MOOCs in STEM Education: Teacher Preparation and Views

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Abstract

This study investigated teachers' views of Massive Open Online Courses (MOOCs). The sample consisted of 30 teachers recruited from different cities of Turkey using criteria sampling. Phenomenology was the research method of choice. Data were collected using a semi-structured interview form and analyzed using content analysis. Participants use MOOCs because they are free of charge and have good content and high quality. MOOCs help them learn science, technology, engineering, and mathematics, gain professional knowledge, and develop skills, and positive attitudes and values. Most participants are interested in integrating MOOCs in their classes; however, they face various problems during MOOCs, such as loss of motivation and Internet connection issues. It is recommended that MOOCs be designed in such a way that they increase participants' motivation and allow for feedback.

Keywords MOOC · Teacher · Teacher preparation · Views

1 Introduction

Advances in information and communication technology (ICT) have transformed not only various fields of knowledge (from health to law) but also how we perceive education. This change has led to a revision of higher education and promoted the efforts to integrate ICTs in higher education (Turan et al. 2013). Recent developments of ICT provide flexibility and facilitate access to information, leading to the emergence of online higher education platforms, one of which is massive open online courses (MOOCs).

2 Massive Open Online Courses

Massive Open Online Courses are free and easily accessible courses that allow thousands of people to receive education at the same time. MOOCs were inspired by the Connectivism and Connective Knowledge course developed by Downes and Siemens in 2008

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(Cormier and Siemens 2010). Massive Open Online Courses have attracted widespread interest in the last decade, but they have been offering courses and certificates on such websites as Coursera, edX, and Udemy since 2012 (Baggaley 2013). Today, MOOCs are also used as a new version of e-learning in higher education and professional development programs (Conole 2014; Laurillard 2016; Vivian et al. 2014; Wang et al. 2018). Massive Open Online Courses have been a point of controversy since they became part of higher education and professional development programs. For example, Martin (2012) and Miller (2012) argue that MOOCs are a disruptive innovation for higher education, whereas Lederman (2013) states that they result in less learning than face-to-face education. Besides, only about 25% of those who enroll in MOOCs complete the courses, which is one of the major setbacks (Bozna 2016; Castaño-Muñoz et al. 2018; Jordan 2014; Radoiu 2014). Another setback is the inadequate technological infrastructure of MOOCs (Sukhbaatar et al. 2018). However, MOOCs are becoming more and more popular and are increasingly used in higher education because they are free of charge, have open resources, promote student–student interaction and contextual learning, and break the limits of time and space.

Massive Open Online Courses have two models (Conole 2013; Daniel 2012); cMOOCs and xMOOCs. cMOOCs place heavy emphasis on knowledge production in network learning environments, while xMOOCs concentrate on repetition and presentation (Conole 2013; Daniel 2012). Coursera, edX, and Udemy are the most popular xMOOCs platforms that offer courses on different topics. xMOOCs are used in a wide range of areas, especially computer engineering, philosophy, history, and nursing (Bellack 2013; Sharma et al. 2014). It has, however, not been long since MOOCs were integrated into professional development programs for teachers (Kellogg and Edelmann 2015; Koutsodimou and Jimoyiannis 2015; Laurillard 2016). Teachers can attend online courses out of work whenever and wherever they want. Therefore, MOOCs are used as an alternative to conventional teacher training programs (Koukis and Jimoyiannis 2018).

Although MOOCs are gaining popularity all over the world, their impact has been understudied (Koukis and Jimoyiannis 2018; Karlsson et al. 2014; Koukis and Jimoyiannis 2017; Koutsodimou and Jimoyiannis 2015; Spradling et al. 2015). Besides, those studies address such topics as coding and the use of web-based tools in language teaching. However, few MOOCs concentrate on the fields of science, technology, engineering, and mathematics (STEM). The “STEM 2026” by the American Institutes for Research (2015) states that MOOCs can be used for STEM education. Subbian (2013) also argues that MOOCs can be used to facilitate interdisciplinary education by teaching STEM fields.

3 STEM Education

STEM education is an interdisciplinary approach to learning that integrates the four disciplines of science, technology, engineering, and mathematics and has long been used in numerous countries (the USA, the UK, Canada, etc.) (Sahin 2015). Those countries apply STEM education to achieve economic and technological advances, to establish a link between schools and industries, and to increase science and mathematics literacy (Türk et al. 2018). Moreover, STEM education helps students develop the creativity, problem-solving, and critical thinking skills required by the 21st-century business world. Therefore, countries integrate STEM education into formal and informal education. Teachers play an essential role in this process (Yıldırım 2020a), but only those who have a good grasp of STEM education can integrate it into formal and informal education (Yıldırım and

Şahin-Topalcengiz 2019). Although STEM education is new to Turkey, many teachers are interested in learning it, increasing the demand for related courses. However, there are few people in Turkey with a Ph.D. in STEM education, and only a certain number of people are allowed to enroll in STEM courses, resulting in unmet demand (Colakoglu and Gokben 2017).

