Instructor Outcomes of Teaching a STEM MOOC

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***Abstract*—Despite the remarkable expansion of massive open online courses (MOOCs) over the last decade, the extent to which they achieve their potential as a "disruptive force" in education is questionable, with limited evidence of true impact. There is a wide range of desired outcomes from both learners themselves and those that invest in MOOCs. Therefore, to truly evaluate the effectiveness of a MOOC, it is necessary to understand the needs and goals of all stakeholder groups involved. While some studies have explored these factors for students who take MOOCs and the institutions offering MOOCs, little research has investigated what the instructors who choose to teach advanced science, technology, engineering, and mathematics (STEM) MOOCs hope to gain from the experience. In order to inform this component of a contextual evaluation framework of MOOCs, this study seeks to answer the question, "What factors drive teaching a MOOC?" in the context of advanced STEM courses. This study explores instructor perspectives through semi-structured interviews with 14 instructors of advanced STEM MOOCs who were identified through purposive sampling. Following transcription, we performed thematic analysis to identify underlying themes. A set of nine themes fell into two main categories: personal factors and situational factors. While the expression of these themes varied from one instructor to the next, the consistent presence of each theme suggests the value of incorporating the themes into a framework for evaluating the effectiveness of a MOOC.**

Keywords—MOOC; instructor; interview

I. Introduction

Recently, institutions have successfully delivered a wide range of academic content to vast audiences across the world through MOOC platforms. These courses cater to enormous audiences, often numbering in the thousands, leading to a considerable growth in the number and diversity of institutions offering MOOCs [1]. However, while MOOC learners can participate in courses at their own convenience and at no cost, instructors and institutions must invest considerable time, labor, and money to develop and produce MOOCs [2]. It is, therefore, valuable to understand whether these investments are worthwhile. Although MOOCs have been examined using traditional classroom metrics, such as retention and passage rates, these may not be the most appropriate way to fully capture the value of a MOOC [3].Thus, such an investigation requires a more holistic understanding of the needs and goals of all stakeholders, including students, institutions, and instructors.

Many previous studies have explored the needs and goals of learners [3]–[5] and institutions [6], [7], but few studies have explored instructor perspectives in the specific context of advanced science, technology, engineering, and mathematics (STEM) MOOCs. The instructors' dedication of time, knowledge, and effort—oftentimes in excess of their current academic teaching and/or research loads—provides the foundation of any MOOC [8]. One cannot help but ask: Why are they putting in this effort? What do they hope to gain? How do they determine whether or not teaching a MOOC was a positive experience? These questions are particularly germane with STEM MOOCs, where the content is highly specialized and not fully appropriate for a broad, general audience. As London and Young [9] suggested, these types of questions are important to ask within the context of engineering education to properly leverage the potential of MOOCs. Further, for the MOOC phenomenon to be sustainable, it is important to understand the reasons why instructors dedicate the time and energy to produce MOOCs and what they hope to achieve. This knowledge may help to properly incentivize the production of MOOCs when needed, or to find suitable alternatives for MOOC stakeholders when they are not.

In this study, we interviewed a purposefully sampled set of advanced STEM MOOC instructors. We asked instructors a series of questions regarding what led them to teach their MOOCs, their experiences in doing so, what they learned from their experiences, and whether they planned to continue teaching MOOCs in the future. We analyzed the interview transcripts using thematic analysis to investigate the factors guiding their decisions to create and implement their MOOCs and the unexpected outcomes encountered throughout the process that would guide future participation. Thus, in this paper we explore the following research question: What factors contribute to instructors' decisions to create and deliver advanced STEM MOOCs?

II. Background

Faculty, in general, are commonly willing to spend time benefiting their community—a survey of almost 34,000 full-time faculty found that nearly 80% engage in some kind of service or volunteer activities [10]. However, only one in eight faculty spend five or more hours per week engaging in these activities; faculty outside of life sciences and social sciences are less likely to engage at all [10]. Given that one of the most highly touted potentials of MOOCs is their ability to provide a service to the greater community by bringing education to a mass audience, and that considerable time is required to develop them, it is reasonable to question instructors about the factors

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that contribute to their decision to engage in the intensive development of a MOOC.

