

Online Courses in Technology and Engineering: To What Extent Do They Tangibly Enhance Professional Development?

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Abstract—Platforms for online courses including Massive Open Online Courses (MOOCs) have become the most remarkable well-built environment for teaching and learning. Until recently the various types of online courses have been an optional and supplementary source of gaining knowledge and skills to compensate the learning loss in formal education. COVID-19 brought unprecedented disruption to the education industry. Work integrated learning in very essential fields, namely, technology and engineering, did not take place. This research addresses the motivations, challenges, and interactions as well as the tangible and intangible impacts of technology and engineering online courses on MENA (Middle East and North Africa) professionals; and to what extent have these courses been able to promote professionals to a new development in their careers? A questionnaire survey with standardized closed-ended and open-ended questions was conducted online with 66 professionals who have been purposely selected. The analysis of responses and findings show that the desire to develop and enhance knowledge previously acquired is the most important motivation. The results also showed weakness in the tangible achievements of the participants, and most of the achievements were the knowledge enhancement. Despite the set of challenges and inadequacies in achievements, the online platforms are providing a valuable well-built environment for life-long learning to advance knowledge, skills and to compensate for learning loss.

Keywords—MOOCs, MENA region, COVID-19, motivations, challenges, interactions, achievements

1 Introduction

Platforms for online courses including Massive Open Online Courses (MOOCs) have become the most remarkable well-built environment for teaching and learning [1]. These emerging forms of self-education have become an agent of change to the whole education process, and day-by-day it proves to be an important pillar in the education system and for professional enhancement. People have a profound need to be

actively involved in learning. On the other hand, the learning process has undergone some fascinating changes because of the technological revolution, including the advent of studying online. Technology advancements have a major influence on the modern working environment, including the transition to technology-driven instruction. Educational institutions are engaged in online training with the goals of reducing costs and creating material that can be delivered anytime, anywhere and tailored to meet individual needs. Learning technical advances have also changed training courses for professional advancement [2].

The various types of online courses were an optional and supplementary source of gaining knowledge and skills, either for students or professionals. There is a common trend within students' community that goes back to the early days of MOOCs. Immediately after graduation, the newly graduates start looking for online courses to recover the learning losses in the formal education programs that are packed with courses and students top concern is to get rid of by passing the exams [3]. They also believe that these courses would have tangible returns on their professionals' careers, such as to start their own businesses, get job or move to new job opportunity, receive incentives and a promotion, i.e. occupational returns as summarized by [4]. In the meantime, the newly graduates are eager to enhancing knowledge, skills, competence and improving candidacy for a new job, that are labelled in this work as intangible achievements, which are seen as very important intangible benefits of completing a MOOC [5].

With the outbreak of the coronavirus pandemic (COVID-19) schooling moved to various forms of remote learning. Those students with no previous exposure and experience with online learning faced a set of challenges to keep up with the new needs to follow up with their daily learning process, and to look for supplementary sources to cover the learning loss in the formal classes.

MOOCs boosted formal education overcoming the challenges of the coronavirus pandemic by moving and providing courses to students online, nonetheless, the learning loss had been maximized. The learning loss has been noteworthy during 2020/2021 where knowledge accumulation, skills and competence significantly declined. It is observed that students lost ground and gained less knowledge and skills that were to be achieved in a COVID-free school year. Evidences come from different regions of the world. [6] claimed that the capacity of the remote learning efforts to substitute for in-person learning is very low and led to large learning losses even in countries with high internet penetration and higher levels of digital skills among the teaching force. The results of a survey for teachers from different regions showed that as classes went online, teachers saw the effectiveness of instruction decline, [7]. The cross-sectional study of [8] in Germany indicates considerable learning loss where students spent less time learning despite of the application of distance learning amid COVID-19 pandemic. In Netherlands, the results of [9] study revealed a learning loss that is equivalent to one-fifth of a school year, and students made little or no progress while learning from home. Examining the students' experiences in an American University, [10] found that remote instruction generated distractions which hindered the students' ability to fully comprehend course material. Lessons learnt from three universities in Spain and Peru during the online teaching is related to less students' motivation and engagement according to [11]. At Lund University, Sweden, the engineering students expressed lower satisfaction with their online courses and found it harder to understand the expectations

and standards of work, [12]. The findings of a survey of undergraduate students in an Indian university by [13] show that students learn better in physical classrooms. Students at Saudi universities faced challenges during remote learning amid COVID-19 including methodology, content perception, technology, and behavioural challenges during the online courses and exams, [14] and [15]. The results of a study on Jordan universities students [16] showed that the prolonged use of digital tools have increased the number of psychological disorders and a drop in students' academic performance.

Most of the articles and research papers generally focused on online courses. Though technology and engineering online courses share similar issues, there is a particularity that is related to the practical side for most of the technology and engineering subjects, which required deeper investigation. The learners in the technology and engineering specialties seek to renew and upskill their knowledge and practical skills and keep pace with the development that is occurring at a high rate, in order to maintain their work, advance, or achieve new goals [3].

The researchers are curious about the vast number of Technology and Engineering online courses that are offered almost free by many educational institutions and organizations. The motivations, challenges, and interactions as well as the tangible and intangible impacts on professionals' careers are also matters of interest. Several studies have been conducted with the aim of knowing the motivations, the challenges and the interactions for online courses [17], [18], [19], [20]. The motivation as outlined by [21] is an important factor for the achievement and satisfaction of learners in online learning, while challenges are the barriers that the learners face during attending online educational courses according to [19]. On the other hand, interactions in online learning lead to higher learners' achievement [22]. Nonetheless, few have been specific to technology and engineering fields. Issues that were insufficiently investigated in previous studies, namely, the interaction between trainees and educators as between trainees and the system's interfaces and with content will also be researched.

To narrow the focus of the research, it has been decided to address the multi-dimensional impact of technology and engineering online courses on MENA professionals, and to what extent have these courses recovered the learning loss in informal education which has been amplified amid the coronavirus pandemic.

To understand the environment the MENA professionals experienced attending online courses, further questions in the three main domains of the study were developed; What are the motivations? the challenges? And the interactions? Then several issues were investigated through open-ended questions. By including all these factors, the current research makes a new scientific contribution that is of added-value and a contribution to knowledge in the field.

