MASSIVE OPEN ONLINE COURSES – AN ADAPTIVE LEARNING FRAMEWORK

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ABSTRACT

Diverse student needs present a challenge in online education. Massive Open Online Courses (MOOCs) attract many diverse learners, so there is need to tailor the course instruction to meet the students' individual needs. This paper investigates an adaptive MOOC system from a personalised learning perspective. Firstly, we review existing literature on adaptive online learning systems, bringing together findings on the relationship to both effective learning support and motivation to study. Secondly, we outline a proposed framework, which tailors the recommendation of instructional material using the learner's profile. In this model, the system can present the user with a suggested learning path to meet appropriate learning objectives. As the student progresses, further recommendations can be made with appropriate resources to enhance and develop the learner's understanding of the previous topics. Adaptation and personalised recommendation have been noted as providing the means for an online system to replicate, in part, the function of a human tutor. However, there are drawbacks both in the limitations of providing the best recommendations and in the danger of users having little control over their own learning. Allowing learners to manage their learning by setting objectives and developing paths has been associated with encouraging effective learning skills, increasing collaboration and enhancing learning. Our framework therefore supports users in creating their own paths, allowing them to make informed choices about appropriate resources based on their expression of current objectives and preferences. The framework will be evaluated by adapting an existing MOOC, allowing comparison of a variety of aspects including choice of learning path, learner satisfaction and effect on attainment and drop-out rate.

Keyword: Online course, MOOC, instructional course, recommendation, adaptive, responsive, learner preference

1 INTRODUCTION

Adaptivity is a way of building a course system to model a user interest and apply it to adaptation based on the user's preferences [1]. *Brusilovsky* pointed out that adaptive hypermedia system build a model of goals, preferences and knowledge of each and every individual in the course, and apply the model althrough the course. However, as the learners interact with the system, their needs were adapted. Adaptive responsive/recommendation system is a system that help user find items of interest [2]. The task of delivering customized course content is often said to be a recommendation activities of which the tailored system recommend learning resources to learner [3,4]. The idea of the system is to tailor the next course concept to study relating to the previous theme [5]. *Tsolis et al.,* pointed out that adaptive e-learning course should not be designed without considering students and teachers needs and adapting the contents during course progression [6]. *Esichaikul et at.,* argued that adaptive e-learning aims at providing students with appropriate contents suitable for their learning knowledge for effective results [7].
According to *Sonwalkar* [8], adaptive learning systems originated from the " area of artificial intelligent (AI), intelligent tutors, and adaptive controls". Adaptive learning system is a technology system with the ability to learn and adapt to the input received from the learners. As noted by *Sonwalkar*, educational adaptive learning process organises the course curriculum contents based on the diagnostic assessment of the individual preferences and goals [8].
One of the main goals of this paper is to present a review of the state-of-the-art in adaptive learning methods. The paper is structured as follows; Firstly, a review of literature on instructional adaptive MOOC contents and concerns relating to learner's preference are presented taking into consideration the effect on education. Secondly, we discussed our proposed method of tailoring adaptive instructional course to learners. We conclude with a discussion of the findings and suggestion of further work.

2 LITERATURE REVIEW

Adaptive learning is a system of learning that customises the structure of learning contents to the desire of the individual learners. Nowadays they system is said to be modelling the learners. This concept has high potential to provide individual learners with the best-personalized learning experiences while studying in a MOOC [8]. *Brusilovsky* applied the concept of an intelligent and adaptivity in a web-based educational application to personalize the experience of distance learning students [9]. However, as pointed out by *Brusilovsky* in 'adaptive and intelligent technology for web-based education', developing an adaptive web-based educational courseware is important due to the high volume of students using the system as compared to any standalone or single educational applications. Clark in an 'adaptive MOOC', explained adaptive MOOC as a personalized learning tailored to every individual student which might provide a solution to the drop-out issues lingering in MOOCs [10,11].

2.1 Learner Modelling

Adaptive learning system stores two basic information related to each registered participant, namely user profile and user model. The user profile stores the personal information of users such as preferences, mode of learning and knowledge of the user. User model on the other hand generate model for each user based on some criteria from the user input profile [12] (as seen in Table 1). *Pazzani et al.,* pointed out that using user history to create a model of the user's preference is a form of learning classification applied as a criteria for adaptivity [13]. Some beginning steps for adaptation was illustrate thus; (i) capturing information about the user, (ii) processing the information to create or update the user model (iii) provide adaptation by using user model. One of the main significance of the user model is the knowledge development within the learning process.