As MOOCs represent a relatively new phenomenon, and given that traditional online and distance education provide the foundation for MOOC instruction [11], an exploration of the MOOC instructors' reasons for teaching should include literature on online and distance learning instructors. It is important to keep in mind that traditional and distance learning instructors generally dealt with smaller, closed enrollments, which could contribute to significant differences. Still, many factors cited throughout the traditional distance and online education literature overlap considerably with MOOCs.

A. Distance Education Instructors

Much of the literature related to faculty participation in online and distance education explores perspectives of both faculty who have taught in these settings and others who have not, as well as perspectives of administrators. While the perspectives of each of these groups were not always consistent [12], the perspectives presented generally fall into two categories: factors that encourage participation and factors that discourage participation. There is considerable overlap between the two categories; the absence of a specific encouraging factor may be seen as a discouraging factor, and vice versa.

There are several factors that encourage participation in digital education: financial factors, professional factors, social factors, personal factors, and altruistic factors. Financial factors include the provision of monetary rewards or support through stipends, overload pay, or increased salary [13-15]. Notably, financial factors were cited more frequently by instructors who had participated than those who had not [12]. Professional factors fell into two main categories. The first was working conditions, such as decreased workload, provision of release time [12], [14–16], and greater flexibility [14]. The second was professional requirements [13], growth, or advancement, including receiving training [14], improving teaching skills [12], [16], building new contacts [12], tenure and promotion [14], and increased visibility, reputation, and prestige in the field [12], [13]. Socially, faculty indicate that they had been encouraged by supportive department heads, departmental commitment, and the involvement of respected faculty who could model the adoption of the medium [12], [14]. Further, faculty stated that they wanted their colleagues and administrators to recognize the work involved in participation [14], [16]. Personally, faculty claim to be drawn in by the desire to learn and use new technology, the ability to discover new ideas [14], the intellectual and personal challenge [12], [14], personal satisfaction [12], [14], [16], and a sense of empowerment [15]. Finally, faculty cite altruistic factors including the improvement of course quality, the diversification of academic programming, the increased convenience for students, and the ability to reach new, wider audiences [12], [14], [16].

Factors discouraging faculty from participating in distance or online education, according to the literature, relate to either environmental and institutional barriers or attitudes and perceptions. Environmental and institutional barriers include insufficient rewards or compensation [12], [13], lack of scholarly respect [14], lack of institutional, administrative, or technical support, lack of training, and lack of relevant knowledge (including specific topics like intellectual property) [12], [14], [16]. Some faculty also possess attitudes or perceptions that discourage participation, including questioning the quality of online courses due to lack of standards [13], [14], fear of being viewed negatively or receiving bad press [12], [13], fear of reduced job security due to greater competition and lower demand [12], [14], fear of a general decline in the quality of higher education [14], fear of losing autonomy, fear of not receiving tenure or promotion, feelings of inadequacy and uncertainty [12], feelings of discomfort with technology, resistance to change, and concerns over lack of time [12], [14].

Many of the factors discouraging faculty participation are correlated with the lack of the factors that would encourage their participation. Further, while many administrators perceived that faculty would be encouraged to participate by extrinsic factors, this expectation was not aligned with the thinking of all faculty because the extrinsic factors were most relevant for younger instructors or instructors with greater technological experience, such as those in engineering [12].

B. MOOC Instructors

While MOOCs represent a natural extension of the distance and online education phenomenon, the massive number of participants that free and open access to enrollment may produce shifts the roles and perceptions of instructors [11]. To reinforce this extension, the literature regarding faculty reasons for participation in MOOC instruction presents similar encouraging and discouraging factors as the literature for distance and online education with a few slight differences.

