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Modeling Personalized E-Learning for Effective Distance Education

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Abstract: ***Worldwide Education Reform raises the importance of Information and Communication Technology (ICT) in Education recently. With the abundance of potential learning resources available on the Web and the pervasive access of the Internet, Web-based learning is becoming a main-stream approach and a major channel for the delivery of teaching and learning materials. One major question in web-based learning is how to harness emerging technologies to provide a learning environment that addresses individual differences in the learning process. "Personalization" is an emerging technology for serving the information needs of different users in a different way according to their individual needs. As a means to cater to individual learning needs, this paper proposes the notion of Personalized Education through the Web. Personalization in education can potentially facilitate students to learn better by incorporating different strategies to create a diversity of learning experiences, and also cater to the teacher's teaching needs in preparing and designing teaching and instructional packages. From past experience, using the technologies without regarding pedagogical concepts frequently leads to failure. A clear understanding about what is personalization, how the technology can be applied effectively to enhance or facilitate the education development, and how to fully utilize the potential value of the available resources is a much needed area for research. To address this open problem, this paper concretizes the notion of Personalized Education (PE) from pedagogical underpinning, conceptual development, system architectural design to the design and implementation of a conceptual framework of Personalized Education.***

Keywords: web personalization, e-learning, collaborative filtering, user profiling, rule based filtering

I. INTRODUCTION

Education, human-learning, is fathomless. The advent of pervasive computing environment offers great flexibility for supporting various aspects of personal development. Personalization Technology (PT) is a fast emerging technology on the web recently which seems to be useful from the view of development an information-literate person with the necessary multi-disciplinary skills to cater for expected life-long learning. The idea of "Personalized Education" (PE) emphasizes not only on facilitating learners to learn better via incorporating different strategies to create various learning experiences but also considering teachers' teaching needs in preparing, designing, managing varied teaching, instructional packages. More importantly, PE stresses individual differences with personal traits. PE is an environment which offers an alternative solution for learners to learn in the most motivated scenario via anticipating personal interests and characteristics. In this paper, we have realized and evaluated: i) the feasibility of using personalization technologies in education (ii) its roles in education relations with teaching and learning; and iii) its duties responsibilities to improve the quality of education that we are already keep working for thousands of years. Our study stresses the design and development of new conceptual framework based on the newly induced PT models to support Personalized Education on the Web, encourage knowledge sharing, information delivery more importantly, to build a natural learning /environment for multiple learning experiences.

A. Education Reform and IT in Education: The Motivation

Education reform is a plan, program, or movement which attempts to bring about a change in educational theory or practice. Typically, 'education reform' refers to a broad plan of systematic change across a community or society. With the advent of computer and information technologies which has inevitably penetrated into our daily life and our learning process, education and the process of delivering it are undergoing fundamental changes. More and more learning processes are making use of computers as tools for delivering learning materials and supporting different learning activities. Globalization and development of the knowledge-based society have brought many opportunities as well as challenges to the design and development of education

IT can potentially provide ample assistance in accomplishing numerous reform goals. Properly designed software offers students the opportunity and facilitates individualized learning such that students can learn in their own paces with regard to their different progressions. Technologies can lessen teachers' workload and empower teachers with the capacity of better monitoring and supporting individual learning progress through appropriate computing environments. Teaching professions are facing daily challenges not only in using innovative technologies, for example, in learning to use different software tools to design, produce and