Table 1 User model classification

User Model	
Granularity	**Tasks**
Content-based modelling Collaborative modelling	Classification Filtering Prediction Recommendation

Some presenters noted that difficulty of learner classification is one problem of adaptive learning system. It is not an optimistic assurance that learners will read the recommended learning resources.

2.1.1 User Model & Captured Data

There are two basic types of information captured in the user model, namely domain specific information and domain independent information [14]. Domain specific information varies as the learner studies the learning resources while the domain independent information contains information not dependent on any domain, for instance, learners objectives, method of learning, experience and so on [15]. Typically an adaptive system is classified into two major parts namely server-server and client-server [16]. The server-server function re-create interaction and information captured for example such as preferences, learning techniques and so on, within the system. The aim of the user modelling is to be able to design an adaptive system in MOOC, which receives a user initial knowledge as the implicit input and explicitly recommend learning resources best suited to each individual user. The following section will illustrate some existing approach and suggested approach to adaptive MOOC system.

2.1.2 Online Educational Systems

Online web-based educational systems are not entirely new technologies for online learning. Historically, they are an inheritance of two main systems: intelligent tutoring systems (ITS) and adaptive hypermedia systems [17, 18]. Within the last period of years thousands of web-based educational studies has been made online. Being adaptive is very important in a MOOC content delivery since most students and distance participants usually work from home. The personalized and intelligent supports large population of students receive from a tutor and peers are not normally experience effectively in a MOOC format of learning [17]. Being adaptive, however, will enable efficient supports to students and to further enhance learning reflection than any standalone traditional educational application [17]. Adaptation in this context means the system can make distinction between the appropriate or relevant contents to the learner. As noted by *Vassileva*, incorporating incentive mechanism in online community is sustainable to stimulate user participation [19]. The incentive was introduced based on status of the user to stimulate contribution to resources. Adaptivity was incorporated in the incentive mechanism towards the current needs of the online community and to the individual preferences.

2.2 Adaptive Course Methodology

The development of a course structure generally follows a typical syllabus curriculum authoring process, which provides alignment to learner's goals, learning objectives and techniques for accessing the learning resources [20]. *Dagger et al.,* argued that the curriculum aligned the contents appropriate for the course with the express objectives, goals and assessments. One of the criteria for the adaptivity mentioned was based on the prior knowledge of the learners and the contents to be delivered [20]. The following are most common adaptive methodology applied for online study for long period:

2.2.1 Adaptive Hypermedia

Since the late 1990s many educational adaptive hypermedia systems have been developed and tested. Almost all the systems developed were web-based systems according to [1]. An adaptive hypermedia information retrieval system supports the users in the area of search-driven

browsing. According to *Brusilovsky*, this was done through standard adaptive navigation technology to support and guide learners with relevant links to support the learning goals of the learner within the current page of study [21].

2.2.2 Adaptive Annotation

Adaptive annotation systems enable users to select links relevant to them by attaching visual cues to the links in the current page. Some empirical studies shows that adaptive annotation have demonstrated it can help learners "acquire knowledge" faster, improve the learning outcomes, encourages non-sequential navigation and reduce navigation overhead [22, 23, 24,25]. According to *Weber et al.,* [26], the goal of adaptive annotation of links is to support the students " in hyperspace orientation and navigation by changing the appearance of visible links". *Brusilovsky et al.,* [22] investigate the motivational effect of adaptive link annotation, which was observed to obtain effective results during the study of and engagement with learning resources. "

2.2.3 Adaptive Recommendation System

Adaptive recommendation system builds a link to nodes that cannot be reach directly from the current course page by deducing the user's preferences from browsing activities and the knowledge of users reliability [22, 27].

2.2.4 Adaptive Web Navigation

Adaptive web navigation is the method of personalizing the course contents based on the learners' browsing patterns [28]. *Anderson et al.,* mentioned, although individuals vary according to their patterns of web navigation, and also most web platforms are static, which are created for general one-size usage.

2.2.5 Adaptive Feedback

Sonwalker uses the assessment results to provide intelligent feedback to the learners as a way of encouraging and motivating learning continuity. The idea was to maximize learning performance through motivational concepts using feedback on the learning progress [8].

