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Reforming Undergraduate Statistics Education in the Arab World in the Era of Information

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ABSTRACT

This article is the first to thoroughly investigate the state of undergraduate statistics education in the Arab world. It discusses evidence with respect to the quality of education in general and statistics education in particular. Based on a survey of statistics programs in Arab universities, several issues pertaining to curriculum structure, pedagogical practices, and matching learning outcomes with labor market needs are discussed. The survey results reveal a gap between the undergraduate statistics programs in Arab universities and the international curriculum guidelines. This gap signals the urgent need for reforming and enhancing statistics education to address the needs of the labor market in this era of information. Recommendations and strategic reforms based on best international practices are outlined.

KEYWORDS

Arab world; ASA curriculum guidelines; Statistics education; Undergraduate statistics programs

1. Introduction

Over the past few decades, statistics education has received considerable attention worldwide, particularly in the western countries. Tremendous efforts have been directed to strengthening the visibility of statistics as a discipline and promoting undergraduate statistics programs (Higgins 1999; Bryce 2002). As a result, curriculum guidelines for undergraduate programs in statistical science were proposed and approved by the American Statistical Association (ASA) early in the 21st century (Bryce et al. 2001; Cannon et al. 2002). To address the expected employability skills of graduates, the ASA guidelines emphasize five core skills: statistical, mathematical, nonmathematical, computer, and substantive skills (Bryce et al. 2001).

Since then, demand for statisticians has steadily grown worldwide due to the greater appreciation for the role of statistics among business, government, and nonprofit organizations and to the rise of the new emerging fields of big data, data analytics, and data science (Kollipara 2014; ASA 2016). Overall employment for statisticians in the United States grew by 54% between 2000 and 2016, and the number of jobs for graduates with expertise in statistics and machine learning is estimated to grow by 27% between 2012 and 2022 (McKinsey Global Institute 2011). On the supply side, the number of bachelor's degrees awarded in statistics approximately tripled from 2003 to 2013, and the number of universities granting a bachelor's degree in statistics grew by more than 50% during the same period (Pierson 2014). Utts (2015) suggested that the projected demand is still much higher than the projected supply of statisticians. In addition, McKinsey Global Institute predicts that by 2018, the United States could face a shortage of up to 190,000 workers with the skills to analyze big data (McKinsey Global Institute 2011). It is worth noting that similar concerns have been raised in other parts of the world, including the United Kingdom (UK) (Isham 2012), Australia (Kong and Harradine 2006), Japan (Takemura 2013), and South Africa (Zewotir and North 2011).

The pace of supply and demand for statisticians in the Arab states has not yet matched international speed, partly due to the lack of a clear appreciation for the role that statistics plays in decision-making and fostering critical thinkers (Innabi 2014). Statistics education is absent in most K-12 education programs in the Arab world; in the few states that have adopted statistics education in their curricula, the focus has been on basic concepts in probability and statistics, and the subject is usually introduced late in the secondary education as part of the mathematics curriculum. Curriculum updates are, however, taking place in some Arab states. For instance, in the United Arab Emirates (UAE) the teaching of statistics is offered in the primary grades instead of the middle and secondary grades (Innabi 2014).

Despite the remarkable progress in statistics education in Western countries, the role and importance of statistics have yet to be fully recognized in the Arab world. So far, little attention has been paid to evaluating the statistics education in Arab universities, as only a few attempts have been made to investigate business statistics education (e.g., Naccache 2012; Hijazi 2016; Hijazi and Zoubeidi 2017). This study, therefore, is the first of its kind to investigate and assess the content, quality, and delivery of the undergraduate statistics programs in Arab universities, mainly to increase the understanding about the general practice and teaching of statistics in the region, together with providing the required support for higher education reform in the region. In particular, the study seeks to address the following research objectives:

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1. Describe the state of the undergraduate statistics programs offered in the Arab world and assess their alignment with the 2014 ASA curriculum guidelines from content and pedagogical perspectives.
2. Identify a possible mismatch between the knowledge and skills acquired by the graduates of statistics programs and the demands of the labor market.
3. Highlight the major challenges facing the delivery of statistics programs in the Arab region.

The rest of the article is arranged as follows: in Section 2, the background of the study is presented, including a description of recent global developments in undergraduate statistics education, followed by an overview of higher education and a closer look at statistics education in the Arab world. In Section 3, the methodological details, including the development of the survey used in the study and the data collection procedures, are described. The results and discussion are presented in Section 4; finally, the conclusion and recommendations are provided in Section 5.

2. Background

2.1. Recent Developments in Statistics Education

Data science expertise and practical skills (including algorithmic thinking; computing ability; and skills in the acquisition, management, and analysis of complex and big data) are critical requirements in today's world of information. This translates into new opportunities for statisticians and a need for a workforce capable of meeting the demands of the data-driven economy of the future (McKinsey Global Institute 2011; De Veaux et al. 2017). The marked proliferation of complex and rich data in science, industry, and government is prompting the need for updated and new curriculum guidelines to bring about additional learning outcomes (Horton 2015; Horton and Hardin 2015; Ridgway 2016). According to Horton (2015), the new curriculum should incorporate multivariate thinking, the early development of data-related skills, and the expansion of the role of simulation and computation. Gibbons and MacGillivray (2014) further emphasized that new statisticians, besides having a sound statistics foundation, should be equipped with proficient statistical thinking, problem-solving, and communication skills. Responding to these calls, the ASA has released newly updated guidelines for undergraduate programs to meet the demands of the new workplace in the era of data and information (ASA-UGW 2014). The adopted changes stress the increased importance of data science, the ability to think with data and communicate results, early exposure to real applications in the curriculum, and the inclusion of more-diverse models and approaches. The new guidelines reflect changes in both curriculum and pedagogy to ensure that new graduates have the appropriate statistical background, critical thinking, problem-solving skills, and capacity to "think with data" and pose and answer diverse statistical questions. More importantly, the 2014 ASA curriculum guidelines intend to promote creativity in providing a synthesis of theory, methods, computation, and applications in the curriculum. To ensure the proper implementation of the new guidelines and the achievement of its outcomes, a rigorous assessment process should be developed within statistics education programs.

The new ASA curriculum guidelines and the rapid development in the data-centric world provide new insights to build stronger collaboration between statistics educators and computer scientists to develop more-innovative approaches to meet the increasing demand for data experts. Hardin et al. (2015) described several approaches and ideas to integrate data science into statistics curricula to promote students' computational and authentic data experiences. Additionally, several approaches have been proposed to enrich statistics courses with an authentic data experience and modern computing (Nolan and Temple Lang 2010; Cobb 2015; Grimshaw 2015). More recently, analogous to the ASA guidelines for statistics programs, De Veaux et al. (2017) developed curriculum guidelines for undergraduate programs in data science. These guidelines, endorsed by the ASA Board of Directors, propose a structure for institutions to help in planning a new major curriculum or revising an existing one in data science.

Besides the efforts of the ASA, the Royal Statistical Society (RSS) has played an important role in promoting and shaping statistics education within the UK and beyond (Pullinger 2013). These efforts have notably been focused on improving the statistics curriculum content at school and college levels, with less emphasis on university statistics programs (Porkess 2012). Additionally, the RSS accreditation of statistics degrees represents a vital development in ensuring that pedagogical practices within the accredited programs are of high quality and produce graduates with the required technical skills and subject knowledge, meeting the needs of both students and employers (RSS 2017). The RSS accreditation is currently receiving considerable attention from British universities, in addition to two Belgian universities (Universiteit Hasselt and Katholieke Universiteit Leuven) and two Arab universities (Kuwait University and Qatar University). It is imperative to note the high similarity, in terms of the knowledge and skills required of modern statisticians, between the RSS accreditation standards and the ASA guidelines.

In addition, the International Association for Statistical Education (IASE), the official section of the International Statistical Institute (ISI), has played a significant role in improving the teaching and learning of statistics at all education levels over the past three decades. The IASE's contribution is evidenced in several professional meetings and projects, including the International Conference on Teaching Statistics, the International Statistical Literacy Project, and advancing research in statistics education (Zieffler, Garfield, and Fry 2018).

2.2. Overview of Higher Education in the Arab World

The Arab world consists of 22 countries in the Middle East and North Africa with a total population of around 411 million and a population growth rate of 1.9% (World Bank 2017). In the last two decades, the higher education (HE) systems in the Arab world have witnessed remarkable developments and reforms resulting from the rapid population growth and the pressure to narrow the gap between the skills demanded by the labor market and those acquired by the graduates of HE institutions (HEIs)

Table 1. Distribution of the undergraduate statistics programs in Arab universities.