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deliver instructional materials, but more challenging tasks are the need and expectation of tightly integrating IT to teach in ways that can fulfill diverse learners' needs. The integration of IT into the curriculum clearly takes many forms, ranging from the development of interactive multimedia courseware, reading and writing capabilities program to the senior capstone work involving complicated research projects. Technology in education starts with the behaviorism (Computer-based/aided Learning CBL/CAL) mainly because of the beliefs about the reinforcement of stimulus-response associations and the development of drill-and-practice programs that accomplished the task of rote learning for remedial learners who needed more practices. In responses to the cognitive/instructive, computer-based tutorials (e.g. Computer-assisted Instruction CAI, Programmed Instructions) sought to respond to individual differences in learning by providing remedial instruction when learners' responses were incorrect. With computerized tutorials, students are not encouraged or able to determine what is important, what they are interested in, to reflect on and assess what they know, or to construct any personal meaning for what they have studied. Through the application AI techniques, the intelligent tutoring system (ITS)[1,2] demonstrated an answer to the constructivist to teach problem solving and procedural knowledge in a variety of domains. The goal in most of these works is to move towards and to encourage higher levels of student participation in the learning process and to move away from the pure skills or passive student behaviors. New technologies provide tools with the potential to reconstruct education [3], and used effectively, new technologies result in positive changes to the way teachers teach and the way learners perceive information [4]. As e-learning systems have become popular tools for teaching and learning, the requirements of these systems are not limited to solely providing digitalized learning resources for the teachers and students. IT can be a tool, a channel, or an assistance that expands and overcomes the limitation of time and space in conventional classroom teaching and learning. Today, the world of information is at our fingertips, we can collect a huge amount of data in a few seconds. The IT pace is developed in unbelievably fast speed that we would easily lose our direction or focus in browsing/searching and have difficulties in drawing conclusions. Advanced IT education platform enables teachers and students to shift one's own paradigm more easily and effectively. Hence, the teaching and learning processes that go hand-in-hand with a web-based learning platform are critical and deserve special attention. Teaching as a profession requires profound knowledge and skills which IT would never substitute.

B. Web-Based Education Systems: The Evolution

Computer technology has made a substantial contribution in teaching and learning to Education during the past two decades. Recently, Internet technology is becoming pervasive in our daily life, and this gradually leads to a paradigm shift from the physical classroom to the virtual space – Web-based learning. The process of learning in the cyber space is more complex than conventional class learning for many reasons. From the educational views, the educational philosophy and psychologists interested in the influences of technologies used in human's beliefs, knowledge and learning [5,6] The learning environment research focused on the changes of traditional classroom settings to computer-based learning or more advanced web-based learning issues/impacts [7] On the other hand, from the scientific and technological point of views, user modeling techniques represent a well understanding about different types of users [8].Various mining techniques support in-depth knowledge construction and tailor information discovery [9,10,11]. Artificial Intelligence techniques have been proven useful in many research areas especially in handling huge amount of data as well as information [12].Learning theories and technologies for designing web-based learning environment are widely studied. Many advanced e-learning systems, such as Web CT, , Click2learn, Cyber University of NSYSU and Web-based virtual online classroom (WVOC), are being used to deliver various kinds of learning materials in different (multimedia) formats (i.e. text, audio and video), as well as to provide functionality for e-mail, conferencing, forums, quizzes and assignments Most existing Course Management System (CMS) provides similar tools of enabling communication through the Internet between the instructor and the learner. Common features include providing navigation tool telling student the lesson schedule, keeping track of students and their records, managing data security, providing assessments to learners and allowing instructors to upload and organize material and create discussions. To explain student intention of using an e-learning system as a supplementary learning tool within a traditional class or a stand-alone distance education method, [13] highlights specific system factors that purport to promote system use. These include *functionality*, *interactivity* and *respond time*. These system characteristics not only influence the belief factors but also directly impact upon student use. With regard to the different learning mode, e-learning systems are increasingly better developed and being used in the past decade, what are still not widely developed and available are pedagogically driven e-learning systems that take advantages of new technologies to search, generate and deliver meaningful learning materials and tasks, provide learning guidance for self-regulated learning in a web-based education environment. One such technology that has been rapidly developed in recent year as a result of the pervasive deployment of Internet and the Web for E-commerce is Personalization technologies.

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II. TOWARDS PERSONALIZED LEARNING

"Personalization Technologies for Personalized Education through the Web". Currently, the majority of the e-learning courses are organized in much the same manner as the original classroom settings. E-learning must not be reduced to the use of new technologies to serve old learning modes or habits (i.e. only transformed the traditional materials into digital form and used it in normal practices). E-learning should lead to new forms of teaching and learning (i.e. E-Educational Philosophies) that take into considerations of:

1) The rapidly changing participation roles of the curriculum developers, teachers and students;
2) The diversified education needs for students with different abilities and interests;
3) The diversifying needs of different teaching/learning styles and preferences; and finally
4) The organization, search, sequencing and delivery of vast amount of authentic/qualified education content or resources available in the Web.

