Context Aware E-Learning System with Dynamically Composable Learning Objects

Minu. M. Das, Manju Bhaskar
Department of Computer Science
Pondicherry University
Pondicherry, India
minu.mtech@gmail.com, manju19j@gmail.com

Dr. T. Chithralekha, Dr. S. Sivasathya
Department of Computer Science
Pondicherry University
Pondicherry, India
tchitu@yahoo.com, sivasathya@yahoo.com

***Abstract*—Context aware E-Learning systems provide learning content according to a learner's context. In the existing context aware E-Learning systems there is no standardized set of context parameters considered and content is adapted based on a randomly considered set of parameters.**

In this work, a standardization of context model for context aware E-learning has been proposed. The design of the standardized context model requires that a learning object should not have a static monolithic structure but be flexible enough to be dynamically composed based on a learner's context. Hence, a flexible learning object model and its representation are defined in this paper. A content management system which stores these flexible learning object constituents and assembles them dynamically based on a learner's context is also described.

Keywords-e-learning; context aware e-learning; personalized learning; adaptive learning; context model

I. INTRODUCTION

Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves.

Context aware E-Learning systems help a learner to get highly customized learning content. The customization of content is made by considering various context parameters such as learning style, learner's preferences, learner's intention, learner's situation etc.

In the existing literature, there are several context-aware E-Learning systems available. But, in each of these systems, different subsets of context parameters are considered. Also, the structure of learning object is highly static making it inflexible for generating context-aware e-content. Hence, in this work, a new context-aware E-Learning system is proposed to be developed. In this system, a context model which has been developed by standardizing the existing context parameters is proposed to be used.

Also, a dynamic structure for the learning object that can hold the context-aware content is proposed to be designed. A content management system that can store the learning object constituents and dynamically compose into a learning object based on the learner's context is also developed.

Section 2 gives the background details on E-Learning, Personalized E-Learning and Context Aware E-Learning system. Section 3 provides the related works which describes the overview of parameters that are used in existing context aware E-Learning systems. Section 4: gives the need for proposed system. Section 5: explains the proposed context aware E-Learning system. Section 6: gives the analysis. Section 7: describes the case study. Section 8: gives the conclusion.

II. BACKGROUND

A. *E-Learning*

In [8] E-Learning is defined as "the delivery of a learning, training or education program by electronic means. E-Learning involves the use of a computer or electronic device (e.g. a mobile phone) in some way to, educational or learning material". E-Learning can involve a greater variety of equipment than online training or education, for as the name implies, online involves using the Internet or an Intranet. CD-ROM and DVD can be used to provide learning materials. Distance education provided the base for E-Learning development. E-Learning can be "on demand". It overcomes timing, attendance and travel difficulties. Plain E-Learning systems cannot adapt to a learner's learning requirements. Hence, E-Learning systems evolved and personalized E-Learning systems which enable customized E-Learning for every learner came into existence.

B. *Personalized E-Learning*

In [14] personalized E-Learning is described as a unique, blended educational model that is tailored to the individual learner's needs and interests. Personalized learning can be used for developing the individual learning programs and also engage these learners into the learning process so that learner's learning potentials and success can be optimized. Personalized learning should not be restricted by time, place and learner's other requirements. Personalized E-Learning is mostly focusing on learner's preferences and current state of a learner to provide the learning content correctly. It does not

focus on the learner's situation. Hence, context- aware E-Learning systems which consider a learner's situation also were developed. These came to be called as context-aware E-Learning systems.

C. Context Aware E-Learning

A context aware E-Learning system considers many parameters that contribute for a learner's contexts. By using these context parameters, the system will give customized information to the user. Context is defined as "any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves."

Context aware E-Learning systems select or filter the learning resources in order to make the E-Learning content more relevant and suitable for the learner in his/her situation. The selection or filtering of the e-learning resources is done by considering the learner's personal information, learning style preferred by him, learner's situation, etc. These parameters constitute for the learner's context.

