

# Public libraries' role in supporting e-learning and spreading lifelong education: a case study

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## Abstract

**Purpose** – Public libraries play a pivotal role in supporting education and literacy. They provide numerous services, activities, collections and resources for education and leisure. Bibliotheca Alexandrina (BA) is an international renowned public library that provides numerous services for different users worldwide. E-learning is an emergent and promising method for teaching and learning different subjects such as the science, technology, engineering and mathematics (STEM). The e-learning educational system is quite novel in Africa and the Middle East; hence, this paper presents the whole concept to the reader. In addition, it demonstrates number of e-courses tackling different domains provided by different educational institutions, national and public libraries worldwide.

**Design/methodology/approach** – In 2017, the BA inaugurated its e-learning services to cope with the new educational trend and to consolidate the lifelong learning concept in the community. The author showed special interest to the case of e-learning in the BA, as it is a regional public library. The main idea of this paper is to attract attention toward public libraries as a promising venue for e-learning implementation for general knowledge, library information sciences, soft skills, elementary and informal STEM education. The paper discusses in details e-learning and its characteristics.

**Findings** – In addition, the paper compares traditional education (face-to-face) with e-learning education, mentions both their pros and cons and recommends blending the two educational methods as they complement each other. Furthermore, the author has selected a sample of different STEM e-courses (203 different e-courses). These e-courses were selected to assert the possibility of presenting STEM topics in the form of e-courses.

**Originality/value** – This study would be one of the emergent research studies that connect e-learning to both STEM disciplines and public libraries. Additionally, this research highlights the importance of public libraries and all the services they provide. In the mean time, it shed light on the important and unique role of specialized librarians. Briefly, public libraries with all their resources, services and expert librarians could provide an exceptional e-learning experience to their community and be of great help to educational institutions and organizations.

**Keywords** E-learning, Public libraries, STEM, Traditional education

**Paper type** Case study

## Introduction

During the late eighteenth and early nineteenth centuries, the whole world witnessed the industrial revolution, which had a powerful impact on all aspects of human lives. Since then, people have been facing unstoppable challenges in education, social, economic and environmental welfare. The most outstanding breakthrough was achieved in both the science and technology fields. Science and technology are key elements toward development in different domains, such as economics, trade, industry, health improvement, education and infrastructure. Therefore, innovative and advanced education systems have lately attracted



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more attention (Chetty, 2012) and (Eagleton and Manolopoulou, 2017). Recently, the information and communication technology (ICT) field has been extensively developed. The growing demand for novel educational techniques and the emerged ICT produced a new method of learning called e-learning. E-learning is an abbreviation that refers to electronic learning; it fluctuates between supporting classroom education to providing totally online distance-education. E-learning emerged due to the increasing number of population and learners, as well as an increasing demand for better, convenient and feasible education systems. Coinciding with this, the first computer-based learning system, PLATO, was developed by Bitzer in 1962 at University of Illinois. Additionally, there were pioneer researchers in this field such as Porter (1959), Uttal (1962) and Suppes (1964) (Bhatnagar, 2016).

### State-of-the-art

Different authors have defined e-learning in the published literature according to the topic covered, providers, techniques and tools used. Sharifabadi (2006) defined e-learning as the use of the Internet to disseminate educational resources and learning materials. Furthermore, the system develops interaction between learners and instructors and/or trainers to enhance the teaching and learning experience (Bhatnagar, 2016). In 2009, Kumbhar defined e-learning as a learning system supported by electronic media. The e-learning educational system depends on computer devices, networks, telecommunication, storage and sharing technology. Moreover, the National Science Teachers Association (NSTA, 2016) defined e-learning as an efficient teaching technique developed by gathering digital content and learning support and services. NSTA stated that e-learning could be used to enhance the teaching of science and technology.

The author intended to point out the role of public libraries in spreading and supporting the e-learning system. Recently, this topic was discussed from different perspective in the published literature (Abbasi and Zardary, 2012; Han and Yates, 2016; Kumbhar, 2009). Abbasi and Zardary were interested about the role of digital libraries on supporting e-learning. They stated that digital libraries could provide both digitized services and electronic resources via Internet to support e-learning. Han and Yates presented a case of an academic library called Monash University Library, Australia that has adopted e-learning system for both research and learning skills development within the university. In this study, the authors showed special interest about the library staff members gained competencies and the impact of this on the sustainability and improving of the e-learning strategy. They concluded that their case study could give a positive sign for organizations which consider integrating e-learning. Additionally, they recommended the presence of qualified and centralized e-learning team who could create and develop easy to use manuals and support e-learning techniques. In 2009, Kumbhar presented a review of e-learning initiative in Library Information Science (LIS). The author stated that traditional and e-learning education systems are complementing each other in spreading LIS education.

### Different educational systems (e-learning vs traditional learning)

The e-learning system is a web-enabled system that provides information and knowledge to various audiences anywhere, anytime. There are different terminologies for e-learning, such as online education, web-based training/learning (WBT, WBL), virtual university, computer-based education, etc. E-learning systems could support educational and teaching systems by using modern ICT tools and through effective use of different educational resources. Furthermore, e-learning facilitates lifelong learning and self-pace education. Time and place cannot limit the e-learning education, and e-learners could enroll and learn any topic anywhere, 24/7.

Nowadays, a large number of organizations are implementing e-learning educational systems as a flexible and timesaving method to train and increase the competence of their

employees. In the meantime, educational institutions such as universities and research centers are heading toward the adoption of e-learning. Educational institutions usually combine face-to-face (traditional/classroom) learning and e-learning systems in what is called “blended learning” (NSTA, 2016). Currently, e-learning uses diverse tools and techniques to facilitate the covering of numerous topics and fields; starting from LIS to engineering sciences, which will be discussed in detail later. Pros and cons of both e-learning and traditional (classroom) learning systems can be briefly outlined in Table I.

From all the above propositions, it could be noticed that both learning systems have advantages and disadvantages. The author recommends using both learning systems, which is called the blended system, which is a combination of both e-learning and traditional methods.

### **Library definition**

Throughout time, libraries have supported education and played a key role in literacy dissemination. The word “library” is derived from the Latin word *liber*, which means “book”. Libraries ensure the provision of educational materials, books collections, electronic resources, periodicals, multimedia materials, referral services, etc. At the same time, this term could refer to the building or space itself, which includes all the previously mentioned materials (Shukla *et al.*, 2013).

In 1994, International Federation of Library Associations/The United Nations Educational, Scientific and Cultural Organization (IFLA/UNESCO) (1996) defined public libraries as the perpetual source of information and knowledge. Public libraries promote lifelong learning, cultural development, peace and social welfare for the public. Public libraries are hubs of information, providing all kinds of knowledge available to users nationally and internationally. Public libraries help communities to develop, improve and carry out decision-making independently. The manifesto stated that public libraries deliver different services and materials for various categories of users based on equity and equality. In addition, IFLA/UNESCO recommended public libraries to disseminate special services, materials and reference sources among users who cannot have access to the regular libraries services and materials, such as linguistic minorities, disabled, hospitalized or imprisoned people (IFLA/UNESCO, 1996).

Users of different categories could easily access all the provided materials and organized collections through the help of well-trained and skilled librarians. Skilled subject librarians act in significant roles in both public and academic libraries. Generally, these tasks include collection-cataloging, development, reference services, building collaboration with educational organizations (schools, universities and research institutions) and providing instructional lectures to users.

The main aim of this study is to investigate the potential role of public libraries in spreading science, technology, engineering and mathematics (STEM) e-learning education. In this paper, the author will focus on STEM e-courses available, list providers (libraries, educational organizations, educational platforms, etc.) and the learning management system (LMS) used to present scientific context. Educational resources could take different formats (text, videos, interactive presentations, audio, animation, etc.) according to the subject covered. Finally, the main target of this study and previously published studies is to shed light on the role of libraries in supporting e-learning education, developing both e-learning and traditional educational systems and to use the advantages of both systems to the maximum for the sake of learners.