2.3 Adaptation of Contents to Users: Goals, Preferences, Knowledge & Experience

The idea of an adaptive system is to provide contents to different users based on the individual learning habits. According to *Brusilovsky* [21], the system was to be able to deliver different contents to the same learners at different times according to their chosen preferences, goals, experience and knowledge. *Sonwalkar* pointed out that the course contents were customized to the needs of individual learners to personalize their learning experiences to reach the necessary competency [8]. Existing adaptive hypermedia system uses learners' knowledge as the main subject to represent the most important feature to adapt content to [21]. In curriculum sequencing, the leaner is supported with the most suitable, personalized sequence of knowledge units to learn and also sequence of learning task based on the knowledge to work with, " it helps the student to find an optional path through the learning material [9, 26]. *Andrews* argued that with the frequent changing preferences based on learner's current experiences during the course process [29], contents are adapted to current competency. Some authors however, acclaimed that course contents are prepared and developed to suit students as they "increasingly seeking to use their own technologies to engage in a range of academic activities"[21, 29].

3 PROPOSED ADAPTIVE FRAMEWORK

Adaptive knowledge representation: Knowledge representation is widely known to be one of the most significant components of an adaptive learning system [30]. The knowledge representation domain is comprised of several concepts. Our study focuses on capturing the users' knowledge using concept-based quizzes. The quizzes are structured in such a way that

each question is mapped to a concept. The user's answers provide a concept map allowing an appropriate learning structure to be created for the user as seen in Fig. 1.

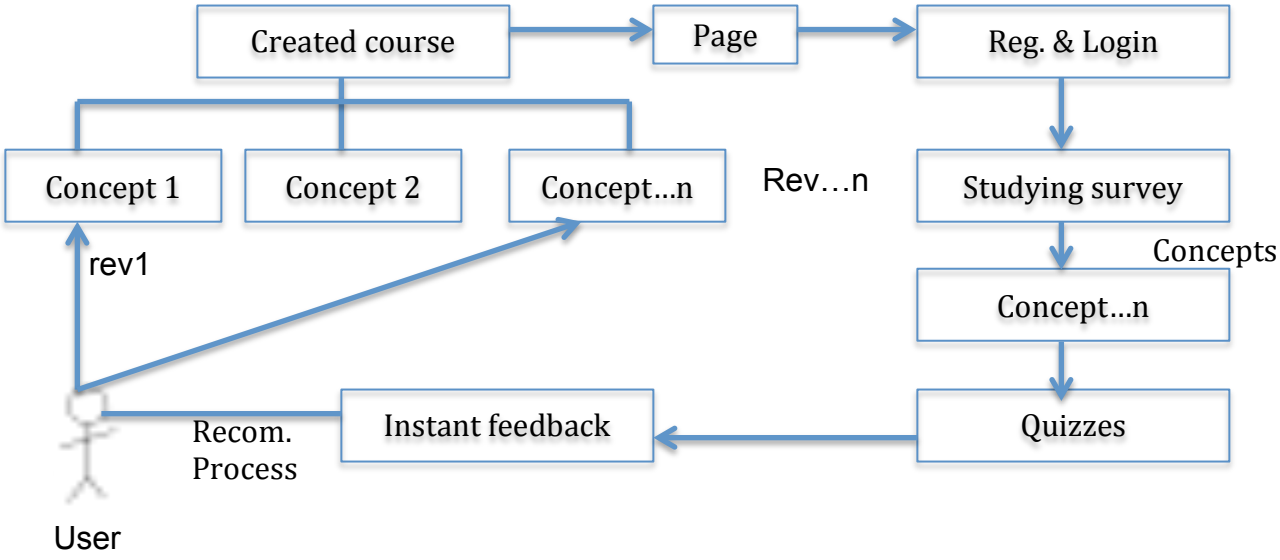

Fig. 1 A proposed learning structure

3.1 Proposed System Workability

As an example, suppose that in the questions related to concept1, the leaner scores 50%. They will receive instant feedback and then may be recommended a revision1 resource for more improvement. But if the user masters the concepts, then no further recommendation is provided, just as in the case of concept 2 in Fig.1. The users also have the freedom to navigate as they wish. The concepts still follows at each topic stage; once a low score is graded in the quizzes, the learners will be given an optional prerequisites to gain more understanding of the current concepts and learning resources.

The focus here is about the learning objective of a learner. The learner object is taking as a survey during the entry registration. After which concepts are provided based on the learning objectives and preferences of the user. These course concepts are retrieved from learning resources (as seen in Table 2). Then the adaptive course structure is then implemented based on the best-recommended learning concepts in the system (seen Fig. 1).