There are many works done on context aware E-Learning systems and in each of them certain subset of parameters are considered for the context. In the subsequent section the context parameters used in existing context aware E-Learning systems are described.

III. RELATED WORKS

A. Context Parameters in Existing Context Aware E-Learning Systems

This section gives an overview of the context parameters used in the various context-aware E-Learning systems. The following are the various context parameters considered.

- Learner personal profile
- Level of Expertise
- Learning Style
- Learner Preferences or Learner Approach
- Learner Intention
- Learner Situation
- Quality of Learning Services (QoLS)
- Network
- Device
- Learning Pace
- Learning State
- Comprehensive Level

1) Learner personal profile: Learner's personal profile contains learner's personal details such as name, ID, Date of Birth, Knowledge of the learner etc. The knowledge of the person is the prior knowledge. Learner's personal profile has been described in [12-16, 21-30].

2) Learner's Level of Expertise: Level of expertise is used to indicate whether the person is a beginner or that learner has some pre-knowledge about a topic or the learner is an expert in that topic. Learner's Level of Expertise has been described in [4, 10, 11]

3) Learning Style: Learning Style corresponds to video, audio, textual or animation media used by the learner for learning his lessons. Learning Style has been given in [1, 2, 13, 24].

4) Learner's Preferences: Most of the existing systems are focusing on Learner's preferences. Learner's preferences correspond to the conceptual, example-oriented, case study or problem-oriented, demonstration, simulation approaches preferred by the learner for learning the e-content. Learner's preference has been described in [14 -17, 19-28, 30].

5) Learner's Intention: Learner's intention means in what intention the learner is coming for E-Learning site. The learner can come for research purpose or survey purpose or purpose or just to learn the concept etc. Learner's Intention has been described in [8, 29].

6) Learner's Situation: Learner's situation defines the situation of the learner. The learner might be driving some vehicle or he/she might be in private place or in public place etc. The learner's location details are also included in learner's situation. Learner's situation has been described in [17, 19,21].

7) Quality of Learning Service (QoLS): QoLS contains functional and non functional quality requirements. The functional requirements are network bandwidth and response time. Non- functional requirements are reliability, availability and cost. Quality of Learning Services (QoLS) has been described in [5, 6, 9].

8) Network: Network can be wired network or wireless network. Network has been described in [15, 32].

9) Device: The device used by learner can be mobile, PC, Laptop, PDA etc. Device has been described in [20, 26, 31].

10) Learning Pace: Learning pace means the speed of learning the subject. This is determined by conducting some test for the learner. The learner can be a fast learner, medium learner or slow learner. Learning Pace has been described in [11, 14].

*11) Learning State: L*earning state can take the following values.

- 'Studied' – if the learner has gone through each and every lesson and in test he/she has not performed well then this value is considered.
- 'To Be Studied' – if the learner skipped some lesson then this value is considered.
- 'To Be Revised' – if the learner has not performed well in test, then this value is considered.

Learning State has been described in [7, 27].

12) Comprehension Level: Comprehension level means whether the person understood the e-content well, or understood completely or understood a little, or not understood. Comprehension level has been given in [13, 16, 25]. Table 1 gives a list of context parameters.

IV. NEED FOR THE PROPOSED SYSTEM

From the study of the existing works in context aware E-Learning, it is obvious that different subsets of the context parameters are considered for capturing the learner's context. Each of them helps to capture certain aspects of the learner's context. But they are incomplete in certain aspects. Hence, there is a need to define a standardized context model which can completely capture the learner's context. Also, to provide the learning content based on a learner's context, a learning object have to be available at different levels of abstraction and media types which is termed as learning chunks. These learning chunks have to be composed dynamically and constitute for a learning object to be delivered to the learner.

At present, the structure of learning objects are monolithic and do not support to provide learning content based on the complete context of the learner. Hence, there is a need to define the modular structure of a learning object that helps to realize a learning object based on complete learner's context. Since a new learning object structure is defined, a suitable representation for the same also has to be proposed. In addition, a content management system for storing the learning chunks and dynamically composing them based on a leaner's context has to be defined.

