Personalized Links Recommendation Based on Learning Analytics in MOOCs

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Abstract— **Increasingly, Massive Open Online Courses (MOOCs) are widely used and have become a key instrument in Technology Enhanced Learning (TEL) models in the last few years. However, the key challenge with this kind of larger scales platforms is how to provide course participants with a quality learning materials that promote effective learning based on their needs. Indeed, this requires careful planning, monitoring and evaluation of all learning activities. Recently, learning analytics and Recommender systems are widely used in MOOCs to overcome this challenge in providing personalization and accessibility learning materials for course participants. The purpose of the current study was to determine the usability and effectiveness of a personalized links recommendation tool based on learning analytics in MOOCs. This personalized links recommendation tool was undertaken the power of crowd sourcing to provide course participants with an high quality learning material from externals recourses, e.g., Open Education Resources (OER). The present study makes several noteworthy contributions such as researching the mapping of learning data, an open personalized - links recommendation architecture, and a user-friendly and dynamic interface to deliver the recommendations.**

Keywords-Massive Open Online Courses; MOOCs; Viedo-Based Learning; Learning analytics; Recommendation Systems.

I. INTRODUCTION

Since then new technologies such as Smartphone's and tablets in combination with social media such as YouTube have contributed to increasing social interaction and have made it easier as ever to integrate video applications in education [1]. More recently, Massive Open Online Courses (MOOCs) have offered a whole new perspective for Video-Based Learning (VBL) in education sector. MOOCs incorporate video-based lectures and new ways of assessment in courses that are offered on the Web and have potentially thousands of participants [2]. In MOOCs teachers, create and share videos related to the learning topic. The learners can then study the topic by themselves and discuss it back by solving problems and doing practical work [3]. In video-based collaborative learning learners, are able to share responsibilities for their learning. Much of the literature since the mid-2000s validates the efficacy of collaborative learning especially in VBL environments. They report on some educational benefits of learners working cooperatively in groups such as shared goals, ideas, resources, activities, and supporting each other [4]. Less than 28% of the studies applied the individual learning style that was consistent with the theory of multiple intelligences [5]. According to this theory VBL should focus on the particular intelligences of each student [1].

The questions that arise here are: what are advantages and disadvantages of current MOOCs? How can the current MOOC environments be improved? To answer these questions a state-of-the art study was conducted in 2015 [6]. The most interesting aspects of this study are:

- MOOCs platform consist of several units comprising video lectures with support of many learning materials such as PDF files, PPT and lecture notes. At the same time the participants can discuss the content in various groups.
- MOOCs are used by several thousand learners per course; the teaching assistance offered to support the learning activities becomes a critical issue.
- Closer inspection of the study results shows the lack of human connection as a big challenge, especially in MOOCs. The learners in these open courses come from all over the world. They speak English in different levels and have different cultural believes.
- The current versions of MOOCs use traditional assessment methods. These include e-tests, quizzes, multiple-choice and short answer questions. These methods are limited in evaluating course participants in open and distributed environment effectively.
- Providing life-long learning for more and more participants for free, facing a big challenge how to deal with information overload caused by massive activities.

Based on these analyses, it can thus be suggested that educational recommender system is a powerful tool enable learners to share their opinions and benefit from each other's experience. Indeed, recommender systems are an emerging field that has the potential to analysis learners' interaction data with MOOC environments to better understand their learning process [7]. One important opportunity to develop MOOCs is to leverage personalized links recommendation based on learning analytics techniques to collect, evaluate, analyse, and report data about learners and their learning activities in the MOOC environments, in order to achieve better learning outcomes. This paper analyzes how personalized links recommendation based on learning analytics techniques can be applied to current MOOCs to guide course participants in personalized inclusive open

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learning scenarios. The remainder of this paper presents the research methodology, the theoretical dimensions and design criteria of recommendation systems in educational scenarios e.g., MOOCs, the design, implementation, and evaluation results of the use of recommendation systems tool in the MOOC in more detail.

II. RESEARCH METHODOLOGY

This work employed case study research methodology, seeking for exploring new processes or behaviors based on the learning experiences surrounding the class of "*Producing Educational Programs*" offered by Fayoum University, Egypt using a blended MOOC platform includes a creative video tool allows learners to upload and collaboratively annotate videos online as shown in Figure 1.

