Research Article

The Design of a MOOC on Health Behaviors: A Practical Blueprint for the Instructional Design of MOOCs

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Massive Open Online Courses (MOOCs) are a primary mode of scaled-up online learning. They have enjoyed great popularity, which grew significantly during the Covid-19 pandemic. Despite the growing demand for MOOCs and the desire of institutions to develop high-quality courses, research indicates that the educational impact of MOOCs is limited. Low instructional design quality has been cited as a culprit for the failure of MOOCs to support learning and skill development, prompting calls for a more thorough design of MOOCs. The aims of our work are to describe the systematic development of guiding principles that informed instructional design decisions for our MOOC on health behaviors and to showcase how these principles were implemented in practice. Through triangulation of various sources of evidence on anticipated learners and the MOOC learning environment, we identified four key aspects we needed to address with our instructional design to facilitate learning. We formulated guiding principles that both addressed these aspects and served as a reference point during instructional design. Our approach to making instructional design decisions can serve as a practical blueprint for other MOOC developers.

Introduction

Massive Open Online Courses (MOOCs) are digital courses that provide affordable learning opportunities in a wide range of professional and academic fields. MOOCs are appealing because they allow people from various backgrounds and from all world regions to enrol in courses designed and delivered by subject-matter experts who are often attached to recognized institutions of higher learning. With this, MOOCs offer an accessible and credible avenue for self-development and competency-building beyond formal settings (Jung & Lee, 2018; Kesim & Altınpulluk, 2015).

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Since their inception in 2008, courses offered and learner numbers have increased significantly, making MOOCs one of the primary modes of scaled-up online learning. While about 6.5 million learners were registered on prominent MOOC platforms (e.g., edX, Coursera) in 2012, this number grew to about 35 million in 2015, and about 58 million people registered for at least one MOOC in 2017 (Mohamed & Hammond, 2018). The Covid-19 pandemic has accelerated this trend, as global demand for quality online education and training grew at an unprecedented pace, leading many institutions to develop courses in ever more diverse fields to meet the needs of a rapidly diversifying learner base (AlQaidoom & Shah, 2020; Bhattacharya, Singh, & Hossain, 2020; Khanra, Budankayala, & & Doddi, 2020). The appetite for MOOCs is likely to continue, considering the growing emphasis on lifelong development and skills building beyond formal certification by accredited institutions. In addition to satisfying learner demand and generating an alternative revenue stream, institutions have vested interests in global outreach, branding, and recognition for future-proof learning opportunities, which will motivate them to continue developing MOOCs (Clarke, 2013; Howarth, D'Alessandro, Johnson, & White, 2017; Jung & Lee, 2018; Khanra et al., 2020).

The problem

Despite great appeal and growing popularity, the educational impact of MOOCs remains questionable - low levels of engagement and completion, as well as limited learning and skill development, have been cited in the literature (Jung & Lee, 2018; Khanra et al., 2020; Xing & Du, 2019; Zhu, Bonk, & Sari, 2018), calling into question the potential for MOOCs to support the significant numbers of learners in their learning. To fully utilize the potential of MOOCs and enable learners to achieve meaningful learning, it is imperative to thoughtfully plan the instructional design of such courses. This is a challenging process for tertiary education instructors who often have little formal training in pedagogy and instructional design, let alone in the realms of online learning and MOOCs (Lowenthal, Snelson, & Perkins, 2018; Müller, Goh, Lim, & Gao, 2021; Oh, Chang, & Park, 2020; Zhu, Bonk, & Sari, 2018). The instructional design experiences gained through tertiary-level teaching do not translate to the MOOC context, as MOOCs are inherently different in terms of the types and number of enrolled learners and the educational environment (Chiu & Hew, 2018; Kasch, van Rosmalen, & Kalz, 2021; Li, Du, & Sun, 2022). With this, it is necessary to approach MOOC design differently compared to university-level credit courses (Guàrdia, Maina, & Sangrà, 2013; Joksimović et al., 2018; Kasch et al., 2021).