Country	Universities	Programs	Respondents	Country	Universities	Programs	Respondents
Egypt	13	18	8	Bahrain[a]	1	1	1
Iraq	10	10	6	Jordan	1	1	1
Sudan	6	7	4	Qatar[a]	1	1	1
Libya	5	5	1	Tunisia	1	1	1
KSA[a]	5	5	5	UAE[a]	1	1	1
Algeria	4	4	4	Yemen	1	1	0
Lebanon	3	3	3	Syria	3	3	0
Morocco	2	2	1	Somalia	3	3	0
Palestine	2	2	2	Mauritania	–	–	–
Oman[a]	1	3	3	Djibouti	–	–	–
Kuwait[a]	1	2	2	Comoro Islands	–	–	–

[a]GCC countries.

(ElObeidy 2014; UNDP 2014). According to the World Bank (2017), the number of HE students in the Arab world increased from around 5.1 million in 2000 to 11 million in 2017, and the gross enrollment ratio jumped from 18% to 30.3% in the same period. The number of HEIs also rose from 233 in 2003 to over 700 in 2015 (Abu-Orabi 2016). A significant portion of the growth in the number of HEIs has been attributed to the rapid growth of HEIs in the Gulf Cooperation Council (GCC) states, namely the Kingdom of Saudi Arabia (KSA), the UAE, Oman, Qatar, Bahrain, and Kuwait, particularly in the UAE and the KSA (Buckner 2011; Hijazi and Zoubeidi 2017). The GCC and Middle Eastern countries have empowered private HEIs to help in meeting this growing demand and improving the quality of HE (Assaad, Badawy, and Krafft 2016). This empowerment has been accompanied by the establishment of local accreditation and quality assurance agencies to oversee the quality of private HEIs, as well as public HEIs in some countries, such as the UAE, the KSA, and Egypt (Hijazi and Zoubeidi 2017).

The above-mentioned reforms have contributed to HE improvements in the region; however, HE systems in the Arab world remain heavily criticized for their low-quality education and learning outcomes compared to international standards (UNDP 2016; Forster 2018). The ability of the HE systems in the Arab world to equip graduates with the skills needed to meet the demands of the labor market has been questioned, and the systems have been blamed for the high unemployment rates in the region (UNDP 2014). In many Arab countries, such as Egypt, Iraq, and North African countries, public HEIs operate under a centralized governmental system that controls student admissions, curriculum design, and program offerings (Wilkens 2011; Assaad, Badawy, and Krafft 2016). This is largely reflected in the high level of similarity in the program structure across the public universities in these countries. Seen as a step forward in the process of education reform, the GCC countries, however, have modernized their public HEIs by adopting Western practices and hence granting substantially greater autonomy of decision-making at the institutional level (Willoughby 2018; Badran and Muwalla 2019).

Doubts have also been cast on the quality of the region's K-12 education systems, which are constantly blamed for not providing the basic foundation skills needed to secure employment (UNESCO 2014). Faour (2015) highlighted the significant improvements in access to education and student enrollment at various education levels in the Arab region. Nevertheless, he raises two issues: the widespread dissatisfaction with the quality of education in the Arab region and the need for a new social contract that will facilitate comprehensive reform in the education and economic systems. Similar concerns have been raised by other authors about the traditional curricula and pedagogical practices in the Arab region (Dagher and Bou-Jaoude 2011; UNDP 2014; Massialas and Jarrar 2016). A major argument behind such concerns is that the current curricula focus on knowledge that can be measured by traditional exams, emphasize memorization and use obsolete teaching practices. They ignore the development of the human personality, including creative and life skills, and deprive generations of gaining experience of broad knowledge and skills such as thinking, communications, and creativity. Massialas and Jarrar (2016), however, note some serious attempts by many Arab states to align their curricula with contemporary educational principles by shifting toward more performance-oriented and competency-based models for the better evaluation of students' learning.

The previous discussion suggests the need for the Arab education system to undertake significant reforms and investments to bring about real changes in curricula, with a particular focus on science education. In this era of a digital divide, the demand for data talents and scientific skills is increasing in virtually all shades of industry (UNDP 2014).

2.3. Overview of Statistics Education in the Arab World

Statistics education at the university level in the Arab world was introduced in the 1950s in Egypt and Iraq. As shown in Table 1, there are currently 64 universities, offering 73 undergraduate programs in statistics across 19 of the 22 Arab countries. In some universities, more than one statistics program is offered either by the same department (e.g., at Kuwait University) or by different departments (mostly science and business departments), as in the case of Sultan Qaboos University in Oman and most Egyptian universities. No statistics programs are offered in universities located in three of the Arab countries, namely Djibouti, Mauritania, and the Comoro Islands. Around 60% of the universities offering statistics programs are located in Egypt, Iraq, and Sudan. In eight Arab countries, statistics programs are offered by only one university.

As shown in Table 2, public universities offer the majority (93%) of the programs; the rest are offered by private not-for-profit universities, mainly in Lebanon and Palestine. Close

Table 2. Characteristics of the undergraduate statistics programs in Arab universities.

Characteristic	Number	Percentage
University type		
Public	57	93%
Private	4	7%
Location		
Science	41	59%
Business	29	41%
Region		
GCC	12	17%
Non-GCC	58	83%
Program title		
Statistics/applied statistics	45	64%
Statistics and computer science	12	17%
Statistics and business	9	13%
Mathematics and statistics	4	6%

Table 3. Statistics graduates in five Arab states during 2013–2016.

Country	2013	2014	2015	2016
Egypt	582	256	491	469
Tunisia	78	58	66	53
UAE	24	28	30	18
Oman	38	35	72	56
Qatar	16	15	12	25

Source: Compiled from statistics centers and universities' websites.

to two-thirds (59%) of the statistics programs are offered by science colleges. These are mainly located in the GCC countries, Sudan, and the North African Arab countries. The remaining 41% of the programs are offered by business colleges, mainly in Iraq, Palestine, and Egypt. Slightly more than a third of these programs are offered jointly with other disciplines, such as computer science, business, or mathematics, with the aim of attracting more students. However, as statistics is not an independent subject at the K-12 level in Arab states, there is no market demand for statistics teachers; therefore, most statistics graduates end up landing nonteaching jobs in the public sector, with few opportunities in the private sector. As a result, many statistics programs in the Arab world are facing a recruitment dilemma and are struggling to survive.

Despite the significant expansion and reforms in the HE systems in the Arab world and the increasing demand for statisticians worldwide, statistics education in the Arab world is still lagging behind similar programs in the Western world. In the last two decades, only four new undergraduate programs in statistics have been initiated—in the KSA and Iraq. Due to the low demand for statistics education, some of the universities have even closed or frozen existing statistics programs or minors (e.g., Tabuk University and Princess Noura Bint Abdulrahman University in the KSA and Birzeit University in Palestine). The demand for statistics education in the Arab world is fluctuating and has never shown any increasing trend (see Table 3), contradicting the worldwide patterns noted earlier in this article. The statistics profession in the Arab world seems to have an identity crisis similar to that observed in the United States in the 20th century (Hunter 1994; Mason 2004). It is clear that the importance and visibility of statistics and statisticians are not evident to society and younger generations. In the United States, the ASA, together with U.S. universities, has worked diligently over the years to strengthen statistics programs and promote statistics as a vital profession (Ruberg and Mason 1988; Landes 2009). In the Arab world, the Union of Arab Statisticians (UAS) was established in 2007 as a professional society for Arab statisticians, with the main objective of helping statisticians and promoting the statistics profession in the Arab states. Unfortunately, the UAS has so far failed to present a good image of Arab statisticians and the critical role that statistics play in all fields of life. The UAS has tended to focus on official statisticians across Arab states, with less attention being paid to academic statisticians and building relationships with universities. Overall, the efforts to improve the profession in the region are still ambivalent and scattered.

The foregoing discussion necessitates further investigation of statistics education in the Arab region. Such research would help to increase the stakeholders' understanding of several issues, including the current state of the undergraduate statistics programs in Arab universities in terms of alignment to recent global curricular updates, in particular the 2014 ASA curriculum guidelines. These guidelines, to the best of our knowledge, are the only detailed and focused roadmap for the structure and delivery of undergraduate statistics programs in the era of globalization and the data revolution. More importantly, these guidelines largely suit Arab universities, where American-style HE has notable popularity (Ghabra and Arnold 2007; Bhandari and El-Amine 2012).

3. Methodology

3.1. Survey Coverage and Design

The target population of this study consisted of 70 statistics programs offered by 61 universities in 18 out of the 22 Arab states. Four states were excluded from the investigation, either because they did not offer statistics programs in their curricula, as in the case of Djibouti, Mauritania, and the Comoro Islands, or due to difficulty in making the required contacts because of ongoing war and instability, as in the case of Somalia. The targeted universities and colleges were identified via their respective websites and local ministries of education in the countries or via lists published by the Webometrics Ranking of World Universities. Contact information relating to department chairs, including E-mail addresses and contact numbers, was obtained from the corresponding websites. Although the targeted respondents in this study were the chairs of the statistics programs, the contact information of the college deans hosting these programs was also collected, in case a follow-up was needed to encourage more responses. Additionally, the curriculum plans of the targeted programs were obtained to allow a detailed review. The choice of the department chairs as respondents to this survey was grounded in the fact that department chairs do assume an essential role of leading faculty in important processes that shape the curriculum and affect the program goals and students' learning. They are also responsible for developing the department's academic programs within the mission and plans of the college and articulating these to internal and external constituencies, including community members and local businesses and industries.

