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Adaptive MOOCs to Foster Personalized Learning

*J. Saul Nicholas[1], F. Sagayaraj Francis[2]
[1] Research Scholar, Department of Computer Science and Applications, SCSVMV University, Enathur, Kanchipuram, India,
[2] Professor, Department of Computer Science and Engineering, Pondicherry Engineering College, Pondicherry, India,
Corresponding Author: J. Saul Nicholas

ABSTRACT
Massive Open Online Courses (MOOCs) provide open access to a wide variety of learning resources in many different knowledge areas, so that finally anyone in the world can join these courses and learn, no matter what the level of education. MOOCs have both great defenders and detractors. As an emerging trend, MOOCs have a great impact in technological and pedagogical areas, but they should demonstrate their real value in specific implementation and within institutional strategies. But MOOCs have different issues such as high dropout rates and low number of cooperative activities among participants. This paper presents a partial adaptive proposal to be applied in MOOC definition and development that may be useful to tackle the mentioned MOOC problems.
Keywords: *MOOCs; adaptive systems; personalized learning; learning styles; adaptive framework*

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I. INTRODUCTION

MOOCs (Massive Open Online Course) are the courses with the most massive and heterogeneous participation that anyone can find these days. In a specific course different kinds of students are involved: pre-university students, university students, postdoctoral students, non-university students, working students, etc. Also, the students' learning goals and objectives are different; some may be interested in knowing the subject, others in applying the knowledge, others in improving what they already know, and even experts in the field enroll in the course to enhance their experience or just to know what others are doing.

The first editions of MOOCs suffer from many problems [1], we would like to highlight three of these weaknesses: 1) a very high dropout rate (around 90%); 2) low number of cooperative activities (outside peer assessment) among participants; and 3) Poor continuity of learning communities once the MOOC ends. These and others issues are have made several educators, researchers and institutions doubt about the effectiveness of the MOOCs, and even take it for granted the failure of these [2].

This research paper establishes the hypothesis that one of the aspects that may cause the high dropout rate, the lack of cooperative activity between course participants and the non-continuity of learning communities once the course is over is the heterogeneity, the different profiles, the different learning objectives and interests of the participants in a MOOC. If the course has a rigid learning design (the same educational level or methodology for all the students) this can cause participant giving up, even before the course starts, due to all the participants have to follow the same work plan (match their interests or not).

A MOOC is not another online course but it has different qualities; the key concept is not to repeat the same classic academic teaching but be able to engage participants to create and share knowledge. Thus, applying the adaptive education general concepts for resources access is needed and it must be completed with knowledge management, informal and social learning and lifelong learning principles.

The main educative principle behind a MOOC proposal should be that participants be able to create new knowledge in a social and collaborative way, allowing that knowledge may be openly used both to improve the MOOC itself and to give continuity to the MOOC learning community. If this were true (i.e., the MOOC expectations are met), it would generate thousands of knowledge resources in different places and by different people, promoting open knowledge and open innovation principles [3]. Therefore, in addition to adapting the learning processes, the learning resources must be managed.

The following are the keys to achieve adaptivity of a learning design:

- Use of adaptive technology and methodology to allow proposing activities that are shared by all the participants, or shared by groups with similar profiles, or individual ones.

- Analysis of the generated data during the learning process (learning analytics) in order to help students to select the most suitable resources for their own goals (adaptive methodology), the collaborative connectivist activities and the relationships with resources more important for other different profiles.
- Promoting and managing the creation of collaborative resources through learning communities linked to the MOOCs. Participants both individually (for example using blogs) or collaboratively (for example using social networks or wikis) may create useful resources that increase and improve the MOOC learning resource database. The most important challenge is to classify, organize and integrate the dynamically generated within the MOOC in order to reinforce the resource adaptation for the different profiles and also, in the other hand, guarantee the continuity of the connectivist activities once the course is over.

Thus, the proposed research about MOOC deal with:

- Adaptive MOOCs design, taking into account each student's profile, goals and social context.
- Learning data analysis aiming both analyzing the learning outcomes effectiveness and helping students to identify the most suitable resources for their own goals.
- Management of the dynamically generated resources inside the learning communities just in order to integrate them in the MOOC and also in the linked community itself once the course edition is over.

