriculum, 6) accountable talk, 7) socializing intelligence, 8) self-management of learning, and 9) learning as an apprenticeship.

The principles mentioned above highlight important aspects of education that should be taken into account when designing plans to implement STEM education. It is important to note that realizing these principles requires that the existing culture of schools is not

(12) This section is based on the following chapter by the author, see Saouma BouJaoude, "STEM Education in the Arab Countries: Rationale, Significance, and Future Prospects", in *STEM in Science Education and S in STEM: From Pedagogy to Learning*, edited by Nasser Mansour and Heba El-Deghaidy (Leiden: Brill, 2021): 213–241, online e-book, https://cutt.ly/a9C3xNm.

disrupted, to prevent resistance to change. The principles are relevant to STEM education as students in STEM programs need to put in the effort to succeed, benefit from clear expectations and fair evaluations, and are motivated to continue working hard when recognized for their achievements. Additionally, the STEM curriculum should be challenging and should focus on critical thinking. Moreover, students should be trained to use evidence in their oral and written arguments. Through this type of argumentation, students learn to use the skills of intelligent thinking that will help them address complex and controversial issues inherent in STEM subjects. Finally, success in STEM subjects also requires proper self-management of learning and guidance from competent mentors.

Schools in the 21st century should emphasize that effort, not just ability leads to high achievement for all students. With proper support, all students can develop the skills, knowledge, and attitudes necessary to excel in all subjects. Effort-based schools have clear and high expectations for all students and these expectations are shared among all stakeholders, including administrators, teachers, parents, and the community. All students should be held to high standards in all subjects, particularly in mathematics, science, and technology, as these subjects provide the tools to succeed in a world saturated with science and technology. Mediocrity should not be tolerated as it can widen the gap between those who have access to knowledge and those who do not.

If students are expected to put in the effort to achieve high and challenging standards, their evaluations should be seen as fair and credible for all stakeholders, not just students, parents, and school professionals. The community, including the business community and institutions of higher education, should acknowledge this credibility. In a competitive global environment, society and the business community expect high school graduates to have mastered

the knowledge and skills and developed positive attitudes that can be transferred to other domains. Therefore, it is not enough to teach students just the "what" of knowledge but also the "how" which will equip them to be knowledge producers instead of passive consumers. Fair and credible evaluations help members of the public and the business community to trust and support pre-college education. It is important to have evaluation methods aligned with what is being taught, such as manipulation of equipment, solving problems, and addressing science and technology-related issues. The credibility of evaluation is closely linked to the alignment of what is being measured and how it is being measured. When students put in the work to meet high expectations and evaluations are unbiased and trustworthy, their true accomplishments should be acknowledged. It is important to guide and support students to create high-quality, independent work that is properly recognized.

In the 21st century, education must shift its focus from traditional basics to critical thinking and problem-solving. Teaching content that is disconnected from students' lives and society is no longer effective. Additionally, teaching thinking and problem-solving skills separately from the subject matter is ineffective. To truly teach content, thinking skills must be integrated. Furthermore, the development of thinking skills should not be limited to programs for gifted students. In this new millennium, thinking and problem-solving are essential for all students. Being "intelligent" is a social activity that requires many problem-solving and reasoning abilities, as well as regular use of those abilities. These abilities can be developed when teachers expect students to use them and provide practice opportunities. Therefore, all students in the 21st century should be allowed to develop critical thinking skills and a strong foundation of knowledge that will make them productive and successful citizens.

All educational curricula, at every level and in every subject, should be challenging and structured around key concepts that allow students to engage in real-world problem-solving. While a rigorous thinking curriculum is important across all subjects, it is essential in science, mathematics, and technology. The rapid pace of scientific advancements and technological developments necessitates a focus on thinking, mastering core concepts, and developing lifelong learning skills. Additionally, students should learn and apply scientific inquiry and investigative techniques, as well as comprehend the relationship between science, technology, and society.

Educational research has shown that the way students talk in the classroom is crucial for learning. Simply allowing students to talk is not enough, what matters is that this talk is held to account by the learning community, by correct and appropriate knowledge, and by rigorous thinking. Accountable talk occurs within a community of learners, is based on the evidence relevant to the discipline, and follows logical standards. When used correctly, accountable talk improves students' thinking and helps them construct meaningful knowledge. It is similar to scientific and technological inquiry, as it takes into account the experiences and evidence of others to produce new claims. To prepare students to be lifelong inquirers, it is essential to teach them to use accountable talk at all educational levels. However, this approach will not work if students rely solely on teachers for their learning and evaluation. Therefore, students who think rigorously and use accountable talk must develop self-monitoring strategies to manage their learning. These strategies are key characteristics of scientifically and technologically literate individuals who are constantly seeking new knowledge and skills to stay current in an ever-changing and advancing scientific and technological environment.