E-learning is regarding learning, not IT. The ideas of using IT to facilitate/enhance teaching and learning stress the importance of good communication (ICT). ICT implies the use of technologies to communicate, an interactive process between humans. In education, the effective communication does not equal to effective presentation of knowledge, it is more about effectively guiding the learners to developing self-learning capability in a discipline. Currently, most of the web-based learning systems are developed in high-level "classic" closed corpus settings, typically with an internal database (or schema) of content, for tertiary education or adult learning, this paper aims to study a framework of Personalized Education The concept of Personalization in education encompasses the ability to intelligently *search for, compile and sequence* learning materials directly from the Web to meet the teaching needs of a teacher, e.g. to compile a package of courseware for a particular group of students; or to meet the learning needs of a student, e.g. to deliver materials for students according to their current learning objectives. Through such a system, anyone can get the information when s/he needs and adjusts the progress according to one's own competence.

III. PERSONALIZATION ON THE WEB

With the diversity and the abundance of information that can potentially be accessed via the Web, "Personalization Technology" (PT) as a fast enabling technology for serving the information needs of different users in a different way according to their individual needs and profiles captures enterprises interest/attention. Enterprises tend to make profit by providing/adding personalization services to their customers on the web. Amazon is a well-known example; it provides personalized features such as making suggestions based on users' transaction and historical records. The idea of personalization can be summarized into three main themes: "*Building a meaningful one-to-one relationship* – [14]", "*Delivering appropriate content and services to fulfill user's needs* [16]", and "*Understanding where and when to suggest the 'right' things*[17]". The ultimate goal of personalization is "User satisfaction". User satisfaction means getting the right thing at the right time in the right place. And more importantly, it should be "just enough" and "just in time". Typically, a personalized web site *recognizes* its users, *collects* information about their preferences and *adapts* its services. In order to match the users' needs, PT improves the web experience of a user by presenting the information that the user wants to see in an appropriate manner and at the appropriate time. PT additionally provides mechanisms to learn more about user's needs, identify future trends and eventually increase/motivate the user to stay or revisit the website. Personalization policy governed the sets of behavior delivered to the final user.

Personalization therefore is rooted in the field of E-commerce and has gone through different development stages. Initially, personalization was used to keep the visitor on the site, exploring more of the site, which provided opportunities to advertise and promote products. The next stage of development attempted to increase how much money a visitor spent at each visit by offering more expensive or related products. Today, personalization is increasingly used as a means to expedite the delivery of information to a visitor, making the site useful and attractive to return to.

There is a growing interest in providing automated personalization processes on Web sites. The reason why so many organizations are now investing in personalization simply because users' experiences with a personalized web site are ultimately more satisfying Personalization becomes an incredulity feature of on-line services that has manifested in different ways and contexts, harnessing a series of developing technologies [15] propose a general architecture for automatic Web personalization by tracking the user's interest from the Web server logs.. Barrett et al. [18] describe the WBI Web Browser Intelligence architecture for personalizing web sites. The previous two approaches rely on a server for the personalization process, but the WBI architecture can be used on the client side, mid-stream or server side. Monica Bonett [16] provides an overview of personalization on the Web and discusses ideas for the development within discovery systems.

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IV. PERSONALIZATION NEEDS IN EDUCATION

Personalization is the process of creating tailor made content satisfying implicit and explicit need. Even long before the age of students Computer and the Internet, Personalization in education has been well recognized the need of students since ancient times, ancient saying that states that "Teach according to the Ability". Considering individual differences, individual instruction and individual learning are the key aspects that have been continuously emphasized in education. Personal tutoring is one way towards personalization in learning, however, to achieve this aim manually and without the help of technology for a large population of learners is a very costly and time-consuming task which few Governments can afford.

Using IT, such as an *Intelligent Tutoring System* (ITS), to help understand as well as diagnose learners' difficulties or subject domain misconceptions and the development of different user modeling techniques can be viewed as early examples of features in e-learning systems that address individual needs. In more recent years, an emerging field of research towards the direction of personal adaptativity in content selection or presentation has evolved – the "*Adaptive Educational Hypermedia Systems*" (AEHS). AEHS inherits and aggregates two earlier educational systems approach: intelligent tutoring systems (ITSs) and adaptive hypermedia systems (AHSs). They attempt to provide some form of adaptive mechanisms for individual in web-based learning and to offer a more individualized environment for the learner. Adaptive educational hypermedia systems (AEH) interact with a user through a learner model of the goals, preferences and use the captured knowledge of each individual learner to adjust specially designed and authored hypermedia learning materials to suit the needs of that user.