3.2. Survey Instrument and Data Collection

To realize the study objectives, the data collection process employed a survey instrument that used an online questionnaire, deployed online using a web-based survey platform. Utilizing the literature review presented in the preceding sections, the questionnaire was designed to gather comprehensive information on the undergraduate statistics programs offered in the Arab region. It consisted of six sections; see the Appendix for detailed coverage on each section. The first section gathered general information about the program's orientation. The second and third sections collected information about the program content and pedagogical delivery in accordance with the ASA-UGW (2014) guidelines. The fourth section contained questions about faculty and employers' perceptions of the quality of the program's graduates. The fifth section consisted of questions about recent and planned curriculum changes, while the last section elicited information about the general and specific challenges facing the program. It is worth noting that the questionnaire was developed in English and translated into Arabic; both versions were made available to participants during the data collection process to eliminate any language-related bias.

An invitation was sent by E-mail to all 70 department chairs, representing the study sampling frame, to participate in the survey during spring 2017. To improve the response rate, four reminders were E-mailed to nonrespondents at two-week intervals. In a few cases, chairs were contacted personally by phone and encouraged to complete the survey. In two other cases, they were approached through the college deans.

After closing the online survey, 44 completed questionnaires had been received, marking a reasonable response rate of around 65%, excluding four inactive programs. As shown in Table 1, all programs offered by the GCC universities and around half of the programs in the Egyptian and Iraqi universities were represented in the survey responses. No responses were received from the universities located in countries witnessing political conflicts, namely Syria and Yemen.

4. Results and Discussion

The results and discussion provided in this section are based on the data gathered from the 44 statistics program representatives using the questionnaire described earlier. The results and discussion are organized to address the three research objectives outlined earlier.

4.1. Sample Summary

Table 4 displays a summary of the general characteristics of the programs surveyed. About a quarter of the statistics programs were located in the GCC region, and about 40% of the responding programs were housed in business colleges. Two-thirds of the surveyed programs used English as the language of instruction including all programs offered in GCC and Lebanese universities, while the Arabic language was used in 25% of the programs mainly in Sudan, Iraq, and Egypt. Only six (14%) North African Arab statistics programs used French in the course delivery. About a third of the programs graduated 10–29 students annually, and another third, mainly in Egypt, Iraq, and Sudan, graduated 50 or more per year. Employment by the government appeared to be the choice destination for more than half of the graduates. Only 10% of the surveyed program representatives specified business or industry sectors as a destination for their statistics graduates. One may attribute such findings to the fact that statistics is still not well recognized by business and industry sectors as a standalone profession, where simple statistics activities are conducted by nonstatisticians with some statistical knowledge.

Table 4. Characteristics of the surveyed statistics programs.

Characteristic	Number (%)	Characteristic	Number (%)
Region		*Annual number of graduates*[a]	
Non-GCC	32 (73)	Fewer than 10	9 (21)
GCC	12 (27)	10–29	15 (35)
Location		30–49	5 (12)
Business	18 (41)	50+	14 (32)
Science	26 (59)		
Language of instruction		*Main destination of statistics graduates*[a]	
Arabic	11 (25)	Government	24 (58)
English	27 (61)	Statistics agencies	13 (32)
French	6 (14)	Business/industry	4 (10)

[a]Slight variations in the reported sample size are due to nonresponses by chairs.

4.2. Topic Coverage

According to the ASA-UGW (2014), statistics programs should provide graduates with sufficient background in the first five areas listed in Table 5. It is apparent that traditional statistical methods and theory, data manipulation, and computation, together with mathematical foundations, are receiving appropriate coverage in the statistics programs in the Arab states. More than two-thirds of the surveyed programs had full or partial coverage of these topics. A review of the curricular structures of the surveyed programs shows reasonable coverage of fundamental concepts such as mathematical statistics, data analysis, surveys and experimental design, and statistical modeling. As noted earlier, the overwhelming majority of the statistics graduates were employed in either government or statistics centers. Hence, the inclusion of official statistics, demography, and survey methodology in courses is a necessity to ensure the readiness of graduates for their potential workplaces. Among the surveyed programs, few offered content on official statistics and demography, but the majority of programs included survey methodology. The statistics programs offered by the GCC universities tended to have reasonable coverage of statistical methods and theory. A few of the programs offered in business colleges in non-GCC universities, mainly in Iraq, reported no coverage of statistical methods and theory.

With regard to data manipulation and computation, all the surveyed programs used at least one professional statistical software package, in particular SPSS (91%), Excel (89%), Minitab (66%), R (61%), and SAS (19%). Minitab and R were more common in programs hosted by colleges of science in the GCC universities. The outcomes from reviewing the curricular content of the surveyed statistics programs indicate that the teaching of statistical computing and simulation (44%) was less common than the teaching of traditional statistical courses that depended on using statistical packages (69%). This is surprising,

Table 5. Topics covered by the surveyed statistics programs.

Topic	Region	Coverage			College	Coverage		
		No/implicit	Partial	Full		No/implicit	Partial	Full
Statistical methods and theory	Non-GCC	25%	13%	62%	Business	17%	17%	66%
	GCC	0%	25%	75%	Science	19%	15%	66%
Data manipulation and computation	Non-GCC	25%	28%	47%	Business	22%	28%	50%
	GCC	8%	33%	59%	Science	19%	31%	50%
Mathematical foundations	Non-GCC	31%	16%	53%	Business	33%	22%	45%
	GCC	17%	8%	75%	Science	23%	8%	69%
Practice and communication of statistical findings	Non-GCC	38%	38%	24%	Business	39%	39%	22%
	GCC	0%	33%	67%	Science	19%	35%	46%
Disciplines other than statistics	Non-GCC	38%	24%	38%	Business	44%	6%	50%
	GCC	42%	8%	50%	Science	35%	30%	35%
Big data and data science	Non-GCC	41%	41%	18%	Business	44%	39%	17%
	GCC	42%	50%	8%	Science	39%	46%	15%

Implicit coverage: Informal coverage (in-class discussion, assignment).
Partial coverage: Covered partially in a course (as a chapter or more).
Full coverage: Covered as a separate course.

considering the widespread availability of free statistical software such as R. Around 60% of the programs emphasized mathematical foundations and concepts, particularly the teaching of probability and calculus. Calculus, together with linear algebra, were common requirements of the statistics programs offered by science colleges. Business mathematics or business calculus, on the other hand, was a common requirement in business colleges.

Topics in statistics devoted to professional practice with hands-on experience are important to develop students' soft skills, such as communication and teamwork skills. According to the survey results, around a third of the programs offered full coverage of statistical practice (see Table 5). Notably, the programs offered in the GCC universities showed considerably higher coverage, which was also apparent in the programs offered by science colleges. In response to the questions with regard to the opportunities given to graduating students to practice the work of statistics, only 7% of the respondents indicated that students were not exposed to practicing statistics through capstone courses or internship opportunities. More than 50% of the programs engaged their undergraduate students in capstone and internship experiences. Interestingly, internship activities were more common in the statistics programs hosted by business colleges, while capstone courses appeared more common in science-based programs. Nonetheless, the lack of access to data and data scarcity in the Arab world, as highlighted by Angel-Urdinola, Hilger, and Ivins (2011), may minimize the opportunities of statistics students to experience working with real data during their internships and course of study.

Discipline-specific knowledge, as illustrated by the ASA-UGW (2014), allows students to apply statistical reasoning to domain-specific questions through deep substantive knowledge in a specific area of application. Nearly 40% of the surveyed programs offered educational experience in another discipline. Half of the statistics programs offered in the GCC countries, as well as half of those offered by business colleges, provided full coverage of experience in other disciplines. Among the surveyed programs, the common disciplines included insurance and operations research in the GCC countries and Egypt; computer science in Sudan and Lebanon; business and economics in North African countries, Iraq, and Palestine; and biostatistics in Oman. In this context, it is important to stress the advantage of offering statistics programs in business colleges, where college requirements expose statistics students to statistical applications in economics, accounting, business, finance, and other related areas.

Big data and data science topics received less attention, with 41% of the surveyed programs having partial coverage and only 16% having full coverage. This finding shows a need for curricular updates to incorporate and emphasize more data science topics. As discussed earlier, topics of data science are essential in today's workplace, and graduates need to develop statistical thinking to be able to understand how to deal with multiple sources of data and to address complex problems.

