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Swot Analysis of MOOCs in Engineering Education: A Developing Country Perspective

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SUMMARY

MOOCs (Massive Open Online Courses) are top universities' digital innovative educational resources and provides broadly, are open to the public, offer teaching guidance, and conduct interactive exchanges. MOOCs has been a reasonably widespread entrant in the field of open and distance education. This innovative approach is pronounced to have the potential to transform learning and development in developing countries by providing eager learners with ready access to knowledge. MOOCs has become one of the most concerned topics in the open and distance education landscape. Along with the appearance of the information society, MOOCs has the great potential to transform people's traditional learning idea and ways. Many MOOCs are prepared and served in specialised online platforms. The topics of the courses vary widely; at the same time, the number of courses increases in engineering. Since the first MOOCs launched in 2008, MOOCs literature has grown tremendously. There are several types of research conducted about various topics in the MOOCs arena. This paper is an attempt to make an effort via a Strengths Weaknesses Opportunities Threats (SWOT) analysis of engineering education in developing countries in the current MOOCs landscape. Finally, the paper will conclude with recommendations considering engineering education's possible paths forward concerning MOOCs.

Keywords: MOOCs, Distance education, Engineering Education

INTRODUCTION

The term MOOCs (Massive Open Online Courses) was first recommended by Dave Cormier and Bryan Alexander in 2008 (Cormier & Siemens, 2010). The first course in this style was offered in 2008 at the University of Manitoba and was entitled Connectivism and Connective Knowledge (Downes, 2008, 2011). A brief definition of a MOOC is that MOOCs is as open, participatory, distributed, and support lifelong network learning (Cormier & Siemens, 2010). OpenupEd, which is worldwide, one of the largest MOOC providers for higher education, developed a definition of MOOCs as "*MOOCs are "online courses designed for large numbers of participants that can be accessed by anyone anywhere as long as they have an internet connection, are open to everyone without entry qualifications, and offer a full/complete course experience online for free*" (Jansen & Schuwer, 2015).

MOOCs refers to Massive Open Online Courses created in the famous universities of the United States and is a new type of online course with characteristics as an enormous scale and open to the public for free. The major platforms in the MOOCs arena, such as in the USA; edX, Coursera, Udacity, in Europe; FutureLearn have brought thousands of courses from top universities, such as MIT, Harvard University, Stanford University, Cambridge, and Oxford universities.

Through the existing cases and research, MOOCs has the following characteristics: massive (large-scale learners), open, free, personalised, networked teaching, "massive", "openness", and "online learning" are considered to be the most apparent features of MOOCs (Zhao, 2019).The first MOOC type was given by George Siemens and Stephen Downes in 2008 (Downes, 2012). Sebastian Thrun and Peter Norvig presented the first extended MOOC in 2011, named the second generation (Martin, 2012). To clarify the difference between these two types of MOOCs, they were named cMOOCs and xMOOCs, respectively (Downes, 2012). Education researchers have classified the pedagogical underpinnings of MOOCs into cMOOCs (connectivist MOOCs) and xMOOCs (a more institution-oriented MOOC model) (Downes, 2012; Rodriguez, 2013) or cMOOCs and AI Stanford similar courses (Rodriguez, 2012). According to Rodriguez (2012), "c-MOOCs establish a many to many relations to develop massive interconnectedness. AI [Stanford-like courses] establishes one to many relationships to reach massive numbers. cMOOCs use multiple learning spaces, tools, technologies, and a distributed interaction governs c-MOOCs". The first and second-generation MOOCs were very successful in academia and higher education institutions. After this, the new experimental idea of hybrid MOOCs were performed, first produced by a group of scholars from the University of Edinburgh in 2013 (Bozkurt, Kilgore, & Crosslin, 2018).

MOOCs Systematic Literature Reviews

Open online education has taken a new turn with the introduction of Massively Open Online Courses (MOOCs), a recent addition to the different types of online learning options. MOOCs are an emerging and rapidly evolving field of practice and research.

An early systematic literature review of the existing peer-reviewed MOOCs literature conducted by Liyanagunawardena, Adams, and Williams (2013) was to classify academic research relating to MOOCs. They found 45 relevant MOOC papers and categorised them into eight categories: concept, educational theory, case study, educational theory, technology, participant focussed, and provider focussed. (Liyanagunawardena, Adams, and Williams 2013).

Some scholars conducted studies on MOOCs education, respectively, from teaching practice, educational style, implementation means. They point out that with the impact of MOOCs in distance education, in reality, there are still challenges and threats. For example, they argued that MOOCs are currently disapproved and disruptive by many educators, posing potential threats to the higher education system. (Haggard et al., 2014).

