An Agent-Based Personalized E-Learning Environment: Effort Prediction Perspective

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***Abstract*—The various components of By virtue of the Information and Communication Technology (ICT), E-Learning becomes an asset in the field of training and education. Among many factors to facilitate the learning process, personalization role to provide the E-Learning Environments oriented towards learners. Personalization encompasses activities over learning content and learning sequence activities. As a new orientation of personalization this paper proposes an agent based personalized intra circle e-Learning Environment for interdisciplinary studies. The proposed system brings out another dimension for the personalization in the E-Learning Environments by providing domain specific content to the learner, especially for the post graduate and dual degree disciplinary courses. Generally the interdisciplinary courses provide their own difficulties to the learner from other discipline of courses. This system fades out the difficulties of these courses in the form of generating domain specific course content based on effort prediction to the learner. The system encompasses two processes for developing the course content and it personalizes the course content in three perspectives such as system's perspective, learner's perspective and teacher's perspective. To be best of our knowledge, this is the first attempt from the different perspective of personalization and of course this will lead a new direction of research in the field of E-Learning Environment.**

Keywords- Computer-managed instruction, Distance learning, education, Effort Prediction, intelligent agents.

I. INTRODUCTION

The competence of Information and Communications Technology (ICT) makes e-learning as an asset in the field of training and education. E-learning opens cultural and technical challenges to adapt completeness, pedagogical flexibility, personalization, Interoperability, etc in a formal way. E-Learning has been taken as a research area today and many key research areas are identified where an innovative utilization of technologies are needed in the E-Learning Environment. One of the key research areas is the personalization in the E-Learning environments which needs the content and activities within a unit of learning can be adapted based on the background details of the learners. Among many factors to facilitate the learning process personalization roles to provide the E-Learning Environments oriented towards learners. Personalization encompasses activities over learning content and learning sequence activities.

Many works have been going on for personalized e-learning. Ali Turker, et al [1] addressed the challenges to create the pedagogically coherent learning content for an individual learner's preferences. This paper introduces iClass project which addresses number of key aspects to perform personalization such as modeling of the learner's needs and preferences, representation of pedagogical strategies, representation of learning assets and the runtime reconciliation of these elements to produce effective and coherent learning experiences. Judy C.R. , et al [8] developed an adaptive learning system on the basis of learning behavior and personal learning style of the learner. The initial learning style of the learners is determined by questionnaires. The interactions and learning results are also considered for adjusting the subject material.

Silvia Schiaffino, et al [12] presented an eTeacher, an intelligent agent, to provide personalized assistance to e-learning students. This agent observes the student's behavior and builds the student' profile containing the student's learning style and performance using Bayesian networks. eTeacher proactively assist the student by suggesting personalized courses to help learner during the learning process. Christian Wolf [6] designed iWeaver to provide a flexible environment for the learner to implement adaptive hypermedia techniques. iWeaver deals with the possibility of fluctuations in a learning style with changing tasks or content. This approach is designed to predict and accommodate fluctuations in the learning style profile.

Tzouveli P., et al [13] shows how to realize personalized learning support in distributed learning environment based on semantic web technologies. Web services are used to provide personalization functionality to the e-learning systems. The developed personal learning assistant files the existing gap between the adaptive educational systems with well-established personalized functionality and open, dynamic learning and information networks. Martin Balík, and Ivan Jelinek [9] introduced general ontological model for adaptive web environments for adaptive personalization. This approach utilizes semantic web technologies to enable data reuse and system interoperability by developing a general model for adaptive hypermedia to provide a formal description.

The structure of the paper is as follows. In Section 2 the system architecture is presented and discussed. System evaluation is described in the section 3. The evaluation consists of preparation of questionnaires, distinct experimental phases. Finally, Section 4 gives the concluding remarks and brief discussion on future work.