1.1 Research objective and setup

For a long time, online courses have been working to support and improve experiences and bridge the gaps between formal education and the needs of the labor market, as well as support continuing education. With the Covid-19 pandemic, many have turned to online courses for several reasons, including compensating for the severe shortage due to the disruption of classrooms for students, as well as the use of time resulting from the closure as a result of the pandemic for others [23].

A good number of research investigated issues related to online courses, such as the challenges and difficulties in getting benefits from online courses [23] and [19], motivation behind attending courses and the motivation to continue [17], and the interactions during the online courses [2]. The main objective of the current research is to investigate how has the attendance of technology and engineering courses compensated and enhanced learners' knowledge and skills, and had an impact on professionals' career, and how the Covid-19 pandemic has boosted the importance of online courses.

In order to achieve this objective, the current study will identify the motivations and challenges of MENA professionals to attend these courses and how they interacted with the courses. Then the impact of attending these courses on the professionals scientific and professional paths will be evaluated.

The sections of the research are structured as follows. A brief introduction on various types of online courses as a supplementary source of gaining knowledge and skills that has been lost during formal classes, and how MOOCs boosted formal education amid the coronavirus lockdown. The introduction is concluded by stating the importance and scientific contribution of the research as well as the research objectives and setup. It is followed by literature review to get the present landscape of the subject matter known. The main elements of the research methodology are outlined and research tools are presented. An in-depth look at the collected data and systematic analysis is carried out. This is followed by explanation of the acquired research findings and a discussion on which a conclusion and recommendations were based and drafted.

The current study focuses on technology and engineering online courses (free/acceptable fee/costly), which means the online courses taught in the universities as major disciplines are not included. The target sample is limited to professionals at MENA region.

2 Literature review

2.1 Online courses and learners' patterns

Online courses are a cost-effective and versatile way to learn new skills and succeed in a career [24]. The ones that are offered by well-known universities have been viewed as a transformative shift in higher education practice with a core principle to be available to all with internet access and the desire to learn [25]. They have the potential to transform the educational landscape. They serve a large number of students, and low-income students are more likely to benefit from them. It is a positive move forward, providing open access to a learning atmosphere that many people find beneficial to their education and future careers [24]. Furthermore, they reflect an educational strategy that enables hundreds of thousands of students to access online courses from anywhere in the world for free. They have attracted a lot of attention because of their sudden rise and disruptive potential [26].

MOOCs tend to attract those who already have a high level of education, rather than broadening their reach; MOOCs are thus far limited in the ability to develop the high-level academic learning, or the high-level intellectual skills needed in a knowledge-based society [27]. Hill [28] has identified the student patterns in Coursera-style courses as: active participants, passive participants, drop-ins, observers and no-shows. Engle [29]

found similar patterns for the University of British Columbia MOOCs on Coursera. Between one third and half do not participate in any other active way from those that initially sign up, between 5–10 % of those that participate in at least one activity go on to successfully complete a certificate, between 5–10% going to achieve certificates, between 10–20% range for those who actively engaged with the MOOC at least once. Milligan [30] found a similar pattern of commitment in MOOCs, as following; passive participants who were those that felt lost in the MOOC and rarely but occasionally logged in; lurkers who were actively following the course but did not engage in any of the activities (under half those interviewed); finally, active participants (just under half those interviewed) who were fully engaged in the course activities.

Therefore, the high registration numbers of MOOCs are misleading; less than half of the registrants actively participate, and of them only a small percentage have successfully completed the course. The Ho and the co-authors [31] identified different levels of commitment across edX MOOCs. 35% registered and never access the courseware, 56% viewed, who access less than half of the available chapters, 4% explored, who access more than half of the available chapters but did not get a certificate, finally, only 5% certified, who earn a certificate.

2.2 COVID-19 pandemic

The various types of online learning and MOOCs were an optional and supplementary source of gaining knowledge and skills, either for students or professionals. The outbreak of the coronavirus pandemic at the end of 2019 brought unprecedented disruption to communities and education. It has had and continues to have devastating effects on the education industry. Schooling either moved to various forms of remote learning or was simply interrupted due to poor digital infrastructure. The crisis-response migration to online education becomes questionable because these processes witnessed the absence of proper planning, design and development of online instructional programs, as is limited to delivery of media without taking cognizance of effective online education theories and models [32]. In some developed countries, where the infrastructure for remote learning is in place, the components of the curriculum were not implemented according to the approved teaching and learning strategies. Those students with no previous exposure and experience with online learning faced a set of challenges to keep up with the new needs to follow up on their daily learning process, and to look for supplementary sources to cover the learning loss in the formal classes. Placements and work-integrated learning in very essential fields, namely, technology and engineering, did not take place, and graduation requirements may have been lessened. MOOCs boosted formal education overcoming the challenges of the coronavirus pandemic by moving to distance learning, nonetheless, the learning loss had been maximized. The learning loss has been noteworthy during 2020/2021 where knowledge accumulation, skills and competence significantly declined. It is observed that students lost ground and gained less knowledge and skills that were to be achieved in a COVID-free school year, as discussed in the introduction section. Evidences from overall the word indicate how the capacity of the remote learning amidst Covid-19 led to a considerable learning loss where students spent less time learning which hindered the students' ability to fully comprehend course material, [8] on Germany, [9] on Netherlands, [10] on the

USA, [13] on India, [14] and [15] on Saudi Arabia, [16] on Jordan, [11] on Spain and Peru, [12] on Sweden, and [6] and [7] based on cross-countries studies.

The findings of an interagency survey conducted by [13] on technical and vocational education and training during the COVID-19 pandemic proved that the absence of appropriate equipment and internet access, as well as the weak digital skills on the part of students and trainers, were the most serious constraints to distance learning. The lack of reliable access to electricity was also reported as a key constraint in developing countries. The available distance learning methods are insufficient to support the acquisition of practical skills even in higher-income countries. Also, the results pointed out that the lack of participatory and experimental training has a hindrance to the acquisition not only of practical abilities but also of socio-emotional skills in such areas as problem-solving. Moreover, the different dynamics of distance learning compared to face-to-face training requires different teaching approaches to ensure optimal student engagement and learning. The difficulty of imparting practical skills by remote learning poses a challenge and necessitates investment in new learning methods and greater flexibility [13]. The findings of a survey of undergraduate students in an Indian university by [33] show that students learn better in physical classrooms due to collaborative activities that are difficult to replicate on an online platform. Yet, MOOCs were a good source that provided students information on a wide range of topics and the latest technologies, which may not be available in their universities, especially those in engineering who typically like to attend MOOCs on subjects such as computer programming and system design.