### **Types of libraries**

Libraries have essential influence on education. Libraries could deeply support education by different means. Different types of libraries are listed and defined below:

Parameters	E-learning system	Traditional system
Accessibility	Learners should have smart device (computers, laptops, tabs and mobiles) and Internet connection Learners could access any educational materials, data banks, up-to-date relevant and reliable scientific e-resources  E-learning is like a virtual classroom. Learners could interact with instructors and each other through different tools, such as (messaging, forums, chat, e-mails, etc.)	Learners should be enrolled on schools and/or campuses  Learners depend on the teachers' explanations, study program, settled curriculum and fixed educational materials Learners interact directly with the class teacher and classmates
Instructor and learners relation	Teacher plays the role of instructor, mentor, moderator and coach Synchronous e-learning enables learners and instructors to directly interact and communicate at definite time. In addition, online materials could be updated and learners could view changes immediately Learners are free to enroll in any e-course regardless of their discipline	Teacher and lecturer plays the role of the knowledge source and transmitter In this system, teachers reach out to students, directly, through speeches and oral communication, hence, students could receive answers for their queries right away It might be an obligation for students to take courses relevant to their specialty
Pedagogical curriculum	It suits wide, specific and general topics, modules and lessons Learners could study at their own pace, independent of the group speed E-learning depends on interactivity and help learners to construct their own knowledge E-learning allows students to access and attend online educational content unlimited times 24/7	It suits applied, detailed and collaborative subjects Both teachers and students are strictly adhered to fixed curriculum Traditional system depends on repetition and students are recipients  Traditional sessions have limited time, and each semester follows a set timetable
Degrees available	Learners could earn diplomas, master's degree and/or PhDs any time anywhere while working in their jobs or in their own space	Students attend classes in person and pass through different assignments, exams and evaluations to earn an academic degree
Assessments and evaluation	Learners could acquire any course and/or training about any subject and/or field of their interest with simple assessment or placement test or none Most of the online courses evaluate participants through multiple choice or short answer assignments The lack of clear objective of learner could be the reason for them to drop out e-courses. In addition, students attending e-courses could be inactive and fail more than students attending the same courses face-to-face in a regular classroom	Students are evaluated according to different progress criteria that represent students' level of achievement or performance Student performance is evaluated orally and via written tests/exams  Student potentials could not be easily measured if the number of classroom students is large (>30)
Suitability of learning system	This system would be considered a convenient system for independent and self-study learners Learners are not limited by age, gender, job, origin, background, place or time	Classroom learning suits different types of learners  Sometimes there is an age barriers to pursue definite degrees

(continued)

**Table I.**  
Pros and cons of e-learning and traditional learning systems (Purdue University Global, 2018; De, 2018; Heap, 2017; Versteijlen *et al.*, 2017)

Parameters	E-learning system	Traditional system
Learners skills	<p>It could be hard to illustrate courses, which require certain tools and kits</p> <p>E-learning system could enhance self-motivation, creative thinking and time management skills</p> <p>Learner is completely his/her own boss; learner is responsible for completing all the online courses requirements such as viewing lectures, interact with peers and instructor, submitting and required assignments before the deadline (self-direction)</p>	<p>It could be preferable for subjects, fields and programs that require hands-on-approach</p> <p>Traditional system is efficient, and it could enhance self-motivation and discipline</p> <p>This system could build strong relations between students and teachers. Meanwhile, it helps young students improve their personalities, increases their self-esteem and assists them in avoiding exam panic</p>
Learning system time-consuming	<p>E-learning is a fast way of presenting lessons. Learners could retrieve and save the online sessions and electronic resources to revise them anytime anywhere</p>	<p>The time required for the teaching process is 20–60 percent higher than the e-learning method</p>
Expenses	<p>Learners could save travel expenses, course materials and accommodation fees by applying for e-learning courses</p>	<p>Traditional learning cost is higher than e-learning (investments, educational buildings, academic staff, teachers and employees' salaries, etc.)</p>
Environmental impact	<p>E-learning education has less impact on the environment. It is a paperless educational system; hence, it saves about 90 percent power and generates 85 percent less amount of CO<sub>2</sub></p>	<p>Carbon footprint increases due to students and academic staff traveling and transportation</p>
Technical barriers	<p>Communication and technology barriers could limit the e-learning process. In addition, computer illiteracy endangers the spreading of the e-learning method</p> <p>Transforming teaching material into interactive e-course is time-consuming and requires good knowledge of tools and technology available. Although by the end of the e-learning experience learner would enhance his/her digital skills</p>	<p>If teacher or lecturer does not integrate technology within curriculum content, this would decrease the digital and technological skills of students</p>

Table I.

*Public library*

As mentioned earlier, public libraries are national organizations, funded and supported by governments and communities. Public libraries have a great impact on society, and they play the vital mission of spreading literacy and lifelong learning to improve and fulfill needs of society. Public libraries are no longer limited to their buildings, physical collection or indoor services. Most public libraries successfully cope with the publics' increasing demands, as well as technological and educational challenges. Thanks to open access and open educational resources, public libraries can offer educational materials, courses, trainings, scientific publications, etc. to users. They manage to deliver their services not only face-to-face but also online. Earlier, all these resources were restricted to educational institutions, accessed in definite places, during specific times and at fixed prices. Nowadays, users and students have a vast amount of raised references on different topics, such as educational and reference resources, digital tools and services. Users access public libraries (physically or virtually) seeking the guidance and help of skilled and competent librarians.

Thus, public libraries should be classified as information hubs and central sources of a multitude of educational materials, ranging from traditional to online-based courses. Nevertheless, public libraries should collaborate with regional educational institutions (schools, universities and adult learning) to execute students' demands and to avoid redundancy (Lifelong Learning, 2012; Balapanidou, 2015). Creelman (Lifelong Learning, 2012) stated that public libraries depend on their librarians' professionalism and expertise. Balapanidou (2015) reviewed a number of published studies and stated that public libraries have played a fundamental role in every community by providing various services to different user categories, for both educational and recreational purposes. Nowadays, they are facing challenges in keeping up with technological evolution, moreover, maintaining and upgrading their services. In the meantime, they should reach and support all types of users, such as the literate, illiterate, children, youth, adults, the disabled, minorities, the hospitalized and/or imprisoned people. There are numerous examples of illuminating and inspiring public libraries, such as the Library of Congress (Washington D.C., USA), Bibliothèque Nationale de France BNF (the National Library of France) and the Bibliotheca Alexandrina (BA) (The Library of Alexandria). In this study, the author will focus on the BA and its different facets. This paper will highlight the efforts done by the Library of Alexandria to spread and increase public participation and support the e-learning educational system.

#### *Special library*

Special libraries could be briefly defined as establishments concerned with a specific subject or field with their own specialized collections. They provide help and guidance for their particular clientele (academia or professionals) (Bilawar, 2013). Generally, specialized libraries are involved in any research and/or educational process in any academic, industrial and business organizations. Special libraries include the following:

- (1) Science libraries;
- (2) Law libraries;
- (3) Medical libraries;
- (4) Music libraries and
- (5) Museum libraries.

#### *Academic library*

Academic libraries are entities that fall under the umbrella of educational or academic organizations, such as schools, universities, colleges or research institutions. They have two fundamental and integral functions: first, to support the curriculum of the educational organization, and second, to promote research in these organizations. Academic libraries are usually located within campuses, and they have materials and collections that help teachers, professors, researchers and students to fulfill their missions.

Examples of academic libraries are as follows:

- (1) American University in Cairo Libraries and
- (2) University of Lorraine Libraries

#### *Digital library*

Digital libraries are emerging paradigms of the rapid development of ICT. Trivedi (2010) defined digital libraries as virtual entities offering very large organized collections stored in

digital formats that can be accessed remotely. They consist of three main elements: the library materials (data), information about the library materials (metadata) and the performed functions that link all the library elements (processes) (Rajput, 2013).

Examples of digital libraries are as follows:

- (1) Egyptian Knowledge Bank (EKB);
- (2) Peking University Digital Library (China) and
- (3) Digitale Bibliothek Information und Medien (Germany).

Recently, it is noticeable that a large number of traditional libraries are heading towards digitizing their collections.

### **Bibliotheca Alexandrina (BA)**

The BA was officially reborn on October 16, 2002. The main target of the modern library is to be a hub of merit in acquaintance creation and spreading. In addition, the BA aspires to be a destination of interchange, learning, tolerance and understanding. This paper will discuss the BA e-learning services as the case study.

The BA provides numerous services for all users. Most of these services are listed on the BA website. The core services, which are offered by the BA, are listed hereunder:

- (1) Free computers, Internet access and free Wi-Fi;
- (2) Electronic resources (open and closed access);
- (3) Community events;
- (4) Study rooms and reading space;
- (5) Printing and copying centers;
- (6) Reference and inquiry services;
- (7) Adult learning courses;
- (8) The BA catalog (enables users to search for items anytime, anywhere);
- (9) Specialized courses for librarians;
- (10) Researchers' services;
- (11) Celebrity authors events;
- (12) Numerous cultural and scientific events and
- (13) Exhibitions, seminars, conferences, concerts and theatrical performances.

### **BA e-learning services**

The BA has established an online educational service in January 2017. The main aim of this service is to enable the BA users (from all over Egypt, the Arab world, Africa and the worldwide) to attend the BA educational courses. This service will introduce the self-learning concept to the BA users and will increase their enthusiasm for self-improvement. This service ensures providing sustainable educational services for all types of users anytime anywhere. The BA e-learning services aim to provide access to massive open online courses (MOOCs), online courses and other e-learning modules. In addition, the BA e-learning Services strive to provide e-learning courses about different

topics not limited to LIS. The BA improves its e-learning resources, techniques and materials indoors and keen to cooperate with other educational organizations and institutions. This could be a positive indication for other public libraries looking forward to implement e-learning system. The BA develops its e-learning service internally depending on the subject expert librarians and externally by cooperating with educational institutions such as Alexandria University, Senghor University, The National Superior School of Information Science and Libraries (ENSSIB), the National Library of France (BnF), etc. [Table II](#) shows the available e-courses and online orientation sessions provided by the BA e-learning services.

