A review of paradigm shift from Conventional to Personalized e-learning

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Abstract—E-learning is a continuously evolving and rapidly progressing interdisciplinary field, which explores use of ICT in education to impart knowledge effectively by improving learner’s experience. Most of the researchers are exploring the concept of Adaptive Educational Hypermedia Systems (AEHS) to attain personalization especially in distance mode of e-learning. Researchers have experimented with different aspects of personalization that demonstrate a paradigm shift from synchronous approach to an adaptive approach of e-learning.

In this paper we propose taxonomy of e-learning. Models of teaching-learning process and learning approaches are also discussed in this paper. We reviewed several methodologies used in adaptive/personalized e-learning and in conclusion presented our view of personalized e-learning.

Index Terms—Technology enabled Teaching-Learning process, e-learning, Learning Style, Cognitive traits, behavioral model, learning environment,

I. INTRODUCTION

Technology enabled Teaching-Learning (TL) process has transformed the conventional way of imparting education. The transformation helped to overcome the barriers of distance, language, rigidity, lack of personalization etc. This multifold transformation in TL process using several electronic tools and appropriate methodologies is broadly referred as e-learning. Several experts in education field, educational psychologist and computer researchers are working on various aspects of imparting education (instruction design, instruction delivery, interaction in distance learning etc.) and proposed effective solutions to improve learners’ experience.

E-learning has evolved from Computer Aided Teaching, Computer Aided Learning or CD based training to personalized instruction delivery, adaptive learning phase. Researchers have proposed to incorporate technology at every minute level of TL process. Furthermore behavioral and cognitive aspects are also used to ensure effective e-learning. Technology enabled learning can be traced back to 1960’s when students of University of Illinois reported to access course information through computer terminal in class while listening lecture [1]. In mid 90’s Schacter et al. [2] compiled survey findings of seven research groups that studied the impact of educational technology on student achievements. All the research groups reported positive gains in achievements due to the use of technology in education. It was also identified that students learnt more in less time when they used technology while learning.

Today there is a complete paradigm shift from technology enabled single terminal group learning to e-learning based personalized self learning system. Mulwa et al. [3] discussed about Technology Enhanced Learning (TEL) with specific reference to Adaptive Educational Hypermedia System (AEHS). Adaptivity can be achieved by personalization in AEHS by measuring Learning Style (LS) of ev-
ery learner. Authors discussed various models of Learning Styles and emphasized the importance of incorporating LS in various AEHS. Authors claimed that such blending of educational psychology and technology helped to increase efficiency in learning experience and achieved better learning outcomes. In this paper, we highlight the transformation in e-learning with respect to learning approach. We categories research work in e-learning using Teaching Learning mode and learning approach aspects. Furthermore, we present an extensive review of several research experiments and models that focus on adaptive learning. The objectives of this paper are, 1. To propose a taxonomy of e-learning particularly for distance mode scenario and 2. To review existing research literature of e-learning pertaining to personalization/adaptive approach. In taxonomy, various aspects of e-learning are grouped hierarchically. Teaching-Learning mode related distinct aspects are grouped at first level while distinct Learning Approaches are at second level of the taxonomy as shown in figure 1.

The rest of the paper is organized as follows. Section 2 describes Teaching-Learning modes. Section 3 discusses in detail about Learning Approaches followed by discussion and review of Personalized e-learning in section. Paper ends with conclusion in section 5.

II. Teaching Learning (TL) modes

E-learning is a TEL. Incorporating technology to facilitate students in their learning experience is a key feature of e-learning. Technology has overcome the barrier of location and let knowledge be disseminated to students who are learning from remote places. Hence, we can see use of technology in Face-to-Face (classroom) teaching as well as technology enables students to learn with or without teacher in geographically wide spread area i.e. Distance mode.

A. Face-to-Face mode

Classroom teaching is mostly teacher centric. The tools of e-learning support teacher to teach effectively. In this process, knowledge transfers from one teacher to many students. Students do not have any active role in this TL process. This mode of e-learning is time dependent as well as location dependent. One of the example of this mode of e-learning is Computer Aided Teaching where teacher uses e-learning tools to describe subject effectively.

B. Distance mode

To overcome the barrier of location as well as time dependency, distance mode of e-learning has been introduced. Several researchers observed the effectiveness of distance mode approach and reported positive indications on students’ learning outcome. The research by Larson et al. [4] claimed to obtain positive feedback from students in distance mode of e-learning on learning satisfaction and learning effectiveness parameters. Students can learn from any where and need not be present in classroom physically. There are several examples of this mode viz. Virtual classroom, LMS based course, open learning.

III. Learning Approaches

In Teaching Learning process learning by learner is the key issue. In what way contents get delivered to learner ? How teacher interacts with students?
Which factors affect on learner’s understanding ability? The answers of these questions lead us to the concept of Learning Approach. There are three types of Learning Approaches as shown in figure 1. Following subsections briefly describe each of these types.