Adham analyses the concept, definitions, background, types of MOOCs, well-known MOOCs platforms in the Western and Arab worlds, and a timeline of the development of MOOCs. He observed the position of MOOCs in the developed world, opportunities in the Middle East, and the impact of the American and European MOOCs on the Arabian landscape from several viewpoints, educational, religious, cultural, and social (Adham, 2015).

Safana and Nat (2017) researched a systematic review of the literature on MOOCs to find whether MOOCs is a way out to African Institutions. Research analysis indicates the much-growing interest in MOOCs scenarios. The learner's perspectives issue is the most widely discussed MOOCs phenomena in the published articles ignoring the institutional perspective and ethical issues concerning the behaviours of the MOOCs' participants view from the facilitator related to the learners and the institution, the background, and the cultural differences existed between the learners, which provide a wide gap in the literature of MOOCs (Safana and Nat, 2017).

The MOOCs literature between 2008-2015 emphasizes four main type of research topics: the potential and challenges of MOOCs for universities, platforms of MOOCs; instruction the design, quality of MOOCs and contents of MOOCs issues (Zawacki et al., 2018).

Hidalgo, Abril, and Parra researched a systematic review of the MOOCs literature between 2012 and 2019 for MOOCs' origins, concept, and didactic applications. A four-stage methodology analysed fifty-five published studies between 2012 and 2019. Findings revealed that, even though MOOCs have the curial potential for distance education, limited studies have pointed out neither the possibilities of these courses for Foreign Language Learning nor the potential of specialisation courses. In conclusion, new types of MOOCs, such as Nano MOOCs, is promising in the near future (Hidalgo, Abril, and Parra, 2020).

Barriers, Challenges, and Opportunities of MOOCs

The potential of MOOCs is mainly in higher education, and then worldwide education development is handled with a particular emphasis on higher education opportunities. Several articles discuss the opportunities and challenges presented by implementing MOOCs at universities.

The authors acknowledge the potential of MOOCs to provide supporting education around the World. MOOCs can create fundamental opportunities for accessing quality higher education by organising learning communities worldwide and decreasing tuition (Ruth, 2012). MOOCs also have potential in corporate training, new techniques, promotion, and marking channels (Dodson et al., 2015, Zawacki-Richter et al., 2018).

In addition to the many positive expectations for MOOCs and their benefits, some articles discuss and examine several challenges. Low completion and high dropout rates in MOOCs are essential topics (Kennedy, 2014). Conole (2015) claims that effective MOOC design is critical in overcoming the challenges, primarily very high dropout rates, learner authentication, cheating, and providing support at a proper scale.

Some researchers point out some vital problems and threats. Hew and Cheung (2014) list four critical challenges to teaching in MOOCs: "*difficulty in evaluating students' studies, having a sense of speaking into a vacuum due to the absence of immediate feedback from students, being burdened by the heavy demands of time and money, and encountering a lack of student participation in online forums. Some scholars summed up the challenges in the development of MOOCs, including several problems such as students' integrity, curriculum quality, performance evaluation, and innovativeness"* (Zheng and Yang, 2017).

In a study about open education (Santos et al., 2016), the participants mention several motivations and obstacles encountered at the individual institutions for open education in general. They classify the need for training academic staff on open education and report the academics' passive resistance as a barrier. Moreover, they

recommend developing scalable technologies, a maintainable financial model, a strategy, and a shared vision (Santos et al., 2016).

There are several opportunities for international MOOC collaboration from an educational, economic, and societal viewpoint. However, similar advantages might be seen as threats to the lecturers and teachers and the institution when collaboration occurs at a national level where competition is more challenging, and branding is more visible (Nortvig and Christiansen, 2017). Most MOOCs are offered in English, with some provision in other general European languages, but there is a deficit of multilingual provision, other than the potential for support groups to be formed by students who share a common first language. Many participants rely on web-based translation systems (mainly Google Translate), but there is significant scepticism about the quality of these translations (Williams et al., 2013).

MOOCs in Education in Developing Countries' Perspective

The evolution of MOOCs in higher education is an urgent topic to be explored as having different, accessible, and innovative forms of qualified education are vital for developing countries.

An essential side of social development in any context is the attitude towards education and how effectively and instantly the design and delivery of education evolve to meet development needs. The challenge of information and knowledge delivery in developing countries and the potential of open and distance education as a viable approach has been acknowledged for a long (Abdon, Raab, & Ninomiya 2008).

Among the developing countries, two countries with a high population of India and China stand out. It is seen that both countries have tried to improve their education systems in recent years and handle distance education effectively. China firstly has joined with some worldwide MOOC platforms like Coursera, edX, and FutureLearn then has developed its platform, XuetangX. It is the primary MOOCs and blended learning portal in China crossed 2.7 million students in May 2016. It offered nearly 400 courses and had over 6 million registrants worldwide, and was the 3rd largest MOOCs provider in the World behind Coursera and edX by registration count by the end of 2016 (Trehan et al., 2017).

