

Boosting the Opportunities of Open Learning (MOOCs) through Learning Theories

Heba A. Fasihuddin, Geoff D. Skinner, and Rukshan I. Athauda

Abstract— The recent evolution of computing technology has led to dramatic developments and changes in online learning. Open learning is a new form of online learning that allows learning materials to be freely available on the Internet and accessible to anyone who is interested. Different initiatives, which are based on the open learning concept, have been initiated by various prestigious institutions. Although all of these initiatives provide courses with free access to content, each has its own approach in terms of teaching, assessment and even their own goals of defining an open learning environment. Massive Open Online Courses is the term for courses provided in these open environments. These courses attract a large number of learners, however their success and efficacy in terms of the learning process has yet to be determined. The authors found that there is no clear model for open learning environments and therein lies our research objective. Many aspects still need to be considered and addressed in order to achieve a reliable and sustainable model. These aspects can be addressed with consideration to the principles of cognitive science so that better learning models can be obtained. This paper presents some learning theories that can be considered and applied to enhance open learning environments. The use of knowledge maps, as an approach to implement schema theory, was selected to present and organize the learning concepts. In addition, the Felder-Silverman learning styles theory was selected to personalize the learning environment and provide learning materials based on every learner's needs and preferences.

Index Terms— Adaptive learning, Cloud computing, Knowledge maps, Learning styles, MOOCs, Open learning.

I. INTRODUCTION

Online learning is an evolutionary learning approach that keeps evolving and changing due to the continuous evolution of technology. Open learning is a new phenomenon of online learning that allows learning materials to be freely available on the Internet for anyone who is interested. This new phenomenon becomes a tangible reality due to the newly emerged cloud computing technology. Cloud computing is a

new era of computing that moves the computing infrastructure and data away from the users to the cloud, and provides the data and infrastructure on-demand as a service over the Internet by a third party.

Recently, various prestigious learning institutions, such as Harvard, MIT, and Stanford, have utilized cloud computing to provide learning materials in an open approach. Coursera [1], edX [2], Udacity [3] and many others are all examples of this inventive open learning style. Courses that are provided through these open environments are termed Massive Open Online Courses (MOOCs). Based on recent published figures, these courses attract an enormous registration rate and seem to be very popular [4]. However, the success of this learning approach cannot be determined yet, as no evaluation on the efficacy of this learning process has been conducted yet. In addition, it is reported lately that the completion rate of MOOCs is very low, lower than 10%. Although this might be due to reasons related to learners' motivations to take and complete such courses, it raises various questions and concerns regarding the success of the open learning approach. It is found that the current format of MOOCs have some limitations that might affect their success and sustainability [5]. These limitations are related to different aspects, such as teaching and learning methods, learning content, assessments, identity authentication, accreditation, learners' varying needs and others. All of these limitations raise different concerns about the sustainability of open learning. The authors believe that there is a need to enhance the current model of open learning and find that this can be done efficiently by considering cognitive science and learning principles.

This paper aims to deliver some learning theories that can be implemented to open learning environments in order to provide learning materials in an approach that suits individual learners and supports them to learn independently. The focus is on the organization and orientation of learning materials and the management of various learners' preferences. Knowledge map was selected to organize learning concepts as an implementation of the concept of schema theory [6]. Felder and Silverman's theory for learning styles was selected to personalize the learning environment and provide learning materials in such a way that it suits every learner's preferences and needs [7]. These theories have been found to be effective in traditional learning, so the authors hypothesize that they will be as effective in open learning even though this still has to be

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determined.

The rest of this paper is organized as follow. First, a background of cloud computing, open learning and the contemporary Massive Open Online Courses are provided in section 2. Following that, section 3 introduces the learning theories that have been selected to be considered as a way to enhance the model of open learning. This includes schema theory and Felder-Silverman learning style theory. After that, the paper is concluded in section 4 and the future work is presented in section 5.

II. BACKGROUND

A. Cloud Computing

Cloud computing is a new era of computing technology. It moves the computing infrastructure and data away from the users to the cloud, and provides these on-demand as a service over the Internet by a third party. Currently, different public cloud providers are around, such as Amazon, Google, Microsoft and others. Cloud computing is defined by NIST as follows:

“Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction” [8].

