Learning Through MOOCs: The Case of Mathematics

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Abstract

Mathematics is an indispensable tool of all scientific research. Besides, the impact and influence of Mathematics on data sciences, social sciences and other allied subjects is as bright as daylight. Given that, on one hand, technology is influencing every part of human life, and on the other hand, the scare of epidemics such as that of COVID-19 has the potential to barricade traditional classroom teaching, we may view technology as having the potential to not only revolutionize the ways we teach and learn but also in giving access-from-distance and self-paced learning options to the learners. Teaching and learning online is gaining momentum and has picked up both pace and popularity during the ongoing pandemic. Whereas online learning may be more suitable in some subjects, the fact remains that learning Mathematics online efficiently is not as difficult as many would view it. This paper reviews and discusses the various aspects associated with teaching and learning Mathematics online. The paper elucidates how Mathematics can be taught effectively at various levels. It also demonstrates how the revolution of MOOCs is impacting education, in general, and Mathematics, in particular. The paper also discusses both the opportunities we have and the challenges we face in opting for online teaching-learning.

Keywords: Mathematics; MOOCs; learning online; Teaching and Learning Online, **revolutionize.**

Introduction

Mathematics can be viewed as a parameter of progress. The amount of Mathematics known and implemented can be linked to the progress of a society. It is a progress indicator. Acknowledging that teaching and learning Mathematics is an indispensable component of any education policy, the standards of teaching and learning Mathematics can be raised and world-class quality Mathematics stuff can be made available to the learners at the ease of distance learning and the ease of self-placed options. Massive Open Online Courses (MOOCs) have gained never-before popularity during the ongoing pandemic while, on one hand, both teachers and students are being sensitized to new opportunities such as blended learning and technology-enabled learning; on the other hand, policymakers have been made to think about the future of imparting education and that of traditional classroom teaching and learning. Though MOOCs are not new, the pandemic has given it unparalleled popularity and impetus. It seems only a matter of time when all education policies, institutional timetables and calendars will include a blend of both online and offline learning. However, switching over to an online mode of teaching and learning cannot be done without taking into consideration the pros and cons of it.

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MOOCs

Popularly known as MOOCs, the massive open online courses have opened several new gateways that had hitherto remained undiscovered or non-existent. With the advent of online learning, researchers, learners and teachers are equipped with more digital weaponry and have more options at hand. MOOCs seem to have emerged from the work of Canadian scholars Stephen Downes and George Siemens (Anders, 2015) at the University of Manitoba. Afterwards, the success of open online courses created by Stanford University and MIT (Chapman, Goodman, Jawitz, & Deacon, 2016) led to the creation of several successful online learning platforms that offer MOOCs such as Coursera, Udacity and EdX. These courses provide quizzes, peer-graded assignments, projects and exams. A striking feature of these courses is their flexibility. A student is free to choose a course of his choice, a teacher of his choice and an institute of his choice. The courses are provided on demand, and users do not necessarily have to complete a course during a defined time. All materials are provided including videos, lecture notes, and assessment materials. Critics of the MOOC movement have cited low completion rates, high development costs (Fischer, 2014), and pedagogical issues (Blaschke, 2012; Doug, 2013) as causes of concern.

MOOCs may be cMOOCs orxMOOCs, the former referred to as connectivist MOOCs, the reason being that Canadian researchers George Siemens, Stephen Downes, and Dave Cormier prepared the concept based on the principles of the theory of connectivism (Kesim& Alt, 2015). CMOOCs are designed to generate network effects for learning, facilitating self-organized patterns of collaborative learning. In it, the learners are permitted to participate using their blog sites and social media accounts. In contrast, xMOOC platforms predominantly employ a cognitive-behaviorist pedagogical approach (Anders, 2015). This same thing is exemplified by the concept of training which is content-based and is delivered at scale through various models. The coming into existence of these possibilities has been made possible due to the recent developments in software and hardware, specifically the developments in internet technologies and those in multimedia.