Recommender system is another form of personalization features in an e-learning system. Such systems allow users to search for information in an efficient and effective way by providing suggestions based on users or other like-minded users' preferences captured in the previous retrieval instances [19]. Apart from applying a recommender system in digital library, [20] proposed a recommender system named Altered Vista which incorporates a collaborative information filtering techniques to provide like-minded recommendations for groups of users, another approach for providing individualized services in education is *Intelligent dynamic webpage*. [21] designed an intelligent dynamic webpage that adjusts the course content dynamically in accordance with students' level, providing learners with the most suitable course material.[22] designed a web-based system recording global course profile and users profile, which allows the system to interact dynamically with the users and enable learners to keep track of their own learning performance.

V. ENABLING TECHNOLOGIES FOR PERSONALIZATION

In order to get a 360° user's view, commercial and academic expertise works on different personalization perspectives which exploits its potential value and demonstrates the feasibility for all user groups, from adult to child. Currently, there are two main development trends in personalization technologies: *Static personalization* (pull approach) and *Dynamic personalization* (push approach). Static personalization services require high users' engagement based on user's explicit inputs while dynamic personalization services offer high automation based on numerous user modeling techniques. Several technologies that have being used on the web catholically. The following discusses briefly some of these technologies. The early techniques for capturing user's information mainly involved the use of *Cookies and certificates* that identify the user's interests based on the data stored in the PC client or host. Later approaches require the user to provide explicitly information relating to their interests through a series of dialogue interfaces. *Customization / Check box personalization* presents a customized view of an electronic catalog to a user on the basis of that user's explicit preferences and historical profile. User checks interests from a checklist, so that the proper information is maintained and presented to the user. *Configuration engines* use a series of predefined questions to route end user through a complex product or service selection process. Recently, machine learning techniques have been applied with some success to capture and infer user preferences from their browsing behaviors or through a stereotyping of user profiles. *Neural nets* emulate the neuronal interconnectivity of the human brain. It learns the user behavioral pattern from analyzing user logs off-line and user clicks stream data. Such user behavioral patterns are then used to predict what content will be most relevant to a particular user. Various filtering techniques such as *Simple Filtering, Content-Based Filtering and Collaborative filtering techniques* typically group users into clusters (or communities) using data clustering techniques based on a set of carefully chosen user features, such as interests, social and demographic background, purchase history, etc, that characterize users' behaviors. The resulting group behavior and preferences are summarized into a user preference template and used to provide recommendations for individuals that fall within a corresponding cluster (or user community). Other AI based approach includes *rule-based and inference techniques* which provide different levels of treatment to users based on human-determined rules or monitoring what the user is doing at the moment and their past actions. More sophisticated techniques use a prior user model [23] to predict user needs in a given situation.

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VI. A CONCEPTUAL FRAMEWORK OF PERSONALIZED LEARNING SYSTEM

With reference to the information architecture components for personalization [23], the business context, content and users are the three important domains that should be taken into careful consideration:

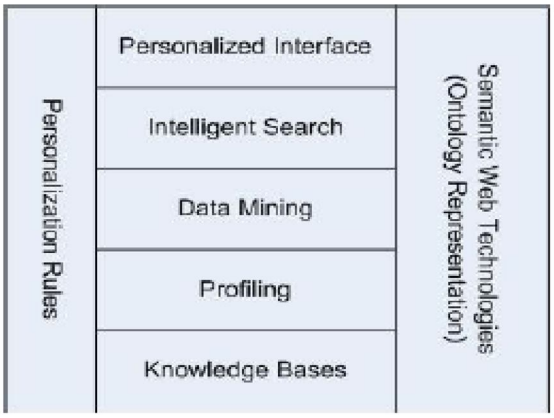


Figure: The Conceptual Framework of the Personalized Education

Users and content have profiles that represent their interests and behaviors. Specific values for a profile are determined by *the set of defined attributes and the possible values for each attribute*. In order to transform static data into meaningful processes, the business context has certain rules that determine how personalization happens.

Within our PE framework, the Internet acts as the resources bank of the framework and holds infinite materials in unsystematic form.