The literature and MOOC platforms provide various guidelines, principles, and practice suggestions for the design of online learning that could be used to inform the instructional design of MOOCs (Kasch et al., 2021; Oh et al., 2020). However, these are often not specific to MOOCs as they have been derived through research and practice experiences related to online learning more generally (Clark & Mayer, 2016; Quality Matters, 2014; TELAS working group, 2021). Yet, MOOCs are a very specific form of online learning. First, teaching and assessment in MOOCs are conducted entirely online and without any synchronous element, which places MOOCs at the far end of the online learning continuum (Allen, Seaman, Poulin, & Straut, 2016; Lakhal & Bélisle, 2020). This is different from most tertiary education courses, where synchronous interaction is commonplace, even when conducted online. Second, the learners in different online learning modes vary, which has various implications. For example, learners who take online courses to complete a tertiary education degree usually share certain similar characteristics and goals and are required to engage regularly to pass the course. In contrast, MOOC learners are often more diverse, have different goals, and are not expected to engage regularly with the course (Chiu & Hew, 2018; Zhu, 2021).

Considering the above, it is important to account for the characteristics of MOOCs and their anticipated learners to inform instructional design decisions. In fact, a systematic process of identifying factors impacting learning in MOOCs based on context and anticipated learner profiles, the formulation of design principles to address these challenges, and the thoughtful translation of these principles into a MOOC is required. Such work is notably absent in the literature (Kasch et al., 2021; Oh et al., 2020).

Objectives

Our objectives are to describe the systematic development of instructional design principles for our MOOC on health behaviors and showcase examples of how these principles were implemented in practice. With this work, we respond to the call for more thoughtful instructional designs of MOOCs (Chen, Woolcott, & Sweller, 2017; Jung & Lee, 2018; Kasch et al., 2021; Zhu, Bonk, & Sari, 2018) and provide a blueprint of best practice for future MOOC developers.

Literature Review

Instructional Design

Instructional design is the cornerstone that enables learning in any environment. It involves making decisions on how learning should be practically facilitated to engage learners and ultimately facilitate learning. According to the widely applied ADDIE Model, instructional design is an iterative process involving analysis of how learning can be facilitated in a given context, design of appropriate learning strategies, development of materials, implementation of these strategies and materials, and formative and summative evaluation (Branch, 2009). As such, instructional design requires the consideration of pedagogical theory, the characteristics and needs of learners, as well as the affordances of the learning environment at the outset (Branch, 2009; Reigeluth, 1983), while also keeping resource constraints in mind. Effective instructional design is achieved when the teaching and learning materials, tasks, and delivery enable learners to learn in a given learning environment.

Common Instructional Design Approaches for MOOCs

MOOCs are often designed through a standardized process established by the offering institutions or MOOC platforms in an effort to develop MOOCs efficiently (Oh et al., 2020). Given that the transmission model of teaching (i.e., the 'teaching by telling' model) has been the predominant design approach for decades across the globe (Kennedy, 2014; Margaryan, Bianco, & Littlejohn, 2015; Oh et al., 2020; Reeves & Hedberg, 2014), the most prominent type of MOOCs (i.e., xMOOCs) was conceived with the transmission model in mind (Höfler & Kopp, 2014; Kennedy, 2014). Therefore, resources, guidance materials, and templates provided to course developers are often based on these traditional instructional design approaches, and course developers are often inclined to adopt these design suggestions given their familiarity with such teaching methods.

Designing MOOCs in such a standardized way, however, is problematic for two key reasons. First, it suggests to course developers that learning can be achieved without examining and accounting for the specific learning context and the learners; effectively ignoring Step 1 of the ADDIE model (i.e., analysis of context and learners). Second and relatedly, designing a course based on the transmission model will likely be ineffective due to the behaviourist perspective that underpins this model; this perspective suggests that learning happens when learners are exposed to information. Yet, by primarily exposing learners to content, engagement and adequate cognitive learning will be

compromised (Höfler & Kopp, 2014; Johnson-Farmer & Frenn, 2009), which might partially explain the lack of learning among MOOC learners. For example, research indicates that for many MOOC learners, skill development and competency acquisition are important, but watching videos and reading texts does not satisfy these needs (Khanra et al., 2020; Milligan & Littlejohn, 2014).

Research to improve the instructional design of MOOCs

Efforts are underway to improve the instructional design of MOOCs (Kasch et al., 2021). As highlighted by numerous reviews, empirical research on MOOCs is often focussed on examining instructional design and its relationship with engagement and learning (Hew, 2018; Jung & Lee, 2018; Veletsianos & Shepherdson, 2016; Zhu, Sari, & Lee, 2018). However, the research is primarily concerned with narrower design aspects such as the use of badges, which are used to show progress and learning achievements, or the implementation of discussion forums (Chiu & Hew, 2018). As learning happens in context, doing research on isolated aspects and features of MOOCs and suggesting their general implementation across topics and learner groups is problematic and is at odds with the suggestion of the ADDIE model to conduct analyses of learners and learning context at the outset of any development. For example, it is unreasonable to assume that the use of badges to engage learners will be universally successful, especially so when considering that many learners in MOOCs are interested in a few topics.