In conclusion, 21st-century schools should take advantage of the research on apprenticeship learning and its potential impact

on education. Apprenticeships provide students with advanced interdisciplinary knowledge, exposure to the norms of professional communities, hands-on skills training in a natural setting, and the opportunity to create authentic products under the guidance of experienced professionals. Schools can create environments that mimic real-world settings to enhance students' learning by placing them in places such as research and development labs or technology companies for short periods to develop their knowledge, skills, and attitudes about science, technology, and the workplace.

In addition to the above principles, all Arab countries need to pay serious attention to integrating technology into the teaching and learning process. It is essential to emphasize that the use of technology, specifically the Internet and computers, has become a vital aspect of education. It offers students access to a vast amount of information and resources which have the potential to improve their learning experience. Computers and the Internet provide Interactive activities, simulations, and virtual reality experiences which can make learning more engaging. Schools are also using online assessments and testing to track student progress and provide personalized feedback. Overall, technology in education improves student engagement and achievement by creating dynamic and interactive learning environments.

About the Author

Prof. Saouma BouJaoude

Saouma BouJaoude graduated from the University of Cincinnati, USA, in 1988, with a Doctorate in Science Education. From 1988 to 1993, he was Assistant Professor at Syracuse University, Syracuse, USA.

In 1993, he joined the American University of Beirut (AUB) where he served as Director of the Science and Math Education Center (1994–2003), Chair of the Department of Education (2003–2009), Director of the Center of Teaching and Learning (2009–2021), Associate Dean of the Faculty of Arts and Sciences (2016–2021), and Interim Dean (January 2022–present).

Prof. BouJaoude has published in the Journal of Research in Science Teaching (JRST), Science Education, International Journal of Science Education, Journal of Science Teacher Education, the Science Teacher, and School Science Review, among others. In addition, he has written chapters in edited books in Arabic and English, edited one book, and has been an active presenter at science education conferences. BouJaoude served as Associate editor of JRST and serves on the editorial boards of several science education journals. BouJaoude received the Excellence in the Field of Education/Takreem Award (2010), Kuwait Prize for Contributions to Education in the Arab World (2017), and the NARST Distinguished Contributions to Science Education through Research Award (2020).

About the World Academy of Sciences for the Advancement of Science in Developing Countries Arab Regional Partner (TWAS-AREP)

The World Academy of Sciences for the Advancement of Science in Developing Countries (TWAS) is a global science academy based in Trieste, Italy, since 1983. It works to advance sciences for sustainable prosperity in the developing countries. TWAS is a "program unit" within the United Nations Educational, Scientific and Cultural Organization (UNESCO), a specialized agency under Article 63 of the Charter of United Nations, and an international intergovernmental organization headquartered in Paris, France. TWAS has five regional partners worldwide; the one that works for the Arab region is TWAS Arab Regional Partner (TWAS-AREP).

TWAS-AREP is hosted at the Bibliotheca Alexandrina (BA) through the Center for Special Studies and Programs (CSSP) since 2005.

TWAS-AREP focuses on supporting young scientists in the Arab region; building their capacities, creating networks of excellence and promoting science to the public.

TWAS-AREP aims to advance sciences for sustainable prosperity in the Arab region; and promote scientific capacity and excellence in the region through annual activities for the Arab scientists especially young researchers.

Through its annual activities, TWAS-AREP works to:

- Support young scientists in the Arab region.
- Build the capacities of the young scientists across the Arab region through various activities.

- Reach out for more women scientists in the Arab region to have gender balance at the various TWAS-AREP activities.
- Have balanced representation from different Arab countries of the selected young affiliates.
- Target more networks of scientists from different Arab countries to bring in new contacts with special attention to the least developed countries.

For additional information about TWAS-AREP, please visit:
www.bibalex.org/TWAS-AREP/

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About the Center for Special Studies and Programs (CSSP)

The Center for Special Studies and Programs (CSSP) is one of the Bibliotheca Alexandrina's (BA) academic research centers affiliated with the BA Academic Research Sector. CSSP is dedicated to collaborating with international and national institutions to help support researchers, young scientists, and the academic community at large, creating networks of international collaboration, carrying out research projects in line with the BA mission, developing different scientific and educational programs as well as events that serve the Egyptian and Arab academic community, sponsoring scientific research projects through research grants, and promoting science and technology through public awareness programs.

The CSSP mission is to become a premier force for the dissemination of good practice, advice, resources and for the delivery of needs-based quality skills trainings for scientists and researchers. All CSSP activities and programs aim to prepare researchers and scientists in Egypt and the region to meet today's world's ever-increasing challenges.

CSSP aims to:

- Create networks of international collaboration.
- Support activities that enhance career progression for researchers and young scientists.
- Build researchers capacities through various programs.
- Promote science and technology through public awareness programs.

For additional information about CSSP, please visit:
www.bibalex.org/cssp

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