2.3 Online courses' motivations

Motivation in education depends on different variables such as age, gender, culture, learning environments. Many studies proved that motivation is one of the important factors that contribute to efficient learning [17], [18], [21]. There are two types of motivations; the first one, is the intention to attend the online training courses, the second one is to continue and finish the course. Alonso-Mencia [17] studied the online courses motivations which belong to the area of computer science, the results found that the lack of technical knowledge is one of the challenges, at the same time, it is one of the reasons why people are not motivated to join online training courses, Also, the study showed that time management skills and self-learning are important to motivate the learners to finish the course [34]. The suggestion of learning resources may improve learners' motivation due the large quantity of information and knowledge available today [35]. On the other hand, time, place, and pace flexibility is highly appreciated as these motivate learners to enroll and persist in online courses [36].

2.4 Online courses' challenges

Challenges are the barriers that the learners face during attending online educational courses. Kara [19] categorized the challenges of attending online courses as internal challenges specifically related to the characteristics of the adult learners, and external challenges influenced by the circumstances of the study, and institutional challenges arising from the educational organization responsible for the instruction delivery. The authors had drawn attention to the fact that online education courses are designed for

regular and adult students who seek to continue studying, so for this reason, this should be considered as the main challenge facing adult learners. Creating a balance between work, family and other social responsibilities is one of the major challenges for adults [37], as are also the technical difficulties [23] that impact learners' progress. On the other hand, external challenges in attending online courses belong to environmental issues, and have been studied by many researcher [13]. These challenges were a lack of technological infrastructure, such as electricity, internet, connectivity, and devices.

Even with the importance of the online platform in delivering course content and enabling learners to increase access to it using a skill set that goes beyond using a computer and the internet, little research has focused exclusively on content [38]. For instance, Connell, 2017 arrived at the result that it is not sufficient to make the content freely available; it also requires careful design of a pedagogical framework that acknowledges the social context of learners and provides suggestions for study environments that learners can thrive in and that maximize opportunities for peer support and social interaction. Diversity is complex and needs to be addressed and investigated to involve diverse learners in online environments in terms of course content, design, delivery, and professional development [39].

2.5 Online courses' interactions

Online learning is more than just accessing material and content; it requires different types of interaction [20]. Instruction of online classes needs to be humanized, personalized, and individualized [40] and [41]. A lack of social interaction was the most severe barrier to online learning and it can increase a sense of isolation [41], [42].

Despite the majority of success that depended on instructor characteristics such as type of instructor personality, knowledge, behaviour, instructor perceptions such as their assumptions or recommendations, and instructor outcomes [43] most online teaching competencies don't distinguish between the needs of the novice and the experienced online instructor [44]. Online educators should design activities that address multiple modes of learning in order to improve the successful experiences for participants with different learners' styles as presented in [45] online article. It divides learners' styles into three main groups: Learning best when information is presented visually and in a written form; Learning best when information is presented visually and, in a picture, or design format; and learning best when information is presented aurally.

3 Research methodology

3.1 Research design

This research had followed the principles of the survey method to address the multi-dimensional impact of technology and engineering online courses on MENA professionals. A structured questionnaire was utilized with two types of questions, closed-ended and open-ended questions. The advantage with structured questionnaire is that answers will be preconceived according to pre-established categories and will lead to uniform data and consequently to a well-organized data analysis [46]. The closed-ended questions intended to provide quantitative data where the participant has the choice to

pick an answer from a given number of options. The open-ended questions to capture respondents’ experiences and perspectives in order to compliment the quantitative data.

3.2 Data collection

To contribute to the expansion of knowledge in the subject matter, the literature reviews should precede the design of any primary data collection [47], and up to date existing knowledge about the research topic should be synthesized [48]. Therefore, an extensive literature review of previous studies on online courses was carried out so that this research work be of added-value on the subject topic, and provide the best answer to the research question. Based on the collected data, a model was developed (Figure 1), and the questionnaire outlines were prepared.

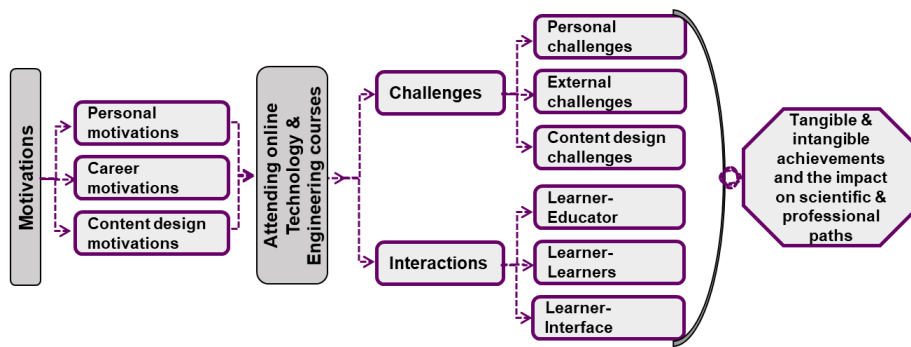


Fig. 1. Research model

The three main domains were pre-established, namely, Motivations, Challenges, and Interactions. The questionnaire was designed following the domains with closed-ended and open-ended questions. The main research domains and questions are shown in the hereunder Tables 1 and 2. These were inserted in an e-template and communicated to participants through electronic means.