4.3. Pedagogical Practices

Table 6 uses data on levels of usage of the various pedagogical approaches in the Arab region, evaluated on a 1–5 scale as suggested by the ASA-UGW (2014). For convenience, the five-point scale has been condensed in Table 6 into three categories of usage—low, medium, and high. The findings reveal a remarkable use of statistical computing, synthesis of theory and applications, and team activities. By contrast, the respondents reported a lower level of emphasis on authentic real-world data, developing problem-solving skills, and incorporating regular assessment of learning.

The statistics programs offered in the GCC countries showed higher levels of involvement in regular outcomes assessment activities, the synthesis of theory and applications, and the development of problem-solving skills. This could mainly be attributed to the adoption of modern pedagogical practices as part of the educational reforms that are aiming to develop 21st-century skills and their success in attracting expatriate faculty with teaching experience in Western institutions. Reviewing the faculty profiles, it is clear that a considerable proportion of the faculty who were teaching statistics in the non-GCC countries had not been exposed to modern pedagogical practices, particularly those faculty who had received their postgraduate education in Arab universities, mainly in Egypt.

Statistics programs in colleges of science, in particular, showed higher levels of modern pedagogical practices, except in the areas of statistical computing and authentic data. It is worth noting that the availability of relevant real-world data is a

Table 6. The use of pedagogical approaches in teaching statistics.

Approach	Region[b]	Usage level[a] Low	Medium	High	College[c]	Usage level Low	Medium	High
Use of authentic real-world data	Non-GCC	13%	32%	55%	Business	17%	28%	55%
	GCC	8%	54%	38%	Science	8%	46%	46%
Develop flexible problem-solving skills	Non-GCC	10%	39%	51%	Business	11%	39%	50%
	GCC	8%	15%	77%	Science	8%	27%	65%
Include experience with statistical computing and data-related skills	Non-GCC	7%	19%	74%	Business	5%	17%	78%
	GCC	0%	46%	54%	Science	4%	35%	61%
Encourage synthesis of theory, methods, computation, and applications	Non-GCC	7%	19%	74%	Business	5%	28%	67%
	GCC	0%	31%	69%	Science	4%	19%	77%
Provide opportunities to work in teams	Non-GCC	17%	17%	66%	Business	17%	22%	61%
	GCC	23%	15%	62%	Science	20%	12%	68%
Integrate training in professional conduct and ethics	Non-GCC	16%	42%	42%	Business	11%	61%	28%
	GCC	8%	46%	46%	Science	15%	31%	54%
Incorporate regular assessment to provide authentic feedback	Non-GCC	19%	42%	39%	Business	22%	45%	33%
	GCC	15%	8%	77%	Science	15%	23%	62%

[a]Low (1–2), medium (3), and high (4–5).
[b]Non-GCC ($n = 32$), GCC ($n = 12$).
[c]Business ($n = 18$), Science ($n = 26$).

prominent challenge in the Arab world. In terms of the focus on outcomes, the majority of the programs did not seem to place strong emphasis on promoting a culture of outcomes assessment. However, the growing interest in local and international accreditations, particularly in business colleges, is leading to an increased focus on this area, mainly in the GCC countries. It is apparent that statistics programs in the Arab world do not seem to emphasize the importance of compliance with ethical guidelines in statistical practices in their pedagogy (see Table 6). Although ethical awareness and reasoning received remarkable attention in general education programs, ethics related to dealing with data was not typically included in such coverage. Hence, it is vital to integrate ethical guidelines for statistical practice throughout the statistics programs, as recommended by the ASA-UGW (2014) and illustrated by Cohen (2014) and Elliott, Stokes, and Cao (2018).

4.4. Quality of Graduates

To assess the quality of statistics graduates in the region, the programs' chairs were asked to evaluate the level of preparation of typical graduates and the feedback they regularly receive from employers. The results, as shown in Table 7, indicate that graduates were well prepared in data visualization, working in teams and presentation skills. However, they showed some weaknesses in communication skills, problem-solving skills, and critical thinking. The graduates of the statistics programs located in the GCC countries were better prepared compared to the graduates of the non-GCC programs in terms of data visualization and communication skills, but less prepared in personal communications, problem-solving skills, and critical thinking.

These observed weaknesses might be attributed to the language barrier, as Arabic is the mother tongue but English is the language of instruction in most of the surveyed statistics programs. English proficiency is not only a factor in developing and promoting oral and written communication skills but also appears to be critical for students' performance in mathematics courses (Yushau 2009; Abdelbasit 2010). Instructors are encouraged to use various pedagogical approaches to engage students in the problem-solving process and to equip them with methods to enhance their critical thinking abilities through interactive activities such as experiential learning (Hakeem 2001), working with real-world data (Neumann, Hood, and Neumann 2013), and analyzing case studies (Khachatryan 2015).

The lack of strong communication skills affects the ability of statistics students to interact and communicate with clients and collaborators. According to the ASA-UGW (2014), students must have genuine opportunities to practice the work of being a statistician through one or more of the following: internships, capstone courses, consulting experiences, or research experiences. As illustrated earlier, statistics students are not expected to fully benefit from internship or consulting experience. Hence, there is an urgent need to strengthen the linkages between universities and the private sector through expanded partnerships. This, undoubtedly, could result in ample internship experiences that would expose students to real-world situations prior to graduation (Wilkens 2011).

The results in the lower panel of Table 7 depict the perceptions of employers with regard to the preparation of statistics graduates, as reported by the chairs of the surveyed programs. As expected, employers had rated their graduates very highly with regard to statistical knowledge and analytical skills, particularly in the GCC countries. However, there was a clear divide over the "overall career preparation" of graduates, reflecting the weak development of soft skills and competencies deemed necessary for the labor market. This average rating was observed in countries with multiple programs such as Egypt, Iraq, and the KSA. This, again, raises the question about the pedagogical approaches followed in these programs and the effectiveness of students' internship experiences.

4.5. Curricular Changes

Changes in undergraduate statistics education are currently a worldwide phenomenon stemming from the need to prepare

Table 7. The perceptions of chairs and employers on the preparation of statistics graduates.

		Quality rating[a]				Quality rating		
	Region[b]	Low	Medium	High	College[c]	Low	Medium	High
Faculty perceptions								
Effective technical writing	Non-GCC	13%	45%	42%	Business	11%	56%	33%
	GCC	8%	54%	38%	Science	12%	42%	46%
Presentation skills	Non-GCC	10%	42%	48%	Business	17%	28%	55%
	GCC	8%	31%	61%	Science	4%	46%	50%
Data visualization	Non-GCC	6%	29%	65%	Business	11%	28%	61%
	GCC	0%	31%	69%	Science	0%	31%	69%
Teamwork and collaboration	Non-GCC	13%	27%	60%	Business	22%	33%	45%
	GCC	8%	31%	61%	Science	4%	24%	72%
Interaction and communications with Others	Non-GCC	10%	43%	47%	Business	22%	39%	39%
	GCC	15%	39%	46%	Science	4%	44%	52%
Problem solving	Non-GCC	10%	48%	42%	Business	17%	55%	28%
	GCC	23%	46%	31%	Science	12%	42%	46%
Critical thinking	Non-GCC	13%	45%	42%	Business	17%	50%	33%
	GCC	23%	39%	38%	Science	15%	39%	46%
Employers perceptions								
Statistical knowledge	Non-GCC	17%	21%	62%	Business	23%	24%	53%
	GCC	0%	9%	91%	Science	4%	13%	83%
Analytical and statistical skills	Non-GCC	10%	17%	73%	Business	12%	23%	65%
	GCC	0%	0%	100%	Science	4%	4%	92%
Overall career preparation	Non-GCC	32%	29%	39%	Business	29%	18%	53%
	GCC	27%	18%	55%	Science	32%	32%	36%

[a]Low (1–2), medium (3), and high (4–5).
[b]Non-GCC ($n = 32$), GCC ($n = 12$).
[c]Business ($n = 18$), Science ($n = 26$).

Table 8. Curriculum development in the undergraduate statistics programs.

	Non-GCC countries ($n = 32$)	GCC countries ($n = 12$)	Business ($n = 18$)	Science ($n = 26$)
Major changes in the program in the past five years	75%	33%	72%	58%
Drivers of curriculum changes				
Labor market needs	66%	75%	78%	62%
Following guidelines from statistical associations	25%	50%	28%	35%
Updating the program structure	63%	75%	78%	58%
Updating the program content	78%	83%	89%	73%
Following university policies	44%	75%	50%	54%
Responding to accreditation requirements	41%	58%	39%	50%
Future plans for curriculum changes	58%	75%	67%	60%

NOTE: Percentages in the table represent the proportions of respondents in each category who nominated each specific driver of curriculum change.

statisticians to meet the expectations of the demanding labor market, to cope with the rapidly changing discipline of statistics and to be ready for the era of information. Table 8 summarizes the past and future plans for curricular changes reported by the representatives of the surveyed programs. About two-thirds of these programs had undergone major changes in the past five years, particularly the programs offered in business colleges and those in the non-GCC countries. The reported modifications concerned changes in the curricula, more learning of statistical software, and more practical and hands-on training. One of the commonly cited changes was adding new courses in areas such as big data, actuarial science, nonlinear regression, finance, and economics.