As a developing country, Chinese MOOCs were first introduced in 2013. MOOCs in Education developed and spread rapidly in China. More than 90 colleges and universities have worked together since its inception. In 2016, a total of 542 MOOCs were available to students, and more than 20 million people enrolled in the courses. Currently, MOOCs are becoming increasingly common, from universities to primary and secondary schools in Shanghai, Guangzhou, and even other developed regions in central China. (Zheng &Yang, 2017).

According to Zheng and Young (2017), "*MOOCs education may be the "double-edged sword"*. MOOCs, which have quality content that allows learners to learn independently of time and space, are questioned about important problems such as students' dropouts and their high costs. (Zheng and Yang, 2017). MOOCs are also noticed in the education systems of African developing countries. Safana and Nat conducted a systematic review of peer-reviewed literature of MOOCs that encapsulated the finding of more than 40 articles by employing the procedure of meta-analysis and primary-analysis to address the research question, is MOOCs a way out to African Institutions? The case for MOOCs in Africa depends on the readiness; the readiness did not lie only on the participants but on the infrastructure as well. Considering the demography of MOOCs participants presented by many research articles, a very small number of students participate from Africa. He claimed some of the significant issues concerning the low participation of African MOOCs include; "*awareness, electric power supply, poor bandwidth, image resolution, course content, language barrier, and access to computers*" (Safana and Nat, 2017). Safana and Nat (2017) are concerned that MOOCs has significant challenges for higher education system in developing countries and recommends blended MOOCs in Africa to achieve the research objectives.

Liyanagunawardena and Williams discuss features of MOOCs and look at them from a developing countries perspective. Access to digital technologies, language and culture, information, and cultural sensitivity are aspects of MOOCs that pose significant challenges to learners from developing countries (Liyanagunawardena and Williams, 2014).

Adham's (2015) study reveals the beginning of MOOC platforms in the Arab World. He explains that MOOCs were crucial for Arabian countries because of the overpopulation, the education system with overfull classrooms, high-priced private universities, the lack of educational resources for learning and professional development, a lack of teachers, and people in distant areas who are not able to go to university. Gender segregation is a crucial problem in the Arab World Education system. MOOCs may be an effective solution to overcome all these problems.

A pilot MOOCs platform has been launched under the Ministry of Labour, specifically for women in Saudi Arabia is strictly enforces gender segregation. MOOCs can help remove these cultural and social limitations, and that the social perspective should not be disregarded. MOOCs can give women the chance of freedom of expression so

they can communicate in a real-world setting (mixed-gender classes), meeting and interacting with others (Adham & Lundqvist, 2015).

MOOCs in Engineering Education

Engineering courses always with unique characteristics in electronic sciences, engineering disciplines, or construction majors. The most significant feature is the engineering practice, in which design and production are the main goals of the projects. Meanwhile, the appearance of cut-edge techniques takes continuous development and changes to engineering courses. From the view of the training target, the necessary qualities of engineering talents are practical ability and innovation ability. When considering the courses, information points in the courses are closely linked, and specialised courses are dependent on prerequisite courses. Compared with the social sciences, the content of the course is boring, which poses enormous challenges to the teaching design (Luan, Y. Y., et al., 2015).

Many universities offer introductory and graduate-level engineering courses in major MOOCs platforms, EdX, Coursera, and FutureLearn. There are some science subjects like mathematics, physics, statistics, and computer programming, in any field of engineering education curriculum. There are plenty of MOOCs topics about all these subjects in the engineering curriculum.

Engineering education is the whole of activities to teach the relevant theories and principles needed by the engineering profession. Although theory and concept formation is essential for engineering students, application and field studies, laboratory studies are very important parts of the engineering profession. Therefore, laboratory practices are a distinctive part of engineering education. Since the participation of students in the laboratory is very important in engineering courses, the theory is supported by practical training. In this context, virtual and remote laboratories can effectively bridge the gap between theory and field practice in online courses (Iqbal et al., 2015). Hadgraft and Kolmos (2020) investigated the studies in the last 20 years on engineering education. In their study, they found four types of answers. These categories are student-centered learning, integration of theory and practice, digital and online learning, and the definition of professional qualifications. They argue that with MOOCs and other online learning, access to new information has increased and is driving this trend. However, the presence of online training may not always lead to the development of students' learning and capacity. To overcome this, students need to develop their lifelong learning competencies both individually and at the level of teamwork (Roger & Kolmos, 2020). (Roger & Kolmos, 2020).