Table 2 Domain knowledge representation

Knowledge		**Concepts**		**Educational Material**
Learning Obj.1	Retrieve concept	Course Concepts A+B+C	Retrieve resources	Learning Resources D+E+F+G
Learning Obj.2	Retrieve concept	Course Concepts A+B+C	Retrieve resources	Learning Resources D+E+F+G
Learning Obj.3	Retrieve concept	Course Concepts A+B+C	Retrieve resources	Learning Resources D+E+F+G

Flow Diagram of Normal MOOC and Adaptive Personalized MOOC Course

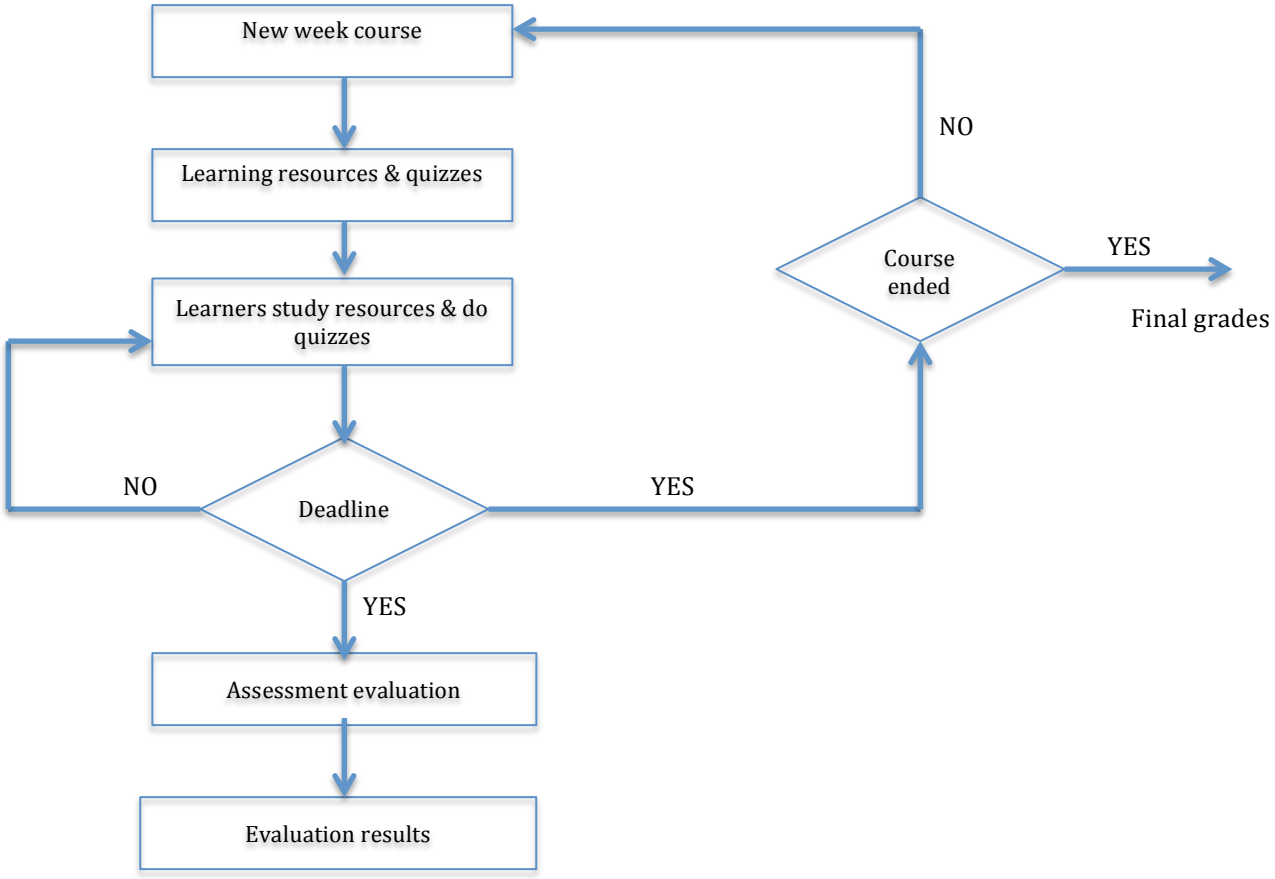

Fig. 2 Normal MOOC system flow diagram

In the normal MOOC system, learners get feedback mostly after the course deadline is over (Fig. 2). This feedback is based on the assignment or assessment evaluated, which can render the usefulness of the feedback at the stage of study void, as most learners must have progress to the next phase.