In the literature, it has been reported that cloud computing offers several benefits and opportunities to learning institutions and online learners. These benefits include financial benefits, better resource management, better services and maintenance, access flexibility and even personal flexible workspace for learners. These benefits are reported in detail in [9]. Some leading learning institutions have already benefitted from the use of cloud computing to offer a variety of online courses in the newly open approach. This new approach can be termed as open learning, which is presented in the following section.

B. Open Learning

As mentioned earlier the evolution of technology leads to continual changing and development in online learning approaches. Recently, open learning has emerged as a new form of online learning based on the utilization of cloud computing capabilities. In open learning, resources are freely available on the Internet to be accessed by anyone who is interested. These resources are provided by different learning providers, who could be lecturers representing learning institutions or individuals who have appropriate knowledge. The main components of open learning can be classified into the following three main categories and are illustrated in Fig. 1.

1) *Cloud Service Providers*: Most of the current open learning initiatives are based on the cloud computing paradigm. This is due to the scalability and flexibility that cloud computing offers, allowing the growing number of learners and offered courses to be maintained. Furthermore,

the open environment can benefit from the

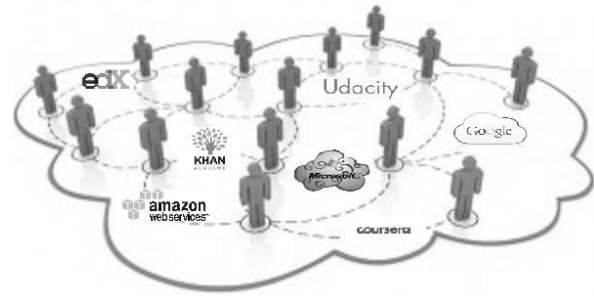


Fig. 1. An illustration of an open learning environment

cloud service by offering fully equipped workstations for learners [10].

These workstations can be shared between learners who belong to different courses from different learning institutions, which leads to better resource utilization and management.

2) *Learning Providers*: Learning providers are represented by expert individuals or learning institutions. The motivations for these learning providers to participate and offer learning in this open format are varied. Offering access to educational materials is the motivation of some, such as Khan Academy [11]. Experimentation and research is another motivation for some prestigious institutions to engage in and offer open courses [12]. In addition, profit is the goal of some of the contemporary initiatives, such as Coursera [1] and Udacity [3]. Recently, Coursera offered a paid option for a signature track in order to accomplish a verified certificate, which was considered a novel business model for open learning [3].

3) *Learners*: Open learning offers the opportunity for individuals to access educational materials for free and without any restrictions. Learners can learn different topics from different providers based on their interests. They also have the opportunity to join different, globally spread learning communities. Similar to learning providers, there are also various motivations that lead learners to engage and learn in open form. According to a recently published study, the motivations for learners to participate in an open course are categorized into four categories [13]. The first category involves learners who aim to support lifelong learning or gain an understanding of a subject with no expectations for completion or accreditation. The second category involves learners who participate for fun, entertainment or social experience. The third category involves learners who choose to do open courses for convenience, as compared to the barriers of traditional learning options. Finally, the fourth category involves learners who would like to experience or explore online education.

The nature and composition of the earlier listed components lead to some distinctive features of open learning. These features are summarized below:

1) *Scalability*: courses provided in open learning environments are designed to support an indefinite number of participants.

2) *Accessibility*: More and more often the open learning

environment is based on a cloud framework, which makes it broadly accessible via a thin client platform. Learners can access the learning resources easily and flexibly. All that is required to access the learning materials is a device with an Internet browser. In addition, learners are able to learn anywhere and anytime, even using devices with limited features, such as tablets, smart phones or even public PCs. This gives opportunities to learners in rural areas with limited technical capabilities to access learning resources and communicate with learning communities. In addition, it gives the chance to learn at a very low cost compared to the traditional way of learning.

3) *Openness*: in the open learning environment, learning is provided in an open form over the Internet. This means that learning resources are freely available to be accessed by anyone who is interested. In addition, knowledge is able to be shared globally, which leads to forming a rich learning environment.

4) *Learner-centered*: It is stated that in open learning learners mostly undertake self-directed independent learning [12]. This puts learners themselves in the role of organizing and managing their learning process.