Moreover, STEM courses are too expensive and too short for teachers. Research shows that a teacher ideally needs 80 h of training to achieve professional development (Johnson and Fargo 2010; Supovitz and Turner 2000). Moreover, teachers are unable to attend long-term courses in STEM education because they take place during the semester, pointing to the need for free and open online STEM courses offered by experts.

4 The Purpose and Significance of the Study

Teachers should be provided with free-of-charge and always-accessible online STEM education courses offered by experts. Not all teachers can have training in STEM education, due to different working conditions and socioeconomic status. However, they all can access online STEM courses and attend them whenever and wherever they want. Massive Open Online Courses can, therefore, be used for online STEM education. Teachers can also take them to improve themselves during the Covid-19 pandemic that has taken hold of the whole world. To that end, an 80-h free training on STEM education was designed for participants in line with the STEM Teacher Institutes model (Yıldırım 2020b). The training was based on xMOOCs, allowing attendees to receive direct information about STEM fields. This study is important because it is the first to offer long and free xMOOC training on STEM fields to teachers in Turkey. Moreover, teachers are expected to acquire professional knowledge and develop professional skills and attitudes in STEM education. We, therefore, believe that this study will pave the way for further research on this topic. In this context, this study aimed to determine how teachers perceived MOOCs for STEM education. The main research question was, “What are teachers’ views of MOOCs for STEM education?” To this end, the study sought answers to the following subquestions:

1. How do teachers define MOOCs?
2. Why do teachers use MOOCs?
3. What do teachers think are the benefits of MOOCs?
4. What effects do teachers think MOOCs have on professional competence?
5. In what way do teachers think they can use MOOCs in their classes?
6. What problems do teachers face during MOOCs?

5 Methodology

Phenomenology, which is a qualitative research method, was used to determine the effects of MOOCs in STEM education. Phenomenology is used to determine how people experience and make sense of a phenomenon or an event (Yıldırım and Şimşek 2011). This was a phenomenological study because it aimed to determine how participants perceived MOOCs and what meaning they attributed to them.

Table 1 FSEMOOCS Items

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1. Why do you use MOOCs?
 2. In what way do you think MOOCs help improve professional competence?
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Table 2 Inclusion criteria and frequency distribution

Theme	Codes	Frequency
Criteria	Watching all course videos and course introduction videos	177
	Completing all assignments in STEM-PDT-MOOCs	115
	Participating in the discussion form in STEM-PDT-MOOCs every week	87
	Completing STEM-PDT- MOOCs	87
	Agreeing to be interviewed	30

6 Participants

Participants were recruited using criteria sampling, which involves the selection of a sample that meets a predetermined set of criteria (Yıldırım and Şimşek 2011). Criteria sampling is a time- and cost-efficient method by which researchers select participants most suited to the research purpose (Patton 2002). Three hundred and ninety-five teachers were enrolled in MOOCs (STEM-PDT-MOOCs) designed for the professional development program for teachers (PDT) in STEM education. Those who met the specified criteria were included in the sample. Table 1

Table 2 shows the sampling procedure. Among 395 participants, 177 watched all the course videos and course introduction videos. Of the 177 participants, 115 completed all assignments. Of the 115 participants, 87 both participated in the discussion form and completed the training successfully. Of the 87 participants, only 30 expressed their views of the process. The sample consisted of 30 teachers from different cities of Turkey who met the inclusion criteria. Participants were assigned pseudonyms (Ali, Ayşe, Mehmet, etc.) in order to assure anonymity. Table 2 shows the participants' demographic characteristics.

7 Instruments

7.1 FSEMOOCs

Semi-structured interviews were conducted to determine participants' views. A Form for Massive Open Online Courses in STEM Education (FSEMOOCs) was developed for interviews. The purpose of the semi-structured interview form is to help the researcher to control the course of the interview (Merriam 2009). It was made sure that the FSEMOOCs items were easy to understand, open-ended, and allowed for follow-up questions. The FSEMOOCs consisted of six items. It was sent to two experts (one in STEM education, and the other in information technology). The FSEMOOCs was revised based on their feedback. A pilot study was conducted with two teachers to determine the intelligibility of the

FSEMOOCs, which was then finalized based on the results. Table 1 shows two of the FSE-MOOCs items. “Appendix” shows all FSEMOOCs items. Table 3

8 Data Analysis

Qualitative data were collected through face-to-face interviews. Each interview lasted 10–30 min and was recorded. The interviews were transcribed and then analyzed using content analysis. First, codes were developed from the transcripts by the researcher and an expert. Content analysis was performed by two people to ensure validity and reliability. The parts on which the researcher and the expert agreed and disagreed during coding were identified. They discussed the codes on which they disagreed and reached a consensus. Second, a literature review was conducted to develop categories and themes and to assign the codes to them. Table 4 shows the themes and some of the codes. Table 4 presents explanations for the themes and some codes to allow readers to understand them better.