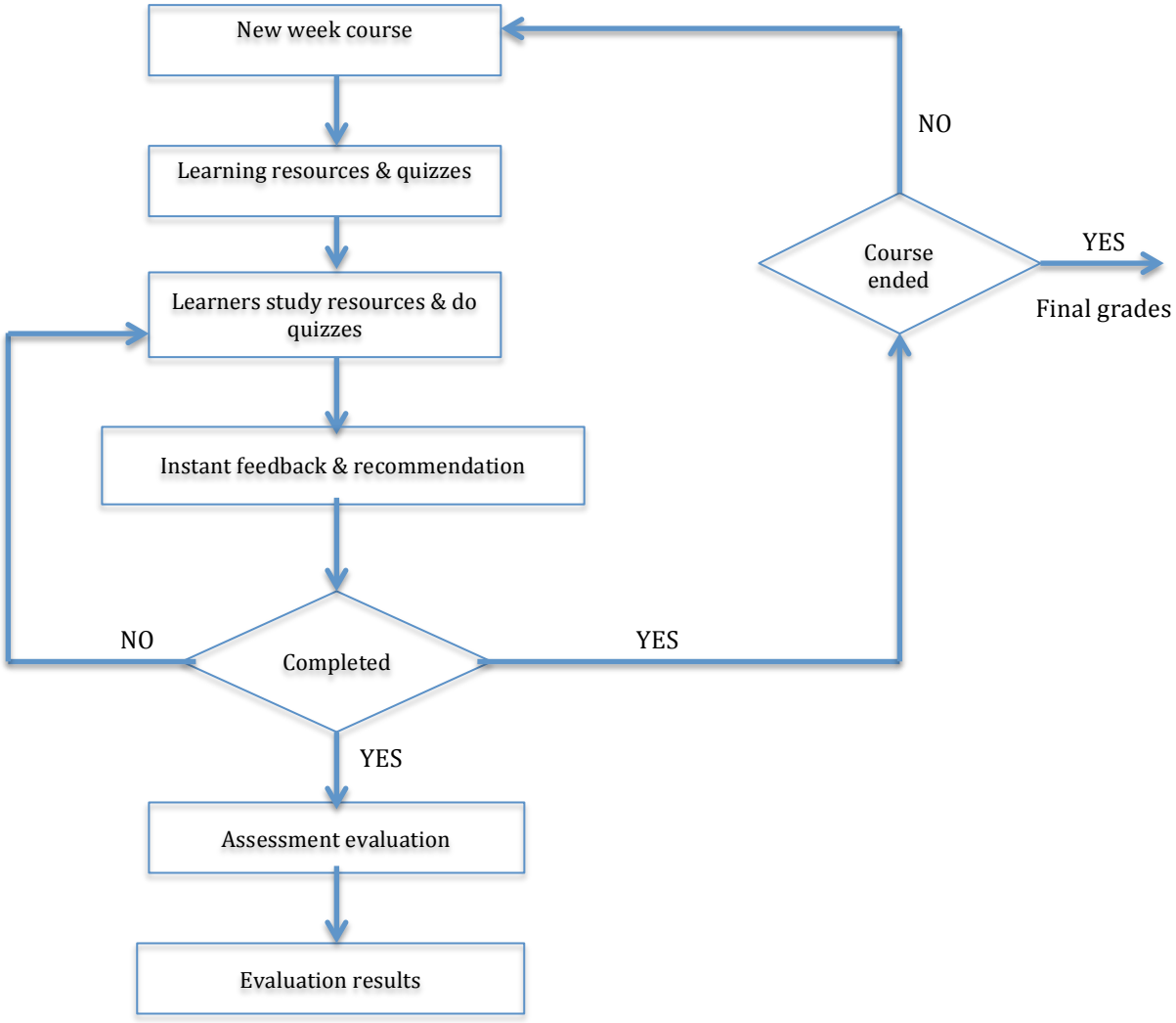

Fig. 3 Proposed adaptive MOOC instant personalized feedback and recommendation system

Here with the implementation of instant personalized feedback during a course assessment, the learner in-turn gain constant results on their progress so far and learning resources recommended based on the instant feedback to support the personalized learning process (as seen in Fig. 3).

Fig. 4 shows the components and structure of the course design and development. The request from the user passes through the web server at the interface to the backend application server that contains some server programming languages, which are connected to the database at the backend. The database receives the request and process the adaptive instructions initiated by the users in the application server languages.