Instructional design guidelines relevant for MOOCs

In addition to research works that provide practical instruction suggestions (Guàrdia et al., 2013; Höfler & Kopp, 2014), there are a number of existing instructional design frameworks and guidelines that might be useful for MOOC development (Kasch et al., 2021; Oh et al., 2020). We discuss a few prominent ones here.

The E-Learning design principles, as proposed by Clark and Mayer, are commonly cited in the online learning literature (Clark & Mayer, 2016). These principles are based on cognitive learning theory and are supposed to be effective for data and information presentation in digital formats. The authors suggest that when online course developers adhere to these principles, cognitive learning processes are supported optimally. The thirteen principles were translated into 56 practical guidelines for creating different e-learning design aspects, such as recommendations for designing course navigation.

Another framework that is occasionally applied when designing MOOCs is Quality Matters (Quality Matters, 2014). The tool was conceived for use in the realms of tertiary education and assesses eight areas of digital course quality. Points are awarded based on the areas of importance for quality online instruction. Quality Matters focuses heavily on basic aspects of course design (e.g., formulation of learning outcomes) at the expense of pedagogical strategies to promote interaction, engagement, and learning. However, it also highlights that the different components assessed should work together to facilitate learning.

Arguably, the most recent guidelines for course development are the Technology Enhanced Learning and Accreditation Standards (TELAS) (TELAS working group, 2021). These standards are meant to be applied to all instruction that is facilitated, to a large degree, through digital technologies. Eight standards are assessed through various criteria which come with success indicators; meeting these criteria indicates digital learning quality and, hence, improved potential for learners to learn. The eight standards, related criteria, as well as indicators have been developed over several years through interaction with available evidence and consultation with stakeholders and practitioners. Currently, four domains can be assessed: online learning environment, learner support, learning and assessment tasks, and learning resources.

Despite the availability of such guidelines and frameworks, the instructional design of MOOCs is not ideal (Egloffstein, Koegler, & Ifenthaler, 2019; Hendriks, Jong, Admiraal, & Reinders, 2020; Kasch et al., 2021; Margaryan et al., 2015; Oh et al., 2020). This might be due to several factors such as course designers not applying such frameworks to their MOOCs, a lack of feasibility of these frameworks due to an overwhelming set of suggestions, and because the frameworks suggest rather generic ways to design MOOCs; creating the perception that comprehensive analyses of interrelationships between learners, their needs, and the learning context, as proposed by the ADDIE model, are less relevant.

Guiding principles to inform MOOC instructional design

When planning and developing educational courses such as MOOCs, it is useful to produce a limited set of guiding principles that can be used to inform most instructional design aspects. Guiding principles stem from the field of health behavior intervention development. They highlight the overarching design principles of an intervention that, when implemented throughout, should improve impact (Yardley, Morrison, Bradbury, & Muller, 2015). They are brief statements on what an intervention

needs to achieve to have an impact. Various health behavior interventions were successfully developed using guiding principles (Bradbury et al., 2019; Essery et al., 2021).

In the realm of MOOCs, guiding principles are a response to the core aspects that impact learning in a MOOC, as identified through analyses of anticipated learners and learning context. They spell out the intention to improve engagement and learning through addressing learner needs, issues, and challenges in the context of a MOOC. Once developed, they serve as the central reference points for all instructional design decisions and should be consulted throughout the design and development process.

The development and implementation of guiding principles involves 4 steps: conduct an analysis of anticipated learners, the MOOC learning environment, and how these can impact learning using various sources of evidence; formulate key aspects that need to be addressed to optimize learning in a MOOC; formulate guiding principles that address these identified aspects; and implement these guiding principles in a MOOC. Figure 1 illustrates these steps.