These content are manipulated through and used in different personalized applications such as Smart Search, Personal Planner, Personal Recommender and Personal Community etc. Users receive relevant information for individual processes and records of their behavior will be kept and analyzed for advanced filtering and mining purposes.

PE is an intelligent computing environment that consists of a range of functional components or agents for participants to conduct their teaching or learning activities in a personalized manner. These components range from automatic search of relevant teaching and learning materials from the Web, anticipating the needs of the participants based on his/her individual descriptive profile and the filtering/matching/sequencing of the retrieved materials based on dynamic monitoring of the student's progress guided by the learner model or based on the teacher's intended pedagogy.

VII. SMART/INTELLIGENCE SEARCH

The great volume of knowledge on the web makes it wonderfully useful yet extremely difficult for locating the information that we want. Users, teachers, especially students, need help to explore and to filter in their preferences from the countless possibilities. There are several problems related to automatic intelligent search from the Web. Focus on teaching and learning, we highlight the top four concerned issues.

First, how to get the most relevant resources for teaching and learning if users have different desires? Second, how to filter the results of high volume returned lists if users are less competent? Third, how to organize the retrieved resources in a systematic way that can benefit teaching and learning given the users' mental development stage are unpredictable? And fourth, how to get help or assistant if the users are lost? To achieve intelligent search and filtering, a search engine should be endowed with the capability of reasoning or has access to a reasoning engine. Such a search engine would be able to reach out to indexes which contain very complete lists of all occurrences of a given term, and then use logic to weed out all but those which can be of use in solving the given problem.

To facilitate the reasoning process, the PE framework makes use of the educational ontologies (e.g. *Curriculum Ontology*, *Pedagogy Ontology*) of PEOnto to provide guidance and insights for path selection and alternative (semantically equivalent) substitutions. For personalization search, it would respond to users' learning progress automatically according to information provided by the *Profile Agent* and *Matching Agent*. The *Filtering Agent* could take advantage of three different prevailing approaches for making recommendations, namely demographic filtering, content-based filtering and collaborative filtering.

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VIII. DATA ANALYTICS (DATA MINING)

Under a new instruction-learning environment, such as PE, learners are expected to deploy different learning strategies. Numerous mining techniques are useful not only in understanding/knowing the user, but also in predicting the user's needs so as to give appropriate recommendations regarding his/her current stage of learning. The PE framework applies data mining techniques to make the personalization process both automatic and dynamic, and hence up-to-date.

Principal elements of Web personalization include i) the categorization and preprocessing of Web data; ii) the extraction of correlations between and across different kinds of such data; and iii) the determination of the actions that should be recommended by such a personalization system [15]. Helping teachers and learners to reach the most relevant resources which particularly match their needs, mining the collected data from multiple sources to acquire as much as information as possible for personalization services are essential. Web mining is an essential step that includes *web usage mining, web content mining* and *behavioral mining [15]*. Four different advanced data mining techniques could be deployed to identify or discover various patterns of users. For example, Clustering techniques would be used to identify different learner groups and their relations with different contents. Classification techniques would be used to discriminate the characteristics between various categories. For instance, a resource or a user would be mapped into one of several predetermined classes. Pattern discovery techniques such as association-rule mining and sequential pattern discovery for the purpose of automatically discovering user profiles, where the body of a rule refers to the demographic information of a user, and optimizing the structure of PE based co-occurrence patterns of pages and deriving learning intelligence. The results will be used as part of the recommendation process if they are matched against an active user profile.

Mining techniques are useful in terms of predicting a user's actions while exploiting as much as information as can be obtained. Every method for predicting a user's future action is based on some form of user profile that links information about the user or the task to expectations about the user behaviors. Here, the PE framework will make use of one of the ontologies (the *People Ontology*) of PEOnto to infer and obtain better understanding and formulation of data association or clustering criteria. *Content-based methods* construct profiles that link information about the contents a user manipulates to the user's preferences concerning those contents. *Collaborative methods* construct profiles that link information about other users' preferences to a given user. Collaborative filtering is able to provide better "individualized" suggestions, makes simplifying assumptions and lumps users into groups or categories. True personalization delivers real-time recommendations that are "individualized" for each learner, at the right time and in the right context to deliver maximum value to the learner. Data mining technologies find and track individual behavior patterns, construct useful knowledge from and about the user to achieve meaningful personalization.