The effectiveness and impacts of open learning on the learning process is still a current research area. Some studies have been conducted in order to find and evaluate this. One study that is presented in [14], found that providing learning materials online was a successful learning approach and was as effective as traditional face-to-face learning. Moreover, it found that this approach contributed to accelerating the learning process. Another study is presented in [15], and it was based on publishing the course materials on YouTube. The process was found to be successful and considered to be a good approach of moving the learning process from a private, closed form to an open, accessible form. It is also considered a helpful approach to enhance teachers' abilities as they have the opportunity to benefit from the experience of each other.

C. *Massive Open Online Courses*

Over the recent years a number of initiatives using cloud technologies in e-learning have been established. Some of these initiatives have been taken by prestigious educational institutions, such as Stanford, Harvard, and MIT, while others are by private organizations and individuals, such as Salman Khan [16]. Some of these initiatives are Coursera [1], edX [2], Udacity [3], Khan Academy [11] and others. All of these initiatives provide learning in an open, flexible form that allows anyone to take them up and learn. However, every learning provider has its own goal for initiating such a service and its own approaches for providing learning materials. University-level courses, which are provided freely in open form, such as Coursera, edX, or others, are known as Massive Open Online Courses (MOOCs).

MOOCs represent a current controversial point and their success cannot be determined yet. Based on some published figures, it seems that MOOCs are very popular with learners and learning institutions. For instance, it has been reported that

Coursera has about 100 universities as partners from around 40 countries and more than 17,000,000 enrolments from students representing 190 countries [17]. However, while the first published course in edX got 154,763 registrations, only 8240 students have completed the course to the final [4]. That makes the completion rate for that particular course only about 5%. In addition, it has been reported recently that the completion rate for MOOCs is no more than 10% [4]. These figures have led to MOOCs becoming the subject of controversy and raise the question of whether MOOCs are a sustainable educational model. Despite the low completion rate, it should be considered that the learners' motivations to take such courses differ and as such might be a reason for the lack of completions. In addition, in the current model there is no obligation on registrants to complete the course, so this might also affect the completion rate. Aside from this, there are some other limitations of MOOCs that also affect their success and sustainability [5].

As with any newly-arising initiative, MOOCs have some strengths and limitations [5]. The first strength point of MOOCs is embodied in the name - Massive Open Online Courses. MOOCs are university level courses that are offered online without any restriction to inform all interested parties in specific academic fields. The second strength of MOOCs is that they are learner-centered courses, so learners are able to work and learn at their own pace. This also gives learners the opportunity to maintain their peak cognitive level and ability, as they are able to access learning resources (i.e. lectures) repeatedly until they meet their learning needs. This continuous access to lectures and learning materials can be considered another strength point, as it allows learners to review the learning materials several times, which possibly leads to constant review and better learning. Despite these strengths of MOOCs, there are some limitations that might affect their efficacy or even the willingness of learners to attempt and complete them. The first limitation of MOOCs is the pacing of courses. Although learners have the chance to learn at their own pace, there are still some deadlines that govern them which can be an obstacle for some learners. The second limitation is the fact that the completion of some of these courses is not certified, which can affect the learners' desire to complete a course. Another limitation of MOOCs is the content that can be delivered, given the current format. There are courses in some fields, such as humanities, where the teaching approach is based on discussion and dialogue, so the offering of such courses in MOOCs is still to be researched [5]. Moreover, it has been claimed that MOOCs are placing less emphasis on providing interactive and dynamic approaches to learning, as there is no creativity in delivering learning content, only the usage of traditional approaches (i.e. video lectures) that lack support for learner's variable needs [18]. Finally, identity authentication and the possibility to create multiple accounts to earn a desired score are other limitations that still need to be considered.

Based on the current status of MOOCs, it can be stated that

there is no clear model for MOOCs or open learning environments. Different aspects still need to be considered and addressed in order to achieve a valid model. Some of the questions that require consideration are: what are the most suitable approaches for teaching and assessing in open environments? What are the subjects that can be taught? What is the most suitable authentication and accreditation method? Who is going to bear the cost? How can it be personalized to allow for a better learning experience? If all of these aspects are addressed carefully, the sustainability of open learning, or even MOOCs, can be assured.

III. THE APPLICATION OF LEARNING THEORIES ON OPEN LEARNING

Developing an online learning environment is a critical and sensitive field due to the implications on learners, instructors and the learning process. Therefore, scientific principles for learning should be considered in the development of MOOCs in order to achieve the desired learning goal. It is stated in [19] that tailoring general learning principles and working with cognitive scientists is able to enhance MOOCs and provide the best outcomes for learners.