II. RELATED WORKS

There is lot of literature about MOOCs [4], specially blog entries more than academic papers, that have arisen since MOOC inception in 2008 with the massive open online course format pioneered by Siemens and Stephen Downes (Connectivism and Connected Knowledge 2008 -CCK08- course [5]) and there are even studies about this literature [6]. Now, several MOOCs have been developed and there are papers that question the MOOC effectiveness of learning [7].

From its own name, MOOCs are massive and open online courses whose participants have heterogeneous profiles [8], and in a negative perspective, when the quality of the process and the assessment is questioned [9] or the low rate of completion of the MOOCs (about 10% on average) is emphasized [10].

Lot also has been written about the different types of MOOCs: xMOOCs (certification based courses that follow a more behaviorist approach) and cMOOCs (connectivism and networking based courses) [11]. They are so distinct in pedagogy that it is confusing to designate them by the same term [12]. This research proposal is more related to cMOOCS as they apply the connectivism principles [13] and their social repercussions and learning enrichment.

According to this, adaptivity is a core characteristic that MOOCs should include in order to achieve successful results, introducing what Nishikant Sonwalkar calls the aMOOC (Adaptive MOOC) concept: "The courses are one-size-fits-all and depend heavily on the video lectures and discussion boards. A MOOC course that adapts to the learning preferences of individual learner using brain-based adaptive learning with learning strategies - apprentice, incidental, inductive, deductive and discovery can lead to much higher completion. The adaptive MOOCs, where the content is presented with differentiated learning strategies and real time intelligent feedback can significantly improve completion rates" [14]. Scott Rapp [15] also goes in the same direction with the "Fuse MOOCs with adaptive learning platforms" strategy by iteratively adjusting questions to student's level, the platform intelligently adapts to meet student's needs and help her learn faster and more effectively in the language area.

Adaptivity in learning models improves the learning process, from initial conditions, such as learning style, knowledge level of a student, and during the learning process [16]. Learning and cognitive styles have been taken into account as vital elements to define adaptive learning methodologies [17]. Adaptive instructional designs based on IMD LD [18] have been proposed using HyCo authoring tool [19]. Adaptive assessment proposals throughout adaptive tests also have been carried out [20].

2.1. Personalised Learning

Personaised learning is 'putting the learner at the heart of the education system' [21]. Personalised learning involves extending the educational concepts of differentiation (teaching tailored to the learning preferences of different learners) and individualisation (teaching paced to the learning needs of different learners) to connect to the learner's interest and experiences and meet the needs, abilities and interests of every student through tailoring curriculum and learning activities to the individual. The ultimate aim of a personalised learning environment is to create an educational system that responds directly to the diverse needs of individuals rather than imposing a 'one size fits all' model on students [22].

Personalised learning changes the role of students from being simply a 'consumer' of education to a 'co-producer and collaborator' of their learning pathway [23]. For a student, personalised learning actively engages students in the process of learning, leading to improved learning outcomes and learning experiences.

For institutions, it enhances their reputation as one that values and supports individual student's learning [24]. Driving the shift towards 'personalisation of learning' in the higher education sector are the broadened experiences and increased expectations of students, affordability of technology and the change of physical and temporal campus boundaries [25].

2.1. Personalised Learning Environment

In practical terms, what does 'personalisation of learning' mean and how can it be enabled?[26]. The synthesis of a body of work associated with a personalised learning approach to identify six key themes that were essential for an effective learning environment:

Locus of control: A learner-centred approach will not succeed without a committed shift towards sharing the ownership of learning with students.
Knowing students as learners: A personalised learning approach requires educators to know the achievement and progress of each student. Learning analytics can be used to make this scalable for large student populations [27].
Student engagement: Connecting learning to the lives and aspirations of the students through authentic activities will provide them with purpose and motivation to gain new knowledge and skills.
Collaboration: Personalised learning environments foster a culture where learners see themselves as both participants and contributors to the learning process.
Effective use of ICT: Technology allows for an anywhere, anytime, anyone approach to learning and can support the shift of culture required for a student-centred approach across two broad areas: (1) to provide the infrastructure to support personalised learning (learning analytics) and (2) to provide a platform to deliver learning activities and resources to students.
Classroom culture: The relationship between educators and students is emphasised in a personalised learning environment and the educator must be aware of each student's interests, learning styles, and should be ready to ensure the needs of each student are met. This creates challenges for large classes but generates opportunities to use educational technologies and learning analytics to support the educator.