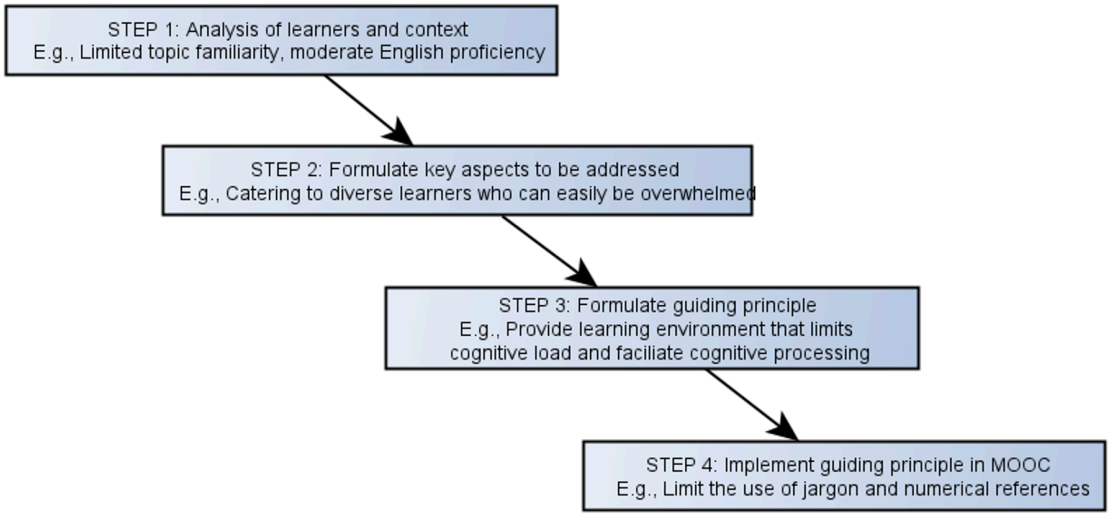

Figure 1. The development of guiding principles and their implementation in a MOOC

Context

The development of guiding principles and their implementation will be described in the context of our MOOC on health behaviors that is available on the edX platform (Müller & Lim, 2022). This MOOC is a 7-week introductory-level course that covers six key lifestyle behaviors (i.e., smoking, alcohol

consumption, dietary behaviors, physical activity, sedentary behavior, and sleep) that are strongly associated with non-communicable diseases, which are a health problem across the globe (Ding, Rogers, van der Ploeg, Stamatakis, & Bauman, 2015). Multi-level factors that impact these behaviors and ways to address them are discussed. Our MOOC does not address clinical questions. Extensive research on major MOOC platforms revealed that such a course was not available previously.

The MOOC provides an overview of health and health behaviors, introduces a model to analyse the factors that impact health behaviors, and examines various levels of influence (i.e., individual, social, environmental, political, and cultural). In each session, we provide videos, reading materials, immersive and reflective activities, discussion forums, and brief multiple-choice assessments. Learners can earn a certificate by passing the multiple-choice assessments and a project assignment.

Our course is meant for learners from health-related backgrounds and others who are interested in the topic. We anticipated that many learners work in medical settings and are interested in supporting people/patients in improving their lifestyles. Others may work in settings that are concerned with health promotion, such as ministries and non-governmental organisations, and are primarily interested in larger-scale approaches to changing behaviors. Finally, learners with unrelated backgrounds are likely interested in learning about health behaviors and changing their own or others' lifestyles.

Methods

In this section, we will describe how our guiding principles were developed and how we approached implementation. We adopted procedures described in the health intervention literature (Yardley et al., 2015) and instructional design literature (Branch, 2009), and made modifications where necessary.

We first formulated the overall goal we wanted to achieve with our instructional design. We decided that we needed to ensure our MOOC enables a diverse group of learners to learn and develop competencies as they need and desire. From the literature, it was clear that engaging meaningfully with the course would be key to achieving learning (Redmond, Heffernan, Abawi, Brown, & Henderson, 2018).

To arrive at the guiding principles that informed the instructional design of our MOOC, we needed to understand the key aspects that impact learning online, especially in the MOOC environment. We examined multiple sources to inquire about the likely characteristics of our MOOC learners and their

needs, how learning takes place and can be facilitated in MOOCs, and the affordances of the MOOC platform. These sources included the published research literature, pedagogy experts and instructional designers, online learning guides and frameworks, as well as conversations with members of our MOOC learning community. Finally, we also drew on insights from our own experiences as university instructors in public health and health promotion.