9 Procedure

This six-month study consisted of eight stages: (1) deciding to conduct the study, (2) choosing the best research method, (3) determining the content, (4) implementing the STEM-PDT-MOOCs process, (5) completing the training, (6) conducting interviews, (7) analyzing and

Table 3 Participants’ demographic characteristics

Theme	Codes	f
Major	Science	7
	Classroom Teaching	6
	Pre-school Teaching	5
	Mathematics Teaching	6
	ICT Teaching	6
	Total	30
Experience (year)	1–5	10
	6–10	9
	11–15	7
	≥ 16	4
	Total	30
Education level (Degree)	Bachelor’s	14
	Master’s	12
	PhD	4
	Total	30
Gender	Woman	18
	Man	12
	Total	30

Participants had different majors and durations of experience. Most participants were women and had a bachelor’s or master’s degree

Table 4 Themes, codes, and definitions

Definition	
Themes	<p>Reasons why participants use MOOCs</p> <p>Why MOOCs are used in STEM Education</p> <p>What participants think are the benefits of MOOCs</p> <p>What participants think are the effects of MOOCs on professional competence</p> <p>Whether participants would like to use MOOCs on general professional competence</p> <p>Why participants would like to use MOOCs in their classes</p> <p>What problems participants face during MOOCs</p> <p>MOOCs are free of charge</p> <p>Equipped instructors with a sound knowledge of the field</p> <p>Receiving training depending on its content</p> <p>A convenient time for training</p> <p>Content of STEM education</p> <p>Instructors are expected to have pedagogical knowledge</p> <p>Internet connection issues during MOOCs</p> <p>Instructors are unable to give feedback to all</p>
Codes	<p>Reasons for using MOOCs</p> <p>Using MOOCs in STEM Education</p> <p>Benefits of MOOCs for STEM education</p> <p>Effect of MOOCs on Professional Competence</p> <p>Effect of MOOCs on General Professional Competence</p> <p>Using MOOCs in lectures</p> <p>Reasons for using MOOCs in lectures</p> <p>Problems</p> <p>Free of charge</p> <p>Instructor qualification</p> <p>Training content</p> <p>Time</p> <p>STEM field knowledge</p> <p>Pedagogical knowledge</p> <p>Internet connection issues</p> <p>Lack of feedback</p>

interpreting data, and (8) writing the study. Detailed information about STEM education is below.

9.1 STEM-PDT-MOOCs Process

STEM-PDT-MOOCs consisted of two stages. In the first stage, STEM-PDT-MOOCs were designed. In the second stage, teachers were trained. The following is detailed information on the designing process of STEM-PDT-MOOCs.

1. **Determining the objective:** Objectives of STEM-PDT-MOOCs were determined, which were raising teachers' awareness of MOOCs and ensuring that they learn the program content and pedagogy appropriate for STEM education.
2. **Choosing a platform for training:** The distance education system of the university was used for STEM-PDT-MOOCs.
3. **Determining the duration of STEM-PDT-MOOCs:** A teacher needs at least 80 h of training to achieve professional development (Johnson and Fargo 2010; Supovitz and Turner 2000). Hodges et al. (2016) argue that MOOCs should be long-term so that they can provide teachers with a sustainable learning opportunity. Polly and Hannafin (2010) also state that long-term training promotes teachers' professional development. Therefore, an 80-h training was designed.
4. **Determining the format of MOOCs for STEM-PDT-MOOCs:** The format was based on xMOOCs, which, unlike conventional online learning, allows teachers to learn directly.
5. **Creating STEM-PDT-MOOCs content:** It was made sure that MOOCs addressed different components, such as course introduction and course registration videos, live classes, discussion forums, assignments, and assessment activities (Agarwal 2012; Chamberlin and Parish 2011; Evans 2012). Afterward, STEM education content was determined because it is stated that education content for teachers should focus on a field and offer pedagogy specific to it (Polly et al. 2010). Therefore, specific content was developed. Table 5 provides information on STEM-PDT-MOOCs components and content.
6. **Registration:** Participants who applied for STEM-PDT-MOOCs were enrolled.
7. **Course attendance system:** It included course attendance during STEM-PDT-MOOCs. The system sent reminders to those who did not attend classes.
8. **Course completion and evaluation:** MOOCs were evaluated, and courses were completed.