A. Synchronous (Instructor-led) Learning

In traditional learning environment teacher must be available in classroom to teach students. E-learning enables teacher to teach in virtual classroom environment. In this approach of learning both teachers as well as students use various e-learning tools. These tools facilitate a teacher to teach students who are not physically present in front of him/her. "Train 1000 teacher" [5] programme initiated by Indian Institute of Technology Bombay (IITB), Mumbai, is one of the best examples of Synchronous Learning. Thousands of teachers distributed at geographically wide spread remote centers all over India logs in at a prespecified time to form virtual classroom. A resource person present at IITB teaches using virtual classroom tool "A-VIEW" [6] in synchronization with all remote centers. Several other e-learning tools viz. elluminate, electa are also available. Distance is not a barrier any more because of this process of knowledge transfer. This is a location independent e-learning approach.

B. Asynchronous (self) Learning

E-learning is continuously evolving to overcome the barriers of both traditional learning as well as distance mode learning. In synchronized learning both teachers and students need to synchronize the time although location may vary. Time dependent learning is a major limitation in synchronous TL process.

Asynchronous (self) learning overcomes the constraint of location as well as time synchronization for learning. This approach is based on Any Where, Any Time analogy. This is a complete paradigm shift from teacher controlled (Synchronous) to student controlled (Asynchronous) learning approach. Several web based learning as well as online learning tools are available for students. Khan Academy [7] is an example of asynchronous e-learning. In this web based learning approach students learn using learning contents in the form of videos, presentations and animated lessons. They interact with system by attempting quizzes, solving problems and simulating various experiments.

C. Adaptive (personalized) Learning

Although asynchronous learning approach allows students to learn any where and that too any time; it does not support personalized learning. Educational psychology proclaims that every student have his/her own way of learning called learning style (LS).

The idea of individualized learning has been supported in Adaptive learning approach. Adaptivity techniques facilitate learners to learn with customized learning contents. Delivery of learning content is based on Learner Model, which is derived from learner’s profile, background knowledge, Learning style and many other parameters. "Auto-Tutor" [8] was the first such type of system which adapted personalized approach.

In the next section we review various experimental models proposed and implemented for adaptive learning.

IV. PERSONALIZED E-LEARNING

Personalized learning not only addresses the issue of location and time-dependent learning, but also offers customized learning environment to deliver contents. Customized learning environment adapts learner’s way of understanding, cognitive ability, learner’s path in learning environment. Sampson et al. [9] reviewed the trends of shift towards personalization from different perspectives including educational, technological and standardization aspects. Authors concluded that personalization in e-learning meet the demand of just-in-time learning, learning-on-demand environment and life-long learning situation.

Adapting personalization to facilitate customized learning environment is a two phase process. As shown in figure 1 the first phase is to determine learner model for personalization. In this phase manual, semi-automatic and fully automatic techniques are employed to determine most suitable
learning model of a learner. Consequently, the second phase deals with personalized delivery. Every individual learner model is different than other and hence learners must be provided contents according to their learning model.

Following subsections elaborate in detail about several aspects of these two phases and reviews work done by various researchers in this area.

A. Determination of Learner Model

In personalized e-learning scenario, every learner learns at different place and at different time. Every learner has different characteristics, needs, abilities, prior knowledge and learning Style. Learner model captures these differences and facilitate personalized learning experience.

Learning Style is one of the major parameters used in determining learner model. Graf et al. [10] discussed incorporation of LS in learner model. Authors studied Felder-Silverman Learning Style Model (FSLSM). An experimental study of 207 students was conducted using Index of Learning Style (ILS) questionnaire. Linear discrimination Analysis was used to analyze data. The results were conclusive and indicated that incorporation of LS in determination of learner model was very useful.


Many other researchers described various methodologies for determination of learner model. Sonamthiang et al. [15] proposed domain independent N-gram analysis model to discover hierarchical patterns of students learning behavior. Their model has three stages. At preprocess stage unrelated attributes of data collected from logs were removed and remaining relevant attributes are categorized in different sets based on level of granularity. In second stage, N-gram based algorithm along with background knowledge is applied to obtain regular or irregular behavior patterns. Finally authors used Rough set based map granule algorithm to cluster students behavior model.

Bousbia et al. [16] proposed an automatic learning style detection approach by analyzing tracks of learner abilities. The classification model used so called learning indicators, observed learner hypermedia interaction to deduce learning style. The attribute values are categorized in educational preference layer, learning process layer and cognitive ability layer.

Joshi et al. [17] used clustering techniques to group students according to their behavioral pattern of accessing study material. Researcher gathered data of 176 students using ILS questionnaire. The analysis of the data showed pattern of overlapping Learning Style. Further researcher tested Rough K-means algorithm on the web logs of students of Saint Mary University to determine LS automatically.

After analysis and careful evaluation of all the criticism about various LS models, Popescu et al. [18] derived a new LS model. They proposed Uniform Learning Style Model (ULSM) that consists of 9 dimensions. This model was adapted in WELSA [19] to determine learner model.