We triangulated the information from the various sources and organised it into themes that reflected similar aspects. For example, all information that related to the learners' background and how it might affect learning was allocated to one theme. Based on the information in each theme, we developed brief statements of the core aspects that needed to be addressed with our instructional design. Subsequently, we formulated and iteratively refined guiding principles that, when implemented through our instructional design, would address the issues. The resultant guiding principles were implemented in various ways in our MOOC (see Results and Discussion section for examples).

Results and Discussion

In this section, we describe the key aspects we needed to address in our MOOC in order to facilitate learning. We highlight the four guiding principles that we formulated to address these aspects and provide examples of how we implemented these guiding principles in our MOOC. Table 1 provides a brief overview of the key aspects and the related guiding principles. See the additional file for a comprehensive overview of how the guiding principles were implemented in our MOOC.

Key aspects to address	Guiding principles
Learner backgrounds: Managing cognitive load of learners from diverse backgrounds who are unfamiliar with the topic, have moderate English-language proficiency and moderate digital literacy.	Provide learning environments, materials, and tasks that limit cognitive load and facilitate cognitive processing.
Learner motivations: Catering to learners with vastly different motivations to join our MOOC and enable them to gain what they need or want.	Support learners in achieving their goals by enabling them to control what and how they want to learn.
Higher-order learning: Enabling higher-order learning to facilitate the acquisition of complex cognitive competencies.	Provide various authentic and personally relatable opportunities to practice and actively learn.
Connecting and instructor presence: Facilitating social connectedness and demonstrating instructor presence while considering the capacity of instructors.	Create a learning atmosphere that resembles human interaction and provide multiple opportunities to connect without overburdening instructors.

Table 1. Key aspects identified and guiding principles to address them in our MOOC on health behaviors

Learner backgrounds

Analysis of various sources

We anticipated that learners in our MOOC have diverse backgrounds, and many are not familiar with the topic of lifestyle-related health behaviors. This was a reasonable assumption considering that understanding and addressing such behaviors is usually a peripheral topic in medical and health-related education (Bezner, Lloyd, Crixell, & Burke, 2017). Learners who are not from these backgrounds would likely not have exposure to such topics at all. Consequently, most learners would have limited mental representations of the content and how different aspects are related. These less-experienced learners can get easily overwhelmed cognitively (Clark & Mayer, 2016; Khanra et al., 2020).

In addition, we anticipated that many learners are moderately proficient in the English language. This is a reasonable assumption considering that MOOCs generally enroll many learners from non-Anglophonic countries (Tan, Zhang, Luo, Sun, & Xu, 2018; Uchidiuno, Koedinger, Hammer, Yarzebinski, & Ogan, 2018), and given we focused our marketing efforts on people residing in South-East Asia. Limited English language proficiency makes it even more challenging to cognitively process and comprehend novel information. This challenge is exacerbated in MOOCs where there is usually no synchronous interaction with the instructors, leaving learners with few opportunities to successfully comprehend information (Uchidiuno et al., 2018). As such, language challenges can leave learners frustrated, reducing their self-efficacy and engagement.

Finally, we anticipated that learners would have diverse levels of digital literacy, which meant that there would be variation in terms of learners' ability to understand, evaluate, communicate, and produce digital information (Ferrari, Punie, & Brecko, 2013). This diversity in digital literacy is partly related to different levels of digital infrastructure in the countries the learners come from. In countries with a stronger digital infrastructure, the use of digital technologies is commonplace, putting MOOC learners from such countries in an advantageous position (Castillo, Lee, Zahra, & Wagner, 2015). Learners with lower digital literacy are likely to be more challenged by online learning with MOOCs (Khanra et al., 2020).

Key aspects identified and related guiding principle

Based on our analysis, it was apparent that we needed to address the issue of catering to diverse learners, many of whom are unfamiliar with the topic, have moderate English-language proficiency, and have moderate digital literacy. Each of these learner characteristics in isolation, but especially in combination, has implications for learners' ability to cognitively process and integrate information, thus affecting the chances for meaningful learning (Chen et al., 2017; Clark & Mayer, 2016).