9.2 Results

The results are presented as themes, codes, and quotations to allow readers to analyze and interpret them easily.

Table 5 STEM-PDT-MOOCs components and content

Theme	Codes	Definition
STEM-PDT-MOOCs Content	Course introduction videos	Short videos explaining the course content
	Lecture videos	Videos teaching course content
	Live classes	Classes offered live on digital platforms
	Discussion forums	Forums where all information on training is shared and participants can interact
	Assignments and assessment activities	Assignments and assessment activities during training

9.3 Participants' Definitions of MOOCs

The first subquestion focused on participants' definitions of MOOCs. Table 6 shows the results.

Participants' definitions of MOOCs were grouped under six codes. They mostly defined them as either online courses with different components or as an online version of undergraduate education.

9.4 Participants' Views of Use of MOOCs for STEM education

The second subquestion addressed why participants used MOOCs for STEM education. Table 7 shows the results.

9.5 Participants' Views of Benefits of MOOCs

The third subquestion addressed participants' views of the benefits of MOOCs for STEM education. Table 8 shows the results.

Participants who found MOOCs useful in STEM education were asked what kind of benefits they thought MOOCs had. Table 9 shows the results.

9.6 Participants' Views of Effect of MOOCs on Professional Competence

The fourth subquestion addressed participants' views on the effect of MOOCs on professional competence. Table 10 shows the results.

Most participants stated that MOOCs helped them develop professional competence, while only two stated that MOOCs did not affect it.

Participants who found MOOCs useful were asked in what way MOOCs helped them develop professional competence. Table 11 shows the results.

Participants stated that MOOCs helped them develop general competence in many respects. Their views were grouped under three subcategories; "professional knowledge," "professional skills," and "attitudes and values." They noted that MOOCs taught them about STEM fields, pedagogy, and course planning, and encouraged them to inquire.

9.7 Participants' Views of Integrating MOOCs into Lectures

The fifth subquestion addressed participants' views of integrating MOOCs into their classes. Table 12 shows the results.

Participants who were interested in using MOOCs in their classes were asked why they were so. Table 13 shows the results.

Participants who were not interested in using MOOCs in their classes were asked why that was the case. Table 14 shows the results.

Table 6 Participants' definitions of MOOCs

Theme	Codes	Quotations	Participants
Definitions	Different components, such as video, forum, etc	<i>They are online courses with different components, like video, presentations, and homework assignments. Fatma</i>	Esra, Halil, Serkan, Veysel, Ayça, Tayfun, Turan
	Online version of undergraduate education	<i>MOOCs can be called an online version of undergraduate courses. The Internet allows for access to those courses from anywhere in the world. Naz</i>	Ceyda, Bilge, Neslihan, Medine, Zehra, Burcu
	Online courses	<i>They are great online courses that provide interactive engagement and online access. Bilal</i>	Esra, Veli, Zekiye, Betül, Büsra
	Courses useful for many people	<i>They are a learning tool that allows for measurement and evaluation and provides simultaneous access to those interested. Yunus</i>	Dilek, Mehmet, Cuma, Esin
	Courses involving effective communication	<i>They are online platforms that allow attendees to communicate with one another. Pınar</i>	Mahmut, Kerem
	A free-of-charge training platform	<i>They are platforms that offer free education to all. Ali</i>	Furkan

Table 7 Participants' views of use of MOOCs for STEM education

Theme	Codes	Quotations	Participants
Use of MOOCs for STEM education	Free of charge (n = 15)	I had not received training in STEM education before because it was costly. I enrolled in this training because it was free of charge. Ali	Furkan, Mehmet, Tayfun, Ayça, Turan, Cuma, Büşra, Esin, Kerem, Zehra, Mahmut, Dilek, Naz, Ceyda
	Instructor qualification (n = 12)	I enrolled because I wanted to be trained by qualified instructors. Esra	Medine, Pınar, Burcu, Bilge, Turan, Esin, Ayça, Zekiye, Bilal, Tayfun, Serkan
	Training content (n = 11)	I enrolled because I believe that education systems will be based on STEM education in the future. Fatma	Veli, Dilek, Mahmut, Zekiye, Betül, Bilal, Naz, Neslihan, Yunus
	Time (n = 7)	I enrolled because it's not always easy to attend face-to-face training. Halil	Fatma, Esra, Ali, Veysel, Furkan, Bilge
	Curiosity (n = 1)	I enrolled because I was curious about the content. Serkan	–
	Certificate (n = 1)	I enrolled because I needed a certificate to open a course. Veysel	–