Table 1. The main research domains, multiple-choice quantitative data type to be collected

Domain	Question	Aim
Motivations	3 questions on: What were your motivations (personal, career/academic, content design) to enroll and continue with the online courses?	To answer the first research question.
Challenges	3 questions on: When you enrolled in an online tech/eng. course, what were the challenges (personal, external, course content) you faced?	To answer the second research question
Interactions	3 questions on: How were interactions (learner-educator, learner-learner, learner-interface) in the online tech/eng. courses you enrolled in?	To answer the third research question
Achievements	2 questions on: What were your achievements (intangible benefits, tangible benefits) after attending technology or engineering online course/s?	To answer the main question

Table 2. The open-ended questions and qualitative data type to be collected

Question	Aim
How did online courses supplement your learning in terms of addressing deficiencies during your pre-pandemic academic study?	To understand the impact of Covid-19 pandemic on boosting online courses in Technology and Engineering. To get respondents viewpoint on how to improves content, design, delivery and tools of technology and engineering online courses
How did your pre-pandemic experience with online courses prepare you to move your activities (e.g., working, teaching, learning, and training) to a virtual environment?	
Did the pandemic increase your interest in MOOCs and online courses?	
In your opinion, what suggestions do you have to improve technology and engineering online courses (e.g., content, design, delivery, tools...etc.)?	

A questionnaire pilot test was conducted with individuals including one e-learning manager in an academic institution, a fresh graduate in civil engineering, a professional in industry and two academics in engineering and information technology fields. Then the questionnaire was refined based on respondents’ feedback.

3.3 The sample characteristics

The sampling approach that is appropriate given the purpose of the research was determined in advance. The researchers assessed and located credible research participants to cover a wide range of perspectives, and to reflect the broad view of participants. While the sample chosen is small, it is diverse and representative.

Based on this sampling strategy, the researchers targeted and approached 78 professionals who are currently practicing the profession and living in various countries inside the MENA region. Feedback received from only 66 persons. The sample varied in terms of age and gender; half of the participants were in the age group (26–40), which is the primary target group; the most homogeneous in term of computer literacy and curiosity for continuous professional development through various means including MOOCs; 30% of respondents are females and 70% are males. In terms of the number of courses, it was found that 45% of respondents have attended more than 15 courses. A good percentage of respondents (58%) intended to seek further education. The demographic distribution of respondents across the MENA region is alphabetically as follows: Algeria, Bahrain, Egypt, Iraq, Jordan, Kuwait, Morocco, Palestine, Saudi Arabia, Sudan, UAE, and Yemen. Thus, the sample included a good variety to support the aim of the research.

4 Analysis, findings and discussion

The main objective of the current research is to investigate how has the attendance of technology and engineering online courses compensate and enhance learners’ knowledge and skills, and to what extent has significantly impacted that MENA professionals’ career. Data from close-ended questions were analysed using descriptive statistics by computing them into numbers per response category. While data from the open-ended questions is to capture respondents’ experiences and perspectives in order to

compliment the quantitative data, as highlighted by [49] that qualitative work might be integrated into a research program as a complement to rather than as a rival or substitute for quantitative analysis.

The three pre-established main domains that are illustrated in the research model (Figure 1) will serve as a reference point for analysis and discussions. The researchers started the analysis by examining the contents of all responses that were in Arabic. The participants' responses were retrieved and tabulated according to the pre-established themes. The researchers then translated the responses verbatim into English, and then carried out the analysis on the basis the main categories (Table 1) that was generated for the purpose of data collection. Subheadings were used for themes that emerged from the retrieved data. Quantitative data that was collected through the predetermined set of answers to closed-ended questions were statistically analyzed and presented graphically as suggested by [50] who stated that it may be feasible or even desirable to present some of the results quantitatively using tables and figures. The quantitative and qualitative data merged during analysis and interpretation. Findings from the quantitative data associated and supported by findings from qualitative data were discussed and presented to give an answer to the research questions.

The researchers will trace the Motivations that inspired participants to attend online courses; the Challenges they faced, and the level of Interactions available for learners. The tangible and intangible achievements for learners are measured based on knowledge acquired by learners as on their professional career.

Motivations

Personal motivations: What were your motivations to enroll and continue with the online courses?

Participants had the choice to respond to this multiple-choice question by selecting any or all fixed list of answer options (Figure 2).

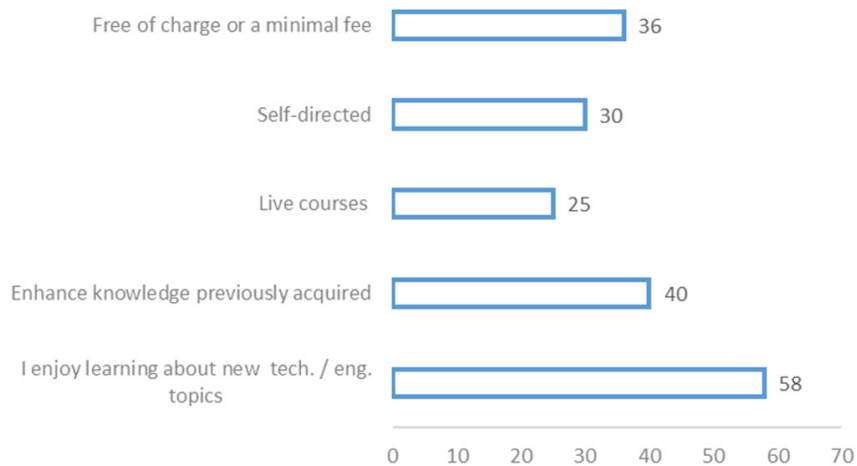


Fig. 2. Personal motivations: Number of individuals for each answer option

Learning new topics in the field of technology and engineering is the main motivator to enroll in online courses, where it was the top answer option for 58 participants. This is in agreement with [51] and [52] who considered the motivation as one of the factors that are influenced enhancing learner engagement. This is followed by the choice of enhancing knowledge previously acquired, where 40 participants are looking to compensate the learning loss and enhance knowledge, which is in line with [52] findings. A good number of respondents (36) found that a free of charge course or one with minimal fees is a motivation to enroll in, and (30) participants were happy with self-directed courses. The motivation to learn new topics is a strong factor because it motivates the learner to continue the course and benefit from it. Bonk and his co-author [45] reported that personal curiosity and interest, as well as professional growth needs and ambitions for self-improvement, inspired people to study informally. Feedback from responses to the open-ended questions shows that professionals did enjoy learning and working virtually. They escaped from daily commuting and gained in terms of time and expenses. Therefore, they attended more courses building on their pre-pandemic experience with remote learning. Whereas newly graduates expressed their worries on how to recover the learning loss that has been maximized with remote learning, and their limited familiarity with online courses as supported by [10], [12], [14] and [15].