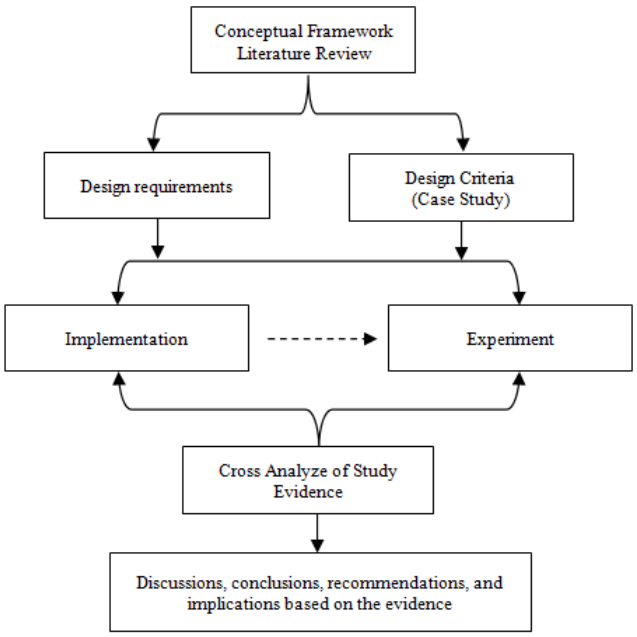

Figure 1. Case study methodology [8]

In addition, the analytical process is collected and combined data from different learners' activities when they interact with learning elements. The approach of the study is depicted below and is based on the work of Yin 2003 [8].

III. CONCEPTUAL FRAMEWORK

Recently, a considerable literature has grown up around the theme of recommender systems and their potential in the educational sector e.g., eLearning and MOOCs. In fact, recommender systems are widely used to handle the current challenges of MOOC environments in providing standards-based solutions for learners as well as, for providers (Professors) [9]. One of the greatest challenges, professors who taught MOOCs have troublesome in recommending learners to select suitable learning materials due to the wide range of educational material and knowledge shared in MOOCs platforms. On the other hand, MOOCs participants feel lost and dispersing to select the educational resources and the learning style that meet their characteristics the best [10],[11],[12]. Thus, research is needed to investigate different approaches of user recommendation in MOOCs. This work proposes a novel approach which applies recommender system techniques for video lectures and discussions forum in MOOCs. The contributions of this work are these design requirements:

- Capture and store large data sets from learners' activities when they watched video lecture.
- Observing the items that a user views the video lectures.
- Keeping a record of the items that a user discusses in the forum and newsgroup articles.
- Analyzing the user's social network and discovering similar likes and dislikes "Only for MOOC lectures".
- Provide a recommendation mechanism that enables learners to discover external video lecture and learning resources based on their interests and activities on the learning environment.

This end has led to a renewed interest for developing video heatmap tracking feature in an educational recommender systems, which are able to visualize exactly where each course participant navigated, second by second, by retracing individual viewing sessions. In this regard learners acquire knowledge and educators support the learning process in order to provide them with external learning material in MOOC environments.

IV. RECOMMENDER SYSTEM IMPLEMENTATION

In their interesting analysis of MOOC design criteria, Yousef et al (2014) collected design criteria regarding the interface, organization, and collaboration in video lectures and discussion [13].Based on the design criteria in this study and the recommender system requirement collected above in Section III, the study at hand aimed to collect more user requirements.

A. *User Requirements*

To gain as full an understanding as possible, an Interactive Process Interviews (IPI) with target learners was conducted to determine which functionalities they are expecting from personalized links recommendation tool. These interviews involved 12 students who were between the ages of 19 and 15 years and all of them had prior experience with MOOCs and recommender systems. Almost two-thirds of the participants (70%) are set out the following additional requirements and functionalities:

- Collect as much data as reasonably possible form the video timeline.
- Support for a wide variety of current and future mobile devices.
- The system must deal with privacy police of the university. The user must be aware about the fact that the application is running, that it is collecting data, or what data it is collecting.

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B. System Architecture

The architecture of the recommender system follows from the design requirements explained above. Figure 2 shows the learners actions are events explicitly generated by them, for example by tapping on the forum, entering text and similar.