As presented earlier, there are many aspects that need to be considered to enhance the model of open learning. The authors' focus in this paper is the organization and presentation of learning materials as well as the personalization of the learning experience. The aim is to organize learning materials in such a way that they simplify the learning concepts and support the learning process. In addition, it is aimed to personalize the learning environment so that every learner get access to materials that suit his/her needs and preferences. The authors found some learning theories to be promising and able to address both concerns. The concepts of schema theory can be adopted for presenting learning materials and concepts while learning styles theory can be applied to achieve a personalized learning environment. Following are overviews of these theories and how they can be implemented in the open learning environment.

A. Applying Schema Theory to Open Learning

As open learning is a self-directed learning environment it should support individual learners to learn independently in such a way that minimizes any possible difficulties. One of the key factors to achieve this is the presentation and organization of learning materials. This is because learners are in the role of organizing their learning process, so materials need to be presented neatly. The concept of schema theory has been found to be suitable to achieve this aim.

Schema theory has been described as the basic building blocks of knowledge and intellectual development that store concepts in human memory [6]. According to Sweller, knowledge and related intellectual skill is heavily dependent on schema acquisition [20]. In addition, it is stated that an organizing schema is especially important for novice learners and essential for low ability learners [6]. Based on that, the authors found that learning concepts need to be presented in

such a way that ensures the building of that schema in learners' memories and consequently to assist in the learning process. Therefore, expert generated knowledge maps were found to be a suitable approach to organize the presentation of learning concepts and materials.

Knowledge maps are a visual representation of knowledge that uses different graphical shapes [21]. It represents an overview of specific knowledge by breaking it down to many concepts that are related to each other. Concepts in the knowledge map are represented by ovals and the relationships between these concepts are represented by lines or arrows. A simple illustration of the main components of knowledge maps is presented in Fig. 2.

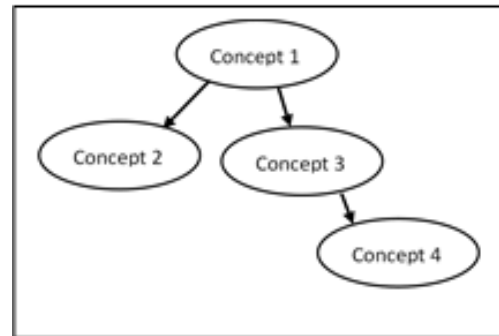


Fig.2. Simple illustration of the main components of a knowledge map

In addition to the concept of schema theory to nominate knowledge maps as an approach to present learning concepts, knowledge maps were found to be effective and supportive in the traditional learning processes. Hall and Dansereau stated that students who use knowledge maps are able to recall more critical and central concepts than students who use texts [22]. In addition, it was found that students with low verbal ability or base knowledge benefit the most from the conceptualization of a knowledge map [23]. Moreover, from a psychological perspective, a knowledge map was found to decrease students' anxiety regarding learning materials and to increase their motivation [24]. All of these findings are consistent with schema theory and have inspired the authors to hypothesize that knowledge maps are going to be as effective in open learning environments and will provide the required support for learners.

Although the benefits of knowledge maps are numerous, there are some reported limitations that might affect their effectiveness in learning. Map shock, cognitive overload, and lack of personalization are reported as the main limitations of knowledge maps. It is stated that large scale knowledge maps, such as a map conceptualizing a whole course, lack the simplicity of conceptualization that knowledge maps should provide, and consequently learners may encounter map shock. To address this limitation while still incorporating knowledge maps, every course can be broken to several main topics, so that the knowledge map can be created to visualize the concepts of each topic instead of the whole course. This will help learners to visualize the schema of each topic and its related concepts and consequently lead to better information retention.

B. Applying Learning Styles Theory to Open Learning

As the open learning environment is a self-directed environment, it should be more personalized and able to adapt to the variability of learners' needs and preferences. The authors found, in the implementation of learning styles theory, the ability to achieve this aim.

Learning style refers to the way a learner receives and processes information [7]. Therefore, different learners have different learning styles [7]. In the literature several models for learning styles were defined and found to be valid and reliable [25]. The model that has been selected is the Felder-Silverman model, which is mainly proposed for engineering education [7]. According to Felder, the original paper of their proposed model was the most frequently cited paper in articles published in the Journal of Engineering Education over a 10-year period. Considering that, the authors hypothesize that such a model will be effective in online learning and particularly in open learning.