II. PROPOSED SYSTEM

A. *Introduction*

The objective of the proposed system is to provide the personalized environment to the learner with the domain specific course content to reduce the effort required for learning the courses. The system personalizes the course content according to the learner's specialized domain. It facilitates the learner to acquire the selected course knowledge by providing the domain specific course content based on effort prediction. The system includes two processes for developing the course content and it personalizes the course content in three perspectives such as system's perspective, learner's perspective and teacher's perspective. The system gives flexibility for personalization to be done by the system, the learner and the teacher in order to bring out the characteristics of some e-learning systems such as adaptive systems, learner centric systems and teacher or instructor-led systems. When any course is introduced in this system the skeleton content for that course is created immediately in order to personalize the content in three perspectives which is carried out by the personalizer agent according to the effort prediction for both the course and the learner.

The architecture of the proposed system is given in the figure 1. The system consists of the following components

- LOs Metadata Repository – contains independent, sharable, reusable, interoperable, discoverable units can be assembled to provide the resources for different learning environment.
- Basic content developer – develops the skeleton content with the basic learning objects (basic principles of the selected course) from the learning object repository.
- Skeleton content – stores the developed basic course content skeleton.
- Personalizer agent– generates the personalized domain specific course content by placing the domain specific learning objects (domain specific examples for the selected course) from the learning object repository in three perspectives.

B. *Components Functionalities*

1) LOs Metadata Repository

This learning objects metadata comprise of learning contents with the characteristics such as independent, sharable, reusable, interoperable, discoverable, etc. units. These units don't rely on the other materials to make sense. The learning objects for the domain specific course content are in the form of text, images, and graphics. LOs metadata are used to form the domain specific course content by giving query to the repositories by the Basic Content Developer and Personalizer components. Repository gets the requests from these services and responses with the appropriate learning objects. These two services requests the Repository for the different kinds of learning objects i.e. the Basic Content Developer requests the repository for the basic principles content of the course topics and the Personalizer requests for the learner domain oriented examples relevant for the basic principles of the course topics.

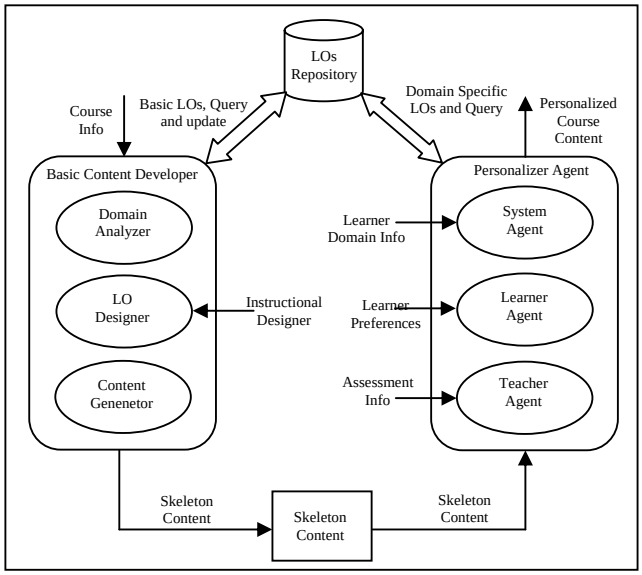

Figure 1. System Architecture

2) Basic Content Developer

The main intention of this component is to develop the skeleton of the course content with only the basic principles of the course topics. The Skeleton content is developed as a generic one as soon as the course is formulated i.e. the skeleton content is independent to the learner's domain. The Basic content developer develops the skeleton of the course content by the following activities with three sub components such as domain analyzer, LO designer and content generator.

- Gets the information about the course to that the course content to be developed to domain analyzer which analyzes and find the details of the course to generate the content.
- Generates the query to the LOs metadata repository to get the basic principles learning objects to develop the course content. If the learning objects are not in the repository then this component get the learning object from the instructional designer of that course and
- update the new learning objects into the repository with the help of LO designer.
- Develops the course content in the form of skeleton with only the basic principles of the course topics which is carried out by the content generator sub component.
- Stores the developed skeleton content to personalize according to the learners who are all select this course.

3) Skeleton Content

This component is used to simply store the developed partial course content which is developed by the Basic Content

Developer. This content is used by the personalizer to completely develop the personalized course content according to the learner's domain. The stored course content is common to the different learners. The storage of this skeleton content is used to personalize the course content again and again in three perspectives to provide domain specific course content.