In summary, the personal motivation of most of the participants is to learn new topics. This could be related to the ever-evolving nature of engineering sciences and technology which send a strong message to online courses platforms.

Career/Academic motivations: What were your motivations to enroll and continue with the online courses?

Participants had the choice to respond to this multiple-choice question by selecting any or all fixed list of answer options (Figure 3).

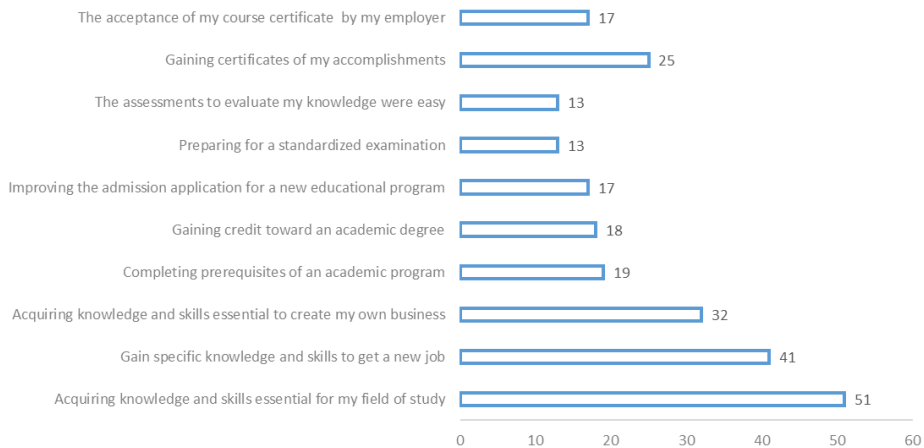


Fig. 3. Career/Academic motivations: Number of individuals for each answer option

Acquiring essential knowledge and skills in the respondents’ field of study is a top motive to attend online courses. This is also an evidence of the learning loss in the formal education in a number of studies, [10], [11], [12], [13], [14], [16] and [15]. Professionals and students rely on online sources to compensate shortages in formal teaching and learning which is line with [53] study findings. Professional upskilling through acquiring specific knowledge and skills to compete for new jobs is an answer option that was selected by 41 respondents. The reskilling is also a trend to enable professionals to create their own businesses as stated by [54], and is the choice for 32 participants. Respondents are also keen to get accredited certificates of achievement to document and enrich their CVs where this answer option was selected by (25) the importance of completion certificates was stressed by [5] and [52]. The participants’ choices for other motivation are converged. Jobs have become widely diversified in their essential requirements. Therefore, it has been found that the professional motives of the participants varied between improving the required expertise and the ambition to find a new job that requires new skills [4] and [55]. Country-related issues that affected the performance of education institutions pushed students and professionals to look for alternatives to build their own knowledge and skills [48] and as illustrated by some respondents in their response to the open-ended questions. The everything-virtual trends during the lockdown due to Covid-19 pandemic was a motive as stated by some respondents where they engaged in remote learning to enhance their knowledge and acquire new skills, as well as self-reliance, time management, and self-motivation, which is in concurrence with [4] and [56] findings.

Content design motivations: What were your motivations to enroll and continue with the online courses?

Participants had the choice to respond to this multiple-choice question by selecting any or all fixed list of answer options (Figure 4).

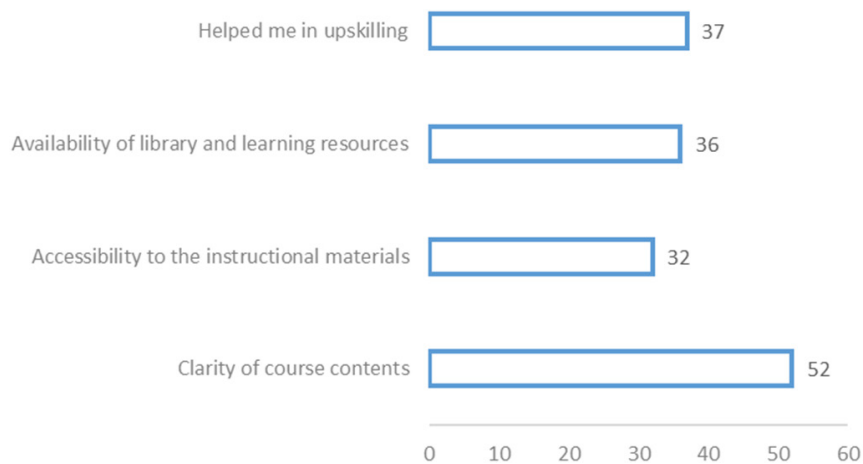


Fig. 4. Content design motivations: Number of individuals for each answer option

As it is noticed in the chart (Figure 4), the clarity of the content is the most attractive factor that motivate participants to enroll and continue attending the course, as it is the choice of 52 respondents, and agrees with [57] findings. The main concern of professionals is to be up to date on skills required in the world of work [55]. Therefore, upskilling is an answer option that was selected by 37 participants. The accessibility of course material and instruction as well as learning resources positively influence the enrollment in online courses as the lack of contents clarity is one of the reasons for not completing the course. This may attract the attention of the online learning providers to the importance of making clearer contents that be supported by relevant sources.

Personal challenges: When you enrolled in an online technology/ engineering course, what were the challenges you most faced?

Participants had the choice to respond to this multiple-choice question by selecting any or all fixed list of answer options (Figure 5).



Fig. 5. Personal challenges: Number of individuals for each answer option

Time management answer option found to be, as is seen in Figure 4, the highest choice as a personal challenge for 45 participants, which complement the findings of researchers [23], [38] who indicated that one of the challenges for learners in MOOCs is the difficulty to plan and manage time. As it is known, most of those enrolled in online courses are students and professionals who have other commitments. It would be a benefit to all, the providers of online courses to take into account this issue and providing recorded resources and be flexible in handing over of the assignments required by learners. The technical difficulties answer option that was selected by 26 participants is a challenge that is highlighted by [23] as barriers in related to the massive amount of information, complexity of the course structure, and lack of prior knowledge.

External challenges: When you enrolled in an online technology/ engineering course, what were the challenges you most faced?