As in distance and online education, the MOOC literature presents several factors encouraging instructors: professional factors, social factors, personal factors, and altruistic factors. Professionally, faculty believe MOOC instruction provides the opportunity to develop stronger instructional practices through feedback, testing, and refinement [17], [18]. They also believe it gives them an opportunity to showcase their institution's best courses [19], enhance their recognition and prestige through worldwide exposure [18], [19], and to obtain a large population to research student behavior, perceptions, and attitudes [18]. Faculty also express similar social factors, including a desire for strong institutional support [19] and recognition from administration, as well as the academic community and leaders [17]. The list of personal factors in the literature is notably shorter than in distance and online education, mostly relating to egoistic rewards [20] and curiosity about the MOOC environment [17], [20]. Finally, as in distance and online education, MOOC instructors were encouraged by a sense of altruism [20] to help democratize high-quality education to a diverse, global population [17]–[19], to provide professionals with professional development [19] and the ability to apply knowledge to new situations and strengthen understanding and critical thinking [17], and to contribute to the body of open educational resources [17].

Within the encouraging factors, the general themes are fairly consistent, but the specifics differ notably - the massiveness and openness of MOOCs make a few of these factors particularly more relevant for MOOCs than for more traditional online

education. For instance, the large global population helps with international exposure and prestige and availability of a sizable sample for research. The altruistic factors shift from focusing on the improved convenience to students to spreading information and making a global impact. The most prominent difference in these two bases of literature is the lack of inclusion of financial factors in the MOOC literature.

There are also many similarities between the distance and online education literature and the MOOC literature regarding discouraging factors for faculty participation, relating to both institutional and environment barriers and attitudes and perceptions. As was seen in the traditional distance education formats, many instructors felt a lack of support from their institutions and the MOOC platforms [18], [19]. Instructors were discouraged by their struggle to find the "right level" at which to present material [19], to evaluate student work effectively [20], and to cope with the logistical complexities of managing large numbers of people and tasks [18]. They also viewed MOOCs as requiring an overwhelming amount of time and effort [18]–[20], distracting from their other professional and personal obligations [19]. Further, from an instructional standpoint, some faculty disliked the lack of personal interactions and immediate feedback from students [19], [20]. Finally, while many anxieties associated with technology and fears of displacement present in the distance and online education literature was lacking in the MOOC literature, faculty still questioned the quality of MOOCs versus traditional instruction [19], feared the potential of extreme criticism and damaged reputations, and struggled to properly scale realistic expectations of student participation and performance for a massive population [18].

One important distinction between the distance and online education literature and the MOOC literature is that the former set consists of a large number of studies (note that a few of the studies cited are literature reviews, themselves [12], [14], [15]) while the latter is only a few smaller scale studies. Thus, additional exploration of reasons for participation in MOOC instruction is justifiable. Further, none of the studies identified examine this issue within the context of advanced STEM courses. Given the guidance of London and Young [9], the differences in content, and their smaller target audiences, advanced STEM MOOCs warrant further investigation.

III. Methods

A. Participants and Data Collection

To collect participants, we searched MOOC platforms edX, Udacity, and Coursera to find STEM MOOCs, then identified the instructors and their home institutions. To capture a broad range of inherent ideas, we selected instructors of STEM MOOCs from a variety of institutions, fields, and nations. We then found their directory listed information and emailed the instructors to recruit for interviews, offering a $25 Amazon gift card for participation. Once a clear repetition of responses to the interview prompts was found, indicating saturation, recruitment concluded. Seventeen instructors responded and phone interviews were conducted between April 2016 and July 2016. Of the respondents, 14 were traditional tenure-track faculty while two were graduate students and one worked in industry. As we were exploring the perspectives of traditional instructors, we chose to exclude the graduate students and industry professional from consideration for this particular study. The remaining interviewees' disciplinary fields and job titles are provided in Table I. The sample size of 14 interviewees is comparable to prior works involving in-depth interviews with MOOC instructors [17], [18].

The interview protocol included an introductory statement to procure informed consent and inform interviewees that their responses were being recorded for research purposes. Interviews were conducted by two researchers using the responsive interviewing method described by Rubin and Rubin [21]. A semi-structured interview protocol consisting of open-ended questions was used for the phone interviews, allowing researchers to develop follow-up questions based on instructor responses. The recordings were transcribed by a third party and, upon completion of transcription, were checked and subsequently reviewed for quality.