Considering this, we anticipated that many learners could be overwhelmed by high cognitive demand. To account for the cognitive demand on learners, we formulated the following guiding principle that informed various aspects of our instructional design: *Provide learning environments, materials, and tasks that limit cognitive load and facilitate cognitive processing.*

Implementation of guiding principle in our MOOC

The implementation of the above principle was achieved by, for example, avoiding the separation of important learning elements that belong together. In practice, we provided essential content in one

place, such as a page within the edX platform, and largely avoided link outs to external websites or documents. This solution is in line with the Contiguity Principle established by Clarke and Mayer (Clark & Mayer, 2016) and is also supported by the Cognitive Load Theory that highlights the limited capacity of the working memory (Sweller, 1988, 2011). Separating important learning elements via link outs, for example, can lead to high cognitive load because the learner would need to keep some learning elements in working memory while also processing elements that are presented at a different place and potentially in a different format. This leaves less cognitive capacity to mentally organize and integrate elements. Learners unfamiliar with a course topic would be particularly challenged as they will be cognitively occupied with building a basic mental representation of the topic (Clark & Mayer, 2016; Sweller, 2011). Keeping learning elements spatially in the same place reduces cognitive load according to previous studies (Chen et al., 2017; Liu, Lin, Tsai, & Paas, 2012). As such, this implementation is likely to limit cognitive load for the diverse learners in our MOOC.

Learner motivations

Analysis of various sources

Through triangulating the different sources of information on MOOC learners, we anticipated that learners would have different motivations for enrolling in our MOOC on health behaviors (Lan & Hew, 2020; Maya-Jariego, Holgado, González-Tinoco, Castaño-Muñoz, & Punie, 2020; Moore & Wang, 2021; Zheng, Rosson, Shih, & Carroll, 2015). We expected that some learners would want to go through the course in a linear fashion in order to gain the full spectrum of knowledge, skills, and competencies on offer to advance in various aspects of life, primarily in work and study (Brooker, Corrin, Barba, Lodge, & Kennedy, 2018; Milligan & Littlejohn, 2017). These learners would likely identify strongly with the intended learning objectives, are more likely to follow through the course as intended by the instructors, and are more likely to regularly spend time on coursework.

However, we expected that a far greater number of learners would only be motivated to learn about specific aspects of the course (Clark & Mayer, 2016). This was a reasonable assumption because we highlighted a variety of valuable job-related and other competencies that could be gained by enrolling in the course. Learners who work in more clinical settings would likely be more interested in content and skill development related to changing health behaviors of individuals such as patients (Bezner et al., 2017). In contrast, learners who work in health-related NGOs or government might be more motivated to learn about changing health behaviors on a larger scale through environmental and

policy interventions. Learners from non-health-related backgrounds might want to change behaviors of friends and family members. Overall, these groups of learners are less likely to fully identify with the intended learning objectives, primarily access materials that are in line with their own goals, and spend time on course work primarily to achieve their distinct personal goals (Moore & Wang, 2021).

Finally, we anticipated that there would be a large group of learners who enroll in our MOOC out of general interest or curiosity, or for other reasons such as networking with other people (Moore & Wang, 2021). These learners would be less likely to pursue specific course-related goals and would primarily access material that piques their interest.

Key aspects identified and related guiding principle

The different learner motivations imply that the intended learning objectives set by us, the instructors, are less relevant to a large proportion of learners (Moore & Wang, 2021). This also means that issues around low continuous engagement in MOOCs, as reported in the literature (Jung & Lee, 2018), are less problematic because learners would want to selectively engage in material that they deem as important or interesting. As a result, we decided that an aspect we needed to address with our instructional design would be catering to learners with vastly different motivations to enable them to gain what they need or want. To address this, we formulated the following guiding principle: *Support learners in achieving their goals by enabling them to control what and how they want to learn.*

Implementation of guiding principle in our MOOC

We implemented the mentioned principle in various ways in our MOOC. We inform learners at the outset of the course about the broad topics that will be covered and how the course will unfold. A welcome message highlights the seven core topics and when they will be covered to give learners the autonomy to decide which session they would like to access. To allow learners to make informed decisions about the material to access in each session, we post brief messages on the learning dashboard that describe questions that will be addressed in the relevant sessions. We also highlight to learners the session learning objectives and activities via an introductory video. Learners can easily navigate to the desired material because we use descriptive headlines to signpost what can be learned or experienced. Finally, we provide optional depth of topics, allowing learners to decide how much they want to learn about something. Such design features give control and autonomy to learners (Clark & Mayer, 2016; Hsu, Wang, & Levesque-Bristol, 2019; Lan & Hew, 2020), which, according to the Self-Determination Theory, is important for meaningful engagement in learning (Ryan & Deci, 2000). Autonomy is also important considering the limited time many MOOC learners have to spend

on learning activities. Research in the context of MOOCs backs this assertion by showing strong correlations between learner autonomy and meaningful learning engagement (Lan & Hew, 2020).