Participants had the choice to respond to this multiple-choice question by selecting any or all fixed list of answer options (Figure 6).

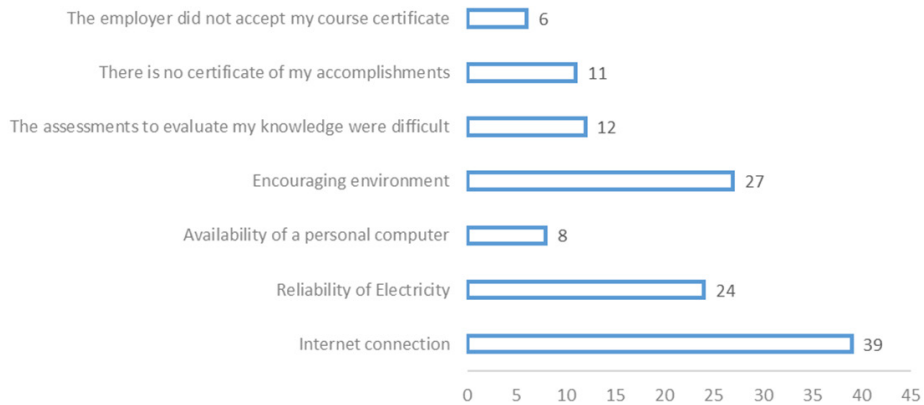


Fig. 6. External challenges: Number of individuals for each answer option

The poor technological infrastructure in the region is one of the major challenges facing e-learning. In responding to open-ended questions, participants conveyed their daily suffering as a result of turmoil, conflicts and destruction to infrastructure [48]. The difficulties in connecting to the internet reinforced [14] and [15] findings along with long hours' blackout of electricity are answer options that are selected by most of the respondents, which reflect the suffering of learners in the region, and this complements [58] findings that highlight the lack of reliable access to electricity as a key constrain. Findings from other regions show that internet connection is not a serious issue [45]. The surrounding environment, cultural and social as detailed by some participants, is not encouraging which is a challenge that has been selected by 27 participants, and is in line with [5] and [57] study findings. Moreover, a good number of participants made it clear that there is a need to pay more attention to the poor digital infrastructure, a problem that some of the MENA countries suffer from, as a prerequisite for benefiting from online courses. The challenge of infrastructure and access to the internet and to adequate technology tools in the MENA region is the most consistent theme among several themes as reported by [59].

Course content challenges: When you enrolled in an online technology/ engineering course, what were the challenges you most faced?

Participants had the choice to respond to this multiple-choice question by selecting any or all fixed list of answer options (Figure 7).

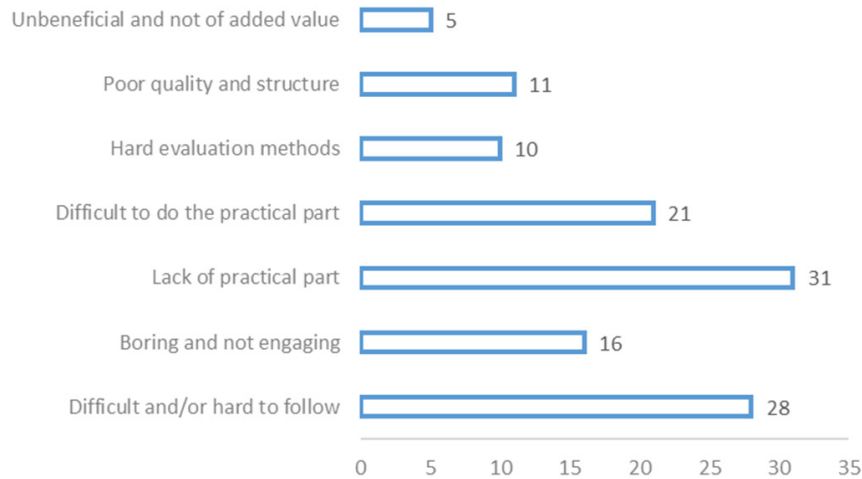


Fig. 7. Course content challenges: Number of individuals for each answer option

As participants are coming from technology and engineering fields, their main concern is the application of knowledge they gain. They have noticeably marked the lack of practical components in course delivery, and even suggest that online courses should consider teaching and learning strategies and tools so that to focus on the practical side more than the theoretical. Respondents suggested that course delivery is to involve virtual laboratories and simulations to demonstrate experiments and practical applications to gain practical experiences [21]. The lack of applied content in courses is favourable answer option to 31 participants where content become difficult and hard to follow without practice as was the choice of 28 participants. The lack of practical learning in lectures, and unreliable or not relatable course materials is also recognized by [60]. It is obvious that online courses may not be designed according to participants' expectations, or may not give enough attention to the skills and ability of some learners which is validated by [27]. However, respondents emphasized that the course content should be more interactive, and to create an interactive environment between peers, in addition to increasing the interaction of the learner with the teacher.

Moreover, some learners do not have the ability of self-learning, which is the most important required skill in online courses as [17] concluded. Others do not have neither the time nor the patience to complete all required hours, so, respondents proposed giving the learners the opportunity to attend the exam without covering the full curriculum, which he/she might be well acquainted with.

Learner-educator interactions: How were interactions in the online technology/engineering courses you enrolled in?

Participants had the choice to respond to this multiple-choice question by selecting any or all fixed list of answer options (Figure 8).