TABLE I. Interviewees, sorted by number

Instructor Number[a]	Instructor Information	
	Discipline	***Job Title***
01	Computer science	Full professor
03	Nanomaterials	Lecturer
04	Industrial engineering/ operations research	Professor
05	Electrical engineering	Professor
06	Mechanics	Department head
08	Computer Science	Associate professor
09	Agricultural and biological engineering, biomedical engineering	Full professor
10	Nanomaterials	Lecturer
11	Physics	Assistant professor
13	Physics	Full professor
14	Information systems	Faculty
15	Mechanical engineering	Professor
16	Mechanical engineering	Senior academic professional
17	Information and communication technology	Associate Professor

[a]. Missing numbers correspond to excluded participants

The interview protocol aimed to capture the experiences of various instructors in designing and implementing their respective MOOCs. The interview questions focused on three key areas: reasons for teaching a MOOC, details about their MOOC, and MOOC information useful to the instructor. In this study, we primarily examined the first focus area: the reasons that instructors teach STEM MOOCs.

B. Data Analysis

In writing about responsive interviewing as a method of data collection, Rubin and Rubin [21] stated that researchers should

immerse themselves in the data before pulling out ideas to form theories and new ideas. As such, interview transcripts were read several times by a researcher before reaching sufficient immersion to begin open coding in the responsive interviewing model. The researcher then grouped his initial open codes into more focused themes, following Patton's general guidelines [22]. Two additional researchers then investigated and modified the original researcher's themes by attempting to independently apply the identified themes to the interviews. The two additional researchers discussed these themes and subsequently modified the themes to reach consensus for each.

IV. RESULTS

During the coding process, we identified nine codes that fall into two general themes relating to instructor participation in advanced STEM MOOCs: personal factors, representing outcomes that instructors would like to see as a result of teaching a MOOC, and situational factors, representing external factors that enable or prompt instructors to teach a MOOC. These codes represent ideas that were consistently expressed throughout the interviews. Table II provides a summary of these codes, along with examples of statements that fall into each.

TABLE II. THEMES, CODES, AND ILLUSTRATIVE EXAMPLES

Theme	Code	Examples
Personal Factors	Outreach	Reaching a wider audience
		Increasing the accessibility of obscure material
		Altruistic motivation
	Impact	Achieving a specific learning outcome for an intended audience
		Satisfying learners
		Attracting students to a field, or to instructor's institution
	Professional Development	Increasing credibility or prominence in field
		Improving teaching skills
	Course/ Pedagogical Development	Development of course materials that can be used outside of the MOOC
		Development of new assessment techniques
	Novelty and personal enjoyment	Seeing teaching MOOC as enjoyable, opportunity for novel experience, or an exciting challenge
Situational Factors	Support	Support in developing or running the MOOC received from institution, colleagues, course platform, etc.
	Institutional Pressures	Instructor was explicitly requested to teach a MOOC
		Instructor volunteered to teach a MOOC as part of a wider institutional initiative
	Material Development	MOOC development facilitated by adaptation of exisiting course materials or ability to re-use MOOC materials in other settings
	Time Commitment	Time required to develop or run a MOOC

A. Personal Factors

The most prominent personal factor driving instructors to teach MOOCs was the concept of outreach. Every instructor interviewed stated that they saw teaching a MOOC as a way to reach an audience that they otherwise would not be able to reach. For instance, instructor 06 noted the ability to teach to a global audience: *"I'm a teacher. I like to teach. I like to be able to reach more students and MOOC is an opportunity to reach a much wider audience than would have been able to do here on campus. That's my first motivation, is really just be the opportunity to reach the much wider audience with the material that I feel excited about and feel passionate about. Breaking the barrier in terms of geographical location or access through MOOC is really exciting. Having students from all over the world at the same time and discussing the materials on the forum is a really great feeling for a teacher. That's I guess, my personal main motivation to this."*