Enabling higher-order learning

Analysis of various sources

From our analysis of the literature and through various discussions, we found that a key inhibitor to meaningful learning in MOOCs is that learners have limited opportunities to actively engage in learning (Kasch et al., 2021). This lack of active learning opportunities stems from conceiving MOOCs primarily as an avenue for transmission of information via videos and texts (Höfler & Kopp, 2014; Zhu, Bonk, & Sari, 2018). Through such a behaviorist approach, only lower-order cognitive skills such as description and explanation can be developed. Consequently, superficial learning and little motivation to engage deeply are common phenomena reported in MOOCs (Clark & Mayer, 2016; Lan & Hew, 2020). However, MOOC learners are interested in higher-order learning and skills-building such as application, evaluation, and creation (Lan & Hew, 2020); that is especially so for learners who have learning goals related to professional development or personal life (Milligan & Littlejohn, 2017).

For our MOOC, we anticipated that many learners would enroll because of their desire to analyse and change health behaviors. Lower-order learning, such as describing a model or intervention strategies as acquired through absorbing content, would not satisfy this desire. This is so because the analysis of health behaviors and construction of strategies to improve them involves complex cognitive skills such as a) information evaluation and model application to map factors impacting health behaviors, as well as b) strategy creation to change health behaviors in the light of identified factors, applicable theories, and the context.

Key aspects identified and related guiding principle

In order to enable the acquisition of such competencies, it is important to give learners opportunities to reflect upon introduced content, integrate new knowledge into existing mental models, or construct new mental models, and apply and iteratively refine such models in a given context (Fosnot, 2005). This can be achieved through authentic practice such as immersive tasks, reflective activities, and projects (Clark & Mayer, 2016). Hence, one aspect we needed to consider was to provide opportunities to engage in active learning and practice in authentic contexts. We formulated the following guiding principle: *Provide various authentic and personally relatable opportunities to practice and actively learn.*

Implementation of guiding principle in our MOOC

In accordance with established principles for higher-order learning in digital environments, we designed active learning tasks that usually follow the introduction of new content, concepts, or ideas (Clark & Mayer, 2016; TELAS working group, 2021). Many of these tasks allow learners to apply and integrate new insights and skills in order to facilitate job-related transfer (Clark & Mayer, 2016), while other tasks are personally relatable to facilitate emotional engagement. To help learners acquire the key competency of analysing what impacts health behaviors, we designed a series of active learning tasks learners could complete. We first used video and text to introduce a model (the ecological model) that learners could use to analyze the factors that impact health behaviors. Following this transmission, we introduced a relatable skit that showcased how this model could be applied to assess the factors that impact sleep behaviors in working adults in Singapore. We encourage learners to adopt the ecological model when analyzing the situation. Following this, we provide a template for learners to assess their own health behaviors using the ecological model. Finally, and to enable far transfer of competencies, learners who aim to earn a certificate must conduct such an analysis as part of their project assignment. The complex project involves a) conducting an analysis of factors that impact a chosen health behavior in a specific population in their country/region and b) designing an intervention that would address the identified factors. To complete this task successfully, learners need to collect information on health behavior influencers in the context of the chosen population and country/region, and they are required to map the identified factors onto the ecological model. Lastly, learners must propose an intervention strategy that could be used to address these identified factors.

Connecting and demonstrating presence

Analysis of various sources

Our multifaceted enquiries revealed that learners often experience a lack of connectedness to others in a MOOC, and that they perceive instructors as abstract providers of learning who are never present. Consequently, many learners often feel that they are on their own in their learning journey and primarily interact with a machine (Garg & Goel, 2021; Khanra et al., 2020; Lan & Hew, 2020; Zou et al., 2021). This is problematic in at least three ways. First, a key reason for joining a MOOC for some learners is to connect with others professionally or otherwise (Moore & Wang, 2021). If the desire to connect is not fulfilled, learners are more likely to disengage (Hew, 2016). Second, if learners feel that there are no other learners with them, they will not develop a sense of belonging to a group, which can

reduce learning commitment (Beachboard, Beachboard, Li, & Adkison, 2011; Hsu et al., 2019; Lan & Hew, 2020). Third, the lack of instructor presence can lead to reduced learning motivation and engagement (Hew, 2016; Jung & Lee, 2018). Researchers have shown that learners expend more learning effort when they feel that they are in a conversation with someone else rather than interacting with an object or machine (Clark & Mayer, 2016; Jung & Lee, 2018). They will often try harder to understand content and be an active participant as they feel more accountable to a real person as compared to a machine. Instructor presence also conveys to learners that there is support and guidance available throughout the learning journey. With this, learners are likely more confident that they can achieve their learning goals, which, in turn, increases their effort to learn (Jung & Lee, 2018).