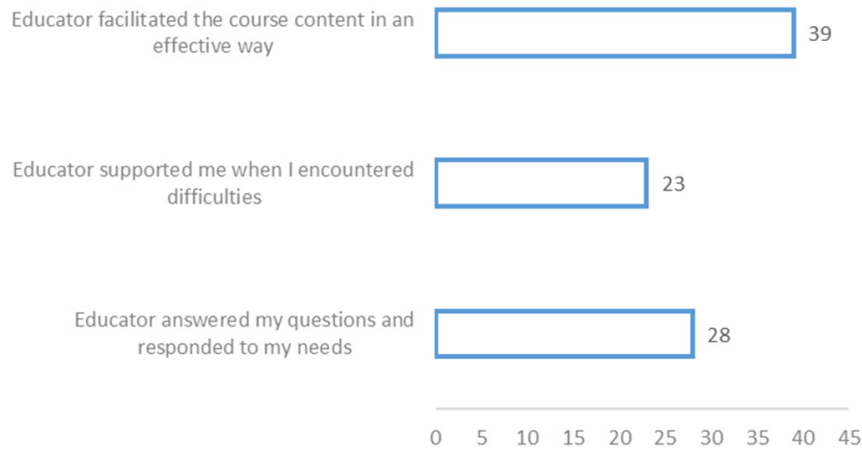


Fig. 8. Learner-educator interactions: Number of individuals for each answer option

Interactions is a vital element in learning. Most of the participants appreciate the educators who act as facilitators. Thus, in response to the answer option if the educator facilitated the course content in an effective way, 39 participants selected this choice that is well-matched with [61] findings where learner–facilitator interactions have a considerable effect on learner, and directly affected social presence and learning engagement [62], and is a decisive factor in online learning [18]. However, only 23 respondents were supported by educators when they faced difficulties, and only 28 got answers to their questions which reflects the poor feedback from instructor’s side that appeals for open communication between students and instructors [15]. To sum up the response of participants to the open-ended questions, there is an agreement that in a remote learning environment, educators should receive professional training on managing the diverse learners with diverse learning abilities and levels [14] and [59].

Learner-learner interactions: How were interactions in the online technology/engineering courses you enrolled in?

Participants had the choice to respond to this multiple-choice question by selecting any or all fixed list of answer options (Figure 9).

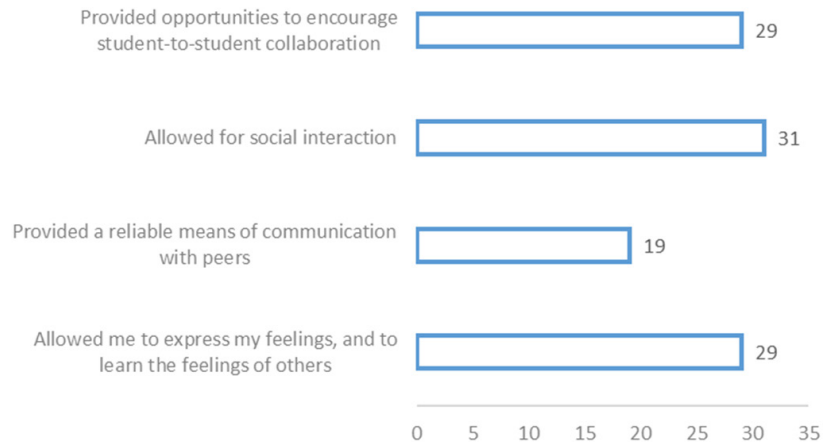


Fig. 9. Learner-learner interactions: Number of individuals for each answer option

The feedback from respondents shows that there are no reliable means to communicate and interact with other learners with only 19 participants having the means to interact. It seems that interaction amongst learners is the missing part in virtual learning. Participants voiced their unhappiness about the lack of interaction with their peers, which is vital for student learning engagement in online teaching according to [63] findings. The participants suggest that course content to be designed in a way to be more interactive to create an interactive environment between learners, as well as between learners and teachers as underlined by [61] that system designers should ensure that e-learning platforms promote Learner-learner interactions as this complements e-learning effect.

Learner-interface interactions: How were interactions in the online technology/ engineering courses you enrolled in?

Participants had the choice to respond to this multiple-choice question by selecting any or all fixed list of answer options (Figure 10).

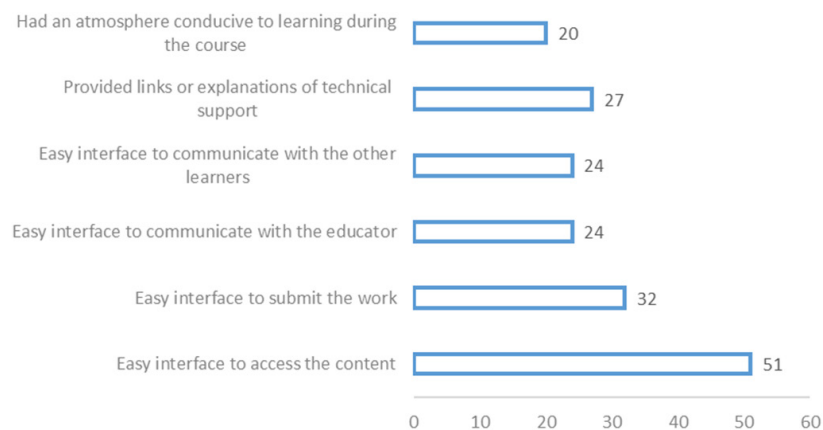


Fig. 10. Learner-interface interactions: Number of individuals for each answer option

As the targeted population is well-educated and IT literate, 51 participants found the courses systems to have an easy interface to access content, and 32 participants found it easy to submit the work. These findings are in contrary to what stated by [33] that learners did not find it easy to perform well on online learning mode. The interfaces of the course system are considered one of the most important elements as it is the learning environment comparable to in-person mode of learning. Therefore, the interactions between learner and interface must be enjoyable and stress-free to navigating course contents, downloading and uploading course work.

Achievements

Intangible achievements: What were your achievements after attending technology or engineering online course/s?

Participants had the choice to respond to this multiple-choice question by selecting any or all fixed list of answer options (Figure 11).

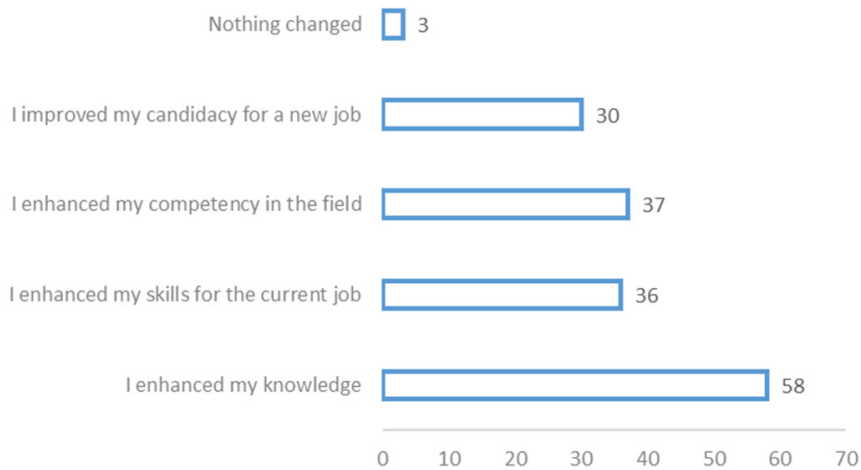


Fig. 11. Intangible achievements: Number of individuals for each answer option

It is obvious that the most intangible achievement for almost all participants is the enhancement of their knowledge where 58 respondents ticked this answer option. Also, a good number of participants enhanced their skills (36) and competency (37). This is in alignment with [4] findings where learners appreciate the new knowledge and skills they had access to, with time flexibility and low entry cost, and [5] findings which indicate that learners have received intangible benefits comparable to their expectations.