IX. PERSONALIZATION PROFILING

Profiling is the process of gathering information for further in-depth analysis. Three different types of profiles are essential for the purpose of personalization: the *user profile*, *the content profile*, and *the usage profile*. The user profiles provide information about the user for customizing the content and the application set to the user's specific and individual needs. The content profiles represent descriptive information about the resources for searching, recommendation and content management. The usage profiles show the user behaviors and the relation with the content.

In our PE framework, the user profiles, teachers and students, play an active role in the overall personalization process. Based on different user groups, an initial stereotype profiles would be used as the starting point and then modified to fit the actual user. All users may not only construct a static personal profile, but also an active, dynamic usage profile which would be used for recording and tracking all current and previous behaviors so as to provide information for analysis. Users' profiles will be treated as a key indicator for identifying individual interests and needs. Therefore, both the static and dynamic profiles would be consistently updated in order to retain the desired accuracy in its exploitation. Hence, the need for suitable techniques to adapt the user profile to new interests and to forget the old ones. Based on user's behaviors, the PES would give relevant responses with the combinations of different aforementioned technologies/techniques. For instance, grouping users into the same category and further dividing users into segments based on rules, and then filtering users' interests by applying agent technologies with different filtering techniques. Finally modify users' profiles and predict or plan next action.

At the same time, personal information/data acquires through the online registration form will construct a static user profile contains demographic information such as name, age, gender, contact, education and interests. Through interacting with the PES, a dynamic user profile would be built and contained information such as a list of subjects that the user is interested in, the number of times the user has visited a particular educational resource on a specific topic, the cumulative time the user has spent with these resources, the

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number and, more interestingly, the sequence of items the user has visited in each access and so on. In addition, the user profile also contains the percentage of user's interest in a particular domain or the result list of retrieval (explicitly or implicitly).

Corresponding to the user profile, the *content profile* aggregates the static description of content. The dynamic information of content usage such as the hit rate, the popularity rate, the last modified date, will be used to support the filtering, matching and mining process. The *usage profile* represents the relationship between the user and the content. The sequence, the time and the type of resource that the user has visited will be accumulated for each user. The count of visited items to the total number of visits of the user would be used to show whether users are interested in or actively participated in the PES. Usage profiles summarize user-assigned ratings of different contents to make predictions by finding users who assigned similar ratings to the contents that the user has previously experienced or to recommend new items that are also rated highly by the collection of similar users.

X. PERSONALIZATION RULES (PRS)

An education environment is a place where learning activities are designed and organized in a way that best support, enrich, and strengthen learning. Personalization is much more than simple Web site preference or user configuration settings. Personalization rules are not totally manually defined, created, and maintained. Different personalization rules models could be designed. For instance, retrieve relevant learning resources based on individual user's needs. The personalized service performs its function based on the stereotypical learning pattern for students in different learning stages. According to the educational psychology, students will learn differently due to various factors such as their age, learning style, family background, personal interest etc. A personal filtering model would be used to classify users into different user groups and retrieve relevant content accordingly. Although personalization rules that have been designed by experts are provided in the initial stage, these rules can be more useful via a heuristic that only offer guidance but not provide answers. As the ultimate goal of PES is serving learners' needs and wants, the personalization rules would be evaluated according to the quality of the resulting user experience. The *Learning Agent* within the framework would handle new cases identified and create a new profile for further actions. To minimize user's burden in searching for relevant learning resources or authoring teaching/learning packages, a personalized matching model should be designed so as to automatically connect learning object characteristics to the learner characteristics. based on the integration of the LOM and the Semantic Web Education Ontology, a Personalized Education Ontology (PEOnto) is designed

The detection mechanism is another essential mechanism in PES. Detection of learner behavioral or interest changes can either be done non-intrusively, such as in detecting learning paths, or intrusively, such as prompting the user for different answers and feedback. Personalization rules are essential throughout the personalized education/learning process. All the independent rules, inference rules, association rules or learning rules would be stored in the knowledge base and managed by the *Knowledge Management Agent*. It can be seen from the above functional overview that a number of agents play specific roles in the PE framework. These agents together form the Personalized Education Agents (or PEAs) of the PE framework. The 3-tiers PES Architecture consists of the client browser front end, the application server and the database server

XI. CONCLUSION AND FUTURE DIRECTION

Personalization Education Technology as a fast enabling technology for serving the information need of different users in a different way according to their individual implicit needs and profiles. Web based personalized learning gives student ample opportunity by providing personalized contents using personal filtering model based on educational psychology, their age, learning style, family background, personal interest etc. The proposed conceptual framework for web personalization will provide relevant content to meet the target of effective web based learning. This conceptual framework can be further developed with the educational website providing e-learning and implementing the framework with the real website usage data with derived personalized rules.