Inferences from several studies point out that students rated those MOOCs high in which the tutors were happy, willing and motivated to interact with students (Hew, 2016), where there was good and healthy social interaction. This means that the students could share the knowledge they gained and ideas they gathered among themselves and also the availability of online learning resources and related activities that engaged them depending on their heterogeneous learning preferences and priorities. However, some

researchers have emphasized the importance of learning design and also environmental factors. The fact remains that there is an obvious gap for studies in pedagogical studies of MOOCs. The upcoming or future design of MOOCs needs to be firmly and properly grounded in human cognition for better, lasting and effective instruction.

1. Course Design

When we consider the question or the problem of a suitable course in Mathematics, we come to understand that online cross-listed mathematics courses have the required potential to be successful in the present time's learning environments because such courses offer students greater flexibility besides allowing the course to be offered to a substantially larger audience, unlike the traditional face-to-face courses. However, to make such a course meaningful, beneficial and successful, there is a need for considerable effort and involvement on the part of the instructor as far as course design, preparation of online lectures, use of appropriate and conveniently available software, use of suitable and appropriate assessment techniques, and a willingness to be available for virtual office hours are concerned.

Though the quantum of research that has been carried out about student achievement and student perceptions of online homework is thorough, extensive and humongous, there are still several unanswered or open questions.

Besides other parameters, online discussion boards and the much-needed student accountability are pivotal and central to the success. Maximization of enforcing students' accountability highly depends on the instructor's style and also on the student group. Unfortunately, there are chances that it can be challenging, and occasionally frustrating, but ultimately a rewarding experience for the instructor to come up with the right dynamic in an online learning community.

Interestingly, online courses in Statistics make use of technology or some software that the student may not be familiar with; this means that since these are statistics courses, one would typically use the R language together with specialized R packages, or SPSS or some other similar software. This is challenging. The introduction of such kind of technology gives rise to challenges since the students can differ greatly in as far as their experience with programming in general, and that of with the R ecosystem or that of SPSS is concerned. Fortunately, several such online courses have presented various fruitful and rewarding ways to mitigate the technology challenges by making use of special packages that include all of the datasets and special functions needed for the course. Consequently, the instructor who is teaching an online statistics course should

brood over carefully the use of software, especially from the point of view of the student who is a novice, naive, inexperienced and unfamiliar with technology.

2. Student Interaction

Another extremely important thing for the success of online teaching in Mathematics is the interaction on the part of students. Odysseys2Sense (popularly known as O2S) is an online forum that is typically adapted for teaching higher-order thinking (HOT) in online and several hybrid academic courses. Students respond anonymously to the various challenges posed by the instructor, besides discussing the responses through posts. For each one of these posts, students give a number rating based on certain set criteria that reward careful higher-order thinking, clear communication, and the soft skill of civility. Such ratings profoundly affect other students' power and influence, thereby adding a game-like feel to the online forum.

Teachers play, arguably, the most important role in online learning. This is because the teaching of mathematics through the course and medium and style of communication and the learning by the students are greatly influenced by the instructor's comfort level with the tools in an online environment. Two of the most important major tools that an instructor has for helping students learn the content required are the course and communication. Caution, experience and skill in the setting up of the course and using all the tools available within the course to tactfully and judiciously cater the course to students' needs is what separates experienced and preferred instructors from the inexperienced and novice.

Several normative practices in mathematics instruction and curriculum design exist which actively encourage the cognitive appraisals and constructions that contribute to students experiencing mathematics anxiety. These are not limited by but they include a predominant focus on supporting conceptions grounded in figurative aspects of thought, the expectation that conceptual understanding depends on or emerges from procedural fluency (Kieran, 2013), a systemic inattention to the meaning and coherence of mathematical ideas (Thompson, 2013), assessment practices that emphasize performance rather than understanding (Niss, 1993), the relative absence of explicit pedagogical theories guiding mathematics instruction and curriculum development (Simon, 2013), a general failure of mathematics instruction to meaningfully build on viable models of students' mathematical thinking (Jacobs, Lamb & Phillip, 2010), and the infrequency with which instructors engender in students an affective and intellectual need for learning what they intend to teach them (Harel, 2013).