Luan et al. (2015) analysed the advantages and disadvantages of MOOCs in engineering education. If MOOCs is used to teach entirely a course of a traditional program it would be difficult to achieve the desired outcomes of the course. However, the idea of MOOCs could be used to realise the flipped class model and for students to learn and obtain guidance from experts with rich teaching experience.

MOOCs based university in Rwanda is one of the prominent examples of using MOOCs in education in developing countries (Leber, 2013). In such initiatives, the providers will need to identify a working model for the given context to support student engagement. Some reports explain that a massive number of MOOCs participants fail to complete them (Liyanagunawardena, Williams, & Adams, 2013). MOOCs can change the educational activities in all undergraduate and graduate engineering programs. With the convenience of online learning, zero tuition fees, and access to renowned academics, it is an important option for many students who cannot access established and traditional universities (Iqbal et al., 2015).

MOOCs Development in Turkey

Before revealing the development of MOOCs in Turkey and Turkish Higher Education, it should provide information about distance education. There are three distance education faculties; which the first one was established in 1982-1983 academic year (Demiray, et al., 2016), the other two faculties Open and Distance Education Faculty in İstanbul University and Open Education Faculty in Atatürk University were established in 2010. There are dozens of different associate and undergraduate programs in these faculties. Besides these three faculties, 79 distance education centres in the universities provide associate and undergraduate programs. Students can register for these programs after graduating from a high school regarding university exam results, people who have previously graduated from a university department, or students who are continuing their undergraduate education at a university without any entrance examination. In the 2019-2020 academic year, the number of registered students in open education faculties are approximately four millions and 240,000 in distance education faculty programs (YOK, 2021).

Turkey located in Europe and Asia, has some challenges facing its own course towards development in the twenty-first century. Although governments in Turkey have not provided active policy support concerning MOOCs, but support distance education, especially in Higher Education. Turkish Ministry of National Education provides

distance education opportunities, mainly for in-service training of teachers and for students in individual learning processes at home.

Some active initiatives offer MOOCs in Turkey. Two initiatives related to the publishing MOOCs of the universities in Turkey started simultaneously in 2013. One of them is presented under the name "Anadolu", which is carried out by Anadolu University, open education faculty, via mooc.anadolu.edu.tr (Yıldız & Sural, 2019). Later, this initiative was completed, and the new MOOCs initiative "AKADEMA" was launched in 2014. The other initiative is ATADEMIX developed by Atatürk University (Aydemir et al., 2016)

Akadema is a social responsibility project of Anadolu University. It was started with seven courses in 2015, and 2500 people registered in the system. Forty-seven thousand seven hundred five registered participants were reached in 2017. A new learning management system was activated, and in 14 categories, 119 courses were offered to the public (Akadema, 2020). The primary purpose of the Akadema project is to provide an online learning platform and course materials that will provide learning opportunities to individuals of all ages to ensure that they have a structured learning experience to support lifelong learning processes (Yıldız & Sural, 2019).

ATADEMIX is another initiative for MOOCs that was developed by the Distance Education Application and Research Centre of Ataturk University in Turkey. ATADEMIX launched on December 29, 2014, it started by offering four courses, and more than 3,000 students enrolled in 2016, 4,500 students enrolled (Aydemir et al., 2016). New courses were added in the following years, and as of 2020, fifteen courses are provided in ATADEMIX (ATADEMIX, 2020).

The open and distance education faculty in Istanbul (AUZEF) was established in 2010. One of the recent MOOCs initiative as a Lifelong Learning system was established in November 2018 within Istanbul University Open and Distance Education Faculty. It provides services to the whole society free of charge and without any conditions. "The aim of AUZEF initiative is built on the meaning gained by knowledge in today's World. Understanding the learning needs of the society; Its primary goal is to provide an improved learning experience with a planned, systematic, and technological infrastructure. AUZEF presents the topics that society needs most through collaborations with experts in the subject and through the online learning system" (AUZEF, 2020).

The other recent MOOCs initiative was developed by METU (Middle East Technical University) and supported by a European Union-funded project called the "BilgeİŞ" platform. It was launched with eight courses on March 8, 2017 (BilgeİŞ, 2017). The main purpose of the Bilge-is project is to increase the ability of workers and employers to adapt to new digital technologies (Bilge-İŞ, 2020). Specifically, the focus is on supporting the small and professional development of medium enterprises by producing hundred MOOCs based on digital office learning (Eşfer & Çağıltay, 2018). In this context, it is aimed to create an online platform for employees and employers, where they can use online lessons for free. After determining the training needs of workers and employers living in five pilot cities, the number of courses for the needs of firms increased to one hundred in 2017 (Eşfer et al., 2017, Eşfer et al. 2018) and in June 2019 number of enrolled students reached up to 126,092 (Çağıltay, 2019). After that, no number of courses were added to the platform (https://bilgeis.net/tr/dersler).

eTwinning MOOCs platform was developed by MEB (Turkish Ministry of Education) and launched with 26 courses. Six thousand teachers enrolled in the portal. The platform is intended to teach efficient courses focusing on improving the teacher's digital literacy and a wide variety of teaching skills. The number of courses increased to 85 by June 2020 (Sayın, Z. et al., 2017).