V. PROPOSED SYSTEM

The proposed context aware E-Learning system is to be developed by using the solutions proposed for each of the following.

- Standardization of Context Model
- Definition of Learning Object Model
- Definition of Learning Object-chunk Representation
- Design and development of Content Management System

Fig. 1 shows the architecture of the proposed Context Aware E-Learning system. The learner will give input through the user interface module. Through this user interface module the learner's context is built. A suitable learning object model which best suits the current context is generated dynamically. The learning object model is the input to content management system which fills the structure with the required learning object chunks and delivered to the learner through the learning object delivery module.

A. Standardization context model for context aware e-learning systems

In the existing E-Learning systems, different subsets of context parameters have been used for capturing a learner's context. Since the subset is not complete, it cannot help to accommodate all the details of a user's context completely. Hence, it is necessary to derive a standardized context model that helps to establish a learner's context comprehensively.

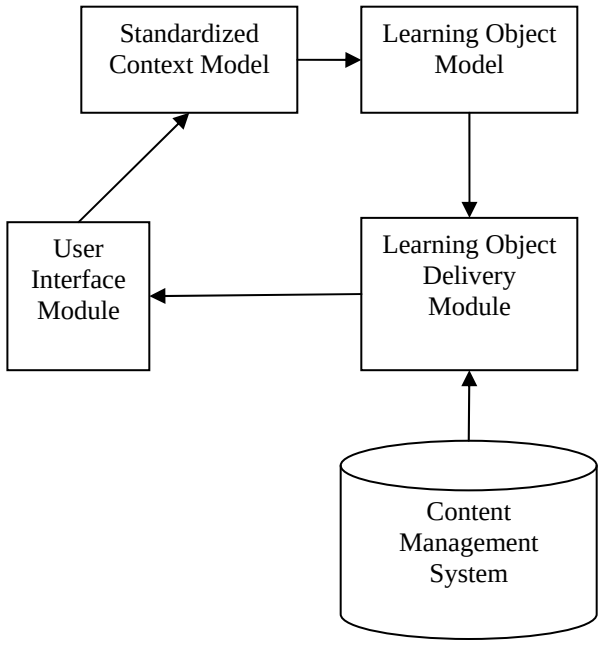

Figure 1. Architecture of proposed context aware E-Learning system.

The standardized context model consists of mainly four sub context parameters which consolidates the existing systems parameters. They are the following.

- Profile Context
- Preference Context
- Infrastructure Context
- Learning Context

The sub parameters for these contexts are given in Table 1.

1) Profile Context: This context is giving information about learner's personal information, personality type and learner's level of expertise.

2) Preference Context: It contains the information about learner's approach or preferences and learner's intention and learning style.

TABLE I
LIST OF CONTEXT PARAMETERS

Context Category	Context Parameters Considered	Compiled set of Sub Context Parameters	Existing Systems
Profile Context	Learner Profile	Name	[2][6][8][10][11][12][14][15] [16] [19][21][22][23][24] [25][26][27][28][30]
		ID	
		DOB	
		Gender	
		Address	
		E -mail ID	
		Phone Number	
		Technologies Known	
		Knowledge Level	
		OS Experience	
		Internet Usage	
	Level of Expertise	Beginner	[4][10][11][12][17][21]
		Practitioner	
		Expert	
Preference Context	Learning Style	Video	[1][2][4][7][8][10][11][12] [13][16][22][24][31]
		Audio	
		Text	
		Animation	
		Slides	
	Learning Preference	Conceptual	[2][6][11][12][14][15][16] [17][19][20][21][23][24] [25][26][27][28][30]
		Example-Oriented	
		Case Study	
		Simulation	
		Demonstration	
	Learning Intention	Research	[8][11][16][28][29]
		Survey/ Overview	
		Quick Reference	
		Basic Introduction	
		Project	
		Assignment	
		Seminar	
Infrastructure Context	Learner Situation	Private	[5][6][9][14][15][17][19] [21]
		Public	
		Driving	
	QoLS	Functional Requirement	[5][6][9]
		Non- Functional Requirement	
	Network	Wired	[5][6][9][14][15][20][21] [26][30][31] [32]
		Wireless	
	Device	Mobile	[5][6][9][14][15][17][19] [20] [21][26][31][32]
		PC	
		Laptop	
		PDA	
Learning Context	Learning Pace	Slow	[11][14]
		Medium	
		Fast	
	Learning State	Studied	[5][7][10][13][14][16] [27][31][32]
		To be Studied	
		To be Revised	
	Comprehension Level	Not Understood	[13][16][25]
		Understood a Little	
		Understood Well	
		Understood Completely	