Improved tools designed precisely keeping in view the needs and requirements that best fit a student bring about better and improved student interaction with technology. The omnipresence of online and computer-assisted instructional platforms has widened the scope of student interaction with these systems. Using peer-mentoring programs is a very useful approach for supporting students in situations where student interaction with online or computer-based instruction is not low. Student anxiety related to their interaction with online systems can be quite high and can increase during the semester as they may become frustrated with systems that seem agnostic and unsure about their success. Support should be put in place that considers student progress as well as their attitudes towards the instructional systems to which they are being exposed. As indicated by Tinto (Tinto, 1990), both social and academic integration are required for student persistence, and this integrative process is driven by student attitudes towards their classroom environment. Peer mentoring, though virtual, can provide a sense of community to students, especially those of first-generation students, those who are at greater risk of departing from their academic studies prematurely.

Moreover, impactful communication is just as important in online as it is in face-to-face mathematics courses. However, there are differences too. So, instructors may have to spend time learning how to obtain fruitful discussions in an online environment. Among others, some common characteristics or features of successful prompts include some effort to personalize the course content and providing an opportunity for students to make the course content relevant to their academic or career interests. Successful prompts tend to be extremely specific, and expectations for the quantity and quality of student responses should be very non-implicit. It may be helpful to think about how the responses will be assessed when creating the prompt. For various problems where students are asked to create their examples, a sample post is usually beneficial though it is not essential.

3. Using Technology

Learning is paced down when the cognitive load exceeds working memory capacity. Mathematical cognitive load is primarily made worse by problems in symbolic decoding, computational fluency, and conceptual understanding. Chen and Wu (2015) have investigated the use of videos in sustained attention, emotion, cognitive load, and learning performance. They found that video lectures enhance performance, and that sustained attention induced by the voice-over presentation type is markedly higher than that in the picture-in-picture type. It is more meaningful to break down mathematics content into smaller segments or piece meals and also to allow the learner to control the speed or the

pace of learning. Content designers should also choose to present information using various media and preferably not a single medium, i.e. combining video, pictures, and animations. This greatly assists as far as sharing the content between the visual and the verbal channels is concerned. Non-essential music should be removed and decorative graphics from the content should be decreased for that is extraneous load. This means that instructional designers are required to be in the know of the cognitive requirements that designs impose.

Written communication plays an extremely important role in the development of mathematics. Students often practice learning challenging topics by writing about them. Writing down exercises enables them to think on a level deeper and beyond the ordinary and also in practice, learners learn using the correct notations and conventions. Furthermore, writing academic reports can benefit and help students appreciate and enjoy mathematics more, and yet so few instructors employ this tool in their course designs. As student anxiety may be a reason, many instructors choose not to explore this option.

Regarding the availability of online resources, a great tool in this connection is “Math in Action Journal (MIA)”, which was developed using a Teaching Enhancement Grant. Submissions to MIA are in the form of short video presentations, along with two-page extended abstracts. Students are incited to be creative in their endeavours of presenting their work. The journal also allows mathematics undergraduate learners to share their work with peers and academics alike. As an example, students in a geometry course could be encouraged to submit video versions of their mini-presentations to MIA, in addition, guidelines regarding how to write mathematics papers and sample video submissions are available on the MIA website for those who are motivated to submit.“Math in Action Journal” has the potential to enrich geometry course profoundly and considerably. Students who have done well on their research papers now have an authentic and legitimate platform where they can easily share their work, which they can use on their CVs as a stepping stone to academia.

Recent development in technology supports online education systems around the world. Consequently, academic institutions have begun to offer more online courses, including the much-dreaded mathematics method courses. Although there are multiple benefits, there are also issues and challenges in online learning environments and the degree of challenges vary on the basis and the nature of the content of the online courses and the group. Mathematics method courses can be challenging to teach in online learning environments. However, to wholeheartedly embrace the ongoing trend in online education systems, instructors need to find ways to overcome the challenges, if any, in

online learning environments. In this direction, instructors can make use of various “Online Education Resources” (OER) in online mathematics method courses.