Instructor 15 saw teaching a MOOC as an opportunity to create an accessible resource for people to learn about a topic that was previously only available to students at a few universities: *"If I look at the impact of this, I think it's a body of knowledge that in the past had not been particularly open, is now open and out there for anyone. That's again because it's a relatively obscure topic that we picked."*

Instructor 01 felt the subject of their course could have a positive impact on society, and that teaching a MOOC, in addition to their on-campus course, maximized that benefit: *"If you had asked me, pre-MOOC, what was my long-term plan as a computer scientist, I would give you the same answer. I think this is a tool for social good, and for more people to learn to use this tool and put some good back into the world. My long-term goal is to maximize that. The MOOC has given us an avenue for doing it that lets us reach so many more people so much more quickly than I could ever had done it before. That's the reason I'm excited about it, right? I'm doing the same thing that I always wanted to do, but all of a sudden the number I can reach is hundreds of times more than what I can reach just in my own campus."*

In addition to simply reaching new audiences, instructors expressed a desire for their courses to have an impact on those audiences. Some hoped that their course would allow a certain group of learners to achieve a specific learning outcome, as explained by Instructor 15: *"We did, from the very beginning, have a very explicit persona for the user in mind…That primary user was someone in the industry that finds themselves in their career or job where suddenly they have to learn something about [this topic], and they didn't have any as an undergraduate or very minimal, and had to go someplace to learn this stuff that they could do pretty easily within the context of their work."*

Other instructors saw their MOOC as being successful if it achieved the more general goal of satisfying the learners who participated.

Instructor 16 explained that this was what motivated them to teach MOOCs: *"It's very rewarding. I've got students, to date,*

around a half a million visitors to my MOOC courses. I've had about over 160,000 active learners…It has a big impact, around the world. I get good comments, they get good ratings. It's rewarding; get a lot of nice notes from students saying, 'Thanks, very much, for making this material available.' That's the main reason I do it."

Some instructors felt that the most important effect that their MOOC could have on students was not teaching them any specific material, but simply generating interest and inspiring them to pursue further studies in the field. Instructor 13 recounted the moment that they decided to become a scientist, and expressed hope that their MOOC might have a similar effect on a new generation of students: *"With physics courses, especially, and I assume chemistry and other science courses, maybe math courses, you can learn things in a meaningful way, you just can't do it in a month. You can invent any technology you like, it's just not going to happen. What can happen, the only sort of thing actually I think where it's valuable is again, sort of, finding people. I remember the moment when I decided to become a scientist. I read a very influential book and I talked also to the author of the book. It was some popular science book and I happened to have met this guy and had a huge impact on me, you know. I decided I really liked this stuff. I didn't know much, but it sounds really intriguing and interesting and whatnot. I think of the MOOCs and the main fact provides, sort of, a window into this science and research and all kinds of things that it's very difficult otherwise to experience. Research itself is sometimes very busy. I have a lot of things to do, the big group and papers and reviews and whatnot. This way I could expose people who otherwise wouldn't have had this possibility. I think this is where the value is for this particular course."*

Most instructors stated that they saw teaching a MOOC as an opportunity for their own professional development. Instructor 10 explained that they saw teaching a MOOC as a way to increase their prominence in their field: *"Okay. There's a couple of motivations. First motivation is to expose my research findings so they would be incorporated into mainstream curriculum to a wider range of students than I could teach to just being at [my institution]. MOOCs really, nowadays, have global reach and impact people from across dozens of countries, and oftentimes have enrollments, especially on edX, of thousands. This gives you much wider exposure for ideas. Second motivation, potentially, is to develop credibility in the field as a researcher on this topic… and to show the value of the techniques that I'm pursuing, and how those could be the foundation for future research projects."*

Other instructors, like Instructor 15, felt that teaching a MOOC improved their skills as teachers: *"The whole process of doing the lectures on camera. We had various field trips we did. Thinking about how problem sets that were auto-graded would work. Thinking about how online chat rooms would work. All that kind of stuff really made me think a little bit more careful about teaching and learning, course design and course development. I think I'm a better teacher overall because of the experience. I think that was a definite benefit for me."*