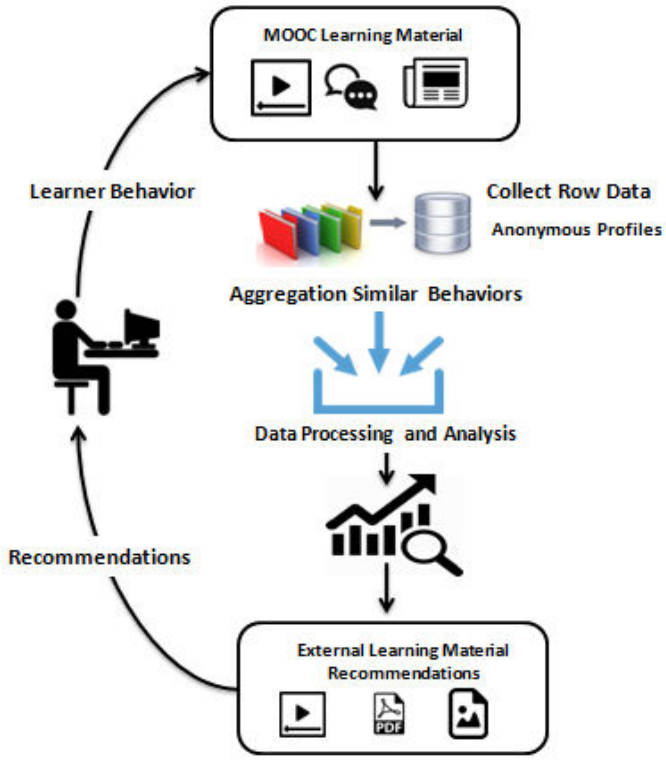

Figure 2. Recommender System Architecture

It would be possible to collect more data by analyzing video time line data or generating a graphical representation of data where the individual values contained in a matrix are represented as a video heatmap. All recommender learning materials presented in this study are based on observed learner's behavior.

V. CASE STUDY

The case study of this experiment took place during the summer semester 2016 with duration of four weeks. It was offered both formally to students from Fayoum University and informally with open enrollment to anybody who is interested in *Producing Educational Programs*. A total of 478 participants completed this course. 89 are formal participants who took the course to earn credits from Fayoum University. These participants were required to complete the course and obtain positive grading of assignments. The rest were informal participants undertaking the learning activities at their own pace without receiving any credits. The teaching staff provided 8 main video lectures and personalized links recommendation tool has suggested 38 related videos, 12 PDF articles and 7 images. This course was taught in both languages Arabic and English and participants were encouraged to self-organize their learning environments, present their own ideas, collaboratively discuss the video lectures, and share knowledge through forum and newsgroup articles.

The case reported here illustrates the an example (video heatmap analysis) of how a timeline of a video was marked-up at various points of analysis with total number of views as seen in Figure 3.

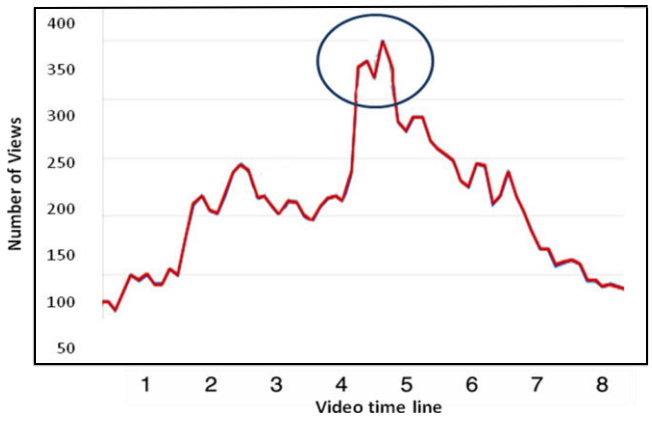

Figure 3. Video Heatmap Analysis

In fact, this case confirms the importance of the personalized links recommendation to predict the learning difficulties and misunderstanding concepts. From the data in Figure 3, it is apparent that minutes between 4:00 and 5:10 are the highest views traffic. By tracking the discussion forum associated with the video time line as presented in Figure 4. It's clear that course participants are comments and asked many questions regarding the minutes between 4:00 and 5:10.

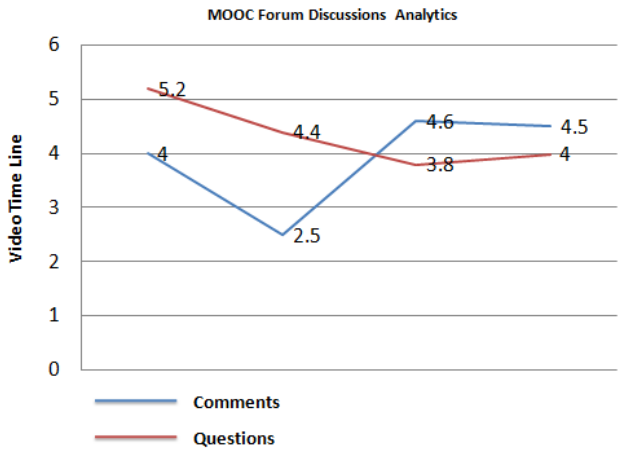

Figure 4. MOOC Discussion Forum Analysis

The personalized links recommendation tool then suggested some related videos and articles for particular participants they are watched this video part as well as for

those who are comments or asked questions for the same video part.

VI. EVALUATION

The next sections are providing the evaluation details of the personalized links recommendation tool. We employed a mixed-method evaluation approach based on the System Usability Scale (SUS) which is a simple, ten-item attitude Likert scale giving a global view of subjective assessments of usability as a general usability evaluation [14] and a custom effectiveness questionnaire reflecting the personalized links recommendation tool.