Some corporations found some MOOC platforms in Turkey. Turkcell Future Writers (Geleceğiyazanlar, 2021) and Çizgi-Tagem (Cizgi-Tagem, 2021) are the non-profit notable MOOCs platforms Koc University contributes to the global MOOCs portal, Coursera.

METHOD

Strategy is a process that must be planned and managed in order for the organisation to achieve its goals (Karatop, 2015). It requires the use of a combination of various thought processes, and it includes both analytical thinking and conceptual ideas (Barutçugil, 2013). Using analytical methods and analyses in determining the strategies contribute to the correct strategy. In this context, SWOT analysis, which is a critical technique in planning the future, is widely used because of its many features and to make effective decisions in many sectors and areas (e.g., Houben et al., 1999; Kurtilla et al., 2000; Kheirkhah et al., 2009; Oetomo and Ardini, 2012; Sevkli et al., 2012).

A SWOT analysis examines the current situation in four dimensions (Strengths, Weaknesses, Opportunities, and Threats). While S-W is controllable factors, O-T refers to non-control factors. It also helps to formulate the strategy by producing evidence (Dyson, 2004). SWOT is an active part of the business development process, not just a static analysis tool that emphasises results (Pickton and Wright, 1998). However, mistakes in SWOT analysis can lead to wrong strategies. In this context, Valentin (2001) states that traditional questions in the SWOT analysis procedure can lead businesses to wrong strategies. If the wrong strategy is not determined, it is possible to

determine weak strategies (Piercy and Giles, 1989). For this reason, it is vital to include expert experience and stakeholder views in the SWOT analysis. It is necessary to perform a SWOT analysis based on data using analytical methods.

Education is an issue that shapes society's future; education strategies should be rigorously fictionalised. At the same time, new models in massive education are being developed with the globalisation of higher education and digitalisation. MOOCs make an impact similar to Ford's first massive production in education (Valkenburg et al., 2014). Due to MOOCs' massive and learning supportive characteristics, the impact and intensity of learning are high.

This situation also reveals the necessity of setting up the decision processes very well. Improper strategy and decision-making can turn an opportunity into a threat. Therefore, SWOT analysis is acknowledged as a fundamental method for making a MOOCs strategy in developing countries.

SWOT analysis also has strategies (Table 1). These strategies consist of taking measures to turn the negative aspects positive or not affected by the negatives by using the positive aspects.

Table 1. SWOT Levels (Source: Karatop, 2015)

	STRENGTH	WEAKNESS	OPPORTUNITY	THREAT
STRENGTH	To strengthen the strengths	Strengthen weaknesses by using strengths	Take advantage of opportunities using strengths	Turning threats into opportunities using strengths or neutralising threats
WEAKNESS			Strengthen weaknesses by using opportunities	To strengthen weaknesses in order to resist threats
OPPORTUNITY			Take advantage of all opportunities using opportunities	Turning threats into opportunities using opportunities or neutralising threats
THREAT				

Methodology and Design of the Research

The main goal of the research is to prepare a SWOT analysis that will contribute to the determination of MOOCs strategies in engineering education. For this purpose, expert knowledge and related literature were used.

Whereas previous bibliographic studies, literature reviews, and analyses looked at the worldwide development of MOOCs, the current situation in developing countries, and some specific opportunities and barriers of MOOCs research. The opinions and ideas of seven academic professionals in engineering and distance education fields were collected in detail for this study. This study aims to provide a SWOT analysis of MOOCs in engineering education in developing countries.

The application consists of 5 steps: i. Determination of experts, ii. Preparation of the SWOT question template, iii. Experts answer the SWOT template, iv. Creation of SWOT with literature and expert knowledge, V. Analysis of the results. SWOT is created at the end of these steps. The purpose of the SWOT analyses in this research is to determine the strategy that uses MOOCs in engineering education in Turkey.

SWOT Analysis for The Use of MOOCs in Turkish Engineering Education

STEP 1. Determination of experts

Experts in the academic staff of engineering faculties in Turkey familiar with and working on e-learning were chosen to ask the questions. In this study, eight academicians from four different faculties were interviewed.

STEP 2. Preparation of the SWOT question template

Hay and Castilla (2006) argue that the following four questions should be asked many times to provide creative input to strategies.

- How can we Use each Strength?
- How can we Stop each Weakness?
- How can we Exploit each Opportunity?

- How can we Defend against each Threat?