4) Personalizer Agent:Effort Prediction Perspective

The activities of this component start when the learner registers the course, when the learner sets preferences and when the teacher wants to facilitate learner content. This personalizer agent personalizes the course content according to the learner's domain knowledge based on effort prediction to reduce the effort requires to learn the courses especially the interdisciplinary studies. It takes the skeleton content and generates the complete personalized course content by placing the appropriate domain specific learning objects of the course topics. The personalizer agent develops the complete course content by the following activities with three agents such as system agent, learner agent and teacher agent based on effort prediction.

- Gets the skeleton content of the course from the skeleton content as soon as any learner selects the course.
- System agent predicts the effort for both the course and the learner by getting the learner's domain details, learner's preferences and assessment details for system's perspective, learner's perspective and teacher's perspective respectively.
- Generates the query to the LOs metadata repository to get the appropriate domain specific learning objects.
- Develops the complete personalized course content by placing the retrieved learning objects to the skeleton content in three perspectives.
- Delivers the personalized course content which are developed in three perspectives to the learner.

The course content development process of personalizer agent based on effort prediction is carried out in three perspectives such as system's perspective, learner's perspective and teacher's perspective by the three agents. Personalization process of this component in three perspectives based on effort prediction as follows.

a) System's Perspective

In this perspective the personalization of the content is carried out with the learner's background detail of learner's specialized domain when the learner registers the course. The system agent gets the learners domain details from the learner registration form and with these details it generates the query to the LO metatdata repository to get the learning objects to personalizes the course content with the learner's domain oriented examples which are exactly relevant or some what related to the selected course concepts.

b) Learner's Perspective

In this perspective the personalization of the content is carried with the learner's preferences such as some other examples for the course topics, more exercises or problem relevant to the learner's domain, etc. The learner agent gets the learner's preferences from the learner and generates the query according to the learner's preferences to the LO metatdata repository to get the learning objects. With the retrieved learning objects the personalizer personalizes the course content for the learner's preferences in order to provide the learner with the Learner-Centric Personalized E-Learning Environment.

c) Teacher's Perspective

In this perspective the personalization of the content is carried with the learner's assessment details when the teacher wants to facilitate the learner content which is either developed by the system's perspective or by the learner's perspective. The teacher agent gets the assessments details of the learner from the evaluator and generates the query to the LO metadata repository to get the learning objects which are best suit to the learner assessment value. The personalizer personalizes the course content again with the retrieved learning objects to provide an easy and more relevant domain oriented examples to the learner.

III. EXPERIMENTATION CATEGORIES AND SYSTEM EVALUATION

We implemented this personalized intra circle E-Learning environment for post graduate programmes. In this environment two courses had been hosted and had been given support to handle 50 learners simultaneously for each course. System was evaluated with 100 participants from with different domain background. The participants registered the course and had gone through the learning process in this personalized environment. The system screenshot is given in the figure 2. After course completion participants were asked to answer the questionnaires to evaluate the system. The result is more than expected one and very encouraging.

The 25 questionnaires were developed to evaluate the functionality and performance of the system with five experimental categories and each category has five questionnaires. The experimental categories and questionnaires are given in the figure 3 and the descriptions of the questionnaires are follows.

Figure. 2. System Screenshot

The feedback and assessment based evaluation evaluates the feedback and assessment related operations of the system in all three perspectives. First questionnaire is to check whether the system is provided with an option to get teacher's perspective. Second questionnaire is to check whether the system responded with the content according to the teacher's perspective. Third questionnaire is to check whether system controls the learning process of the learner in all the three perspectives. Fourth questionnaire is to check whether the system makes the evaluation of the learning experience of the leaner easy. Fifth questionnaire is to check whether the system respond to the requests quickly.

Content Generation

Q1 This E-Learning Environment provides personalized domain specific content.
Q2 This E-Learning Environment provides the needed learning content.
Q3 This E-Learning Environment provides meaningful content in all perspectives.
Q4 This E-Learning Environment provides the content that exactly fits to the course.
Q5 This E-Learning Environment adapts the content from the learner and teacher.