The respondents cited updating program content and labor market needs as the main driving forces behind these changes. Interestingly, about a third of the respondents, mainly those from the GCC countries, indicated that responding to the ASA guidelines was one of the reasons for the implemented changes. This is not surprising, considering that the survey results showed that around 30% of the respondents were not aware of such guidelines, particularly in the North African universities, where more links are made with the French education system. As further shown in Table 8, the emerging culture of accreditation and quality assurance played a significant role in initiating changes in the statistics programs, particularly those in the GCC countries. It is worth noting that the statistics programs offered by Kuwait University and Qatar University are accredited by the RSS.

The survey further revealed that over 60% of the respondents, including 75% of those in the GCC countries, were expecting more changes in the next 2–3 years. Generally, the reported expected changes were minor in nature compared to those required to align with best international practices. They do not specifically respond to the rapid changes in the image and job description of modern statisticians. This might partially be attributed to the status quo culture in the Arab HE systems and the low interest in introducing serious changes, especially in the traditional education systems in countries such as Egypt, Iraq, and those in North Africa. Wilkens (2011) indicated that there is a need for Arab universities to focus on adopting a culture of evaluation and accountability to assess teaching, program quality, and student outcomes. To move forward, there is a

Table 9. The perceptions of the challenges facing the delivery of the statistics programs.

Obstacles	Region[b]	Level[a] Low	Medium	High	College[c]	Level Low	Medium	High
Shortage of qualified faculty	Non-GCC	33%	17%	50%	Business	22%	28%	50%
	GCC	15%	31%	54%	Science	32%	16%	52%
Availability of textbooks	Non-GCC	33%	23%	44%	Business	39%	17%	44%
	GCC	62%	23%	15%	Science	44%	28%	28%
Availability of authentic real data	Non-GCC	40%	13%	47%	Business	33%	11%	56%
	GCC	15%	39%	46%	Science	32%	28%	40%
Availability of statistical packages	Non-GCC	37%	23%	40%	Business	33%	28%	39%
	GCC	46%	15%	39%	Science	44%	16%	40%
Attracting good students	Non-GCC	17%	13%	70%	Business	11%	11%	78%
	GCC	8%	15%	77%	Science	16%	16%	68%
Employability of graduates	Non-GCC	21%	14%	65%	Business	12%	12%	76%
	GCC	25%	17%	58%	Science	29%	17%	54%
Business/industry collaboration	Non-GCC	23%	13%	64%	Business	11%	6%	83%
	GCC	31%	23%	46%	Science	36%	24%	40%
Availability of internship opportunities for students	Non-GCC	33%	7%	60%	Business	22%	11%	67%
	GCC	15%	31%	54%	Science	32%	16%	52%

[a]Low (1–2), medium (3), and high (4–5).
[b]Non-GCC ($n = 32$), GCC ($n = 12$).
[c]Business ($n = 18$), science ($n = 26$).

need to realign and benchmark practices with quality assurance standards to ensure relevance and improved educational and societal outcomes (Ahmad et al. 2016).

4.6. Challenges

The Arab world is no exception to the growing challenges and opportunities facing statistics education worldwide. Table 9 summarizes some of the most prominent challenges facing statistics programs in the Arab world, as reported by the surveyed program chairs. The ability to recruit talented students to statistics programs represents the biggest challenge. According to Makar and Rubin (2018), there is a serious concern about the decline in the number of students joining mathematics and statistics programs in developed countries such as Australia and the UK. In the Arab world, statistics as a discipline has an identity crisis, and a career in statistics is not well recognized. Due to social and cultural norms, studying medicine or engineering is usually the top choice for high-performing secondary school graduates, while business education remains the first choice for national students in the GCC countries. In general, students joining colleges of science are looking mainly for a career in teaching mathematics or science, while those admitted to business colleges are mainly aspiring to managerial or financial careers. In the Arab world, statisticians still do not fit in any of these career avenues. In the United States, the Advanced Placement (AP) Statistics Exam has played a crucial role in publicizing and marketing statistics among high school students (Franklin et al. 2011). As emphasized by Innabi (2014), the perception of the Arab public toward statistics needs to change, and the role of statistics in developing and fostering critical thinking should be recognized and acknowledged.

The respondents also raised concerns about the employability of their graduates, their relationships with the business sector and the availability of internship opportunities for their students, particularly in the non-GCC countries and in the business-based statistics programs. Undoubtedly, these challenges are interrelated and need to be addressed. As recommended in many knowledge-sharing and policy development debates, universities should take genuine steps toward building and expanding partnerships and cooperation with the business and economic sectors (Wilkens 2011). Forging such partnerships would imply that HEIs are seriously working on achieving the goals of aligning education programs with the labor market and societal needs. As for the students and graduates of statistics, such partnerships would create crucial opportunities for training, internship, and employment. Moreover, building strong linkages with the governmental and business sectors would facilitate access to relevant and authentic real-life data for teaching, learning, and research purposes. As noted earlier, Arab statistics programs are offered mainly by public universities, which gives an advantage to these universities to establish collaborations with the public sector and the private sector. Most of the public universities in the region have been operating for decades and hence have succeeded in establishing ties with the surrounding community. They further enjoy the privilege of having greater access to governmental institutions compared to the private and newly established colleges.

The shortage of qualified faculty generally, and particularly in statistics, is another challenge to statistics education in the Arab region. The responding chairs from the GCC countries expressed concerns about this issue. The problem is a global one, as similar concerns have been raised in Western countries (Tishkovskaya and Lancaster 2012). With the rapidly growing demand for statisticians and data scientists worldwide, the problem is likely to get more complicated. Only a few postgraduate programs in statistics are available in the Arab world, mainly in Egypt and Syria and recently in Saudi Arabia. Traditionally, Arab students have headed to the West to pursue postgraduate education in statistics. Most of these students either stay in the West to access better career opportunities or are recruited to work in the oil-rich GCC countries. The chairs of the statistics programs in the GCC universities also shared similar concerns with regard to shortages in qualified statisticians. It seems that there are no clear workable strategies to address this regional problem. One suggested solution involves reattracting doctorally prepared Arab statisticians to help in capacity building and

the training of local human resources. Istaiteyeh and Beatrice (2011) noted a positive impact from the return of Arab Ph.D. graduates from the West in building and promoting the HE systems in the region.

The availability of teaching and learning resources was not perceived as a serious obstacle for the statistics programs in the GCC countries. Traditionally, GCC public universities have been fully financed by central governments. Students in this region enjoy education free of tuition fees, in addition to the availability of IT infrastructure and modern learning and teaching technologies. As English was the official language of instruction in all the surveyed GCC statistics programs, Western textbooks constituted the primary course material in these programs. Yet, as Abdelbasit (2010) indicated, most of the examples and exercises in Western textbooks are irrelevant to Arab culture and hence may hinder the understanding and application of statistical concepts. On the other hand, the availability of textbooks and statistical software packages represented a notable obstacle for the non-GCC programs, particularly those delivered in Arabic and French. Although providing textbooks written in the Arabic language is an advantage, the quality of such textbooks in business and science remains a concern (Hijazi and Zoubeidi 2017). The limited resources and the high cost of statistical software packages presented further challenges to the non-GCC statistics programs. The recent release, however, of powerful free software such as R has helped to minimize the need for high-cost statistical packages. Finally, the availability of authentic real data remained a considerable challenge for the statistics programs due to the data scarcity in the Arab world, as indicated earlier.

5. Conclusion and Recommendations

In this study, 44 undergraduate statistics programs from 16 Arab countries were surveyed to investigate the status of undergraduate statistics education in the Arab world. Content, pedagogy, and practices were compared to the best practices recommended by international statistical societies.

The results of the study indicate that the statistics curriculum in the Arab region is still traditional and is not in line with the rapidly changing discipline of statistics in the era of information. Moreover, there has been great emphasis on statistical knowledge while ignoring the soft skills and competencies expected from 21st-century statisticians. The HE systems in the Arab states have long been criticized for the lack of educational quality and appropriate preparation of graduates for the labor market. Statistics education is no exception in this regard. The challenges facing statistics programs in the region, as previously noted, jeopardize the future of the statistics discipline and the job prospects for statisticians in the Arab world.