III. AMDF'S LEARNING STYLE MODEL

The main objective behind AMDF (Adaptive MOOC Design Framework), was to show how a MOOC should be designed in order to fulfill most of the personalization parameters. Furthermore, as learning style is one of the important personalization parameters, FSLSM (Felder and Silverman's learning style model) was chosen to pass this parameter because of the following reasons:

1. It has been successfully implemented in previous studies and models [28].
2. It has been approved by its author and other research scholars [29].
3. It is user-friendly and the results are easy to understand and practice [30].
4. It has been recognized as the most suitable learning style for eLearning or web based learning platforms all over the world [31].

In this section, some adaptive learning systems that were based on FSLSM have been assessed and evaluated. The idea behind this evaluation was to see what kind of media elements they have used for their framework for each of the dimensions of FSLSM to get some ideas of what media should be used in AMDF.\

3.1. Parvez et al [32]

Parvez et al have put forward a design framework that supports Felder and Silverman's learning styles model. It has the following media elements:
1. Definition: It contains definitions of domain concepts and is useful for many learning style dimensions including verbal, sensor, intuitive
2. Example: It contains examples that can illustrate a given concept useful for almost any learning style, especially the sensor style.
3. Question: It contains questions which is very useful in making the learner think about his problem solving and very important for reflective learners.
4. Suggestion: It suggests to a learner who might be lost. It helps in pointing the student in the right direction.
5. Picture: It contains images that illustrate a concept for the visual learner.
6. Relationship: It contains information that provides the relationship of a given concept to the big picture useful for global learners.
7. Facts: It contains facts about a concept that extends beyond the concept definition useful for sensory learners but can also be used for other types of learners

Table 1: summary of the elements used to fulfill FSLSM other adaptive learning systems.

	View					View			
Style	**Parvez et Al**	**Flexi-OLM**	**Algorithms Course**	**Farnzoni et al**	**Opposite Style**	**Parvez et Al**	**Flexi-OLM**	**Algorithms Course**	**Farnzoni et al**
Active				Forums, Chat	**Reflective**	Definition, question			Slideshows
Verbal	Definition	Textual description	Plain text	Text and Sounds	**Visual**	Picture	Concept map, pre-requisite, lecture structure, Hierarchy of concepts, index, list	Picture, Table	Visual Representations and diagrams, forums and Slideshows
Sensory	Definition, example, Facts	Index, List	Examples with little explanations	forums, laboratory And experiments, pictures And Graphics	**Intuitive**	Definition	Concept map, pre-requisite	Examples with little Explanations	Theoretical And Abstraction
Global	Relations Hip	Hierarchy of concepts		Media that allow to See everything as a whole, forums, Chat	**Sequential**		Lecture structure		Media that Allows content to be shown in steps, Slideshows

3.2. Flexi-OLM [33]

Papanikolaou et al have investigated the design of Flexi-OLM which is also designed basing on the Silverman's learning styles model. It has the following seven views to support different dimensions but does not have any view for the active-reflective dimension:

1. Hierarchy of concepts
2. Lecture structure
3. Concept maps
4. Pre-requisites
5. Alphabetical index
6. List ranked according to performance
7. Textual description

3.3. Algorithms course [34]

The algorithms course designed for a C programming course had adapted by providing different representations for each student and using different types of resources. For example, it was showing different interfaces for visual and verbal learners; pictures and tables to visual learners and plain text to verbal learners. For other dimensions like active-reflective learners, it was showing very similar material.

3.4. Franzoni et al [35]

In a consolidated study on how to choose the appropriate electronic media for FSLSM, they have suggested to use media such as:

1. forums and chat for active and slideshows for reflective learners
2. text and sounds for verbal and visual representations and diagrams, forums, slideshows for visual learners
3. forums, laboratory and experiments, pictures and graphics for sensory learners and theoretical and abstraction for intuitive leaners
4. media that allow to see everything as a whole, forums, chat for global learners and media that allows content to be shown in steps and slideshows for sequential learners. The summary of the study could be found in the table 1.

IV. TERMINOLOGY

Before going to the design framework, the main terminologies used in this design framework will be explained. These terminologies have been used according to the literature regarding eLearning.