All the previously mentioned e-courses, sessions and trainings are presented using the Moodle platform. The BA e-learning services adopted Moodle platform due to its special features such as:

- (1) Open access learning management system (LMS);
- (2) Free platform with unlimited time;
- (3) User-friendly platform (learners, tutors and administrators);
- (4) A well-organized and easy to navigate platform;
- (5) The design to be responsive and accessible (it is easy to navigate on both desktops and smart devices);
- (6) Multilingual capability platform (The BA uses Arabic, English and French);
- (7) Various modules, features, tools, and customizable themes and layout;
- (8) Modular design that simplifies syllabus and curriculum arrangement;
- (9) Interactivity between tutors and learners through various activities and collaborative tools (i.e. forums, chats, wikis, glossaries, databases, quizzes, etc.);
- (10) Easy plugin (sign in) management;
- (11) Consistent security updates;
- (12) Supports multimedia integration (courses could be uploaded in all types of formats as text and multimedia files);
- (13) Can integrate with different cloud storage services to share files such as MS OneDrive, Dropbox and Google Drive and
- (14) Implements both synchronous and asynchronous learning.

### **Application of e-learning in international public libraries**

A number of published researches have indicated that public libraries are playing a key role in spreading and serving as remote sites for e-learning. Public libraries play a critical role in developing and expanding e-learning education ([Proudfoot and Kebritchi, 2017](#)). The traditional role of a public library is to offer information resources for users and play as information keepers. Nowadays, this role should be expanded to include being information providers and a gateway to knowledge ([Sharifabadi, 2006](#)). In this study, the author has listed a number of e-courses provided by three examples: the National Library of New Zealand, the American Library Association (ALA) and Australian Library and Information Association in [Table III](#). The three selected examples are using Moodle as the LMS. From the previous context, it is clear that e-learning education is growing and developing rapidly; hence, libraries are pressured to support and embrace e-learning at massive scale.



**Table II.**  
E-courses, sessions,  
and trainings offered  
by the BA E-learning  
Services

Courses/Trainings session	Subject	Topic	Organization	Duration	Certified	Language
Orientation sessions	General Knowledge	Introductory Session: History of Suez Canal Bibliotheca Alexandrina (BA) Orientation Egyptian Knowledge Bank (EKB) Orientation Bibliotheca Alexandrina Information for Africa (BAIFA) How to Use Moodle Sharing Large Files over the internet Effective Presentations Information for All	Bibliotheca Alexandrina (BA)	Self-paced	N/A	Arabic Arabic and English Arabic English and French English English Arabic, English and French Arabic and English Arabic and English Arabic and English Arabic and English Arabic and English Arabic and English Arabic and English English
Training courses for beginners						
Advanced training courses	Library Science	Citation BA Online Catalog Internet References Electronic Resources Web 2.0 Innovation et Bibliothèques Marketing for Library Academic Writing References Management Systems Data Analysis Poster Preparation				
Researchers' Program	Specialized Courses for Postgraduates and Researchers					English Arabic and English

(continued)

Courses/Trainings session	Subject	Topic	Organization	Duration	Certified	Language
Le Diplôme Universitaire en Sciences de l'Information et des Bibliothèques (DUSIB Programme)	Information and Library Sciences	Introduction Générale aux Bibliothèques Gestion du Patrimoine Audiovisuel Droit de la Propriété Intellectuelle Médiation et Ingénierie Culturelle IFLA International Advocacy Program Cell Press Authoring and Researcher Engagement	l'Université Senghor d'Alexandr, i.e. l'Ecole Nationale Supérieure des Sciences de l'Information et des Bibliothèques (Enssib), la Bibliotheca Alexandrina (BA), et la Bibliothèque Nationale de France (BnF), avec l'Appui de l'Association des Amis de la Bibliotheca Alexandrina	9 months	Certified Diploma	French
Webinar			Bibliotheca Alexandrina (BA)	Self-paced	N/A	English

Table II.

Topic	Organization	Duration	Cost	Country	Language
Inquiry Learning: The Role of Resources to Inspire and Inform Building a Responsive Collection for Your School Library	National Library of New Zealand	5 weeks	Paid course	New Zealand	English
Developing Digital Literacy in Your School		5 weeks			
Raising Readers: School and Home Connections		5 weeks			
Sail into Summer Reading: Keeping Students Reading Over Summer		5 weeks			
Developing Your School Library Services		6 weeks			
Organization and Personnel Management	American Library Association (ALA)	2 weeks		USA	
Science, Technology, Engineering, and Math (STEM) Programs Made Easy		4 weeks			
Fundamentals of Cataloging		6 weeks			
Fundamentals of Metadata		6 weeks			
Mindfulness in Libraries		4 weeks			
Budget and Finance		5 weeks			
Making Games and Online Interactive Content		3 weeks			
Fundamentals of Acquisitions		6 weeks			
Fundamentals of Electronic Resources Acquisitions		4 weeks			
Fundamentals of Collection Development and Management		4 weeks			
Fundamentals of Collection Assessment		6 weeks			
Fundamentals of Preservation		4 weeks			
Whole Person Librarianship: Social Work Concepts for Holistic Patron Services		5 weeks			
Project Management in Libraries		4 weeks			
E-Resources Licensing: Best Practices		3 weeks			
Building An Accessible and Inclusive Library Community		6 weeks			
Contemporary Issues in Action: Ethics for Librarians		4 weeks			
Storytelling with Puppets		5 weeks			
Fundraising and Grantmanship		5 weeks			
Who Manages, Who Leads?		4 weeks			
Negotiating License Agreements and Pricing with Confidence		3 weeks			
Planning and Management of Library Buildings		6 weeks			
Marketing the 21st Century Library		4 weeks			
Management of Technology		6 weeks			
STEM in Libraries	Australian Library and Information Association	4 weeks	Paid Course	Australia	English

**Table III.**  
E-courses, sessions and trainings offered by international libraries

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### Research design and sampling procedure

This study implemented an empirical data analysis, which applied qualitative and quantitative approaches to data collection and analysis. The collected data were retrieved via web searches. The collected data were e-courses provided by different universities and educational organizations and hosted by different MOOCs platforms. In order to make the study representative, data were collected based on three criteria: the selected e-courses should be limited to STEM topics, should have best review and rating, the educational institution/organization which provided the e-course should have high-ranking. The selected data are listed in [Table AI](#).

### STEM e-learning education

In this part, the author has selected a sample of different STEM e-courses that are relevant to the spectrum of the study. Additionally, the author was keen to choose e-courses based on the following factors to narrow down the sampling process:

- (1) Topic is limited to STEM fields;
- (2) E-courses should have best review and rating and
- (3) Educational organization/institution which provided the e-courses should have high ranking.

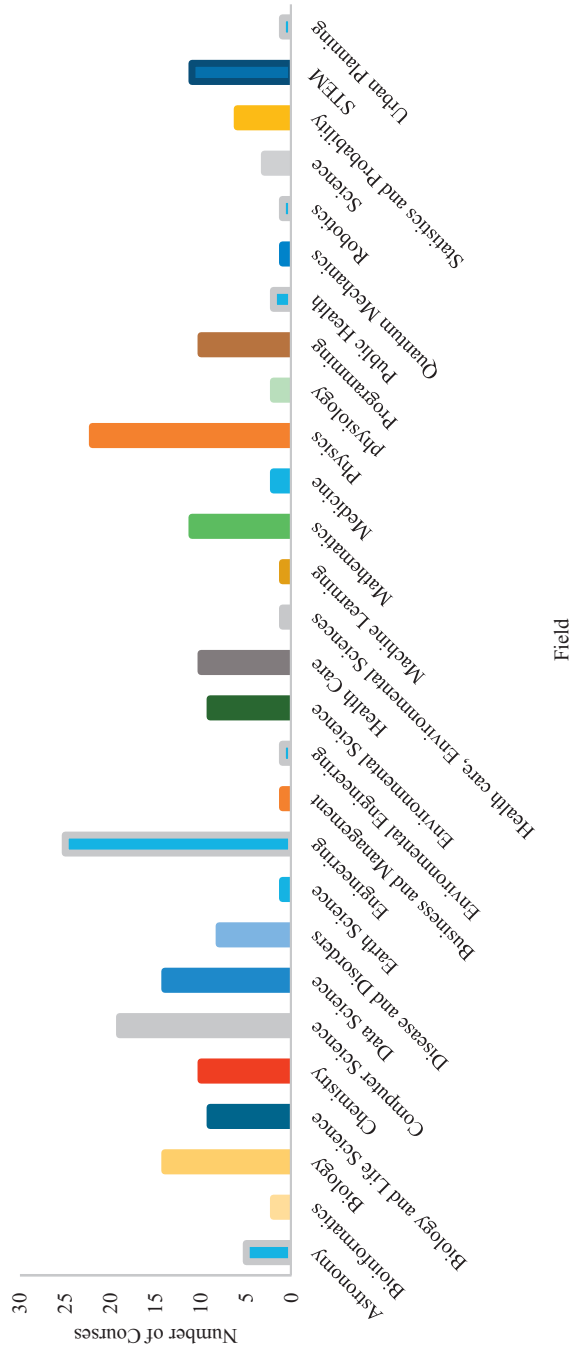
The list of these e-courses are shown in [Table AI](#). [Figures 1 and 2](#) illustrate the STEM fields were covered, the number and percent of the e-courses provided.