The need for the reform of statistics education is inevitable in the Arab HE systems. Undoubtedly, the reform should start with a better introduction of statistics in schools' curricula as a 21st-century science, emphasizing the utilization of modern technologies and data visualization and modeling techniques. The Guidelines for Assessment and Instruction in Statistics Education (GAISE) for pre-K-12 education, endorsed by the ASA, presents a developmental framework for structuring a statistics curriculum and provides valuable guidelines for teaching statistics and assessment at the pre-K-12 level (Franklin et al. 2007). This influential report could serve as a basis for the reform of statistics education in schools in the Arab region. Several countries, including the UAE, Qatar, and Palestine, have recently introduced the teaching of probability and data analysis in school mathematics curricula, starting from the early years of schooling. Other Arab countries need to follow a similar track.

More work needs to be done also at the college level. For this to happen, education programs need to go beyond cosmetic changes and explore more-comprehensive and -sustainable reform strategies. Another important stage involves promoting statistics among the younger generations and strengthening its role in economic development and the knowledge economy, as well as in everyday life activities. The statistics programs in Arab universities, with help from statistics agencies and government support, should implement strategic marketing initiatives to achieve this goal. As evidenced by this study, most of the graduates of the statistics programs in the region are employed by the government and the public sector. The small presence of statisticians in the private sector may in part reflect the lack of appreciation of statistics and statisticians in this region of the world. Hence, building and strengthening linkages with the private sector will start by marketing statistics in a way that reflects its versatility and vitality in the process of business improvement and decision-making.

At the university level, statistics programs should initiate thorough program reviews, taking into account the curriculum guidelines introduced by international statistics societies such as the ASA-UGW (2014), in addition to the demands of the local market. Additionally, the inclusion of emerging and attractive topics such as data analytics, big data, and data science is critical to help to market statistics majors and attract talented students. Moreover, to better prepare graduates for successful careers in statistics, statistics programs should provide students with ample opportunities to practice statistics through, for example, capstone courses, internships, consulting experiences, research experiences, or a combination of these (ASA-UGW 2014). Such experiences would improve students' outcomes and their career opportunities and would allow students to develop a passion for statistics (Martonosi and Williams 2016).

The placement of many statistics programs in colleges of business is an advantage that should be exploited to augment statistics degrees with minors or concentrations in business themes such as economics, finance, marketing, and management. In addition, the programs hosted by colleges of science should consider similar approaches to enrich their programs with discipline-specific knowledge in areas such as biology, chemistry, or computer science. Fortunately, the ASA-UGW (2014) presented updated guidelines for undergraduate statistics minors and concentrations in the above-mentioned fields. Additionally, and depending on labor market needs, universities may introduce new programs in data science through collaboration between the statistics and information science faculties. In this context, De Veaux et al. (2017) and the National Academies of Sciences, Engineering and Medicine (NASEM 2018) provide basic guidelines for developing new programs in data science for undergraduates.

As stressed by the ASA-UGW (2014) and Wild, Utts, and Horton (2018), a new curriculum requires a new pedagogy

to ensure the better application of statistics. Instructors are expected to address, in addition to statistical knowledge, the skills and competencies expected of modern statisticians. These include, but are not limited to, oral and written communications, critical thinking, problem-solving, teamwork and collaboration, ethics and social responsibility, and computing abilities. The aforementioned qualities should be developed through appropriate pedagogical approaches as recommended by researchers and practitioners and consistent with the learning and teaching cultures in the Arab world. In this regard, instructors are strongly advised to refer to the GAISE College Report 2016 (Carver et al. 2016) for useful guidelines on teaching introductory and advanced statistics courses. The report provides valuable recommendations to instructors on making statistics relevant by introducing it as an investigative process of problem-solving and decision-making and integrating real data with a context and a purpose. In this context, as suggested by Abdelbasit (2010), academic statisticians across Arab universities should play a significant role in publishing statistics textbooks in English with brief explanations and discussions supplemented with exercises and examples contextualized and relevant to the region. Moreover, the diversity of the languages of instruction necessitates expanding these efforts to publishing quality textbooks in Arabic and French as well.

Reforms and revamps of statistics education in the Arab region should be accompanied by periodic reviews, assessments, and benchmarking of the statistics programs and curricula with best international practices. This requires the adoption of a solid assessment process that starts by setting appropriate program learning outcomes to conduct regular assessment and concludes with closing the loop to ensure continuous improvement (Chance and Peck 2015; Moore and Kaplan 2015).

More importantly, efforts to reform statistics education in the Arab world should be part of a bigger strategic vision to reform the educational systems in the region. However, in the era of information, it is the responsibility of academic statisticians to build up the drive toward comprehensive reforms of statistics education and the promotion of the role of statisticians in society.

The nonresponse rate in the survey represented a limitation in this study worth mentioning, as it likely influenced the results presented in Section 4. The majority of the nonrespondents represented programs from countries where the education systems are ranked rather low globally in terms of general quality and in the education of science, mathematics, and business in particular (Schwab 2009, 2017). The political conflicts in Libya, Syria, and Yemen over the past few years have undermined economic progress (Schwab 2017) and have consequently affected the quality of education in these countries negatively. Moreover, although the Egyptian education system stands out as the largest in region, it has failed to produce the skilled graduates needed by the labor market (ElObeidy 2016). Undoubtedly, the inclusion of the nonresponding programs in the analysis could have helped to reveal more and deeper weaknesses in the undergraduate statistics programs in the region.

Apart from the possible nonresponse bias, another limitation of this study is in the discussion on the pedagogical practices and the quality of graduates. This discussion is based mainly on the views of program chairs and overlooks the views of individual instructors and employers. Therefore, there is a need for an in-depth investigation of the pedagogical practices used by individual instructors across various statistics courses. Additionally, exploring the perceptions of employers on the quality of current statistics graduates and the employability skills and competences deemed critical for statistics graduates would be of great significance.

Finally, this study focused only on the undergraduate statistics programs in the Arab region. Future research hence needs to further explore the current state of graduate statistics programs in Arab universities to provide a thorough understanding of the state of statistics education in the region. In addition, with the increasing attention paid to the role of women in statistics globally, it would be a significant endeavor to examine the participation of women in statistics education in the Arab region. Furthermore, research is also needed, particularly at the country level, to assess statistics education in schools and benchmark it against best international practices.

Appendix: Questionnaire

Section (1): Program Information

1. **Please enter your university information:**

   University: _____

   College/Faculty: _____

   Program Title: _____

2. **Please give your best estimate of the number of your department's graduating majors last academic year.**

   ◯ Less than 10
   ◯ 10-29
   ◯ 30-49
   ◯ 50 or more

3. **What is the predominant language of instruction (language of teaching)?**

   ◯ Arabic
   ◯ English
   ◯ French

4. **Who are the main employers of your statistics graduates (Rank with 1 represents the first destination). Rank the following items using numbers from 1 to 3.**

   - ------ Statistics Centers
   - ------ Government
   - ------ Business/Industry

Section (2): Curricular Structure

5. **To what extent does your statistics program cover the following topics:**

Topics	Not covered at all	Implicitly covered	Covered partially in a course (as a chapter or more)	Covered as a separate course
Statistical methods and theory (design and modeling)				
Data manipulation and computation				
Mathematical foundations				
Statistical practice (ability to understand and communicate statistical findings)				
Disciplinespecific knowledge (a subject besides statistics)				
Big data and data science				

6. **Which of the following packages your statistics graduates will be able to use properly? (Check all apply)**

☐ Excel
☐ Minitab
☐ SPSS
☐ R
☐ STATA
☐ SAS
☐ Others, please specify

7. **Which of the following does your department require students to complete? (Check all apply)**

☐ A capstone experience (e.g., a senior project, a senior thesis, or seminar course)
☐ Internship (Practical training)
☐ An exit exam (written or oral)

Section (3): Pedagogical Considerations

8. **To what extent do faculty take the following activities in their teaching? (1 = Lowest, 5 = highest)**

Activities	1	2	3	4	5
Emphasize authentic real-world data (nontextbook data)					
Develop flexible problem solving skills					
Include experience with statistical computing and data-related skills					
Encourage synthesis of theory, methods, computation, and applications					
Provide opportunities to work in teams					
Integrate training in professional conduct and ethics					
Incorporate regular assessment to provide authentic feedback					

Section (4): Quality of Graduates

9. **To what extent a "typical" or "average" graduate will have the following skills and competencies. (1 = Lowest, 5 = highest)**

Skills and competencies	1	2	3	4	5
Effective technical writing					
Presentation skills					
Data visualization					
Teamwork and collaboration					
Ability to interact with the and communicate with a variety of clients and collaborators					
Problem solving					
Critical thinking					

10. **In general, how do employers rate your statistics graduates with regard to the following aspects? (1 = Lowest, 5 = highest)**

Skills and competencies	1	2	3	4	5
Statistical knowledge					
Analytical and statistical skills					
Overall career preparation					

Section (5): Recent and Potential Curriculum Changes

11. **Have you made any major changes in your statistics program in the past 5 years?**

◯ Yes
◯ No

If Yes, please briefly describe these changes

12. **If you have made changes to the program, which of the followings was a driver for the change? (Check all apply)**

☐ Labor market needs
☐ Following guidelines from international statistical associations (ASA, ISI, etc.)
☐ Updating the program structure
☐ Updating the program contents
☐ Following university policies
☐ Responding to accreditation requirements
- If other, please specify _____

13. **Have you ever considered the American Statistical Association Guidelines for Undergraduate Statistics majors in designing or reviewing your program?**

◯ Yes
◯ No
◯ Not aware of it

Section (6): Challenges Facing the Program

14. **To what extent do the following issues present a challenge/problem to the delivery of statistics programs? (1 = Lowest, 5 = highest)**

Challenges	1	2	3	4	5
Shortage of qualified faculty					
Availability of textbooks					
Availability of authentic (nontextbook) real data					
Availability of statistical packages					
Attracting good students					
Employability of graduates					
Business/industry collaboration					
Availability of training/internship opportunities for students					

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References

Abdelbasit, K. M. (2010), "Teaching statistics in a language other than the students'" in *Data and Context in Statistics Education: Towards an Evidence-Based Society. Proceedings of the Eighth International Conference on Teaching Statistics*, Voorburg, Netherlands: ISI, available at *https://iase-web.org/documents/papers/icots8/ICOTS8_C215_ABDELBASIT.pdf*.

