Guideline for Organizing Content in Adaptive Learning System

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Abstract. In the past few years, various adaptive learning systems were developed in response to a widespread desire for all encompassing educational environments. However, these learning systems were developed by educational researchers using various techniques thereby resulting in varying outcomes. This is so because there is no specified guideline that leads to the development of an efficient and effective online adaptive learning system. Therefore, the need to propose guidelines for organizing content in an online adaptive learning system that will cater for all learners regardless of their differences. Several databases and keywords were used to ascertain the lack of guidelines in organizing content in adaptive learning systems. In this study, we propose a content adaptation guidelines for different type of learners in online adaptive learning systems based on Martinez learning style model as employing the same instructional conditions to all students can be pedagogically inefficient. The guideline is developed on the adaptation mapping from information in the student model which is carried out in four stages Organizing content, Individualized content, Adaptive navigation and Control level. These guidelines will help developers as well as educators with basic steps in developing a seamless online adaptive learning system for different type of learners.

Keywords: Guidelines · Learning style · Mapping · Adaptation

1 Introduction

The emergence of the internet and information technology has changed the future of our educational settings leading researchers to develop methods, tools and environments for online based learning [1, 2]. Nowadays, online learning also known as web-based learning plays a huge role in shaping our learning process. It provide students with a high level of user control and rich materials corresponding to their learning needs [3]. Online learning system (OLS) refers to the use of computer network to conduct the process of learning in order to distribute learning course content and material to the learners [4]. Course content and materials are directly accessed by students through the internet without the need to be physically present within the four walls of a classroom. On the side of the teachers or educators, they don't have to spend too much time attending classroom to conduct the class as their burden has been

reduced to guidance and much less supervision. The total benefits of online learning are both classroom and platform independence [5]. It offers flexible access from anywhere, anytime and allows learners to get engaged into the learning environment with little or no guidance from instructors [6]. However, online learning has its own shortcomings. Most of the course content in an OLS was organized in an arbitrary manner. Thus, making it difficult for students to get hold of the salient message that is being transmitted [7]. Based on these concerns, the purpose of this study is to propose adaptation guidelines for organizing content that can be used in adaptive learning systems (ALS) authoring tools to help teachers or educators develop an ALS with less effort accommodating different type of learners. Student's individual differences play a key role in the learning value chain including OLS [8].

Individuals have different cognitive styles that influence how they organize and process information, influencing their learning performance [8, 9]. Research on individual differences has received a sounding devotion and has been identified as the panacea to the problems bedeviling the educational field [10]. To ensure learners are responsible and engaged to their learning process, it is suggested that individual differences of each learner must be taken into consideration when preparing a learning process [11]. Thus, adaptive systems are becoming dominant in the educational settings.

Adaptation refers to making an adjustment towards learning environment in order to meet the requirement of presenting the appropriate learning content that can accommodate different learners based on their needs and preferences [4]. Adaptive learning system (ALS) is considered a new learning medium that employs online instructional strategies and hypermedia techniques [4]. This system has the capability of providing the adaptive lesson to different types of learners considering their individual differences [5]. ALS builds the adaptive learning content based on learners profile in the learner model such as student preferences, interests, goal, knowledge as their attributes that determine learners personalized features which makes them different in learning [12].

2   Theoretical Foundation

2.1   Online Learning System

Online learning has become the new choice that is employed in conducting teaching and learning in an innovative way. Through online learning, learners have direct and flexible access to the resources and information that are available in the learning platform. OLS refers to the use of internet to access learning materials; to interact with the content, instructor, and other learners. There are various terms used to represent online learning and some of which are: e-learning, computer-assisted learning, web-based learning and distance learning [13]. All of this type of online learning applies the same concept in its application where a learner uses some form of technology to access or experience learning. This form of learning has the capability to provide students with easy access to information and resources without the restriction of time and space.

Learning and teaching process can be done anytime and anywhere without overly dependent on the few available teachers or classrooms. Learners are also provided with high level of control and direct access to rich learning material corresponding to their needs, abilities in learning, and learning styles [14].