4.1. Stakeholders

First and foremost, [36] has suggested a MOOC framework has four stakeholders; course designers, managers, tutors and learners. Therefore, the same terminology has been used in this research but with the following roles:

- **Learner:** the student who is taking the course
- **Tutor:** the person who is responsible for designing the contents of the course. For example, the tutor should provide separate material for visual learners and the verbal learners.
- **Course designer:** the person who has a higher-level perspective to the course than the tutor. The course designer is the person responsible for defining the framework of the course. In other words, the course designer has to define what should be covered in the course and what should not from a general perspective. For instance, she defines that in the second lecture in the "Introduction to C programming" course, C language's "arithmetic operators" should be taught. Then, it is the tutor's responsibility to provide the content for teaching this subject.
- **Manager:** the person responsible for designing the MOOC platform's settings in general.

4.2. Modular Content Hierarchy

In this section, the terminology used for the content shall be covered. So, as learning objects are the core of AMDF, it should be defined clearly. Learning Objects are "a collection of content items, practice items, and assessment items that are combined based on a single learning objective [37]". Learning Object is important since it is a key concept in many standards and specification, such as SCORM [38]. SCORM that is an abbreviation for Sharable Content Object Reference Model, is a set of technical standards of the Advanced Distributed Learning (ADL), initiative for eLearning software products and it is the industry standard for eLearning interoperability [39].

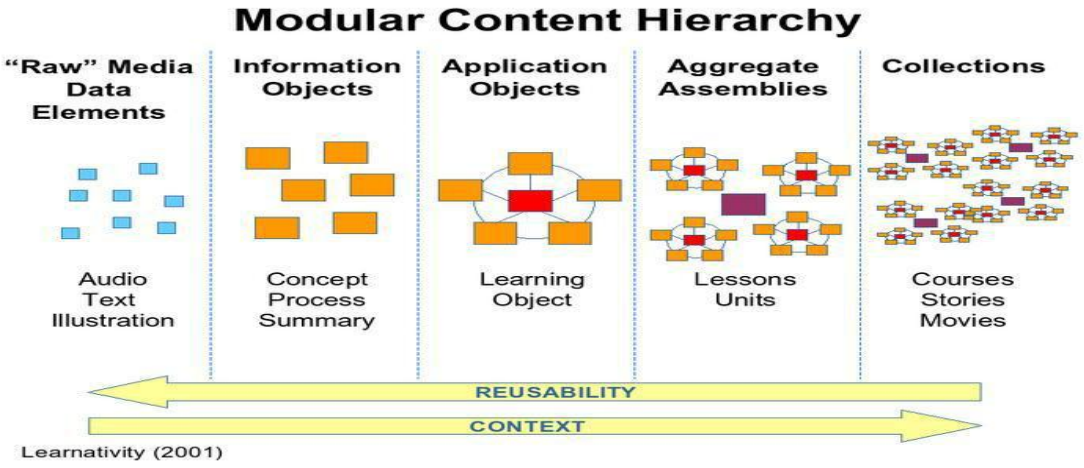

Figure 1. Modular Content Hierarchy [41].

Table 2. The terminology used in the literature for the modular content hierarchy and their corresponding terminology in AMDF.

Terminology in the literature	Corresponding terminology in AMDF
Raw Media Content	Media element
Information Object	Information Object
Application Specific Object	Lesson node or node
Aggregate Assembly	Lesson
Collection	Course

Further, the hierarchy of modular content has been divided into five levels according to the terms used in [40]:

1. **Raw Media Contents:** the smallest level in this model, consists of raw media elements including media types such as text, audio, illustration, animation.
2. **Information Objects:** sets of raw media elements. They describe a certain procedure, process or structure, define a concept, present a fact, or provide an overview on some subject. The plan is to generalize the concepts to deal with more advanced and innovative content.
3. **Application Specific Objects:** Based on a single objective, information objects are then selected and assembled into the third level of Application Specific Objects. The "learning objects" defined above reside at this level.
4. **Aggregate Assemblies:** deal with larger objectives which correspond with lessons.
   Collections: aggregate assemblies are themselves assembled together to form collections like courses. Figure 1 shows the above mentioned hierarchy in a diagram:

Therefore, in AMDF, each course is consists of a sequence of lessons and each lesson is a combination of Learning Objects where these Learning Objects are called "lesson nodes" or simply "nodes". The nodes are themselves combination of information objects and the information objects are a set of media elements. Table 2 shows the summary of the terminology used in AMDF.

V. CONCLUSION

This paper presents the problems of MOOC and the relevant need for adaptivity in order to foster personalized learning. It is a partial adaptive proposal to be applied in MOOC definition and development that may be useful to tackle the mentioned MOOC problems. Further efforts ought to be carried out on AMDF to achieve the required level of adaptivity and personalization.

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