A. *Usability Evaluation*

The System Usability Scale (SUS) was invented by John Brooke who, in 1986 and provides a "quick and dirty", reliable tool for measuring the usability [14].The System Usability Scale is a Likert Scale which includes 10 questions which users of your website will answer. Participants are asked to score 10 items with one of five responses that range from Strongly Agree to Strongly disagree. Of the study population, 213 subjects completed and returned the questionnaire.

TABLE I. SYSTEM USABILITY SCALE (N= 213)

No	System Usability Scale (SUS)		
	Item	***User Rating***	***SUS Score***
1	I think that I would like to use this website frequently	4.3	3.3
2	I found the website unnecessarily complex	2.3	2.7
3	I thought the website was easy to use	3.9	2.9
4	I think that I would need the support of a technical person to be able to use this website	2.1	2.9
5	I found the various functions in this website were well integrated	4.6	3.6
6	I thought there was too much inconsistency in this website	1.9	3.1
7	I would imagine that most people would learn to use this website very quickly	4.6	3.6
8	I found the website very cumbersome to use	1.1	3.9
9	I felt very confident using the website	4.8	3.8
10	I needed to learn a lot of things before I could get going with this website	1.2	3.8
SUS Total Score			84

The majority of respondents were in the 18-25 age range. Male respondents formed the majority (56%). Participants have a high level of educational attainment: 70% of participants are studying Bachelor's degree at Fayoum University and 30% have a Bachelor's degree or higher. They also have an experience with TEL courses, nearly, 75% reported that they attended more than two TEL courses.

The overall System Usability Scale (SUS) score from the questionnaires was 84, which translates to "Users like your site and will recommend it to their friends".

B. *Effectivness Evaluation*

The second part of this evaluation aimed to examine the effectiveness of using personalized links recommendation tool in MOOCs. Effective evaluation questionnaire was designed to collect feedback from the course participants' reflection the most applied objectives reported in Section III, as shown in Table 2. A 5-point Likert scale was used from (1) strongly disagree to (5) strongly agree. In addition to ensure the relevance of these questions, we sent this questionnaire to a small panel of 5 learners as well as 5 learning technologies experts. They were asked for their opinions and suggestions for revising the questionnaire. Their feedback included a refinement of some questions and replacing some others. The revised questionnaire was then given to the course participants.

TABLE II. EFFECTIVENESS EVALUATION (N= 213)

No	Effectiveness Evaluation		
	Item	***Mean***	***SD***
1	I think that I the system is able to provide specific recommendation for me	4.3	0.45
2	I thought the system is able to recommend me (four to five) relevant learning material.	4.3	0.73
3	The remmended learning material help me to better understand the course content.	4.1	0.91
4	I think that items recommended to me are diverse (Videos, PDF, Images).	3.45	1.20
5	I found the rating system (Likes) helps me to assess the quality of the learning material	4.6	0.62
6	I found it is too easy to obtain the recommened learning resources for me form OER.	3.9	1.13
7	The personalized links recommendation helps me to reflect on my own performance.	4.6	0.61
8	I found the system is very respect of my praivacy.	4.6	0.34
9	I think the discciions formu helps me to improve collaboration with peers.	4.8	3.8
10	I can get help at any point that is tailored to where is me.	4.2	0.82
Effectiveness Evaluation Average Score		4.28	1.06

The aim of this research was to explore and explain the personalized links recommendation tool in MOOCs. According to Table 2, responses regarding recommendation provided through this tool were largely positive. However, some learners received only recommended videos. One possible reason for this is that, those participants didn't participate in the discussion forum or students news group [15]. It would be interesting to compare experiences of individuals within the same group activities.

VII. CONCLUSION

The concept of Massive Open Online Courses (MOOCs) is currently accredited with high relevance for prospective developments in eLearning technologies in higher education. MOOC providers worldwide are hard pressed in meeting the challenges of teaching an increasing number of course participants and dealing with growing student heterogeneity. Recommendations can be applied to

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overcome current limitations of MOOCs in providing personalization and accessibility features such as recommending resources (e.g., papers, books, images. Video lectures). In this investigation, the aim was to assess the personalized links recommendation tool in MOOCs. One of the more significant findings to emerge from this study is the use of information aggregation capabilities of a recommender system to improve the teaching assistance and consulting course participants in an automated way and thus scale tutoring and consulting in a personalized way for a large scale of learners worldwide. To validate this approach, a mixed-method evaluation approach was employed based on the System Usability Scale (SUS) as a general usability evaluation and a custom effectiveness questionnaire reflecting the personalized links recommendation tool. The findings from this study make several contributions to the current literature. First, experimental results show that the proposed personalized links recommendation tool can enhance learners' performance. Second, create dynamic system architecture and finally, a user-friendly and accessible interface to deliver the recommendations.

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