From the collected data, the selected STEM e-courses were categorized into five main classes: the scientific discipline or field, the educational organization, the country, language of the e-course and the used platform. From [Figure 3](#), it is noticeable that the chosen STEM e-courses are offered by countries in the following order: the USA, the UK and Egypt. Switzerland, Australia, South Africa, Canada, Denmark and Italy offered the remaining 8 percent of the covered STEM e-courses. Accordingly, the topics covered by the USA and UK are illustrated in [Figures 4 and 5](#). The collected data show that the fields are represented as follows: 22.3 percent computer science, 12.9 percent engineering, 12.4 percent medicine, 11.4 percent biology, 10.9 percent physics, 5.4 percent mathematics, 5.4 percent STEM, 5 percent chemistry, 5 percent environmental sciences, 3 percent statistics and probability, 2.5 percent astronomy, 1.5 percent science, 1 percent bioinformatics, 0.5 percent Earth science, 0.5 percent quantum mechanics and 0.5 percent urban planning.

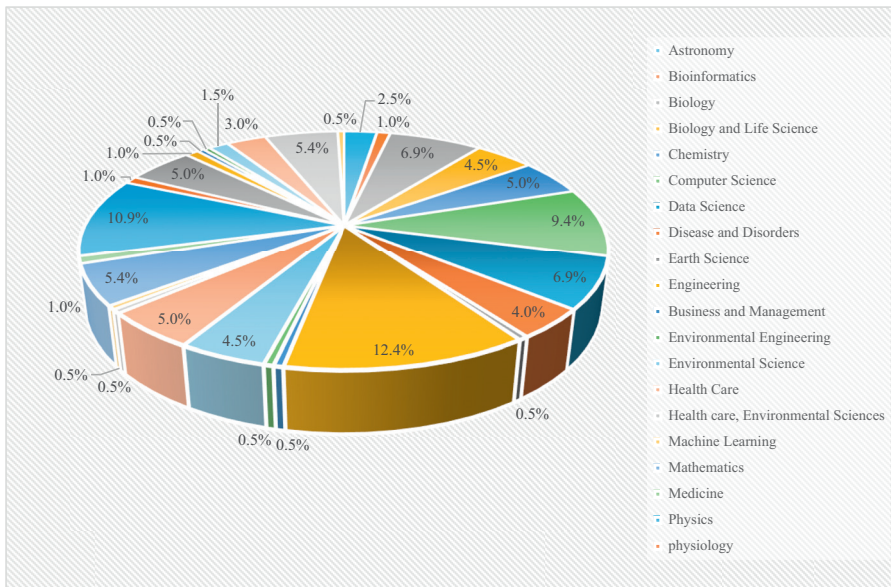
### Discussion

Recently e-learning has shown significant expansion and attracted learners' attention worldwide. E-learning assists learners who are geographically remote from educational institutions, unable to participate as full-or part-time campus students and grownups. E-learning promotes the "lifelong-learning" concept, ensures learning equity and increases the competence of workforce in order to cope with the overwhelming development in the modern economy and industry. Generally, e-learning depends on three main factors:

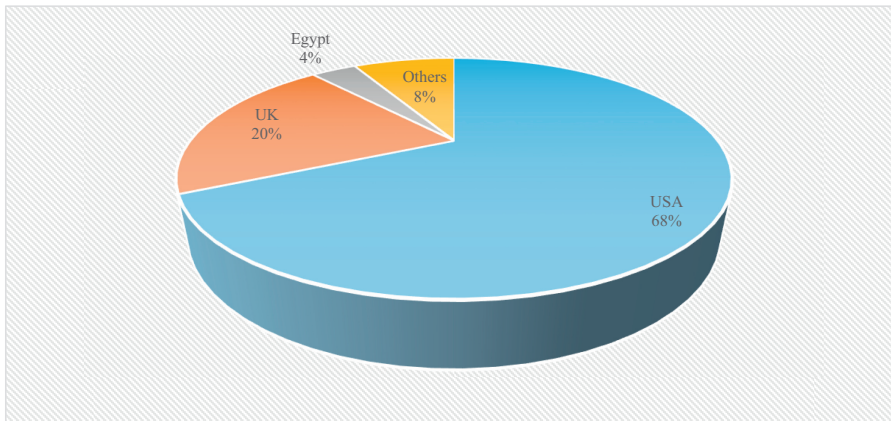
- (1) The instructor (teacher or tutor) and learner;
- (2) Educational institution, which creates and influences the process and
- (3) LMS that provides two-way communication between instructor, educational institution and learners.



**Figure 1.**  
STEM E-courses  
provided by different  
educational  
organizations



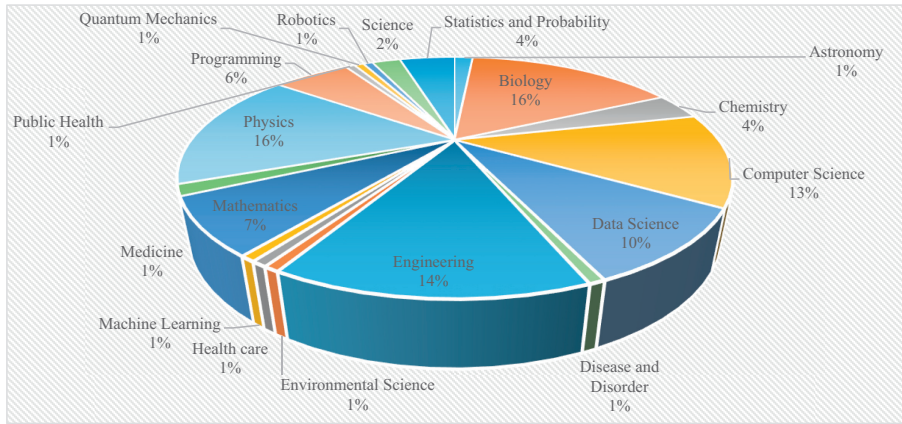
**Figure 2.** The percent of the covered STEM e-courses



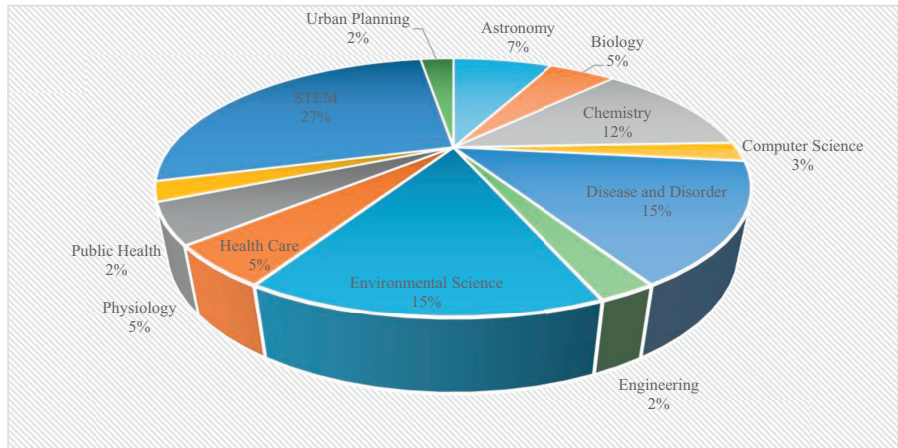
**Figure 3.** The percent of the covered STEM e-courses

In addition, LMS carries the e-courses materials and offers different tools and techniques to evaluate and transform courses into interactive and interesting e-courses.

In the twenty-first century, it is clear that science, technology, engineering and mathematic fields have great influence on the labor market (Chen *et al.*, 2018). These fields are in continuous and hectic expansion. As a result, educators and learners are in great need of implementing technological innovations to become more engaged with STEM education and its latest topics. Nowadays, a number of researchers, scientists and professors are searching for more innovative techniques for STEM teaching. A number of published studies in literature have shown that e-learning plays a key role in STEM education (Tiwari, 2011). STEM education via e-learning could be of great help to schools and university students. E-learning could foster science literacy and introduce new scientific findings to the public.



**Figure 4.**  
The STEM topics covered by the USA



**Figure 5.**  
The STEM topics covered by UK

From the collected data, it is obvious that STEM education via e-learning is widely spreading, covering mostly all topics and offered by distinguished institutions worldwide.