The majority of instructors interviewed said that teaching a MOOC represented a new experience or challenge for them. Only Instructor 11 specifically stated that they had not enjoyed teaching a MOOC, saying that they were *"traumatized by the amount of work."*

B. Situational Factors

The instructors interviewed made it clear that support is potentially the most important factor in enabling instructors to teach MOOCs, whether it comes in the form of compensation or duty relief from an institutional obligation, pedagogical advice from a colleague, or assistance with developing course materials. The level at which institutions are supporting MOOC instructors currently varies, but Instructor 08 described the effects of the strong support they received from their university: *"The university also is very invested. I certainly would not have been able to prepare the materials for my MOOC without significant help from the organization here at [my institution] that helps do things like edit videos, create the website, manage the website, translate the quiz questions I give them into the Coursera format. Those things would not have been possible for me to do given that I'm also teaching an on campus course at the same time. I think it's really important that the institution has a buy-in and invests significant amount of resources, manual resources in helping the instructor out."*

It appears that very few instructors decided to teach a MOOC entirely of their own volition. Out of the instructors interviewed, the majority decided to teach a MOOC in response to a wider initiative at their institution. Instructor 06 described the situation at their institution, which resides outside of the United States: *"So actually, when [my institution] started doing MOOCs around here a couple of years ago, the first MOOCs were started by colleagues from other fields, and at some point we were wondering whether we should start one in our field of mechanics, and because I had a course which was already, which I taught already in English, and we were looking for a course to be able to move to a MOOC in English, so I somehow volunteered for that, and that's a great class."*

A few instructors, such as Instructor 03, were directly requested to teach their MOOC: *"Well, the suggestion that perhaps the university should have a MOOC in this area because it's one of our areas where we are leading in research. The thinking came from the university management or from the [institute] management. They asked me if I could take on this responsibility because I generally do a lot of outreach and public engagement, doing public lectures and stuff like that in addition to my lecturing activity. They asked me if I could take this on and put one together and I agreed. Basically I didn't come up with the idea, someone else did ask me if I could do it."*

Most instructors said that their MOOC was adapted from an existing course, and some said that developing their MOOC was especially simple since they already had the necessary materials for something similar. Others said that they did not mind developing new materials for their MOOC because they would be able to re-use those materials in their campus course or other settings. The interchangeability of materials between an instructor's MOOC and their other courses was generally seen as being synergistic.

The most likely explanation is that the time commitment required to develop and run a MOOC is a significant challenge. Many instructors reported that the development of a MOOC

represented a major time commitment, but that once the MOOC went live, it became much more manageable. Instructor 04 cited time as the main obstacle to teaching another MOOC: *"I don't have any plans to do it again. I've been in some discussions about doing one again. It's a big time commitment to do one that's a full course. The one I did was a smaller time commitment. I want to make sure I have the time to do it right."*

V. Discussion

The themes we identified regarding reasons for participating in MOOCs through our interviews with advanced STEM MOOC instructors were mostly aligned with the reasons we found throughout the literature; however, the ways they were discussed allowed us to identify some nuances that led us to organize our themes a little differently. As our interviews were conducted with experienced MOOC instructors with mostly positive experiences, our themes did not break down into encouraging factors and discouraging factors, but rather the personal and situational factors that either drove their initial participation or became apparent throughout their experiences. Additionally, there were a few ideas that emerged that may highlight aspects that relate more specifically to instructors of advanced STEM topics.

As both MOOC and online and distance learning literature indicated, instructors participated to reach wider audiences [12], [15]–[19]. In contrast with prior literature, our interviews highlighted that instructors are also concerned with making an impact on that audience. They recognized that the advanced nature of their topics made some of their material obscure, and that it was more challenging for learners to find high-quality sources of that information. In these cases, these instructors were driven to increase the accessibility of that material and either attract new students to their fields or even their own labs or, at the very least, instill a sense of appreciation for the topic in their audiences.