Participants used MOOCs for STEM education because they were free of charge and had STEM-related content taught by qualified instructors

Table 8 Participants' views of benefits of MOOCs for STEM education

Theme	Codes	Quotations	Participants
Benefits of MOOCs for STEM education	Yes (n = 28)	I think that they are useful for STEM education. Ayça	Ali, Esra, Fatma, Halil, Serkan, Veysel, Ayça, Mehmet, Tayfun, Turan, Mahmut, Zekiye, Furkan, Cuma, Betül, Bülğra, Esin, Kerem, Burecu, Bilal, Zehra, Pınar, Yunus, Medine, Neslihan, Bilge, Ceyda, Naz
	No (n = 2)	I don't think they are useful for STEM education. It was just a repetition of what I already knew. Veli It was too much theory. I could find that information anywhere. Dilek	–

Most participants thought that MOOCs were useful in STEM education, while only two participants thought otherwise

Table 9 Participants' views of benefits of MOOCs in STEM education

Theme	Codes	Quotations	Participants
Benefits	Raising one's awareness of MOOCs (n = 16)	They help teachers develop themselves and raise their awareness of MOOCs. Mehmet	Halil, Serkan, Veysel, Mehmet, Tayfun, Turan, Mahmut, Zekiye, Burcu, Zehra, Pınar, Yunus, Bilge, Ceyda, Naz
	Providing information on measurement and evaluation (n = 11)	They help me better integrate rubrics and other assessment methods. Tayfun	Ali, Ayça, Mahmut, Mehmet, Büşra, Cuma, Kerem, Medine, Yunus, Ceyda
	Providing pedagogical information (n = 10)	They positively affect the teaching–learning process. Turan	Kerem, Esin, Bilal, Yunus, Medine, Neslihan, Naz, Cuma, Veysel
	Providing information on technology (n = 10)	They have provided me with information on technology. Mahmut	Veli, Dilek, Pınar, Yunus, Ali, Serkan, Betül, Büşra, Fatma
	Providing information on engineering (n = 8)	They have taught me about engineering and design. Zekiye	Bilge, Ceyda, Ayça, Tayfun, Furkan, Esra, Zehra
	Exchange of ideas (n = 6)	Discussions in the forums allow us to exchange ideas. Furkan	Mahmut, Kerem, Pınar, Esin, Naz
	Collaboration (n = 6)	I think that they allow teachers to collaborate. Cuma	Mahmut, Kerem, Pınar, Mehmet, Halil
	Participants stated that MOOCs raised their awareness and provided them with information on measurement and evaluation and pedagogy		

Table 10 Participants' views of effect of MOOCs on professional competence

Theme	Codes	Quotations	Participants
Effect of MOOCs on Professional Competence	Yes (n = 28)	I think that they improve teachers' professional competence because they allow them to synthesize what they have learned from their teachers and colleagues. Turan	Ali, Esra, Fatma, Halil, Serkan, Veysel, Ayça, Mehmet, Tayfun, Turan, Mahmut, Zekiye, Furkan, Cuma, Betül, Bişra, Esin, Kerem, Burcu, Bilal, Zehra, Pınar, Yunus, Medine, Neslihan, Bilge, Ceyda, Naz
	No (n = 2)	I don't think they have much effect. Veli STEM education was too theoretical. So, I wouldn't say that MOOCs improved my professional competence. Dilek	–

Table 11 Participants' views of effect of MOOCs on professional competence

Theme	Subtheme	Codes	Quotations	Participants
General Professional Competence	Professional knowledge	STEM field knowledge (n = 19)	I think that they have increased my knowledge of STEM education. Betül	Esra, Fatma, Halil, Serkan, Veysel, Mehmet, Tayfun, Mahmut, Zekiye, Cuma, Büşra, Kerem, Burcu, Bilal, Zehra, Pınar, Yunus, Medine,
		Providing pedagogical information (n = 5)	They have increased my knowledge of teaching strategies. Ali	Turan, Ayça, Furkan, Esin,
		Providing information on course plan development (n = 5)	I have learned what I should pay attention to when planning lessons. Büşra	Neslihan, Bilge, Ceyda, Naz
	Professional skills	Providing information on measurement and evaluation (n = 4)	I have learned that I should use measurement and evaluation methods together and in accordance with objectives. Tayfun	Esra, Ayça, Zekiye, Pınar
		Attitudes and values	Enquiry (n = 6)	The more I inquire, the more I learn, and the more I learn, the more I feel the need to inquire. Esin
	Problem-solving	Effective communication and collaboration (n = 3)	I think that they increase student–student and student–teacher interaction. Kerem	Pınar, Cuma
		Problem-solving (n = 2)	They help develop problem-solving skills. Burcu	Veysel
		Increasing motivation (n = 1)	MOOCs increased my motivation after moving beyond the question “When will I ever need this in real life?” Furkan	–
		Attitudes towards students (n = 1)	I think that I will do my best to ensure that students have positive attitudes towards STEM fields. Fatma	–