From all the above propositions, international educational, commercial and cultural institutions have created numerous programs and e-courses. A number of international agencies are supporting e-learning, such as the Commonwealth and the World Bank Group. Public libraries have supporting elements and great potential to empower them to play significant roles in developing and spreading e-learning education. Each public library has different scope and objectives, nevertheless, all presented cases showed positive indications that e-learning education could be offered by public libraries depending on their resources, skilled librarian staff and collaboration with different educational organizations (Universities, research institutions, information services' centers, etc.). However, most of the libraries providing e-learning services are confined to the LIS field. The collected data show that STEM subjects are successfully presented in interactive e-courses carried by LMS. The author suggests that as learners participate in engaging positive STEM e-learning courses, they would become more concerned with STEM and STEM-related careers. From the collected data, it is obvious that public libraries have full capacity

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(potential) to offer e-learning in STEM fields. This paper points out the value in having e-learning team experts, this team could provide simple and/or deep scientific content; provide, support and develop e-learning technologies; as well as create interactive and entertaining e-courses. IT support teams could provide consultation to the e-learning teams. In this study, the author has attempted to shed light on the role of the BA in e-learning as a case study. The BA is a public library emerged as a hub for excellence providing a wide range of innovative services. Among the remarkable services come the BA e-learning services. The nascent service aims to deploy the lifelong learning approach and introduces emerging scientific findings in interactive and simple means to specialized and non-specialized audience. The BA e-learning services will achieve these goals by developing collaboration between the BA and different educational institutions (schools, universities and research institutions).

The BA e-learning service during three years was able to offer different e-courses categories that could match the requirements of various users (general and lifelong learner, LIS specialist, researchers and postgraduates). The BA in cooperation with Senghor University, The National Superior School of Information Science and Libraries (ENSSIB), the National Library of France (BnF) was able to award the DUSIB 2018–2019 alumni their diploma and launched its second round 2019–2020. In year 2019, it offered the Researchers' Program, which covers different topics, targets researchers and postgraduates and aims to enhance their competencies. Researchers, scientists and professors from academia and specialized librarians could cooperate to prepare and provide interactive, hands-on and useful scientific e-courses. The author would like to highlight the idea that the role of public libraries is providing online education to assist educational organizations, enhance society literacy, increase public awareness and to embrace lifelong learning concept. Indeed, public libraries could be partner to educational organizations not a substitute or alternative. There are varieties of e-learning platforms that produce STEM e-courses for individuals. Many library users are looking to public libraries to provide access to these platforms. Gale course, Knowledgecity and Skillsoft are examples of platforms that provide various e-courses topics for libraries. Briefly, public libraries with all their resources, services and expert librarians could provide an exceptional e-learning experience to their community and be of great help to educational institutions and organizations.

## Conclusion

There is a diversity of e-courses, activities and programs that promote STEM education, but there are limited models of extending STEM e-courses by employing e-learning platforms in public libraries. These trials could be a positive sign that public libraries are promising key players in developing and supporting e-learning education in different fields not only in LIS. There is an increased need to augment STEM education via e-learning in a technology-driven society and generate initiatives that develop STEM literacy and increase individuals' awareness toward STEM, health, environmental issues and related professions. E-learning is considered one of the most rapid and emergent industries. It is obvious that e-learning has left a significant footprint on educational systems worldwide. Nowadays, public libraries with their immense capacities open a new gateway toward e-learning. Public libraries have an important and critical role to disseminate knowledge, education and literacy to the community. They should ensure the quality of the provided educational material and services. Public libraries should work on delivering their services equally to all types of public users. To achieve their goal in the e-learning industry, public libraries should build strong collaborations and partnerships with different educational institutions. Specialized librarians are uniquely qualified to become active members of the e-learning team and assist both their libraries and the educational institutions to effectively integrate STEM subjects into



e-courses. Public libraries should focus on basic and elementary STEM concepts, as well as create and enhance awareness of STEM fields and possible occupations. In conclusion, spreading the concepts of e-learning, STEM and lifelong education could have great impact on developing labor competence, enhancing socio-cultural and environmental public awareness.

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Annex 1

**Table A1.**  
STEM e-courses  
collected data

#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
1	Biology and Life Sciences	Quantitative Biology Workshop	Massachusetts Institute of Technology (MITx)	edx	8 weeks	Paid certificate	Free	USA	English
2	Engineering, Business and Management, Math, Data Analysis and Statistics	Principles of Manufacturing (8 courses)	Massachusetts Institute of Technology (MITx)	edx	8 weeks	Paid certificate	Free	USA	English
3	Astronomy	The Science of Solar System	California Institute of Technology (Caltech)	Coursera	10 weeks	Paid certificate	Free	USA	English (subtitles: English, French)
4	Astronomy	Astrobiology and the Search for Extra-terrestrial Life	University of Edinburgh	Coursera	5 weeks	Paid certificate	Free	UK	English (Subtitles: English, Russian, Romanian, German)
5	Astronomy	Introduction to Astronomy	Duke University	Coursera	10 weeks	Certificate available	Free	USA	English
6	Astronomy	Atmospheric Chemistry, Planets and Life Beyond Earth	University of Leeds	FutureLearn	2 weeks	Paid certificate	Free	UK	English
7	Astronomy	Our Solar System and Beyond: Teaching Primary Science	Royal Observatory Greenwich	FutureLearn	3 weeks	Paid certificate	Free	UK	English
8	Biology	Dino 101: Dinosaur Paleobiology	University of Alberta	Coursera	12 weeks	Paid certificate	Free	Canada	English (Subtitles: English, French, Italian, German, Spanish)

(continued)

#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
9	Biology	Understanding the Brain: the Neurobiology of Everyday Life	The University of Chicago	Coursera	11 weeks	Paid certificate	Free	USA	English
10	Biology	Introduction to Genetics and Evolution	Duke University	Coursera	11 weeks	Paid certificate	Free	USA	English (Subtitles: English, Romanian)
11	Biology	Introductory Human Physiology	Duke University	Coursera	10 weeks	Paid certificate	Free	USA	English
12	Biology	Medical Neuroscience	Duke University	Coursera	13 weeks	Paid certificate	Free	USA	English
13	Biology	Visual Perception and Brain	Duke University	Coursera	5 weeks	Paid certificate	Free	USA	English
14	Biology	Music as Biology: What We Like to Hear and Why	Duke University	Coursera	6 weeks	Paid certificate	Free	USA	English
15	Biology	Bioelectricity: A Quantitative Approach	Duke University	Coursera	7 weeks	Paid certificate	Free	USA	English
16	Biology	Bioelectricity: the Mechanism of Origin of Extracellular Potentials	Duke University	Coursera	7 weeks	Paid certificate	Free	USA	English
17	Biology	Foundational Neuroscience for Perception and Action	Duke University	Coursera	9 weeks	Certificate available	Free	USA	English
18	Biology	Neuroscience: Perception, Action and the Brain Capstone	Duke University	Coursera	6 weeks	Certificate available	Paid course	USA	English
19	Biology	Anatomy: Know Your Abdomen	University of Leeds	FutureLearn	2 weeks	Paid certificate	Free	UK	English

(continued)

Table A1.

#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
20	Biology	How Does the Body Use DNA as a Blueprint?	University of Aberdeen	FutureLearn	3 weeks	Paid certificate	Free	UK	English
21	Biology	Extinctions: Past and Present	University of Cape Town	FutureLearn	5 weeks	Paid certificate	Free	South Africa	English
22	Biology and Life Sciences	Introduction to Biology: the secret of life	Massachusetts Institute of Technology (MITx)	edx	12 weeks	Paid certificate	Free	USA	English (Transcripts Simplified Chinese)
23	Biology and Life Sciences	Molecular Biology – Part 1: DNA Replication and Repair	Massachusetts Institute of Technology (MITx)	edx	8 weeks	Paid certificate	Free	USA	English
24	Biology and Life Sciences	Molecular Biology – Part 2: Transcription and Transposition	Massachusetts Institute of Technology (MITx)	edx	7 weeks	Paid certificate	Free	USA	English
25	Biology and Life Sciences	Introduction to Biology – The Secret of Life	Massachusetts Institute of Technology (MITx)	edx	12 weeks	Paid certificate	Free	USA	English
26	Biology and Life Sciences	Biochemistry: Biomolecules, Methods and Mechanisms	Massachusetts Institute of Technology (MITx)	edx	12 weeks	Paid certificate	Free	USA	English
27	Biology and Life Sciences	Making Biologic Medicines for Patients: The Principles of Biopharmaceutical Manufacturing	Massachusetts Institute of Technology (MITx)	edx	6 weeks	Paid certificate	Free	USA	English

*(continued)*

#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
28	Biology and Life Sciences	Making Biologic Medicines for Patients: The Principles of Biopharmaceutical Manufacturing	Massachusetts Institute of Technology (MITx)	edX	8 weeks	Paid certificate	Free	USA	English
29	Biology and Life Sciences	Light, Spike and Sight: The Neuroscience of Vision	Massachusetts Institute of Technology (MITx)	edX	9 weeks	Paid certificate	Free	USA	English
30	Bioinformatics	Algorithms for DNA Sequencing	Johns Hopkins University	Coursera	4 weeks	Paid certificate	Free	USA	English
31	Bioinformatics	Finding Hidden Messages in DNA (Bioinformatics I)	University of California, San Diego	Coursera	5 weeks	Paid certificate	Free	USA	English
32	Chemistry	The Brain and Space	Duke University	Coursera	6 weeks	Paid certificate	Free	USA	English
33	Chemistry	Introduction to Chemistry: Structures and Solutions	Duke University	Coursera	7 weeks	Paid certificate	Free	USA	English
34	Chemistry	Introduction to Chemistry: Reactions and Ratios	Duke University	Coursera	7 weeks	Paid certificate	Free	USA	English
35	Chemistry	Introduction to Chemistry	Duke University	Coursera	9 weeks	Certificate available	Free	USA	English
36	Chemistry	Discovering Science: Medicinal Chemistry	University of Leeds	FutureLearn	2 weeks	Paid certificate	Free	UK	English
37	Chemistry	Discovering Science: Global challenges	University of Leeds	FutureLearn	2 weeks	Paid certificate	Free	UK	English
38	Chemistry	Discovering Science: Chemical Products	University of Leeds	FutureLearn	2 weeks	Paid certificate	Free	UK	English
39	Chemistry	Discovering Science: Atmospheric Chemistry	University of Leeds	FutureLearn	2 weeks	Paid certificate	Free	UK	English

(continued)

Table AI.