The other personal factors that we identified shared much in common with the literature. As with both sets of literature, we found themes related to enhancing reputation [12], [13], [18], [19] and being attracted to novelty and challenge of teaching in a new medium [12], [14], [17], [20]. Similarly, our instructors also viewed MOOC instruction as a means to improve both their pedagogical skills and their specific courses [12], [16]–[18]. However, the faculty we interviewed did not express the many hesitations and anxieties presented throughout the literature, particularly regarding intimidation of technology [12], [14], [18]. In fact, we found instructors who were eager to drive technology forward, such as automated assessment. It could be that our sample was self-selected and simply did not include instructors who struggled with these anxieties, but STEM instructors may also be less likely to face such barriers.

The situational factors we identified as posing barriers to instruction were highly consistent with the literature, but again, our interviews highlighted some interesting nuances. Primarily, as seen nearly universally across the literature [14], [16], [18]–[20], inconsistent support from institutions and platforms and excessive time and effort commitments were clear in our interviews. These issues appear to be the greatest possible detractors from instructing in MOOCs. Still, despite extreme time demands, the desired outcomes of teaching MOOCs and the participation of the faculty we interviewed reinforces the idea that faculty are committed to serving broader communities [10].

Our interviews illustrated possibly increasing trends toward wider institutional initiatives promoting the development of MOOCs, and instances in which instructors were specifically approached to run MOOCs. Our interviews also demonstrated the way instructors might leverage the pre-existence or development of course materials. Like personal factors, it should also be noted that we did not detect nearly as many situational obstacles as we identified in the literature. Whether this is due to our sample consisting of faculty possessing MOOC experience or having technical backgrounds, as Wolcott [12] suggests, is difficult to ascertain.

Possible limitations of the participant selection method include self-selection on the part of the instructors and the fact that only three course platforms were examined. It is possible that course platforms with different goals or instructional design strategies would attract instructors with different views. Future research should consider a more international representation of STEM MOOC instructors, as the instructors were recruited from US-based platforms.

VI. Conclusion

Overall, we identified two major themes influencing faculty instruction in advanced STEM MOOCs: personal and situational factors. Of these, two of the personal factors carry direct implications for the evaluation of MOOCs: outreach and impact.

Instructors are concerned with making their content available to audiences that might not otherwise have access to that knowledge. In order to assess the extent to which MOOCs have achieved this goal, learners could be asked questions about the opportunities that may or may not have been afforded to them without the specific MOOC, such as "If this course were not available through a MOOC provider, would you be able to learn this material from another source?" In this way, access means more than just reaching typically defined underrepresented groups. We found that to STEM instructors, increasing access meant getting specialized information into the hands of those who could use it – which would be those with STEM backgrounds who met the prerequisite knowledge. While some may criticize the fact that STEM professionals are not underserved, being a STEM professional does not automatically guarantee access to cutting-edge research findings. Just as completion must be contextualized according to learner and stakeholder goals, the metric of access must be contextualized to mean more than reaching those with no or little educational opportunities. The instructors of STEM MOOCs share many factors with the broader set of MOOC instructors, but the highly technical content of their courses may drive them to produce high-quality material that might otherwise be challenging to understand and difficult to find. Increasing access to technical content for working professionals or students studying specialized subjects is still worthwhile, even if the material is not readily useable to someone with no STEM background.

Instructors want their MOOCs to have some kind of impact on learners, but this desired impact can take many forms. Examples provided by instructors ranged from enabling learners to apply specialized knowledge in their careers to simply generating interest in a scientific field. Metrics such as course completion and final exam scores are not always sufficient to evaluate the specific goals that an instructor has for their course. Our results show that STEM instructors often have goals for their MOOCs that may be challenging to evaluate. For example, a STEM professional who takes a MOOC intended to provide them with a skill that they can apply in their career may not know whether they have been able to apply that skill successfully until well after completing the MOOC. We are currently conducting work to determine what kinds of information STEM instructors use or want in order to provide evidence that their MOOC is has achieved its desired impact.

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