Abu-Orabi, S. (2016), "Higher Education and Scientific Research in the Arab World," *Presented at the 15th IAU General Conference on Higher Education: A Catalyst for Innovative and Sustainable Societies*, November 13–16, 2016, Bangkok, Thailand, available at *https://www.eiseverywhere.com/docs/5618/Abu-Orabi*.

Ahmad, A. R., Da Wan, C., Ismail, R., Lai, Y. M., and Ayub, Z. A. (2016), "Reflections and the Way Forward," in *Higher Education in the Middle East and North Africa*, eds. Y. Lai, A. Ahmad, and C. Wan, Singapore: Springer, pp.147–155.

American Statistical Association (ASA) (2016), Statistician Projected as Top 10 Fastest-Growing Job, Alexandria, VA: American Statistical Association, available at *http://thisisstatistics.org/statistician-projected-as-top-10-fastest-growing-job/*.

American Statistical Association Undergraduate Guidelines Workgroup (ASA-UGW) (2014), *2014 Curriculum Guidelines for Undergraduate Programs in Statistical Science*, Alexandria, VA: American Statistical Association, available at *http://www.amstat.org/asa/files/pdfs/EDU-guidelines2014-11-15.pdf*.

Angel-Urdinola, D. F., Hilger, A., and Ivins, I. B. (2011), "Enhancing Access to Micro-Data in the Middle East and North Africa," *Arab World Brief*, 4, 1–4.

Assaad, R., Badawy, E., and Krafft, C. (2016), "Pedagogy, Accountability, and Perceptions of Quality by Type of Higher Education in Egypt and Jordan," *Comparative Education Review*, 60, 746–775.

Badran, A., and Muwalla, M. (2019), "Quality Assurance and Relevance for Competitive Higher Education: Context of Jordan," in *Major Challenges Facing Higher Education in the Arab World: Quality Assurance and Relevance*, eds. A. Badran, E. Baydoun, and J. Hillman, Cham: Springer, pp. 257–276.

Bhandari, R., and El-Amine, A. (2012), *Higher Education Classification in the Middle East and North Africa: A Pilot Study*, New York: Institute of International Education.

Bryce, G. R. (2002), "Undergraduate Statistics Education: An Introduction and Review of Selected Literature," *Journal of Statistics Education*, 10, 189–198.

Bryce, G. R., Gould, R., Notz, W. I., and Peck, R. L. (2001), "Curriculum Guidelines for Bachelor of Science Degrees in Statistical Science," *The American Statistician*, 55, 7–13.

Buckner, E. (2011), "The Role of Higher Education in the Arab State and Society: Historical Legacies and Recent Reform Patterns," *Comparative & International Higher Education*, 3, 21–26.

Cannon, A., Hartlaub, B., Lock, R., Notz, W., and Parker, M. (2002), "Guidelines for Undergraduate Minors and Concentrations in Statistical Science," *Journal of Statistics Education*, 10, available at *https://www.tandfonline.com/doi/full/10.1080/10691898.2002.11910666*.

Carver, R., Everson, M., Gabrosek, J., Horton, N., Lock, R., Mocko, M., Rossman, A., Rowell, G. H., Velleman, P., Witmer, J., and Wood, B. (2016), *Guidelines for Assessment and Instruction in Statistics Education: College Report 2016*, Alexandria, VA: ASA, available at *http://www.amstat.org/education/gaise*.

Chance, B., and Peck, R. (2015), "From Curriculum Guidelines to Learning Outcomes: Assessment at the Program Level," *The American Statistician*, 69, 409–416.

Cobb, G. (2015), "Mere Renovation Is Too Little Too Late: We Need to Rethink Our Undergraduate Curriculum From the Ground Up," *The American Statistician*, 69, 266–282.

Cohen, S. (2014), "Ethics for Undergraduates: Workgroup on Undergraduate Education," available at *https://www.amstat.org/asa/files/pdfs/EDU-EthicsUndergraduates.pdf*.

Dagher, Z. R., and BouJaoude, S. (2011), "Science Education in Arab States: Bright Future or Status Quo?," *Studies in Science Education*, 47, 73–101.

De Veaux, R. D., Agarwal, M., Averett, M., Baumer, B. S., Bray, A., Bressoud, T. C., Bryant, L., Cheng, L. Z., Francis, A., Gould, R., Kim, A. Y., Kretchmar, M., Lu, Q., Moskol, A., Nolan, D., Pelayo, R., Raleigh, S., Sethi, R. J., Sondjaja, M., Tiruviluamala, N., Uhlig, P. X., Washington, T. M., Wesley, C. L., White, D., and Ye, P. (2017), "Curriculum Guidelines for Undergraduate Programs in Data Science," *Annual Review of Statistics and Its Application*, 4, 15–30.

Elliott, A. C., Stokes, S. L., and Cao, J. (2018), "Teaching Ethics in a Statistics Curriculum With a Cross-Cultural Emphasis," *The American Statistician*, 72, 359–367.

ElObeidy, A. A. (2014), "Governing Public Universities in Arab Countries," *Perspectives: Policy and Practice in Higher Education*, 18, 131–137.

——— (2016), "The Role of Education and Training in Enhancing Labour Productivity in Arab Countries in Africa," *International Journal of Training and Development*, 20, 238–245.

Faour, M. (2015), "Enhancing Employability: The Double Transition From Education to Work in the Arab World," in *Proceedings of the Third Arab Development Symposium*, November 5, 2014, Kuwait, available at *http://siteresources.worldbank.org/INTMENA/Resources/LATESTVERSION.pdf*.

Forster, N. (2018), "Why Are There So Few World-Class Universities in the Middle East and North Africa?," *Journal of Further and Higher Education*, 42, 1025–1039.

Franklin, C., Hartlaub, B., Peck, R., Scheaffer, R., Thiel, D., and Tranbarger Freier, K. (2011), "AP Statistics: Building Bridges Between High School and College Statistics Education," *The American Statistician*, 65, 177–182.

Franklin, C., Kader, G., Mewborn, D. S., Moreno, J., Peck, R., Perry, M., and Scheaffer, R. (2007), *Guidelines for Assessment and Instruction in Statistics Education Report: A Pre-K-12 Curriculum Framework*, Alexandria, VA: ASA, available at *http://www.amstat.org/education/gaise*.

Ghabra, S., and Arnold, M. (2007), "Studying the American way: An Assessment of American-Style Higher Education in Arab Countries," Policy Focus 71, available at *https://www.washingtoninstitute.org/uploads/Documents/pubs/PolicyFocus71.pdf*.

Gibbons, K., and MacGillivray, H. (2014), "Education for a Workplace Statistician," in *Topics from Australian Conferences on Teaching Statistics*, eds. H. MacGillivray, B. Phillips, and M. Martin, New York: Springer, pp. 267–293.

Grimshaw, S. D. (2015), "A Framework for Infusing Authentic Data Experiences Within Statistics Courses," *The American Statistician*, 69, 307–314.

Hakeem, S. A. (2001), "Effect of Experiential Learning in Business Statistics," *Journal of Education for Business*, 77, 95–98.

Hardin, J., Hoerl, R., Horton, N. J., Nolan, D., Baumer, B., Hall-Holt, O., Murrell, P., Peng, R., Roback, P., Temple Lang, D., and Ward, M.