While creating the SWOT, it is not limited to traditional questions. SWOT template questions were prepared by preparing more specific questions for each SWOT factor (Table 2). Thus, it was provided to offer a homogeneous approach to all experts.

Table 2. Question template for SWOT analysis of MOOCs in engineering education

SWOT	**Question template for SWOT**
STRENGTHS	1. What are the advantages of MOOCs in engineering education? 2. Outsiders/stakeholders see which aspects of MOOCs are substantial in engineering education. 3. What are / what can be the advantages of using MOOCs in engineering education? 4. Which aspects of MOOCs can be better used in engineering education in Turkey than in other countries. 5. The use of MOOCs in engineering education in Turkey is a leader in what aspects from other countries.
WEAKNESSES	1. What are the disadvantages of MOOCs in engineering education? 2. Outsiders/stakeholders see which aspects of MOOCs are weak in engineering education. 3. What are / what can be the disadvantages of using MOOCs in engineering education? 4. Which aspects of MOOCs can be worse used in engineering education in Turkey than in other countries. 5. The use of MOOCs in engineering education in Turkey is not a leader in what aspects from other countries.
OPPORTUNITIES	1. What are the opportunities that stand before MOOCs in engineering education, 2.What (interesting) developments in the environment related to MOOCs are experienced in engineering education 3. What advantages in technology are opportunities for MOOCs in engineering education? 4. What kind of developments in the world provide MOOCs with opportunities in engineering education. 5. What trends in education are opportunities for MOOCs in Engineering education? 6. What opportunities are waiting for MOOCs in Engineering education in the coming years?
THREATS	1. What are the threats that stand before MOOCs in engineering education, 2 What (interesting) threats are developing in engineering education related to MOOCs. 3. What disadvantages in technology are opportunities for MOOCs in engineering education? 4. What kind of developments in the World provide MOOCs with threats in engineering education. 5. What trends in education are threats for MOOCs in Engineering education? 6. What threats are waiting for MOOCs in Engineering education in the coming years

STEP 3. Experts answer the SWOT template

The questions were answered face-to-face with the experts. The questions were used only to inspire experts, not to limit their views.

STEP 4. Creation of SWOT with literature and expert knowledge

In order to prepare a SWOT about MOOCs in engineering education, firstly, information was obtained from the literature. Experts' interviews were taken by asking the experts the template questions in Table 1. Some information is both in the literature and expert opinion. These are shown in table 3.

Table 3. SWOT analysis of MOOCs in engineering education

SWOT	ADVANTAGES (Strengths - Opportunities)	DISADVANTAGES (Weakness – Threads)
INNER (S-W)	S1. Well-prepared educational material provides standardised and adequate information flow (Expert) S2. Possibility to repeat the point where the participant does not understand the ability to follow the training while he is mentally ready (Expert) S3. It provides an educational environment in the classroom where distractions do not affect. (Expert)	W1. Difficulty in providing application laboratories to a large number of students. (Expert) W2. Lack of application, lack of living in the area where he was trained in the laboratory (Expert)

	S4. It provides access to more students and decreases unit education costs compared to school education. (Expert) S5. MOOCs have been expanding their horizon of admission to engineering education at all levels and improving on-campus learning (Iqbal et al., 2015). S6. MOOCs are independent of time and place (Expert) S7. MOOCs are free or low-cost (Expert) S8. To be able to follow the lectures taught at different universities (Expert) S9. More advantageous for candidates who do not have opportunities abroad (Expert)	W3. The training does not correspond to ECTS. (Expert) W4. Not common. (Expert) W5. Accreditation such as ABET / MÜDEK is not yet available. (Expert) W6. It is not as effective as face-to-face education, and it is impossible to touch the student. (Expert) W7. Being an internet-dependent system (maybe a weakness for those who do not have internet.) (Expert). W8. Not being used to online training enough. (Expert). W9. Practical training in MOOCs in engineering education is not satisfactory (Expert).
ENVIRONMENT (O-T)	O1. Widening access to higher education through the development of 21st Century digital campus (Brown and Costello, 2014). O2. Completing the current education system's deficiencies ensures that the details that need attention should be overlooked with well-prepared images on subjects that do not need a laboratory. (Expert) O3. Hologram and virtual reality. (Expert) O4. Thanks to the hologram and virtual reality, it attracts the student to the event despite the lack of contact with the item (Expert) O5. To be able to produce a completed information block by adding a standardised and missing element. (Expert) O6. Visualisation of details that he could not observe in laboratory conditions. (Expert) O7. With a legal arrangement, the status of summer school in faculties is the primary opportunity (Expert) O8. Computer simulations are a good substitute for expensive laboratories. For data collection and analysis, the engineers often use computer simulations (Iqbal et al., 2015). O9. Engineering MOOCs are also increasing (Iqbal et al., 2015). O10. MOOCs being accessible to broad audiences (Iqbal et al., 2015). O11. Providing the existing formal education by distance education method during the epidemic period. O12. Youths use internet technologies intensively and effectively in their daily lives. (Expert) O13. Benefiting from the knowledge of different experts through MOOCs, communicating with them. (Expert). O14. Increasing accessibility of the Internet in Turkey. (Expert) O15. The use of MOOCs is increasing due to the rapid technological developments and the increase in epidemics (Expert).	T1. Failure to be convinced that training on distance education is becoming more and more common (Expert) T2. The fact that digitisation with Industry 4.0 does not find enough space in the service sector (Expert) T3. transfer of almost every course or subject from many domestic or foreign centres over the internet (Expert) T4. Theoretical and memorised training (Expert) T5. Prejudice of students and teachers regarding MOOCs in engineering education (Expert).