Table A1.

#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
40	Chemistry	Teaching Practical Science: Chemistry	National STEM Learning Center	FutureLearn	3 weeks	Paid certificate	Free	UK	English
41	Chemistry	Introduction to Solid State Chemistry	Massachusetts Institute of Technology (MITx)	edx	15 weeks	Paid certificate	Free	USA	English
42	Computer Science	Robotics	Columbia University (ColumbiaX)	edx	12 weeks	Paid certificate	Free	USA	English
43	Computer Science	Artificial Intelligence (AI)	Columbia University (ColumbiaX)	edx	12 weeks	Paid certificate	Free	USA	English
44	Computer Science	Machine Learning	Columbia University (ColumbiaX)	edx	12 weeks	Paid certificate	Free	USA	English
45	Computer Science	Introduction to Computer Science and Programming Using Python	Institute of Technology (MITx)	edx	9 weeks	Paid certificate	Free	USA	English
46	Computer Science	Global Health Informatics to Improve Quality of Care	Massachusetts Institute of Technology (MITx)	edx	10 weeks	Paid certificate	Free	USA	English
47	Computer Science	Computational Thinking for Modeling and Simulation	Massachusetts Institute of Technology (MITx)	edx	6 weeks	Paid certificate	Free	USA	English
48	Computer Science	Principles of Synthetic Biology	Massachusetts Institute of Technology (MITx)	edx	15 weeks	Paid certificate	Free	USA	English

*(continued)*

#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
49	Computer Science	Introduction to Computational Thinking and Data Science	Massachusetts Institute of Technology (MITx)	edx	9 weeks	Paid certificate	Free	USA	English
50	Computer Science	Quantum Information Science I, Part 1	Massachusetts Institute of Technology (MITx)	edx	5 weeks	Paid certificate	Free	USA	English
51	Computer Science	Quantum Information Science I, Part 3	Massachusetts Institute of Technology (MITx)	edx	7 weeks	Paid certificate	Free	USA	English
52	Computer Science	Understanding Robotics	Massachusetts Institute of Technology (MITx)	edx	11 weeks	Paid certificate	Free	USA	English
53	Computer Science	Functional Programming Principles in Scala	Ecole Polytechnique Fédérale de Lausanne	Coursera	6 weeks	Paid certificate	Free	Switzerland	English
54	Computer Science	CS188.Ix: Artificial Intelligence	University of California	edx	12 weeks	Paid certificate	Free	USA	English
55	Computer Science	CS50's Introduction to Computer Science	Harvard University	edx	4 weeks	Paid certificate	Free	USA	English
56	Computer Science	Learning from Data (Introductory Machine Learning)	University of California	edx	10 weeks	Paid certificate	Free	USA	English
57	Computer Science	Intro to Computer Science	Institute of Technology (Caltech)	Udacity	12 weeks	Paid certificate	Free	USA	English
58	Computer Science	Cryptography I	University of Virginia Stanford University	Coursera	7 weeks	Paid certificate	Free	USA	English

(continued)



Table A1.

#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
59	Computer Science	Bitcoin and Cryptocurrency Technologies	Princeton University	Coursera	11 weeks		Free	USA	English
60	Computer Science	Introduction to Cyber Security	The Open University	FutureLearn	8 weeks	Paid certificate	Free	UK	English
61	Data Science	Statistical Thinking for Data Science and Analytics	Columbia University (ColumbiaX)	edx	5 weeks	Paid certificate	Free	USA	English
62	Data Science	Machine Learning for Data Science and Analytics	Columbia University (ColumbiaX)	edx	5 weeks	Paid certificate	Free	USA	English
63	Data Science	Enabling Technologies for Data Science and Analytics: the internet of Things	Columbia University (ColumbiaX)	edx	5 weeks	Paid certificate	Free	USA	English
64	Data Science	Data Science for Executives (3 Courses)	Columbia University (ColumbiaX)	edx	15 weeks	Paid certificate	Free	USA	English
65	Data Science	Capstone Exam in Statistics and Data Science	Massachusetts Institute of Technology (MITx)	edx	2 weeks	Paid certificate	Free	USA	English
66	Data Science	Statistics and Data Science (5 courses)	Massachusetts Institute of Technology (MITx)	edx	9 weeks	Paid certificate	Free	USA	English
67	Data Science	Introduction to Probability – The Science of Uncertainty	Massachusetts Institute of Technology (MITx)	edx	16 weeks	Paid certificate	Free	USA	English

*(continued)*

#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
68	Data Science	The Analytics Edge	Massachusetts Institute of Technology (MITx)	edx	13 weeks	Paid certificate	Free	USA	English
69	Data Science	Data Mining with Weka	University of Waikato	Independent	5 weeks		Free	New Zealand	English
70	Data Science	Big Data Analysis with Apache Spark	University of California, Berkeley	edx	4 weeks		Free	USA	English
71	Data Science	Data Science: R Basics	Harvard University	edx	8 weeks	Paid certificate	Free	USA	English
72	Data Science	Analyzing and Visualizing Data with Excel	Microsoft	edx	6 weeks	Paid certificate	Free	USA	English
73	Data Science	Introduction to Data Analysis Using Excel	Microsoft	edx	4 weeks	Paid certificate	Free	USA	English
74	Data Science	Python for Data Science	University of California, San Diego	edx	10 weeks		Free	USA	English
75	Disease and Disorders	Tropical Parasitology: Protozoans, Worms, Vectors and Human Diseases	Duke University	Coursera	8 weeks	Paid certificate	Free	USA	English
76	Disease and Disorders	Causes of Human Disease: Understanding Causes of Disease	University of Leeds	FutureLearn	2 weeks	Paid certificate	Free	UK	English
77	Disease and Disorders	Exploring Cancer Medicines	University of Leeds	FutureLearn	2 weeks	Paid certificate	Free	UK	English
78	Disease and Disorders	Causes of Human Disease: Transmitting and Fighting Infection	University of Leeds	FutureLearn	2 weeks	Paid certificate	Free	UK	English

(continued)

Table A1.

#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
79	Disease and Disorders	Causes of Human Disease: Exploring Cancer and Genetic Disease	University of Leeds	FutureLearn	2 weeks	Paid certificate	Free	UK	English
80	Disease and Disorders	Causes of Human Disease: Understanding Cardiovascular Disease	University of Leeds	FutureLearn	2 weeks	Paid certificate	Free	UK	English
81	Disease and Disorders	Causes of Human Disease: Nutrition and Environment	University of Leeds	FutureLearn	2 weeks	Paid certificate	Free	UK	English
82	Disease and Disorders	Understanding Dementia	University of Tasmania	Independent	7 weeks	Certificate available	Free	Australia	English
83	Earth Science	Introduction to Solar Cells	Technical University of Denmark	Coursera	5 weeks	Paid certificate	Paid course	Denmark	English
84	Engineering	Major Engineering Project Performance	University of Leeds	Coursera	5 weeks	Paid certificate	Free	UK	English
85	Engineering	Circuits and Electronics 1: Basic Circuit Analysis	Massachusetts Institute of Technology (MITx)	edX	5 weeks	Paid certificate	Free	USA	English
86	Engineering	Circuits and Electronics 2: Amplification, Speed, and Delay	Massachusetts Institute of Technology (MITx)	edX	5 weeks	Paid certificate	Free	USA	English
87	Engineering	Circuits and Electronics 3: Applications	Massachusetts Institute of Technology (MITx)	edX	7 weeks	Paid certificate	Free	USA	English

*(continued)*

#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
88	Engineering	Structure of Materials, Part 1: Fundamentals of Materials Structure	Massachusetts Institute of Technology (MITx)	edx	5 weeks	Paid certificate	Free	USA	English
89	Engineering	Manufacturing Systems II	Massachusetts Institute of Technology (MITx)	edx	8 weeks	Paid certificate	Free	USA	English
90	Engineering	Supply Chains for Manufacturing II	Massachusetts Institute of Technology (MITx)	edx	8 weeks	Paid certificate	Free	USA	English
91	Engineering	Mechanics of Deformable Structures: Part 1	Massachusetts Institute of Technology (MITx)	edx	12 weeks	Paid certificate	Free	USA	English
92	Engineering	Structure of Materials, Part 2: The Crystalline State	Massachusetts Institute of Technology (MITx)	edx	5 weeks	Paid certificate	Free	USA	English
93	Engineering	Management in Engineering II	Massachusetts Institute of Technology (MITx)	edx	8 weeks	Paid certificate	Free	USA	English
94	Engineering	Manufacturing Process Control I	Massachusetts Institute of Technology (MITx)	edx	8 weeks	Paid certificate	Free	USA	English
95	Engineering	Mechanical Behavior of Materials, Part 1: Linear Elastic Behavior	Massachusetts Institute of Technology (MITx)	edx	5 weeks	Paid certificate	Free	USA	English

(continued)

Table A1.