Accessibility and Control

Q1 This E-Learning Environment is easy to use.
Q2 This E-Learning Environment has given priority for preference.
Q3 This E-Learning Environment is user-friendly.
Q4 This E-Learning Environment provides stable operation.
Q5 This E-Learning Environment is easy to access.

Feedback and Assessment

Q1 This E-Learning Environment provides an option to get teacher's perspective.
Q2 This E-Learning Environment provides the content according to the teacher's requests.
Q3 This E-Learning Environment controls the learning process.
Q4 This E-Learning Environment makes easy to evaluate my learning performance
Q5 This E-Learning Environment responds to the requests fast enough.

Personalization

Q1 This E-Learning Environment provides an option to get learner's perspective.
Q2 This E-Learning Environment provides the content according to the learner's preferences.
Q3 This E-Learning Environment provides flexibility to choose the content.
Q4 This E-Learning Environment facilitates the learning process.
Q5 This E-Learning Environment provides the personalized learning support.

Overall Satisfaction

Q1 This E-Learning Environment reduces the difficulties of doing interdisciplinary course.
Q2 This E-Learning Environment reduces the period of learning process.
Q3 This E-Learning Environment satisfied me.
Q4 This E-Learning Environment is successful.
Q5 This E-Learning Environment has given value to my educational experience.

Figure 3. Questionnaires

The personalization based evaluation evaluates the personalization achieved in the proposed system in all three perspectives. First questionnaire is to check whether the system is provided with an option to get learner's perspective. Second questionnaire is to check whether the system responded with the content according to the learner's perspective. Third questionnaire is to check whether system provided flexibility to choose the content. Fourth questionnaire is to check whether the system facilitates the learning process. Fifth questionnaire is to check whether the system provided the personalized learning support.

The overall satisfaction based evaluation evaluates the system satisfaction in all three perspectives. First questionnaire is to check whether the system reduced the difficulties of doing interdisciplinary course. Second questionnaire is to check whether the system reduces the period of learning process since it provided the domain specific content. Third questionnaire is to check whether system is satisfactory to the learner. Fourth questionnaire is to check whether the system is successful. Fifth questionnaire is to check whether the system has given value to learner educational experience.

The participants of the course were provided with questionnaires form to answer the questionnaires with the five point scaling factor after the completion of their course. The average answers for the questionnaires from the participants of the two courses were given in the table I.

TABLE I: QUESTIONNAIRES DATA AND SYSTEM CONTRAST T-TEST VALUES

S. N.	Categories	Questi on-naires	EEE			BBA			TV
			PS	TS	CV	PS	TS	CV	2.5 %
1	*Content Generation*	*Q1*	4	2	3.50	5	2	3.83	2.31
		Q2	5	3		5	3		
		Q3	4	3		5	3		
		Q4	3	2		3	2		
		Q5	4	3		4	3		
2	*Accessibility and Control*	*Q1*	5	4	2.13	5	4	2.13	2.31
		Q2	4	3		4	3		
		Q3	5	5		5	5		
		Q4	4	3		4	3		
		Q5	5	3		5	3		
3	*Feedback and Assessment*	*Q1*	5	2	5.36	5	2	6.12	2.31
		Q2	5	2		5	2		
		Q3	4	1		4	1		
		Q4	4	3		5	3		
		Q5	5	3		5	3		
4	Personalizati on	*Q1*	5	2	7.48	5	2	7.48	2.31
		Q2	5	2		5	2		
		Q3	5	1		5	1		
		Q4	5	3		5	3		
		Q5	5	3		5	3		
5	*Overall Satisfaction*	*Q1*	4	1	5.10	5	1	5.10	2.31
		Q2	4	1		5	1		
		Q3	5	3		5	3		
		Q4	5	3		4	3		
		Q5	5	2		4	2		

IV. RESULT ANALYSIS

This experimental study has devised into two different phases with five questionnaires categories. The first phase has been conducted to the engineering background students and the second phase has been conducted to the management background students. The system evaluation is carried in two contrasts, one is between the proposed system and the traditional system, and second is between the two different environments (engineering and management).