The Felder-Silverman model classifies learning styles to five dimensions and identifies two types of learners for each dimension. The dimensions are perception, input, organization, processing, and understanding. Firstly, the perception dimension defines the type of information that learners prefer to receive and learn by. Intuitive learners prefer meaning and theories while sensory learners prefer learning by examples and practice. The second dimension is input, which defines the approach the learners prefer to learn with. Visual learners prefer pictures, diagrams and flowcharts while verbal learners prefer written or spoken explanations. The third dimension is organization which defines the approach of organizing and presenting information to learners. Inductive learners prefer facts and observations to be given and underlying principles to be inferred. On the other hand, deductive learners prefer principles to be given, with consequences and applications to be deduced. Processing dimension indicates how learners prefer to process and practice their learning. Active learners prefer working with others while reflective learners prefer thinking and working alone. Finally, the understanding dimension indicates how learners progress toward understanding. Sequential learners learn in continual small steps while global learners learn holistically in large jumps Table I represents these learning styles with their associated types.

Applying this theory in the development of an open learning environment needs to be done dynamically. This approach refers to the ability of the learning environment to identify the learners' preferred learning styles based on their interactions and choices of the provided learning resources. Consequently, the environment can adapt to the learners' preferences and a set of learning materials that match the learners' preferred learning styles can be suggested. For instance, materials supported with pictures, diagrams, and flowcharts need to be recommended for visual learners, while materials involving spoken explanations need to be recommended for verbal learners. Moreover, materials that consist of theories

TABLE I
FELDER AND SILVERMAN LEARNING STYLES

Dimension	Preferred Learning Style
Perception	sensory/intuitive
Input	visual/verbal
Organization	inductive/deductive
Processing	active/reflective
Understanding	sequential/global

need to be recommended for intuitive learners, while materials with more examples and practices need to be recommended for sensory learners.

IV. CONCLUSION

E-learning is a continually evolving field with many recent changes, particularly in terms of scope and size of online course offerings. Recently, e-learning has embraced a free open approach to learning and access to knowledge. A number of initiatives have been proposed and implemented by a few prestigious institutions based on this model. They offer a variety of courses in a diverse range of subjects. These courses are termed Massive Open Online Courses (MOOCs). They seem to have a high popularity, as they attract a very high number of registrations. However, the success of these courses cannot be determined yet as an evaluation of the impacts on the learning process has not been conducted yet.

The authors believe that there is no clear model for open learning environments or for MOOCs. Many aspects still need to be considered and addressed in order to achieve an effective sustainable model. Cognitive science and learning principles can be applied to maximize the outcomes of MOOCs and increase their opportunities to be sustainable [19]. Based on this, some learning theories have been considered for application to improve and enhance the current model of open learning.

The focus in this paper is to introduce an approach for organizing and presenting learning materials that is able to support the process of self-directed learning. Another focus is to personalize the open environment by allowing it to adapt to every learner's needs and preferences. Based on schema theory, knowledge maps, which is a graphical representation of learning concepts, has been selected to organize and present learning. This is because it was found to be an approach that helped in building a schema of learning concepts in learners' memories and consequently assisted them in the learning process. In regards to the personalization of the open environment, the model of Felder and Silverman for learning styles was selected for application to provide a dynamic approach, so that every learner can get access to learning materials that match his/her preferences and needs.

V. FUTURE WORK

The future work of this study involves the development of an open learning prototype with the incorporation of selected learning theories to evaluate their efficacy and impacts on the learning process. The prototype will be developed as a website

that has the proposed features, which are the use of knowledge maps and the adaptability of learning styles. The prototype will be piloted in an IT course at the University of Newcastle. Different open source learning materials will be selected by experts in the field of the selected course (i.e. lecturers). In addition, knowledge maps will also be generated by those experts. In regards to the adaptability feature, an algorithm will be developed based on Bayesian probability theory [26]. This algorithm will be able to track the learners' usage and interaction with the learning environment and consequently determine the preferred learning style. After the development of the prototype, students who are enrolled in the selected course will be invited to use the prototype and then provide their perspectives through surveys. Students will be surveyed about the usage of developed features and their impacts on their learning process. After that, the collected data will be analyzed and the efficacy of the proposed features can be determined.

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