Table 12 Participants' views of using MOOCs in lectures

Theme	Codes	Quotations	Participants
Using MOOCs in lectures	Yes (n = 20)	I can use them in the future to help students prepare for exams. Zehra	Esra, Ali, Halil, Serkan, Mehmet, Tayfun, Turan, Mahmut, Zekiye, Furkan, Betül, Fatma, Esin, Kerem, Burcu, Zehra, Pınar, Yunus, Medine, Neslihan
	No (n = 10)	I don't think that I will use them in my classes because I don't think that they would do much but increase my workload. Veysel	Mehmet, Dilek, Mahmut, Cuma, Bilge, Ceyda, Naz, Kerem, Büşra

Most participants stated that they would like to use MOOCs in their classes, while one third stated that they would not

Table 13 Participants' reasons for wanting to use MOOCs in lectures

Theme	Codes	Quotations	Participants
Reasons for wanting to use MOOCs in lectures	Revision (n = 9)	Videos can be uploaded to help students revise the topics they have difficulty comprehending. Medine	Esra, Tayfun, Furkan, Betül, Esin, Bilal,
	Keeping track of students (n = 5)	They can be used to keep track of students. Fatma	Burcu, Zehra
	Creating an environment for discussion (n = 3)	Discussion forums can be created to go over the subjects. Ali	Halil, Serkan, Veli, Turan
	Keeping track of assignments (n = 1)	They can be used to keep track of assignments. Neslihan	Ayça, Zekiye

Participants would like to use MOOCs in their classes to revise topics that students had difficulty comprehending, to create an environment for discussion, and to keep track of students and assignments

Table 14 Participants' reasons for not wanting to use MOOCs in lectures

Theme	Codes	Quotations	Participants
Reasons for not wanting to use MOOCs in lectures	Reducing the quality of education (n=4)	I think that they would reduce the quality of education because students would not watch it. Mehmet	Dilek, Cuma, Bilge,
	Lack of infrastructure (n=3)	I don't think every student has the technological infrastructure in their home. Mahmut	Kerem, Bişra
	Taking too much time (n=3)	MOOCs take too much time. I don't think I have enough time for that. Kerem	Ceyda, Naz
	Increasing workload (n=2)	I don't think that I will use them in my classes because I don't think they would do much but to increase my workload. Veysel	Mahmut

Participants were not interested in integrating MOOCs into their classes because they thought that MOOCs would reduce the quality of education, increase the workload, and take too much time and also because not every student had the technological infrastructure in their home

Table 15 Participants' problems during MOOCs

Theme	Codes	Quotations	Participants
Problems	Internet connection issues (n = 24)	Poor audio and video quality due to Internet connection issues. Medine	Veli, Halil, Serkan, Veysel, Ayça, Mehmet, Tayfun, Turan, Zekiye, Furkan, Betül, Büşra, Esin, Kerem, Burcu, Bilal, Zehra, Pınar, Yunus, Medine, Neslihan, Bilge, Ceyda
	Lack of feedback (n = 20)	Thousands of people enroll in courses, and therefore, teachers cannot provide support and feedback to all of them. Burcu	Ceyda, Naz, Halil, Serkan, Mehmet, Tayfun, Turan, Mahmut, Zekiye, Furkan, Betül, Fatma, Esin, Kerem, Zehra, Pınar, Büşra, Medine, Neslihan, Dilek
	Reduced motivation (n = 19)	They may reduce motivation. Esra	Veli, Mahmut, Cuma, Neslihan, Dilek, Tayfun, Turan, Büşra, Pınar, Ayça, Ali, Halil, Serkan, Medine, Bilal, Esin, Furkan
	Communication problems (n = 13)	The worst thing for me is that I can't express myself as I would like to. Bilge	Mehmet, Tayfun, Turan, Zekiye, Furkan, Betül, Büşra, Esin, Kerem, Burcu, Bilal, Zehra, Pınar
	Inadequate teacher-student interaction (n = 11)	One of the major problems of MOOCs is limited teacher-student interaction. Furkan	Tayfun, Turan, Büşra, Pınar, Ayça, Ali, Halil, Esin, Betül, Büşra
	Poor video quality (n = 10)	I think that videos have poor quality. Fatma	Esra, Kerem, Mahmut, Cuma, Bilge, Ceyda, Ali, Kerem, Yunus, Veysel,
	Problems with the discussion form (n = 9)	The discussion form is not used correctly. The discussion topics in the form are insufficient. Cuma	Tayfun, Turan, Mahmut, Zekiye, Furkan, Betül, Fatma, Esin
	Inadequate measurement and evaluation (n = 8)	Another disadvantage of online education is that instructors cannot fully measure and evaluate students. Veli	Bilge, Dilek, Mehmet, Zehra, Ayça, Ali, Bilal
	Lack of teamwork (n = 2)	There is no room for teamwork. Ceyda	Fatma
	Lack of practice (n = 1)	I haven't been able to have enough experience in applying them or integrating them into classes. Dilek	–