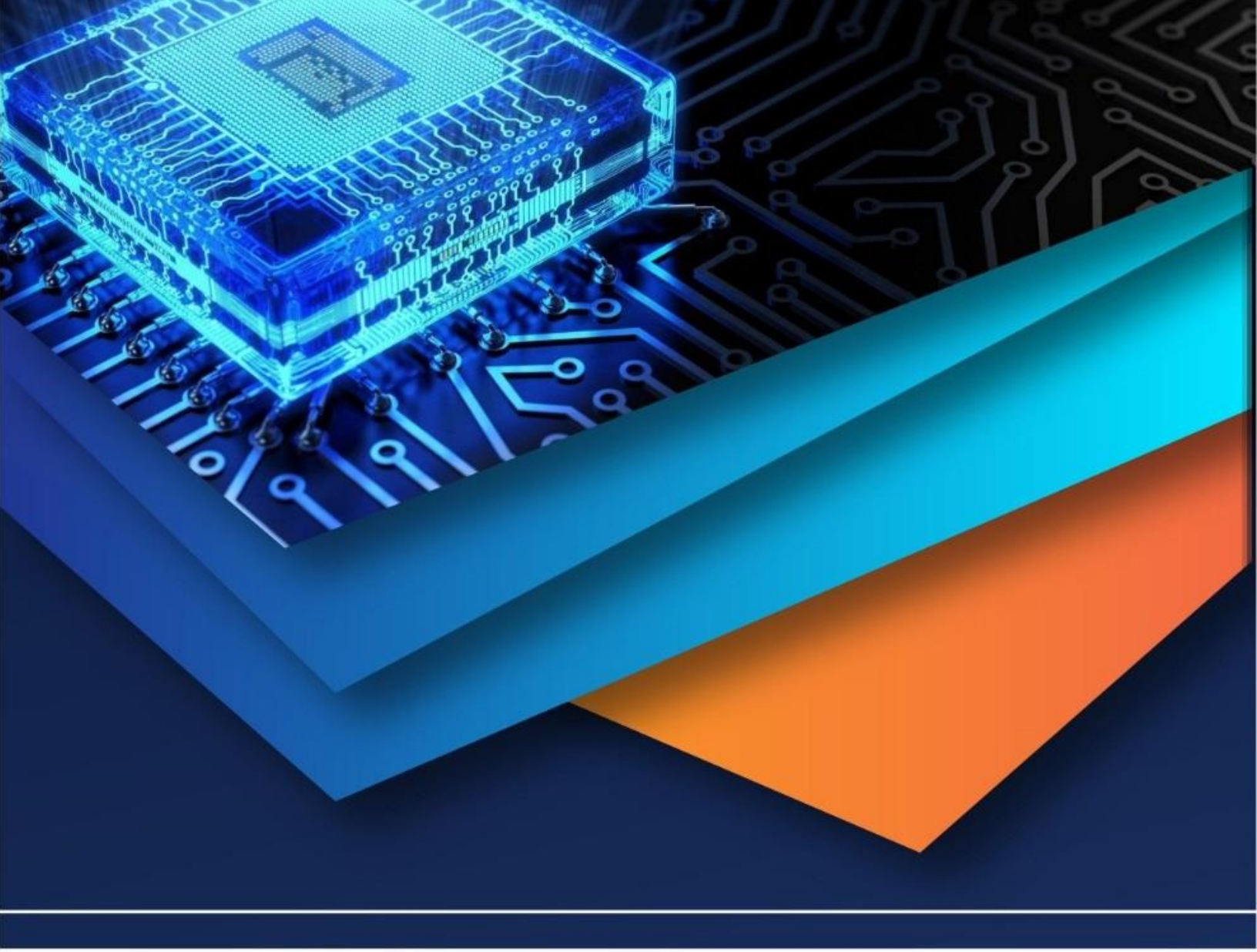
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