3) Infrastructure Context: It describes the information about learner's situation, network and device used by the learner.

4) Learning Context: This describes the information about the learning pace, learning state and the comprehension level of the learner.

These sub-contexts are either Static type or Dynamic type. Static contexts are constant; it will not change in the entire E-Learning session. In the above sub-contexts, the profile context, preference context and infrastructure contexts are static because it will remain the same for the entire course session. Learning context is dynamic context because it changes according to the learner's pace, learner's state and comprehension level. Formalized way of representing the standardized context model is given in Fig.2.

B. Definition of Learning Object Model for Context Aware E-Learning systems

The design of the standardized context model requires a flexible learning object model. That is, the learning object structure should not be static. The structure of the learning object will change according the learner's preferences and intentions.

This requires that the learning object is structured in terms of different levels of abstractions as given below in Table 2. That is, the same learning object is available in the form of a concept, detailed concept, example, case study, simulation and demonstration. Each of these corresponds to the various abstraction of the same learning object. Every abstraction would be available in different media types. These learning object abstractions in the various media types are called as learning object chunks.

When a learner whose learning preference is learning by case study approaches the E-Learning system with the intention of preparing for interview, the different learning object abstraction chunks chosen to constitute the learning object structure and the sequencing order of these abstractions while presenting to the learner is as shown below

Simple Concept → Case Study → Example.

Thus, for the above mentioned scenario, the learning object is structured with three abstractions – simple concept, case study and example. This structure is dynamically determined based on the learning preference and intention of the learner.

Formalized way of representing the learning object model for different intentions of the learner is given in Fig 3. This shows the different learner's intention and the corresponding sequencing of the learning object abstractions for each of these intentions.

TABLE 2
DIFFERENT LEVELS OF ABSTRACTIONS

Concept
Detailed Concept
Example
Case Study
Simulation
Demonstration

C. Definition of Learning Object-Chunk Representation

For representing the standard context model and structured learning object model a suitable representation technique has to be identified. Every learning chunk corresponds to a particular domain. It is available in a particular level of abstraction in a particular media. Thus, learning objects chunks are represented in a three- dimensional way. X-axis represents the domain ontology. Y-axis represents the level of abstraction and the Z-axis represents the media. Fig. 4 shows the 3 dimensional representation of learning object chunks.

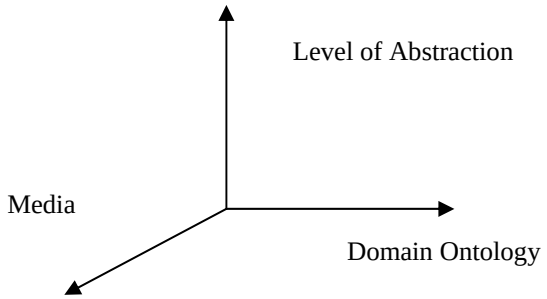

Figure 4. Three dimensional representation of learning object chunks

The following Fig. 5 shows hierarchical representation of learning object. That is, a learning object x, is available in abstractions y1..y_n and abstraction is available in z_1.. z_n media types.