#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
96	Engineering	Mechanical Behavior of Materials, Part 2: Stress Transformations, Beams, Columns and Cellular Solids	Massachusetts Institute of Technology (MITx)	edx	4 weeks	Paid certificate	Free	USA	English
97	Engineering	Mechanical Behavior of Materials, Part 3: Time Dependent Behavior and Failure	Massachusetts Institute of Technology (MITx)	edx	6 weeks	Paid certificate	Free	USA	English
98	Engineering	Engineering the Space Shuttle	Massachusetts Institute of Technology (MITx)	edx	12 weeks	Paid certificate	Free	USA	English
99	Engineering	Introduction to Aerospace Engineering: Astronautics and Human Spaceflight	Massachusetts Institute of Technology (MITx)	edx	8 weeks	Paid certificate	Free	USA	English
100	Engineering	Introduction to Aerodynamics	Massachusetts Institute of Technology (MITx)	edx	15 weeks	Paid certificate	Free	USA	English
101	Engineering	Analysis of Transport Phenomena I: Mathematical Methods	Massachusetts Institute of Technology (MITx)	edx	12 weeks	Paid certificate	Free	USA	English
102	Engineering	Computer-Aided Engineering (CADE)	American University in Cairo (AUC)	moodle	3 months	Paid certificate	Paid course	Egypt	English and Arabic

*(continued)*

#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
103	Engineering	Engineering Management Professional Certification (PCEM) Risk Assessment (RASH)	American University in Cairo (AUC)	moodle	3 months	Paid certificate	Paid course	Egypt	English and Arabic
104	Engineering	Welding Engineering (WLEN)	American University in Cairo (AUC)	moodle	3 months	Paid certificate	Paid course	Egypt	English and Arabic
105	Engineering	Cement Industry	American University in Cairo (AUC)	moodle	3 months	Paid certificate	Paid course	Egypt	English and Arabic
106	Engineering	The 3D Printing Revolution	University of Illinois at Urbana-Champaign	Coursea	2 weeks	Paid certificate	Free	USA	English
107	Engineering	Introduction to Engineering Mechanics	Georgia Institute of Technology	Coursea	5 weeks	Paid certificate	Free	USA	English
108	Environmental Engineering	Environmental Engineering (EVEN)	American University in Cairo (AUC)	moodle	3 months	Paid certificate	Paid course	Egypt	English and Arabic
109	Environmental Science	Marine Megafauna: an Introduction to Marine Science and Conservation	Duke University	Coursea	8 weeks	Certificate available	Free	USA	English
110	Environmental Science	Environmental Challenges: Justice in Natural Resource Management	University of Leeds	FutureLearn	2 weeks	Paid certificate	Free	UK	English

(continued)

Table A1.

#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
112	Environmental Science	Environmental Challenges: Rights and Values in Ecosystem Services	University of Leeds	FutureLearn	2 weeks	Paid certificate	Free	UK	English
113	Environmental Science	Environmental Challenges: Hierarchy in Property Rights	University of Leeds	FutureLearn	2 weeks	Paid certificate	Free	UK	English
114	Environmental Science	Environmental Challenges: Human Impact in the Natural Environment	University of Leeds	FutureLearn	2 weeks	Paid certificate	Free	UK	English
115	Environmental Science	Fairness and Nature: when worlds collide	University of Leeds	FutureLearn	2 weeks	Paid certificate	Free	UK	English
116	Environmental Science	Environmental Management: Social-Ecological Systems	University of Leeds	FutureLearn	3 weeks	Paid certificate	Free	UK	English
117	Environmental Science	Global Biosecurity for One Health	Murdoch University	FutureLearn	3 weeks	Paid certificate	Free	Australia	English
118	Environmental Science	Sustainable Development in Humanitarian Action	International Federation of Red Cross and Red Crescent Societies	FutureLearn	4 weeks	Paid certificate	Free	Switzerland	English
119	Health care	Improving Healthcare Through Clinical Research	University of Leeds	FutureLearn	4 weeks	Paid certificate	Free	UK	English
120	Health care	Whole Genome Sequencing: Decoding the Language of Life and Health	NHS Health Education England	FutureLearn	3 weeks	Paid certificate	Free	England	English

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#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
121	Health care	Dysphagia: Swallowing Difficulties and Medicines	University of East Anglia	FutureLearn	6 weeks	Paid certificate	Free	UK	English
122	Health care	Creating Moments of Joy for People with Alzheimer's	Purdue University	FutureLearn	2 weeks	Paid certificate	Free	USA	English
123	Health care	First aid for adults	International Federation of Red Cross and Red Crescent Societies	FutureLearn	2 weeks	Paid certificate	Free	Switzerland	English
124	Health care	First aid for babies and children	International Federation of Red Cross and Red Crescent Societies	FutureLearn	2 weeks	Paid certificate	Free	Switzerland	English
125	Health care	Be Ready: Staying Safe During Disasters	International Federation of Red Cross and Red Crescent Societies	FutureLearn	2 weeks	Paid certificate	Free	Switzerland	English
126	Health care	Medicine and the Arts: Humanizing Healthcare	University of Cape Town	FutureLearn	6 weeks	Paid certificate	Free	South Africa	English
127	Health care	Mindfulness for Wellbeing and Peak Performance	Monash University	FutureLearn	6weeks	Paid certificate	Free	Australia	English
128	Health care	Understanding Clinical Research: Behind the Statistics	University of Cape Town	Coursera	6 weeks	Paid certificate	Free	South Africa	English

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Table AI.

#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
129	Health care, Environmental Sciences	Occupational Health, Safety and Environmental Control (HSE) (OSHA)	American University in Cairo (AUC)	moodle	12 weeks	Paid certificate	Paid course	Egypt	English and Arabic
130	Machine Learning	Machine Learning	Stanford University	Coursera	11 weeks	Paid certificate	Free	USA	English
131	Mathematics	Differential Equations: Linear Algebra and NxN Systems of Differential Equations	Massachusetts Institute of Technology (MITx)	edx	9 weeks	Paid certificate	Free	USA	English
132	Mathematics	Calculus One	Ohio State University	Coursera	16 weeks		Free	USA	English
133	Mathematics	Calculus 1A: Differentiation	Massachusetts Institute of Technology (MITx)	edx	12 weeks	Paid certificate	Free	USA	English
134	Mathematics	Calculus 1B: Integration	Massachusetts Institute of Technology (MITx)	edx	15 weeks	Paid certificate	Free	USA	English
135	Mathematics	Calculus 1C: Coordinate Systems and Infinite Series	Massachusetts Institute of Technology (MITx)	edx	8 weeks	Paid certificate	Free	USA	English
136	Mathematics	Differential Equations: Fourier Series and Partial Differential Equations	Massachusetts Institute of Technology (MITx)	edx	9 weeks	Paid certificate	Free	USA	English
137	Mathematics	Fractals and Scaling	Santa Fe Institute	Complexity Explorer	7 weeks	Certificate available	Free	USA	English
138	Mathematics	Introduction to Mathematical Thinking	Stanford University	Coursera	9 weeks	Paid certificate	Free	USA	English

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#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
139	Mathematics	Algorithms: Design and Analysis, Part 1	Stanford University	Coursera	7 weeks	Paid certificate	Free	USA	English
140	Mathematics	Algorithms, Part I	Princeton University	Coursera	6 weeks		Free	USA	English
141	Mathematics	Introduction to Dynamical Systems and Chaos	Santa Fe Institute	Complexity Explorer	10 weeks	Certificate available	Free	USA	English
142	Medicine	Pediatric HIV Nursing	Columbia University (ColumbiaX)	edx	8 weeks	Paid certificate	Free	USA	English
143	Medicine	Fighting HIV with Antiretroviral Therapy: Implementing the Treat-All Approach	Columbia University (ColumbiaX)	edx	6 weeks	Paid certificate	Free	USA	English
144	Physics	How Things Work: an Introduction to Physics	University of Virginia	Coursera	8 weeks	Paid certificate	Free	USA	English (Subtitles: English, Arabic, French, Portuguese (European), Chinese (Simplified), Greek, Italian, Korean, German, Urdu, Russian, Hebrew, Spanish, Hindi, Japanese)
145	Physics	Mechanics: Rotational Dynamics	Massachusetts Institute of Technology (MITx)	edx	6 weeks	Paid certificate	Free	USA	English

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Table AI.