	O16. Developments in online education. (Expert). O17. Increasing awareness of online education due to epidemics (e.g. COVID-19) (Expert). O18. The widespread use of MOOCs in different areas. (Expert). O19. All over the World, and be quick and widespread use of the Internet in Turkey. The internet is economically accessible (Expert).

STEP 5. Analysis of the results

There are several advantages to the SWOT analysis of MOOCs in Turkish engineering education. Table 1 is an optimistic one. It is also seen that environmental factors are high. This situation tells us, "Factors that are completely outside the MOOCs are many. Moreover, the majority of these factors are advantageous."

In the SWOT analysis, "Opportunities" appear to be numerically superior in all factors. Although strengths and weaknesses are equal, there are many advantages in the overall picture. However, not only the numerical superiority of SWOT factors but also their impact power should be considered. Therefore, all factors can be prioritised by finding their influence powers.

FINDINGS

The Internet technologies that increased globalisation have been expected to create a revolution in higher education by providing access across the globe to people who were excluded from the traditional education system. For instance, Massive Open Online Courses (MOOCs) can be enrolled in by anyone anywhere in the World for free, offered that they have access. Although it has yet to produce the expected revolution in the developing World, the impact of technology-mediated distance education is broadly observed worldwide, mainly in the higher education sector.

MOOCs challenge the structure of traditional education. Just for this reason, digitalization in higher education has started to accelerate. The effects of these courses are increasing. Courses developed for the engineering field are prepared besides introductory theoretical courses and supporting laboratory courses and field studies.

This paper presented the SWOT analysis of MOOCs in engineering education. The SWOT analysis strategy consists of taking measures to change the negative aspects to positive or not to be affected by the negatives by using the positive aspects. It is aimed to remove weaknesses and threats with strengths and opportunities. It also includes "strengthen the strengths" and "take advantage of all opportunities using opportunities" strategies (table 1).

As a result, experts are more focused on opportunities. The most emphasised weakness is that MOOCs do not match ECTS and is not satisfactory for laboratory applications used in engineering education. At the same time, the most emphasised opportunity is, with a legal arrangement, the summer school status at the faculties is the primary opportunity. The following strategies have been developed, considering the SWOT analysis in Table 3. The summary table of the strategies is given in table 4.

Table 4. SWOT strategies chart

	S	W	0	T
S	S1 - S4	S4 - W4	S5 - O10	S1 - T4
W			W1,W2,W9 O3,O4,O8,O12 W4 - O9	W4 - T3
O			O7, O11	T1,T5 - O11, O12
T				

SS Strategy (Strengthen the strengths): With well-prepared educational materials and information flow, the use of MOOCs in engineering education is strengthened by providing access to more students (S1&S4).

SW Strategy (Strengthen weaknesses by using strengths): "Not common "weakness can be eliminated with the "It provides access to more students" strength. In summary, W4 weakness can be eliminated by using S4 power (S4&W4).

SO Strategy (Take advantage of opportunities using strengths): For the use of MOOCs in engineering education, improvements can be made in the quality and cost of education by using S5 and O10 (S5&O10).

ST (Turning threats into opportunities using strengths or neutralising threats): Theoretical and memorising training threats can be eliminated with well-prepared MOOCs course materials. In short, the T4 threat can be eliminated or minimised with S1 power (S1&T4).

WO Strategy (Strengthen weaknesses by using opportunities): Virtual reality and holographic laboratories can be used to overcome the problem of "laboratory applications required for engineering education". In summary, W1 and W2 weaknesses can be eliminated with the O3, O4, O8 and O12 opportunities (W1, W2, W9 & O3, O4, O8, O12). Similarly, W4 weakness can be eliminated with the O9 opportunity (W4&O9).