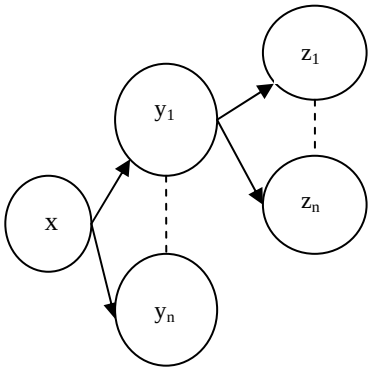

Figure 5. Hierarchical representation of learning objects

Context Ontology – {Profile, Preference, Infrastructure, Learning State}

Profile – {Personal Information, Personality Type, Level of Expertise}		
Personal Information	{Name, ID, DOB, Gender, Address, Email-id, Phone Number, Technologies Known, Knowledge Level, OS Experience, Internet Usage}	
Personality Type	{Extrovert, Sensory, Thinkers, Judges,}	
Level of Expertise	{Beginner, Practitioner, Expert}	
Preference - {Learner's Preference, Learner's Intension, Learning Style}		
Learner's Preference	{Conceptual, Example- Oriented, Case Study, Demonstration, Simulation}	
Learner's Intension	{Research, Survey, Quick Reference, Basic Introduction, Project, Assignment, Seminar}	
Learning Style	{Video, Audio, Text, Animation}	
Infrastructure – {Learner's Situation, QoLS, Network, Device}		
Learner's Situation	{Public, Private, Driving}	
QoLS	{Functional Requirements, Non-Functional Requirements}	
	Functional Requirements	{Bandwidth, Response Time}
	Non-Functional Requirements	{Reliability, Availability, Cost}
Network	{Wired, Wireless}	
Device	{Mobile, PDA, Laptop, PC}	
Learning State **–** {Learning Pace, Learner's State, Comprehension Level}		
Learning Pace	{Slow, Medium, Fast}	
Learner's State	{Studied, To Be Studied, To Be Revised}	
Comprehension Level	{Not Understood, Understood a Little, Understood Well, Understood Completely}	

Figure 2. Formalized way of representing standardized context model.

Research – {Simple Concept, Detailed Concept, Example, Case Study, Demonstration, Simulation}

Survey – {Detailed Concept, Example, Case Study}

Quick Reference – {Simple Concept, Example, Case Study}

Basic Introduction – {Simple Concept, Example}

Project – {Detailed Concept, Example, Case Study, Simulation, Demonstration}

Seminar – {Detailed Concept, Example, Case Study, Demonstration}

Assignment – {Detailed Concept, Example, Case Study}

Figure 3. Learning object structure based on the learner's preferences and intentions.

D. Content Management Systems for Context Aware E-Learning Systems

In order to accommodate the newly designed standardized context model and learning object content model, a content management system which can store the learning object chunks and dynamically compose a learning object according to the current context of the learner is required.

The content management system has to store and retrieve the learning object chunks. During content generation, the learning object delivery module makes use of the learning object model which is dynamically generated for the learner's context and composes a learning object in terms of many z_s which correspond to the various y_s that have been chosen to constitute for the structure of the learning object in a domain x.

The advantages of the proposed system are that it generates content based on a standardized set of context parameters. Also, since the learning object structure is dynamically composed it can cater to learner's preference an intentions so that the learner will get highly customized learning content.

VI. ANALYSIS

In this section, the evaluation of the standardized context model is performed by considering the requirements fulfilled by context aware E-Learning systems. An evaluation of proposed E-learning system with the existing E-Learning system has been carried out. This is given in Table 3. Table 3 shows whether the existing systems are satisfying the contexts parameters of the standardized context which is described in this paper. The total score is given based on the context parameters fulfilled.