2.2 Learning Style

Learning style is a concept that followed the research from a cognitive perspective starting in the 1960's [15]. It refers to how learners are different in the way they perceive, accept, think, solve problems and learn [16]. Also, learning styles can be defined as a subset of wide ranges in individual differences that may affect the process of learning [8]. There are many approaches in defining, classifying and identifying learning styles [17]. It can be used as a preferred approach that consistently adapt in developing learners learning experience that may affect their choice in making the learning strategies to achieve their learning goal. Learning styles influence how learners go through the learning process, how teacher should teach them and how the interaction between the two of them should take place [11]. Therefore it is important for educators to determine different pedagogical procedures in approaching learners in their process of learning.

2.3 Adaptive Educational System

Adaptive Educational System (AES) is defined as a new approach in education that can make learning systems more effective by adapting the presentation of information and overall linkage structure to each individual learner preferences [18–20]. Through this assumption, each individual learner has different learning characteristic that make them different in learning and presenting a different educational setting can be more suitable for one type of learner than for others. Any form of instruction accommodating learners' individual needs can be considered adaptive, whether it is delivered face-to-face or in a technology-based format [21]. AES provide mechanisms to individualize instruction of teaching strategies (such as learning content, interface, strategies, and assessment) for learners based on their individual differences [12]. Based on the need to accommodate different types of learners, an AES with the capability to deliver online learning content adaptively to each individual learner were developed. Basically, this system can prevent information overload on the learners, discontinuous flow of learning, cognitive overload and content un-readiness [21].

3 Adaptation Components

The concept of adaptation refers to making an adjustment towards learning environment in order to meet the requirement of presenting an appropriate learning content that can accommodate different learners based on their needs and preferences [4]. There are two important components involved in the process of adaptation and they are Learners model and Adaptation mapping.

3.1   Learners Model

Learners model consist of information about learners which include general profiles, type of learner, knowledge level that are stored in the system's database [22]. In order to present an appropriate course content that fits different types of learners, the information stored in the learners' model is identified and exploited by the system into course organization, course presentation and course navigation in the OLS. There are two main sub-component of the learner model and they are: learner type and knowledge level.

Learner type can be categorized into three derived from Martinez learning style model and they are transforming learner, performing learner and conforming learner. There are also three categories of knowledge level stored in the learner model which are: Learning Goal, Learning concept and Educational Material. They are as shown in Table 1.

Table 1. Categories of Knowledge level

Knowledge Level (KL)	Description	Level of achievement
Learning Goal (LG)	Stored the learners' progress on their achievement of selected learning goal	{Beginner, Advanced, Proficient}
Learning Concept (LC)	Stored the learners' progress on their achievement on the learning concept related to selected learning goal Consist of the KL on learning outcome (LO), Prerequisite (Pr) and related topic (RT) of learning concept	{Beginner, Advanced, Proficient}
Educational Material (EM)	Stored the learners' progress on their level of performance in EM page EM page are organized in three different level of performance: Remember, Use and Find	{Beginner, Advanced, Proficient}

3.2   Adaptation Mapping Process

As one of the two adaptation components, the process of mapping between the learners' model in the system with the adaptation technologies and organizational presentation strategies is carried out in this phase. This process is conducted through four stages: Organizing content, Individualized content, Adaptive navigation and Control level as indicated by [23]. In general, the explanation on each of the four stages is described briefly below together with the adaptation technology and organizational presentation strategy used.

Organizing Content: It is the process of structuring and organizing the course content so that the presentation of domain knowledge is adapted with learners' knowledge level in the learner model. Use curriculum sequencing and adaptive navigation support as adaptation technologies and Elaboration theory (ET) together with Component Display Theory (CDT) to organize the presentation of course content.

Individualized Content: It is the process of matching the presentation of course content so that the presentation of education material knowledge modules in domain knowledge adapt with the type of learner based on their learning style (transforming, performing, conforming) that are stored in the learner model. Use CDT to match the adaptive presentation of course content by using adaptive presentation technology.