Participants stated that they encountered numerous problems during MOOCs, such as Internet connection issues, lack of feedback, and reduced motivation

9.8 Participants' Problems during MOOCs

The sixth subquestion addressed the problems participants faced during MOOCs. Table 15 shows the results.

10 Discussion and Conclusion

This study investigated teachers' views of MOOCs for STEM education and reached the following results:

The first subquestion addressed participants' definitions of MOOCs. They define MOOCs as free-access online educational platforms consisting of videos and forums. This result shows that they understand what a MOOC is because their definitions of MOOCs are similar to those in the literature. For example, Misra (2018) defines MOOCs as an open educational program. Nortvig and Christiansen (2017) define them as an online and free educational platform that is available for anyone to enroll. Margaryan et al. (2015) define them as a new version of online learning.

The second subquestion addressed why participants use MOOCs for STEM education. They use MOOCs because they are flexible, certified, and free of charge courses with STEM-related content taught by qualified instructors. Kirschner (2012) and Martin (2012) also reported that attendees use MOOCs because they would like to learn about a specific field and receive a certificate at the end of training for free. Young (2013) emphasized that one of the main reasons why learners use MOOCs is because they receive a certificate at the end of the training. According to Bali (2013), teachers use MOOCs because they have the opportunity to observe online learning environments, participate in discussions, experience student specializations, and have access to free resources of high quality. Brooks and Gibson (2012) also reported that teachers use MOOCs because those courses are flexible, facilitate teacher–teacher communication, and can be attended anywhere, anytime. These results show that teachers use online education services when they are provided with appropriate learning platforms. The fact that our participants highlighted the content of MOOCs and the qualification of instructors shows that they want to get the right information.

The third subquestion addressed participants' views of the benefits of MOOCs in STEM education. Most participants find MOOCs useful in STEM education, which is consistent with the literature. Subbian (2013) states that MOOCs can be used to facilitate interdisciplinary education, to achieve learning in STEM fields, and to teach the pedagogy of STEM education. Both our results and those of others show that MOOCs can be used in STEM education. Some studies suggest that MOOCs can also be used to teach topics related to specific fields. For example, Parson et al. (2019) reported that most teachers find MOOCs useful for professional development, which is in line with our results. However, some studies argue that MOOCs are not useful (Martin 2012; Miller 2012; Sukhbaatar et al. 2018), which is in contrast to our result. These results show that MOOCs are a new online educational platform that warrants further research. The COVID-19 pandemic has also shown how crucial online education is. MOOCs play a vital role in sustaining education during outbreaks and other extraordinary circumstances. In other words, they are a useful source of training and education for both educators and learners. Moreover, they are convenient because they are easily accessible to anyone interested in deepening their knowledge

whenever and wherever they want. Therefore, they allow people to access education 24/7 and support lifelong learning. The results show that they can be used to continue education in both ordinary and extraordinary situations, like the COVID-19 pandemic.

Participants think that MOOCs provide information on pedagogy, technology, and engineering. Donitsa-Schmidt and Beverley Topaz (2018) also state that MOOCs provide field knowledge, pedagogical knowledge, and pedagogical field knowledge. Our participants believe that MOOCs also improve communication and collaboration, which is consistent with the literature (Al-Rahmi et al. 2019; Sharov et al. 2019; Skiba 2012; Yuan and Powell 2013). This is a significant result because the exchange of ideas and collaboration is essential for the professional development of teachers (Jho et al. 2016; Jones and Carter 2007).

The fourth subquestion addressed the effect of MOOCs on professional competence. The results show that MOOCs help teachers develop professional competence. Koutsodimou and Jimoyiannis (2015) and Misra (2018) also argue that MOOCs can be used as an alternative for the professional development of teachers because they help teachers develop Web 2.0 knowledge and professional skills. Overall, MOOCs can also be an alternative to in-service training.