D. (2015), "Data Science in Statistics Curricula: Preparing Students to 'Think With Data'," *The American Statistician*, 69, 343–353.
Higgins, J. J. (1999), "Nonmathematical Statistics: A New Direction for the Undergraduate Discipline," *The American Statistician*, 53, 1–6.
Hijazi, R. (2016), "Statistics Education in GCC Business Schools," *Global Business and Economics Review*, 18, 1–14.
Hijazi, R., and Zoubeidi, T. (2017), "State of Business Statistics Education in MENA Region: A Comparative Study With Best Practices," *Journal of International Education in Business*, 10, 68–88.
Horton, N. (2015), "Challenges and Opportunities for Statistics and Statistical Education: Looking Back, Looking Forward," *The American Statistician*, 69, 138–145.
Horton, N. J., and Hardin, J. S. (2015), "Teaching the Next Generation of Statistics Students to 'Think With Data': Special Issue on Statistics and the Undergraduate Curriculum," *The American Statistician*, 69, 259–265.
Hunter, J. S. (1994), "Statistics as a Profession," *Journal of the American Statistical Association*, 89, 1–6.
Innabi, H. (2014), "Teaching Statistics in the Arab Countries: The Ambitions and the Needs," in *Proceedings of the 9th International Conference on Teaching Statistics (ICOTS9)*, Flagstaff, AZ, available at *http://icots.info/9/proceedings/pdfs/ICOTS9_C286_INNABI.pdf*.
Isham, V. (2012), "The Evolving Society: United We Stand," *Journal of the Royal Statistical Society*, Series A, 175, 315–335.
Istaiteyeh, R., and Beatrice, K. (2011), "The Impact of PhD Returnees in Driving Economic Development of Origin Countries: The Case of Jordan," in *Rethinking Development in an Age of Scarcity and Uncertainty: IDS at the DSA/EADI Conference*, University of York, September 19–22, 2011, New York.
Khachatryan, D. (2015), "Incorporating Statistical Consulting Case Studies in Introductory Time Series Courses," *The American Statistician*, 69, 387–396.
Kollipara, P. (2014), "Careers in Statistics Evolve and Expand," *Science*, available at *http://www.sciencemag.org/careers/2014/03/careers-statistics-evolve-and-expand*.
Kong, S., and Harradine, A. (2006), "CensusAtSchool in Australia," in *Proceedings of the 7th International Conference on Teaching Statistics (ICOTS7)*, Salvador, Bahia, Brazil, available at *https://www.ime.usp.br/~abe/ICOTS7/Proceedings/PDFs/InvitedPapers/9D2_KONG.pdf*.
Landes, R. D. (2009), "Passing on the Passion for the Profession," *The American Statistician*, 63, 163–172.
Makar, K., and Rubin, A. (2018), "Learning About Statistical Inference," in *International Handbook of Research in Statistics Education*, eds. D. Ben-Zvi, K. Makar, and J. Garfield, Cham: Springer, pp. 261–294.
Martonosi, S. E., and Williams, T. D. (2016), "A Survey of Statistical Capstone Projects," *Journal of Statistics Education*, 24, 127–135.
Mason, R. L. (2004), "Does the Statistics Profession Have an Identity Crisis?," *Journal of the American Statistical Association*, 99, 1–6.
Massialas, B. G., and Jarrar, S. A. (2016), *Arab Education in Transition: A Source Book*, London: Routledge.
McKinsey Global Institute (2011), "Big Data: The Next Frontier for Innovation, Competition, and Productivity," available at *http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/big-data-the-next-frontier-for-innovation*.
Moore, A. A., and Kaplan, J. J. (2015), "Program Assessment for an Undergraduate Statistics Major," *The American Statistician*, 69, 417–424.
Naccache, H. S. (2012), "Factors Related to Student Performance in Statistics Courses in Lebanon," Doctoral dissertation, The University of Southern Mississippi, MS, available at *https://aquila.usm.edu/dissertations/852/*.
National Academies of Sciences, Engineering and Medicine (NASEM) (2018), *Data Science for Undergraduates: Opportunities and Options*, Washington, DC: The National Academies Press, available at *https://www.nap.edu/catalog/25104/data-science-for-undergraduates-opportunities-and-options*.
Neumann, D. L., Hood, M., and Neumann, M. M. (2013), "Using Real-Life Data When Teaching Statistics: Student Perceptions of This Strategy in an Introductory Statistics Course," *Statistics Education Research Journal*, 12, 59–70.
Nolan, D., and Temple Lang, D. (2010), "Computing in the Statistics Curricula," *The American Statistician*, 64, 97–107.
Pierson, S. (2014), "Bachelor's Degrees in Statistics Surge Another 20%," *Amstat News*, available at *http://magazine.amstat.org/blog/2014/09/01/degrees/*.
Porkess, R. (2012), *The Future of Statistics in Our Schools and Colleges*, London: RSS, available at *https://www.rss.org.uk/Images/PDF/publications/rss-reports-future-statistics-schools-colleges-roger-porkess-2012.pdf*.
Pullinger, J. (2013), "Statistics Making an Impact," *Journal of the Royal Statistical Society*, Series A, 176, 819–840.
Ridgway, J. (2016), "Implications of the Data Revolution for Statistics Education," *International Statistical Review*, 84, 528–549.
Royal Statistical Society (RSS) (2017), "The RSS Accreditation Scheme," available at *https://www.rss.org.uk/Images/PDF/pro-dev/2017/rss-accreditation-scheme-guide-Mar-2017.pdf*.
Ruberg, S. J., and Mason, R. L. (1988), "Increasing Public Awareness of Statistics as a Science and a Profession—Starting in the High Schools," *The American Statistician*, 42, 167–170.
Schwab, K. (2009), *The Global Competitiveness Report 2009–2010*, Geneva: World Economic Forum, available at *https://www.weforum.org/reports/global-competitiveness-report-2009-2010*.
——— (2017), *The Global Competitiveness Report 2016–2017*, Geneva: World Economic Forum, available at *http://www3.weforum.org/docs/GCR2016-2017/05FullReport/TheGlobalCompetitivenessReport2016-2017_FINAL.pdf*.
Takemura, A. (2013), "Activities of Japanese Inter-university Network for Statistical Education (JINSE)," *Paper Presented at the 2013 Joint IASE/IAOS Satellite Conference*, Macao, China.
Tishkovskaya, S., and Lancaster, G. A. (2012), "Statistical Education in the 21st Century: A Review of Challenges, Teaching Innovations and Strategies for Reform," *Journal of Statistics Education*, 20, available at *http://jse.amstat.org/v20n2/tishkovskaya.pdf*. (https://www.tandfonline.com/doi/pdf/10.1080/10691898.2012.11889641).
United Nations Development Programme (UNDP) (2014), *Arab Knowledge Report 2014: Youth and Localisation of Knowledge*, Dubai: Mohammed Bin Rashid Al Maktoum Foundation (MBRF) and UNDP Regional Bureau for Arab States, available at *http://www.undp.org/content/dam/rbas/report/UNDP-GENERAL-REPORT-ENG.pdf*.
——— (2016), *Arab Human Development Report 2016: Youth and the Prospects for Human Development in a Changing Reality*, New York: UNDP Regional Bureau for Arab States, available at *http://www.arab-hdr.org/reports/2016/english/AHDR2016En.pdf*.
United Nations Educational, Scientific and Cultural Organization (UNESCO) (2014), "*Education for All: Global Monitoring Report: Regional Fact Sheet: Education in the Arab States*," available at *https://en.unesco.org/gem-report/sites/gem-report/files/219170e.pdf*.
Utts, J. (2015), "The Many Facets of Statistics Education: 175 Years of Common Themes," *The American Statistician*, 69, 100–107.
Wild, C. J., Utts, J. M., and Horton, N. J. (2018), "What Is Statistics?," in *International Handbook of Research in Statistics Education*, eds. D. Ben-Zvi, K. Makar, and J. Garfield, Cham: Springer, pp. 5–36.
Wilkens, K. (2011), "Higher Education Reform in the Arab World," The Brookings Project on US Relations With the Islamic World, available at *https://www.brookings.edu/wp-content/uploads/2016/06/08_education_reform_wilkins.pdf*.
Willoughby, J. (2018), "Educational Reform, Privatization, and the Challenge of Collaborative Governance in Higher Education in the Arab World," in *Higher Education Governance in the Arab World*, ed. G. Azzi, Cham: Palgrave Macmillan, pp. 131–146.
World Bank (2017), "World Development Indicators," available at *http://databank.worldbank.org/data/source/world-development-indicators*.
Yushau, B. (2009), "Mathematics and Language: Issues Among Bilingual Arabs in English Medium Universities," *International Journal of Mathematical Education in Science and Technology*, 40, 915–926.
Zewotir, T., and North, D. (2011), "Opportunities and Challenges for Statistics Education in South Africa," *Pythagoras*, 32, 1–5.
Zieffler, A., Garfield, J., and Fry, E. (2018), "What Is Statistics Education?," in *International Handbook of Research in Statistics Education*, eds. D. Ben-Zvi, K. Makar, and J. Garfield, Cham: Springer, pp. 37–70.