The results of the different phases of the experiments in association with the questionnaires related to the different categories presented in the table I. The use of statistical models, particularly, t-tests is recommended to analyze the variations in system behavior over the two contrasts. Hence, the variations in the ability of different environments are analyzed using the t-tests in this experiment and the level of confidence is kept at 2.5% significant level to achieve minimum confidence.

In the system evaluation for the first contrast, t-test for the both two phases is applied between the proposed system (PS) and traditional system (TS) for every experimental categories and the calculated value (EV) is given in the table I. The variation between the proposed system and traditional system is identified by comparing the calculated value and the tabulated value (TV).

If the tcal > ttab then there is a significant difference between the proposed system and the traditional system. If the tcal < ttab then there is a no significant difference between the proposed system and the traditional system. For the second contrast, the t-test for the different phases is applied between the two different courses in the proposed system to show there is no difference between them. The calculated t-test value for the second contrast is given in the table II.

In the first contrast, the five experimental categories are evaluated between the proposed system and traditional system for the two phases. In the first phase, for engineering course, the content generation category result show that tcal = 3.5 > ttab = 2.31 which confirms there is a significant difference between the proposed system and traditional system in this category. The accessibility and control category result shows that tcal = 2.13 < ttab = 2.31 which confirms there is no significant difference between the proposed system and traditional system in this category. The feedback and assessment category result shows that tcal = 5.36 >ttab = 2.31 which confirms there is a significant difference between the proposed system and traditional system in this category.

The personalization category result shows that tcal = 7.48 >ttab = 2.31 which confirms there is a significant difference between the proposed system and traditional system in this category. The overall satisfaction category result shows that tcal = 5.10 >ttab = 2.31 which confirms there is a significant difference between the proposed system and traditional system in this category. The result analysis for this phase.

In the second phase, for management course, the content generation category result show that tcal = 3.83 > ttab = 2.31 which confirms there is a significant difference between the proposed system and traditional system in this category.

The accessibility and control category result shows that tcal = 2.13 < ttab = 2.31 which confirms there is no significant difference between the proposed system and traditional system in this category. The feedback and assessment category result shows that tcal = 6.12 >ttab = 2.31 which confirms there is a significant difference between the proposed system and traditional system in this category. The personalization category result shows that tcal = 7.48 >ttab = 2.31 which confirms there is a significant difference between the proposed system and traditional system in this category. The overall satisfaction category result shows that tcal = 5.10 >ttab = 2.31 which confirms there is a significant difference between the proposed system and traditional system in this category. The result analysis for this phase.

The t-test values, listed in the table I, shows that there is a significant difference in the proposed system in four categories such as Content Generation, Feedback and Assessment, Personalization, and Overall Satisfaction and no significant difference in the Accessibility and Control category compare to traditional system.

TABLE II: PROPOSED SYSTEM CONTRAST

Course Contrast (PS)	**EEE**	**BBA**	**CV**	**TV 2.5%**
Engineering and Management Courses	3.50	3.83	-0.17	2.31
	2.13	2.13		
	5.36	6.12		
	7.48	7.48		
	5.10	5.10		

In the second contrast, the two different phases (engineering and management) of the proposed system is evaluated. The t-test values of five experimental categories of the two courses in the proposed system are used to identify is there any difference between the two phases of the proposed system.

The t-test result value for this contrast recorded in the table II shows that tcal =–0.17 < ttab = 2.31 which confirms there is no significant difference between the two different phases of the proposed system. The experimental result analysis shows that this e-learning environment reduced the effort required for learning the courses.

V. CONCLUSION

The paper proposed an agent-based personalized e-learning environment to reduce the effort required for learning the courses especially the interdisciplinary studies. This work is a first attempt from the different perspective of personalization and to best of our knowledge this attempt will lead a new direction in the field of e-learning environment. The proposed system is presented in three perspectives to provide the domain specific content to the learner based on the effort prediction according to their background details. The personalized domain specific content is generated and can be modified according to the leaners and teacher perspectives. The proposed system is evaluated with five experimental categories and two different phases. The evaluated result is more than expected one and

very encouraging. In future this new approach will be developed as a plug-in to fit the standard e-learning environments.

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