B. Learner model driven Delivery

Learning environment encompasses whole range of components and activities within which learning happens. It integrates learning content, evaluation, feedback and log of learner’s navigation. Learning Object (LO) is the smallest unit of learning content. Learning Object Metadata (LOM) stores all the characteristics of LO, which can be used for proper selection of LOs. Several LOMs are available viz. IEEE standard [20], DublinCore [21], CanCore [22]. Learning Object Repository (LOR) is a digital library of LOs where various types of LOs can be stored and retrieved as per learners requirements.

The main challenge in personalized learning is the selection and delivery of learning content based on learner model. This is achieved either using a Learning Management System or with the help of a customized learning environment. To achieve personalization for every learner, learning environment either generates different course views for different learners (course level personalization) or fetches appropriate LOs suitable to learner model and delivers it as course. In this way personalization can be attained at two levels 1. Course Level and
2. Learning Object Level. Following subsections describe research work in these types of personalization of learning.

1) Course Level: Personalized learning contents help learner to understand better. Learners with different learner models demand different learning contents. Researchers working on personalized learning systems suggested different structured learning contents in the form of course views. Different course views are mapped to different learner models. Papanikolaou et al. [23] advocates for adaptive educational systems and evaluated the effectiveness of learner style and preference based content delivery. Authors experimented with two learning environments namely flexi-OLM and INSPIRE systems, which are based on Felder-Silverman Learning Style and Honey-Mumford Learning Style model respectively. Authors analyzed how students with different learning style interact with content that are organized in seven different Learning Style dependent course views. Effectiveness of content understanding was also derived and accordingly observations were put forth. Conclusions derived from analysis suggested that their learning style help in designing learning environment as well as individual differences can be accommodated in the learning environment. Graf et al. [11] introduced an adaptive system that uses learning style as principle component of learner model. Authors suggested automatic, dynamic and global student modeling. The concept of proposed adaptive mechanism offered different course structures based on learner model. LMS was used to deliver course structure. Further, authors summarized that the aim of the adaptive mechanism was to provide easy learning to every learner.

2) Learning Object Level: In course level content delivery, courses are generated and delivered based on learner models. Personalization is at course level. But personalization can be extended upto a level of LO. In course level, the focus is on delivery of one of the course views according to learner model. However, LOs can also be developed to match with learner model. For a single topic distinct LOs are selected and delivered dynamically in accordance with learner model. Learning Object level delivery facilitates learner model driven LOs selection and delivery mechanism. Some researchers partly implemented this idea. Unified Learning Style Model suggested by Popecus et al. [19] was implemented in WELSA (Web-based Educational system with Learning Style Adaptation). In this system LOs were selected based on of ULSM and presented in the form of web page. An experimental study of 65 students in AI course is reported [24]. The result of their experiment showed that the use of LS in learning system (WELSA) helped students to understand concepts effectively. It also proved the practical ability of WELSA from student and teacher perspective. Grigoriadou et al. [25] proposed an adaptive educational hypermedia system named INSPIRE. This system dynamically generates lessons by continuously monitoring interactions of students with it to accomplish the desired learning outcome. The system has five modules namely Interaction Monitoring module, Learner’s Diagnostic module, Lesson Generation module, Presentation module and Data Storage. Learner model was built by using learner information, LS, knowledge level and learners interaction log. Lesson was generated based on knowledge level and LS of the learner. Lesson then presented to a learner by the presentation module and further refined according to learner feedback after gradual interaction with the system. Author stated that students feedback was encouraging and concluded that INSPIRE is an adaptive system. iWeaver was an adaptive educational hypermedia system suggested by Wolf [26]. The architecture of this system is mostly similar to INSPIRE [25]. In iWeaver, learner model was designed solely based on Dunn-Dunn LS model. Based on learner model, content representation model generates course page. The generated course page has two types of contents namely Media experience and Learning tool. Navigation through media experiences page and learning tools page was stored as learner data in each learner’s session. The feedback about subjective effectiveness of learning content and overall impression was taken for further analysis. Author summarized about media experience and learning.
tools and further claimed its usefulness in adaptive approach. Wang et al. [27] suggested a web based tutoring system CooTutor. The system was specially designed to address understanding difficulty in spatial geometric transformation domain. Learner model in CooTutor was designed by considering learner’s spatial ability, learning style and learning traits. Adaptivity of the system consist of concept sequencing and material selection, which present learning material to learners. Empirical evaluation of CooTutor found that it was beneficial for student to learn specific domain contents.

V. CONCLUSION

Today, learning experience is increased with technology enhanced learning environment. Paradigm shift to personalized e-learning plays important role in enhanced and effective learning experiences. In this paper we proposed taxonomy of e-learning. With reference to the taxonomy, we stated teaching learning models and learning approach. Personalized e-learning was also explained at course level and learning object level. We conclude that many researchers have used adaptivity of learner model in learning content selection and delivery has been at course level. Very few researchers have partially implemented LO level personalization. Future work include study and analysis of integrated approach of LS dimension and its application in determination of learner model. LO level personalization needs to be fully implemented and result to be investigated.

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