Adaptive Navigation: It is the process of allowing learners to find the optimal learning path i.e. next node to be learned.

Control Level: The process of allowing learner to tailor the system to their preferences and adapt it to their needs that change over time. The control level supports learner into several levels of adaptation.

Figure 1 shows the adaptation process which leads to the adaptation mapping on the on the right side of the figure.

Figure 1 indicates that the mapping process that is implemented when the learners' information were obtained from the learner's model which will eventually be mapped with certain adaptation technologies leading to personalized learning.
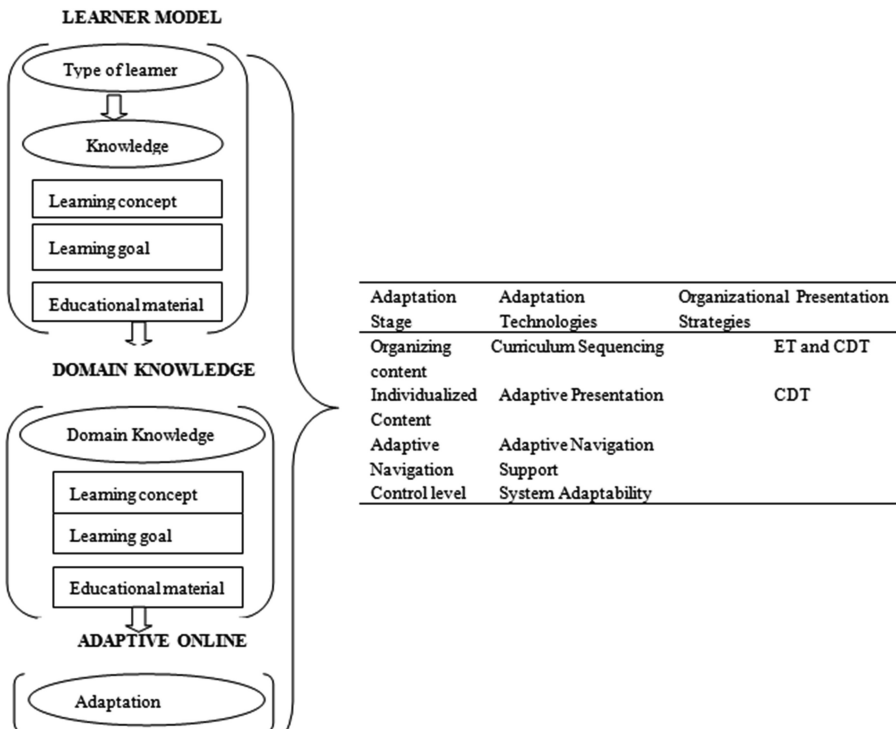

LEARNER MODEL

Adaptation Stage	Adaptation Technologies	Organizational Presentation Strategies
Organizing content	Curriculum Sequencing	ET and CDT
Individualized Content	Adaptive Presentation	CDT
Adaptive Navigation	Adaptive Navigation Support	
Control level	System Adaptability	

Fig. 1. Adaptation process

4 Adaptation Guidelines for Different Types of Learners in Adaptive Online Learning System

The proposed adaptation guidelines for different type of learners in online adaptive learning system designed in this study follows the adaptation process. It is built to show the sequence flow of adaptive presentation on different type of learners based on their learning style. These guidelines are significant in providing learners with the appropriate learning system that will suit their differences in the learning process. It would be used by content developers and educators in designing a befitting adaptive OLS content that suit the various types of learners. The guidelines consist of planning an adaptive OLS that specify learners needs and preferences based on their characteristics in the learners model into the development of the course content, adaptive presentation of course content and adaptive navigation.