Another result of the fourth subquestion is that participants think that MOOCs improve professional knowledge, professional skills, and attitudes and values in various ways. They believe that MOOCs teach them about STEM fields, pedagogy, course planning, and communication, and collaboration. Donitsa-Schmidt and Beverley Topaz (2018) and Urrutia et al. (2016) also note that MOOCs help teachers develop professional, technological, and academic skills. MOOCs are useful in teaching subject-specific topics as well (Karlsson et al. 2014; Koukis and Jimoyiannis 2017; Koutsodimou and Jimoyiannis 2015; Spradling et al. 2015). Our results are consistent with the literature, indicating that well-planned MOOCs can help teachers develop professional competence.

The fifth subquestion addressed participants' views of using MOOCs in lectures. Most participants are interested in using MOOCs in their classes to revise difficult topics, to keep track of students and their assignments, and to create a safe environment for discussion. This result has been reported by Koutsodimou and Jimoyiannis (2015) and Bruff et al. (2013) as well. This result indicates that teachers are open to improving themselves and learning about new approaches. However, some participants are not interested in using MOOCs in their classes because they think that MOOCs reduce the quality of education and increase the workload and also because not every student has the technological infrastructure in their home. This result has been reported by some studies as well (Lederman 2013; Sukhbaatar et al. 2018). This result indicates that those participants are not interested in improving themselves and learning about new approaches.

The sixth subquestion addressed the problems that participants faced during MOOCs. Participants have to deal with Internet connection issues, communication problems, problems with the discussion form, weak student–teacher interaction, poor video quality, inadequate measurement and evaluation, and lack of practice. Moreover, one of the most critical problems of MOOCs is the lack of feedback, according to most participants. However, it is impossible to give feedback to everyone on time due to the nature of MOOCs (Hodges et al. 2016; Roth 2013), which is why student–student interaction is so crucial in MOOCs. These results are similar to ours, suggesting that giving instant feedback to attendees during MOOCs ensures success. Our participants also stated that the lack of feedback during MOOCs reduced their motivation.

Participants lose motivation during MOOCs, making it all the more difficult for them to concentrate on classes. Research also shows that motivation plays a key role in completing MOOCs (Alraimi et al. 2015; Barba et al. 2016). Learners face some other problems

during MOOCs, such as low teacher-student interaction, a lack of an open environment for discussion, and insufficient infrastructure (Ji and Cao 2016; Karlsson et al. 2014; King et al. 2018; Rice 2013; Christensen and Alcorn 2014). Insufficient infrastructure, reduced motivation, and the lack of feedback are the major obstacles to MOOCs because the completion rate for the most MOOCs is moderate.

11 Recommendations

MOOCs help teachers develop professional competence. In case of an excessive number of teachers and inadequate in-service training, MOOCs can be used as an alternative to professional development programs and in-service training. Online learning has become necessary during the COVID-19 pandemic because school closures worldwide have left millions of students out of school. MOOCs ensure that education continues regardless of the circumstances. Therefore, teachers can use them both to receive STEM education and to improve themselves in other fields. For example, Coursera offers online courses for anyone interested in engineering. In this context, MOOCs provide teachers with the opportunity to improve professional competence and ensure lifelong learning.

Our results show that there should also be MOOCs designed for teachers who are interested in improving themselves but want to do it where they are. Such MOOCs can meet teachers' learning needs and promote personal development.

The problems that teachers face should be taken into account when designing MOOCs. For example, the completion rate for MOOCs is moderate due to the loss of motivation and the lack of feedback. Therefore, MOOCs should be designed in such a way that they can increase participants' motivation and allow for feedback.

Some participants are interested in using MOOCs in their classes while some others are not. Teachers' views should be taken into consideration, and classes should integrate MOOCs with face-to-face learning. We believe that this type of teaching can improve the quality of education and encourage learners to engage more in learning. Further research should address the effects of MOOCs combined with face-to-face learning.

This study shows that MOOCs should be used in STEM education. Further research should be conducted to better understand the effects of MOOCs on teacher training and to identify its challenges in order to design the best learning experiences.

12 Limitations

The study had three limitations. First, the sample consisted only of Turkish teachers who were interested in STEM education, and therefore, the results cannot be generalized. Second, the sample size was too small to understand the advantages and disadvantages of MOOCs for teacher training better. Third, phenomenology was the method of choice for capturing teachers' experience with MOOCs. However, phenomenology may fall short of obtaining in-depth and detailed information on the phenomenon in question.

Compliance with Ethical Standards

Conflict of interest The author declare that they have no conflict of interest.

Appendix

FSEMOOCs

1. How do you define MOOCs?
2. Why do you use MOOCs?
3. What do you think about using MOOCs for STEM education?
4. What do you think are the benefits of MOOCs for STEM education?
5. Do you think that MOOCs help to improve professional competence?
6. In what way do you think MOOCs help to improve professional competence?
7. What do you think about integrating MOOCs into classes?
8. What problems do you face during MOOCs?

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