In spite, of being a very recently emerging field, the increasing number of research studies reported different types of benefits of OER. For example, OER is reported to have a positive impact on learners' attitudes and perceptions of learning. It magnifies and intensifies the learning interest and is open access to every single learner. Besides, it helps in expanding teachers’ roles and making them more active in sharing information and learning from each other. Another dimension of distance learning is the independence and increased responsibility for self-learning, which can be increased by integrating and making use of the appropriator. OER provides a lending hand to distance learners so that they are more independent of instructors, authors, and textbooks. More importantly, using OER in an online learning environment equips the instructor to bridge the gap between on-campus and online courses in terms of classroom activities, discussions and interaction. OER appears to be even more relevant and important to the rapidly growing online educational system. However, more research studies need to be conducted in this area. Just simply integrating OER does not necessarily enhance the learning. "There is a need to continue the development of the tools and resources to support the transition to OER" (Miller 2016).

It is evident that mathematical diagrams play a crucial role in mathematics and are highly appreciated in geometry. Geometry is one of the earliest branches of mathematics, and a visual field that keeps succinct, sketchy, rigorous, and expressive diagrams at the core of its heart. Such diagrams involve, besides other things, shapes, solids, and spatial figures and relationships, as well as their properties and relationships. Alternatively, interactive and dynamic diagrams play the most crucial role in mathematical diagramming, and hence in the endeavour of mathematizing in an online platform. Software packages such as GeoGebra and other related software tools can make the teaching and learning of Geometry joyful, productive and fun.

4. Teacher Education

As is often the case, teachers feel short of skills when they encounter next-generation students. Teachers need to evolve and for that, they require capacity building and learning of new skills. Several initiatives such as the initiative by MHRD India and Commonwealth of Learning Canada have given due emphasis to this thing. Mere up-gradation of infrastructure, equipment and technology cannot bring about the desired results. Teachers who constitute an important agency in the transmission of information

and knowledge need regular up-skilling and up-gradation. An Italian project, "Math MOOC UniTo" project for teacher education has had positive repercussions and outcomes on the professional development of the teachers who took part in it.

Conclusion

In the ongoing education systems, types of classrooms vary considerably and widely. Traditional classrooms are now giving way to web-facilitated, hybrid, and online courses as learning through technology is becoming a mainstream learning modality and option. Neither offline teaching nor online teaching can be done away with. They are not contradictory. They are complementary. A perfect blend of the two is the desired target. The role of the teacher, thus, has not been eliminated. The role of the teacher is modified. The teacher is a facilitator whose job is to make the content available and as per the needs and requirements of the learners.

Allen and Seaman (2016), share the Integrated Postsecondary Education Data System (IPEDS) definition of distance education, stating that distance education is:

"Education that uses one or more technologies to deliver instruction to students who are separated from the instructor and to support regular and substantive interaction between the students and the instructor synchronously or asynchronously"

Allen and Seaman (2016) have been very busy tracking the growth, expansion and acceptance of online learning modalities at the higher education level since the year 2003. In their 2016 report on online learning in higher education in the United States, Allen and Seaman came up with the report that 5.8 million students embarked on online courses during the fall of 2014 semester. Of these 5.8 million students, 2.85 million were simply purely online students, which meant that they were taking all of their coursework in an online format, while 2.97 million were taking parts, but not all, of their courses online.

Lastly, online learning presents several unique opportunities, experiences, and challenges for teachers and students. However, caution should not be thrown to the wind. The baby cannot be thrown away with the bath water. While we reference online education, it is important to remember that mere switching over to online does not constitute any educational experience. It has come to the notice of several experienced online teachers that different types of support and assistance are needed as learners go through various issues and problems while learning in an online environment (Burden, 2008). Courses that are taught through an online platform provide different opportunities for students and are often organized differently than traditional face-to-face courses (Moore &Kearsley, 2012). In an online environment, blending connectivity and personal learning freedom

becomes a very important focal point as content delivery and access to information concerns are built into many learning system designs (Garrison, 2011).

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