WT Strategy (Strengthen weaknesses in order to resist threats): Many lectures and courses are available online. Although this issue seems like an opportunity, it has been considered as a threat to MOOCs in engineering education. W4 weaknesses need to be strengthened to resist the T3 Threat (W4&T3).

OO Strategy (Take advantage of all opportunities using opportunities): It is a significant opportunity "to provide the current formal education by distance education during the epidemic period" (O11). Nowadays, this opportunity is enough to mobilise all opportunities. Also, summer schools can be considered pilots for the use of MOOCs in engineering education. Therefore, a strategy has been created with O11 and O7 opportunities (O7&11).

OT Strategy (Turning threats into opportunities using opportunities or neutralising threats): Most experts and trainers argue that distance education cannot provide engineering education. However, they experienced that this was possible during the COVID-19 period all over the World. Therefore, the T1 and T5 threats can be eliminated with the opportunity of O11 and O12 (T1&O11, O12).

As a result, experts generally think that MOOCs will improve engineering education if the MOOCs are well designed.

CONCLUSION

For graduates of distance education programs in Turkey, students who graduated from formal degree programs have the rights. The fact that university graduates in public institutions obtain higher degrees than high school graduates and receive an additional allowance motivated civil servants to receive education in open and distance education programs. Therefore, the number of students in the programs in these faculties has always been high. Official degree-granting programs in Turkey pose an obstacle to accepting MOOCs universities. For example, AUZEF and AKADEMA explain that the developed courses on the MOOCs platform will support lifelong learning. At the same time, when the existing courses are examined, it is seen that almost none of the course's content is equivalent to any lesson in higher education programs or provides content supporting any university degree lessons.

Similarly, BilgeİŞ aims to offer courses to meet the needs of businesses and employers and works in that direction. However, from the very beginning, MOOCs were prepared as an alternative to many courses, starting with the introductory courses at universities. Courses supporting fundamental science and mathematics lessons, especially engineering courses, are available on platforms such as edX, Coursera, and Udacity. New courses are diversified and added to these platforms every day. In this context, Turkey's unique infrastructure of distance education in Turkey that disrupts the MOOCs development said the World is not directed to support university courses as examples. Turkey does not take place within higher education institutions MOOCs of 2016-2020 and 2019-2023 strategic plans. Under these circumstances, it is seen that the Turkish higher education system might have crucial problems adapting to the innovative and emerging future MOOCs landscape.

In addition, more works and funding are needed in the near future to guide academics and administrators in Higher Education throughout the developing countries in the World so that they will realize the benefits of MOOCs. Lastly, there are a few numbers of MOOCs resources in local languages in developing countries, especially in engineering subjects.

The data collection part of this study was carried out before the Covid-19 epidemics, and the article was completed during the epidemic. We expect that MOOCs will change the use strategies in engineering education, which has many application courses in the curriculum Covid-19 epidemic, which has caused the closure of all education levels in the World. For this reason, it would be helpful to reveal what developments have been experienced in the ongoing epidemic process in the recent period by updating the SWOT analysis questions in a new study. At the

same time, exciting results can be obtained by comparing the results of the pre-epidemic SWOT analysis with the post-epidemic SWOT analysis results.

In the subsequent studies, multi-criteria decision making (MCDM) techniques and fuzzy logic can be used together while transforming the results obtained from the SWOT analysis into a strategy. Researchers generally accept that optimum results are obtained when MCDM and fuzzy logic are used together in real life problems (Sevkli, et al., 2012; Yüksel & Dagdeviren, 2007; Zavadskas et al., 2011).

MOOCs represent a promising approach to update, improving, and broaden the education of engineering students (Rauf, Daud, and Said, 2016) and professional development for engineers. One of the crucial points of using MOOCs in engineering education is designing and implementing MOOCs that maximise student learning. They have to serve all lessons' outcomes, especially field studies, contents of laboratory course, and hard to learn topics to the MOOCs creation team. Therefore, to create practical engineering MOOCs, some members of engineering departments should work with educational technology departments in their universities.

Finding various subjects and teaching materials in the engineering discipline remains challenging despite the growing amount of available open and online education and teaching materials. Furthermore, MOOCs is still far from a university accepted (Ouwehand & Hooijdonk, 2015). In this context, such courses should be given importance for engineering students to experience and gain experience with developing online learning platforms for their post-graduate professional development. It is crucial to prepare a strategic plan for integrating new digital learning environments, including MOOCs, into university courses. Otherwise, individual studies of departments and academicians will not be adequate. Because MOOCs require teamwork, bringing together employees from different disciplines and setting a specific budget.

Finally, it is vitally important that future MOOCs be developed using evidence-based best practices to maximize their benefits to the learners (Hicks et al., 2017). It would be appropriate for academics and university administrators to work more intensively and collaboratively for online learning environments, especially MOOCs.

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