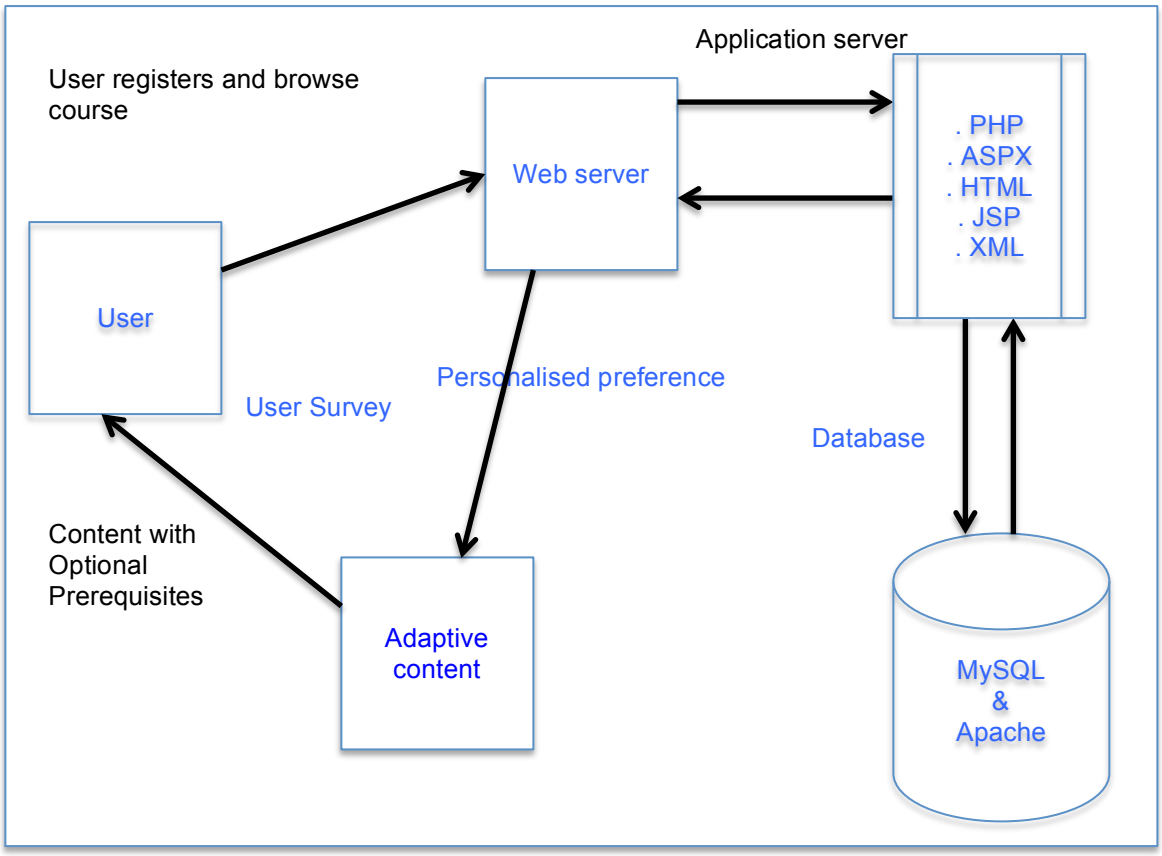

Fig. 4 A proposed structure adaptive learning architecture

4. CONCLUSIONS & FURTHER WORK

This research was developed from existing adaptive methodologies and the various techniques applied to support learners. Although, in some selected literature review, identification of specific state-of-the-art adaptive concepts were addressed. These concepts applied certain unique patterns to addressing the topic about online course adaptivity and it's effectiveness as an innovative technology in education. Our motivation was to be able to address the prevalent issues of high dropout rates within online learning system especially Massive Open Online Courses as discussed in one of our papers [11]. The proposed system design allows additional privileges to learners to navigate and study based on their learning capability. We intend to capture the learning analytics of the participants to observe if the actually adhere to our propose instructional base adaptive course concepts via navigation links or otherwise. Further more, we intend to observe the responses and behaviours of the learners when guided in an adaptive structured manner. Finally, we will compare the two learning patterns; firstly, self-regulated learners following their own choice of learning, and secondly, adaptive sequential, structure learning participants with links support navigation. At the implementation stage of this proposed system design, we intend to conduct a collaborative rating of the course contents to investigate the usefulness of the system to satisfying leaners' preferences.

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