Key aspect identified and related guiding principle

Enabling social connectedness and showing instructor presence are challenging in digital learning environments (Clark & Mayer, 2016; Quality Matters, 2014; TELAS working group, 2021). This is especially true for MOOCs due to the asynchronous nature of instruction and the limited capacity of instructors to set up and manage high-quality spaces to connect (Lan & Hew, 2020). For our MOOC on health behaviors, we decided that we needed to address the lack of connectedness and presence in our instructional design while considering our own capacity as full-time university instructors. We formulated the following guiding principle: *Create a learning atmosphere that resembles human interaction and provide multiple opportunities to connect without overburdening instructors.*

Implementation of guiding principle in our MOOC

To facilitate social connection building and create instructor presence, we implemented various strategies in our MOOC. Throughout the course, we revealed personal information about ourselves and used conversational language to break down pre-conceived hierarchies and make us more real and relatable. For example, we posted a light-hearted introductory video in which we spoke about our hobbies and what we like to eat. Such an approach resembles human-to-human interaction that learners are familiar with; and it conveys to learners that there is a conversation partner with whom they need to make an effort to understand, which can result in more engagement in learning (Clark & Mayer, 2016). We also prompted learners through a dedicated discussion forum to do the same and reveal some personal information. To demonstrate presence throughout the course, we replied to learner introductions and also to other discussion forum posts in a personable manner by responding to personal cues that learners shared (TELAS working group, 2021).

Conclusion

MOOCs are scaled-up courses that offer accessible avenues for self-development and competency building in various fields. With the demand for MOOCs rising steadily, many institutions are developing courses to increase their reach and generate new revenue streams. Despite their growing popularity, many MOOCs do not deliver on their promise of meaningful learning (Jung & Lee, 2018; Xing & Du, 2019). This might be, in part, due to the less optimal instructional design of MOOCs (Hendriks et al., 2020; Kasch et al., 2021; Oh et al., 2020). As for other modes of instruction, MOOCs should be designed systematically (Branch, 2009). That means designers ought to conduct analyses of the potential learners and the learning environment while also considering pedagogical theory and research prior to formulating design principles and implementing these in a MOOC.

In this paper, we describe such a systematic process in the context of our MOOC on health behaviors. Through consulting various sources, we identified four key aspects we needed to address with our instructional design to facilitate engagement and learning: diverse learner backgrounds, diverse motivations to enrol in our MOOC, enabling higher-order learning, promoting social connections, and demonstrating presence. To address these aspects, we formulated four guiding principles. These guiding principles informed our instructional design decisions and were implemented in various ways in our MOOC.

With this work, we responded to the call by many (Chen et al., 2017; Jung & Lee, 2018; Kasch et al., 2021) to design MOOCs in a more thorough and thoughtful way in order to actualize their potential of enabling high-quality learning for people from all walks of life and in every region on the planet. It is our hope that this paper will serve as a practical blueprint for other MOOC developers who aim to do the same.

Abbreviations

- MOOC: Massive Open Online Course
- TELAS: Technology Enhanced Learning and Accreditation Standards

Additional Material

The following material is available from the Supplementary Data section and can be downloaded here:

- **Additional table:** Key aspects identified, related guiding principles, and comprehensive list of principles implementation. Screenshots showcasing implementation of guiding principles are provided below this table.

Statements and Declarations

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Authors' Contributions

AMM and RBTL led the development of the MOOC on health behaviors. AMM, CT, and CG sourced the literature and consulted other sources to inform the development of the instructional design guidelines. All authors supported the implementation of the guidelines in our MOOC. AMM conceptualized the current manuscript and received substantial comments and advice from RBTL and CT to improve structure and content. AMM drafted the manuscript and received critical feedback and input from RBTL, CT, and CG. All authors have read the manuscript and agreed to its submission.

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Declarations

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