#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
146	Physics	Applications of Quantum Mechanics	Massachusetts Institute of Technology (MITx)	edx	19 weeks	Paid certificate	Free	USA	English
147	Physics	Electricity and Magnetism: Electrostatics	Massachusetts Institute of Technology (MITx)	edx	7 weeks	Paid certificate	Free	USA	English
148	Physics	Electricity and Magnetism: Maxwell's Equations	Massachusetts Institute of Technology (MITx)	edx	6 weeks	Paid certificate	Free	USA	English
149	Physics	Electricity and Magnetism: Magnetic Fields and Forces	Massachusetts Institute of Technology (MITx)	edx	6 weeks	Paid certificate	Free	USA	English
150	Physics	Mastering Quantum Mechanics Part 1: Wave Mechanics	Massachusetts Institute of Technology (MITx)	edx	5 weeks	Paid certificate	Free	USA	English
151	Physics	Mastering Quantum Mechanics Part 2: Quantum Dynamics	Massachusetts Institute of Technology (MITx)	edx	5 weeks	Paid certificate	Free	USA	English
152	Physics	Mastering Quantum Mechanics Part 3: Entanglement and Angular Momentum	Massachusetts Institute of Technology (MITx)	edx	5 weeks	Paid certificate	Free	USA	English
153	Physics	Quantum Mechanics: 1D Scattering and Central Potentials	Massachusetts Institute of Technology (MITx)	edx	7 weeks	Paid certificate	Free	USA	English

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#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
154	Physics	Mechanics: Momentum and Energy	Massachusetts Institute of Technology (MITx)	edx	7 weeks	Paid certificate	Free	USA	English
155	Physics	Quantum Mechanics: Quantum physics in 1D Potentials	Massachusetts Institute of Technology (MITx)	edx	7 weeks	Paid certificate	Free	USA	English
156	Physics	Mechanics: Simple Harmonic Motion	Massachusetts Institute of Technology (MITx)	edx	4 weeks	Paid certificate	Free	USA	English
157	Physics	Mechanics: Kinematics and Dynamics	Massachusetts Institute of Technology (MITx)	edx	6 weeks	Paid certificate	Free	USA	English
158	Physics	Quantum Mechanics: Wave functions, Operators and Expectation Values	Massachusetts Institute of Technology (MITx)	edx	7 weeks	Paid certificate	Free	USA	English
159	Physics	Quantum Information Science II: Efficient Quantum Computing – fault tolerance and complexity	Massachusetts Institute of Technology (MITx)	edx	4 weeks	Paid certificate	Free	USA	English
160	Physics	Quantum Information Science I, Part 2	Massachusetts Institute of Technology (MITx)	edx	6 weeks	Paid certificate	Free	USA	English
161	Physics	Quantum Information Science II	Massachusetts Institute of Technology (MITx)	edx	9 weeks	Paid certificate	Free	USA	English

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Table A1.

#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
162	Physics	Atomic and Optical Physics I – Part 1: Resonance	Massachusetts Institute of Technology (MITx)	edx	4 weeks	Paid certificate	Free	USA	English
163	Physics	Atomic and Optical Physics: Optical Bloch Equations and Open System Dynamics	Massachusetts Institute of Technology (MITx)	edx	4 weeks	Paid certificate	Free	USA	English
164	Physics	Global Warming Science	Massachusetts Institute of Technology (MITx)	edx	12 weeks	Paid certificate	Free	USA	English
165	Physics	Effective Field Theory	Massachusetts Institute of Technology (MITx)	edx	18 weeks	Paid certificate	Free	USA	English
166	Physiology	What is body?	University of Aberdeen	FutureLearn	3 weeks	Paid certificate	Free	UK	English
167	Physiology	What Drives the Body?	University of Aberdeen	FutureLearn	3 weeks	Paid certificate	Free	UK	English
168	Programming	An Introduction to Interactive Programming in Python (Part 1)	Rice University	Coursera	5 weeks	Paid certificate	Free	USA	English
169	Programming	Introduction to Programming with MATLAB	Vanderbilt University	Coursera	9 weeks	Paid certificate	Free	USA	English
170	Programming	Programming for Everybody (Getting Started with Python)	University of Michigan	Coursera	7 weeks	Paid certificate	Free	USA	English
171	Programming	Learn to Program: The Fundamentals	University of Toronto	Coursera	7 weeks	Paid certificate	Free	Canada	English

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#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
172	Programming	Learn to Program in Java	Microsoft	edx	4 weeks	Paid certificate	Free	USA	English
173	Programming	Java Programming Basics		Udacity	6 weeks		Free		English
174	Programming	Introduction to Python: Absolute Beginner	Microsoft	edx	5 weeks	Paid certificate	Free	USA	English
175	Programming	Android Basics: User Interface	Google	Udacity	2 weeks		Free	USA	English
176	Programming	Programming Foundations with Python		Udacity	6 weeks		Free	USA	English
177	Programming	Developing Android Apps		Udacity	Self-paced		Free	USA	English
178	Public Health	The Challenges of Global Health	Duke University	Coursera	5 weeks	Paid certificate	Free	USA	English
179	Public Health	Discover Dentistry	The University of Sheffield	FutureLearn	6 weeks	Paid certificate	Free	UK	English
180	Quantum Mechanics	Quantum Mechanics for everyone	Georgetown University (GeorgetownX)	edx	4 weeks	Paid certificate	Free	USA	English
181	Robotics	Artificial Intelligence for Robotics	Stanford University	Udacity	8 weeks		Free	USA	English
182	Science	Nuclear Energy: Science, Systems and Society	Massachusetts Institute of Technology (MITx)	edx	8 weeks	Paid certificate	Free	USA	English
183	Science	Introduction to Complexity	Santa Fe Institute	Complexity Explorer	10 weeks	Certificate available	Free	USA	English
184	Science	The Science of Everyday Thinking	University of Queensland	edx	12 weeks		Free	USA	English

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Table AI.

Table AI.

#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
185	Statistics	Fundamentals of Statistics	Massachusetts Institute of Technology (MITx)	edX	14 weeks	Paid certificate	Free	USA	English
186	Statistics and Probability	Bayesian Statistics	Duke University	Coursera	5 weeks	Paid certificate	Free	USA	English
187	Statistics and Probability	Linear Regression and Modeling	Duke University	Coursera	4 weeks	Paid certificate	Free	USA	English
188	Statistics and Probability	Introduction to Probability and Data	Duke University	Coursera	5 weeks	Paid certificate	Free	USA	English
189	Statistics and Probability	Statistics with R Capstone	Duke University	Coursera	8 weeks	Paid certificate	Paid course	USA	English
190	Statistics and Probability	Teaching Statistical Thinking: Part 1	Duke University	Coursera	5 weeks	Certificate available	Free	USA	English
191	STEM	Descriptive Statistics Assessment for Learning in STEM Teaching	University of Leeds	FutureLearn	6 weeks	Certificate available	Free	UK	English
192	STEM	Inspiring Young People In STEM (Program)	National STEM Learning Center	FutureLearn	8 weeks	Paid certificate	Free	UK	English
193	STEM	Assessment for Learning in STEM Teaching	National STEM Learning Center	FutureLearn	6 weeks	Paid certificate	Free	UK	English
194	STEM	Teaching STEM Subjects; Planning for Learning	National STEM Learning Center	FutureLearn	5 weeks	Paid certificate	Free	UK	English
195	STEM	Teaching Primary Science: Getting Started	National STEM Learning Center	FutureLearn	3 weeks	Paid certificate	Free	UK	English

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#	Scientific subject	Topic	Provider	Platform	Duration	Certified	Cost	Country	Language
196	STEM	Teaching STEM Subjects: Differentiation for Learning	National STEM Learning Center	FutureLearn	5 weeks	Paid certificate	Free	UK	English
197	STEM	Linking STEM Curriculum Learning to Careers	National STEM Learning Center	FutureLearn	4 weeks	Paid certificate	Free	UK	English
198	STEM	Maths Subject Knowledge: Proportional Reasoning	National STEM Learning Center	FutureLearn	4 weeks	Paid certificate	Free	UK	English
199	STEM	Teaching Practical Science: Physics	National STEM Learning Center	FutureLearn	3 weeks	Paid certificate	Free	UK	English
200	STEM	Teaching Practical Science: Biology	National STEM Learning Center	FutureLearn	3 weeks	Paid certificate	Free	UK	English
201	STEM	Planning for Learning in STEM Teaching: Formative Assessment for Tailored Learning	National STEM Learning Center	FutureLearn	5 weeks	Paid certificate	Free	UK	English
202	STEM	Coding in your Classroom, Now!	University of Urbino	EMMA	13 weeks		Free	Italy	Italian
203	Urban Planning	Transport Systems: Global Issues and Future Innovations	University of Leeds	FutureLearn	2 weeks	Paid certificate	Free	UK	English

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