4.1 Guideline for Organizing Content

The guidelines for organizing content depict the appropriate method to organize domain knowledge of learning concept outcome, educational material for a specific learning goal depending on the learners' knowledge level. Given the level of the learner, the adaptive system develops a pattern on how the content of the domain knowledge will be presented and subsequently altered as the learning progresses. The system adapts and map content according to the guideline in Table 2. As can be seen from Table 2, the knowledge level goes from beginner, advance, and proficient. Depending on the knowledge level, the learner is placed on a certain layer of the learning outcome concept, after which educational materials are prepared according to either the remember level, use level or the find level.

Table 2. Guidelines for organizing content

Knowledge level		Learning outcome concept	Educational material page	Curriculum sequencing
LC	EM			
Beginner	Beginner	Layer 1	Remember	Present the outcome concept of layer 1 and entire set of prerequisite concept and related topic Present EM of Remember level of performance for the outcome concept
Beginner	Advance	Layer 1	Remember, Use	Present the outcome concept of layer 1 and entire set of prerequisite concept and related topic Present EM of Remember and Use level of performance for the outcome concept

Table 2. (*continued*)

| Knowledge level | | Learning outcome concept | Educational material page | Curriculum sequencing |
LC	EM			
Beginner	Proficient	Layer 1	Remember, Use, Find	Present the outcome concept of layer 1 and entire set of prerequisite concept and related topic Present EM of Remember, Use and Find level knowledge modules of performance for the outcome concept
Advance	Beginner	Layer 1, Layer 2	Remember	Present the outcome concept of both layer 1 and 2 together with the entire set of prerequisite concept and related topic Present EM of Remember level knowledge modules of performance for the outcome concept
Advance	Advance	Layer 1, Layer 2	Remember, Use	Presented the outcome concept of both layer 1 and 2 together with the entire set of prerequisite concept and related topic Present EM of Remember and Use level of performance for the outcome concept
Advance	Proficient	Layer 1, Layer 2	Remember, Use, Find	Present the outcome concept of both layer 1 and 2 together with the entire set of prerequisite concept and related topic Present EM of Remember, Use and Find level knowledge modules of performance for the outcome concept
Proficient	Beginner	Layer 1, Layer 2, Layer 3	Remember	Present the outcome concept of both layer 1, 2 and 3 together with the entire set of prerequisite concept and related topic Present EM of Remember level of performance for the outcome concept
Proficient	Advance	Layer 1, Layer 2, Layer 3	Remember, Use	Present the outcome concept of both layer 1, 2 and 3 together with the entire set of prerequisite concept and related topic Present EM of Remember and Use level knowledge modules of performance for the outcome concept
Proficient	Proficient	Layer 1, Layer 2, Layer 3	Remember, Use, Find	Present the outcome concept of both layer 1, 2 and 3 together with the entire set of prerequisite concept and related topic Present EM of Remember, Use and Find level knowledge modules of performance for the outcome concept

5   Discussion

This study develops a guideline for developing an adaptive learning system based on Martinez learning style model. The model guides the researchers in taking care of the different styles of learning among students. This is very important as there is no one size fits all in the learning domain [5]. Therefore, the development of adaptive learning systems can now be done in an effective and efficient way as it is made to be student centered. This will also give students the confidence and encouragement to utilize this system no matter the learning style.

6   Conclusions

The call for adaptive learning system by the educational research community has been widely disseminated for several years. And rightly so, researchers have given their much precious time and resources in developing systems that caters for all learners taking their individual differences into consideration in what is termed personalization. However, these researchers employ different approaches and techniques in developing the content of these systems resulting in varying outcomes. This shed light to the need for guidelines that will lead the way for the development of an effective and efficient content for adaptive learning systems. In this paper, we proposed adaption guidelines for organizing content which take individual learning styles into consideration. The proposed content organization guideline can be used as a basic guideline for the development of content for online adaptive learning system. Therefore we conclude that, the proposed guidelines will result in the development of online adaptive systems that will motivate and also improve learner satisfaction. Additionally, in the future, we hope to develop a prototype system to validate the guidelines and also propose other guidelines for the various stages of the adaptation process.

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