TABLE 3
COMPARISON OF PROPOSED SYSTEM WITH EXISTING SYSTEMS

Systems	Profile Awareness	Preference Awareness	Infrastructure Awareness	Learning State Awareness	Total Score
[1]	✓	✓	✓	×	3
[2]	✓	✓	✓	×	3
[3]	✓	✓	×	✓	3
[4]	✓	×	×	×	1
[5]	✓	✓	✓	×	3
[6]	✓	✓	×	×	2
[7]	×	✓	✓	×	2
[8]	✓	×	×	✓	2
[9]	✓	×	✓	✓	3
[10]	×	×	✓	×	1
[11]	✓	✓	×	×	2
[12]	✓	✓	✓	×	3
[13]	✓	✓	✓	×	3
[14]	✓	✓	×	✓	3
[15]	✓	✓	×	✓	3
[16]	✓	✓	✓	×	3
[17]	×	×	✓	×	1
[18]	✓	✓	✓	×	3
[19]	✓	✓	×	×	2
[20]	✓	✓	×	×	2
[21]	✓	×	×	✓	2
[22]	×	✓	×	×	1
[23]	✓	✓	×	×	2
[24]	✓	×	×	✓	2
[25]	✓	✓	×	×	2
[26]	×	×	✓	✓	2
[27]	✓	×	✓	✓	3
[28]	×	✓	×	×	1
[29]	✓	✓	×	×	2
[30]	✓	✓	✓	×	3
Proposed System	✓	✓	✓	✓	4

The following Fig. 6 shows the graphical representation of the evaluation. The X coordinate represents the E-Learning systems and Y coordinates represents the Total Value of that each system obtained. Most of these existing systems are satisfying only 3 context parameters described in the proposed context model but the proposed E-Learning system satisfies all the 4 context parameters and is shaded in Fig. 6.

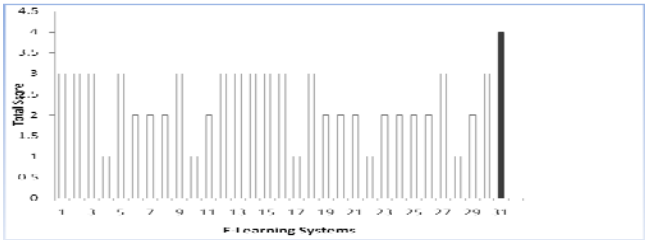

Figure 6. Graphical representation of evaluation of Context models in existing E-Learning systems against standardized context model

VII. CASE STUDY: GURUDEV

The proposed context aware E-learning system is entitled as GURUDEV. GURUDEV defines everything that is described above. Fig. 7 shows the user interface of the GURUDEV. Fig.8 gives the learner context for generating the appropriate learning content dynamically. In Fig. 8 the learner comes with an intention of seminar. For this, the learner provides detailed concept as his learning preference. The situation here will be given as private; while the basic tools he needs will be a media –in the form of text, a device- in the form of a laptop, a network- wired one and a domain as network topology. Then, the sequencing of abstraction of learning object chunk will be in the following form

Detailed Concept →Example→ Case Study→ Demonstration.

Finally the system dynamically composes learning objects according to the learner's context and is given to the learner. That is shown in Fig. 9.

Figure 7. User Interface of proposed system

Figure 8. Learner's context for generating learning content dynamically

Figure 9. Dynamically composed adaptive learning object

VIII. CONCLUSION

A context aware E-Learning system considers many parameters that contribute for a learner's learning context. By using these context parameters, an E-Learning system will give customized information to the user. Context aware E-Learning systems select or filter the learning resources in order to make the E-Learning content more relevant and suitable for the learner in his/her situation. But most of the existing context aware E-Learning systems uses only some of the context parameters namely learner's preferences, learning styles, learner's intentions etc.

In this work a context aware E-Learning system is proposed to be developed. For this, a standardized context model and learning object model are devised. A new content management system (CMS) which can store the structured learning objects and deliver highly customized content to the learner by dynamically composing the learning objects is also developed.

References

[1] ADLI Sharable Content Object Reference Model (SCORM), *Advanced Distributed Learning Initiative*, 2003.

[2] Adriana Berlanga, Francisco J. Garcia, "Towards reusable Adaptive Rules".

[3] Andreas Schmidt, "IMPACT OF CONTEXT-AWARENESS ON THE ARCHITECTURE OF LEARNING SUPPORT SYSTEMS", *Architecture solutions for E-Learning systems*, Idea- Group Publishing, 2007.