Tangible achievements: What were your achievements after attending technology or engineering online course/s?

Participants had the choice to respond to this multiple-choice question by selecting any or all fixed list of answer options (Figure 12).

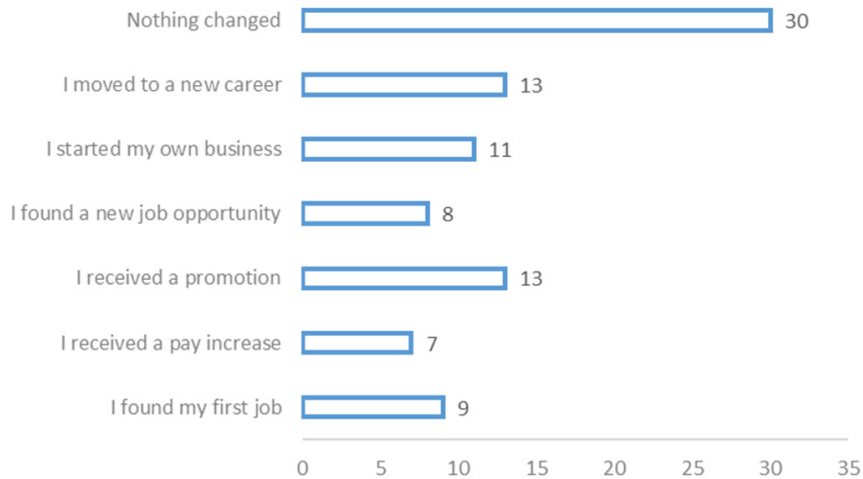


Fig. 12. Tangible achievements: Number of individuals for each answer option

After completing many MOOCs, a good number of respondents gained tangible achievements such as receiving promotion, moving to new job opportunity, or starting their own businesses. This supports findings from previous studies that MOOCs gave tangible returns in the form of greater chances either of job promotion [4] or moving to new career [5]. Unfortunately, the tangible achievements were frustrating, as many participants reported that there was no tangible change in their achievements after attending online courses. Thirty respondents have not had any tangible achievements and they consequently selected the answer option “Nothing changed”. This is a pivotal and essential point that the platforms concerned with providing online courses in engineering and technology should pay more attention to appraising why attending the courses do not have an impact on the learners’ professional careers.

5 Conclusion and recommendations

The main objective of the current research is to investigate the motivations, challenges and interactions on attending technology and engineering online courses, and how had the attendance of these courses compensated and enhanced learners’ knowledge and skills, and the tangible and intangible impact on MENA professionals’ career. The research design, methodology and data collection have been instrumental in responding to this multidimensional questions.

While online courses are designed for a wide variety of learners in terms of age, gender, education and skill level, as well as for diverse seekers needs, a good number of participants in the current study stressed the need for the online platforms to encourage registered learners to be self-directed in their study by providing methods, tools, and guidelines that help learners make the most of the course. Additionally, course registration requirements should be clear in terms of scientific background, required skills, and technical requirements in order to reduce the number of course registrants who found themselves unable to complete the course as illustrated in Figure 7. Despite

courses being open to those interested, the course designers must take into account the motivation of a large segment of the target audience and note what incentives they may have to participate in the courses and what is the motivation to make them continue the course. It is well noticed in the participants' answers that the practical side is very important and to be designed well and be easy to follow by many participants with different skills and abilities. Undoubtedly, the most important incentives are the presence of a tangible result from the courses in the field of technology and engineering, which is the acquisition, in addition to knowledge, of practical skills that lead the learners to improve their professional careers and lives.

The online course platforms have a variety of pedagogical and technological obstacles. Based on the findings, it is concluded that there is an urgent need to re-structure courses in order to address several challenges including how to incorporate the practical side of the engineering and technology field, and to assign well-qualified teachers.

There are weaknesses in the tangible achievements of participants as a result of not granting a recognized certificate at the end of the course. The platforms should seek confidence in the certificates granted in terms of setting precise controls to gain the employers confidence. The lack of accredited certificates is one of the reasons for weak enrollment as learners' desire to benefit from these courses for promotion or to obtain better opportunities.

One of the most important challenges of enrolling in remote learning is the weak digital infrastructure in some of the MENA countries where respondents stressed the necessity to improve the digital infrastructure. Yet, the results of the current study proved that the online platforms are providing a significant well-built environment for learning new topics in the field of technology and engineering, enhancing knowledge previously acquired and compensating learning loss in formal education.

Based on the lessons-learned and participants' inputs to this study, and in order to enable online learning courses to achieve the desired benefit, which is the dissemination of knowledge and enabling sustainable professional development of learners, it is recommended that online courses developers and providers to take into consideration the multi-dimensional surroundings of interaction; learners – learners, learners – instructors, learners-interface. Courses components, theoretical and practical, to focus on the current and future needs of the world of work. Platforms should consider providing free of charge quality courses with adequate free online learning resources to increase adoption and participation from low-income communities.

A healthy surrounding environment, cultural, social and technical, should be furnished. Seekers of professional development as well those who wish to enhance their knowledge and compensate learning loss in formal education had to be encouraged.

Society should appreciate their efforts and recognize achievements and certificates.

In the meantime, the digital infrastructure in a number of MENA countries should be improved. A more extensive statistical analysis would be of great importance to explore whether there are differences by gender, age, country, etc. when taking the courses.

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