[4] Andreas Schmidt, Claudia W., "User Context Aware Delivery of E-Learning Material: Approach and Architecture", *Journal of Universal Computer Science*, Vol. 10, No. 1, 2004, pp. 38-46.

[5] Bill N. S, Norman Adams, and Roy Want, "Context-Aware Computing Applications", *IEEE Workshop on Mobile Computing Systems and Applications*, 1994.

[6] Carla Limongelli, Filippo Sciarrone, Marco Temperini, Giulia Vaste, "Adaptive Learning with the LS-Plan System: a Field Evaluation", *IEEE Transaction on Learning Technologies*, 2008.

[7] Darrel Woelk "e-Learning, Semantic Web Services and Competency Ontologies", *IEEE First International Workshop on Education Technology and Computer Science*, 2009, pp. 233-237.

[8] Derek Stockley. "E-learning Definition and Explanation (Elearning, Online Training, Online Learning)". 2003.

[9] Dey, Anind K. "Understanding and Using Context". *Personal Ubiquitous Computing*, 2001, Vol. 5, No.1, pp. 4–7.

[10] Enrico Rukzio, George N. Prezerakos, Giovanni Cortese, Eleftherios Koutsoloukas, Sofia Kapellaki, "Context for Simplicity: A Basis for Context-aware Systems Based on the 3GPP Generic User Profile", *International Journal of Computational Intelligence*, Vol. 1, No. 1, 2004, pp. 1-12.

[11] Howe, D, Free online dictionary of computing, 2006, Imperial College Department of Computing London, UK.

[12] H. Srimathi, S.K. Srivatsa, "Identification of ontology based learning object using instructional design.

[13] IMS Global Learning Consortium," *IMS Abstract Framework: White paper*", 2003.

[14] Jeongwoo Ko, Fumihiko Murase, Teruko Mitamura, Eric Nyberg, Masahiko Tateishi, Ichiro Akahori, "Context-Aware Dialog Strategies for Multimodal Mobile Dialog Systems", *Journal on AAAI*, 2006.

[15] Jose Manuel Marquez, Juan Antonio Ortega, Luis Gonzalez-Abril, Francisco Velasco, "Creating adaptive learning paths using Ant Colony Optimization and Bayesian Networks", *IEEE International Joint Conference on Neural Networks (IJCNN 2008)*, 2008, pp. 3834-3839.

[16] Jovanovic, J., Gasevic, D., Knight, C., Richards, G., " Ontologies for Effective Use of Context in e-Learning Settings", *Educational Technology & Society*, 2007, Vol. 10, No. 3, pp. 47-59.

[17] Kawanishi, N. Jin, K.S. Si, H. Kawahara, Y. Morikawa, H., "Building Context-Aware Applications and Probe Space Infrastructure", *IEEE International Symposium on Intelligent Signal Processing and Communications*, 2006, pp. 103-106.

[18] K.K. Thyagharajan, Ratnamanjari Nayak, "Adaptive Content Creation for Personalized e-Learning Using Web Services", *Journal of Applied Sciences Research*, 2007, Vol. 3, No. 9, pp. 828-836.

[19] Koun-Tem Sun, Hsin-Te Chan, "The Study of Using Sure Stream to Construct Ubiquitous Learning Environment", *2008 IEEE International Conference on Sensor Networks, Ubiquitous, and Trustworthy Computing*, 2008, pp. 534-548.

[20] Lanzilotti, R., Ardito, C., & Costabile, M. F., De Angeli, A.," eLSE Methodology: a Systematic Approach to the eLearning Systems Evaluation", *Educational Technology & Society*, 2006, Vol. 9, No. 4, pp. 42-53.

[21] Maria Zajac, "Using Learning Styles to Personalize Online Learning", *Journal on Campus- Wide Information System*, 2009, Vol. 26, No. 3, pp.256-265.

[22] Mianxiong Dong, Kaoru Ota, Zixue Cheng, Guojun Wang, "A Support Method for Improving Learner's Learning Habit Using Behavior Analysis in a Ubiquitous Environment", *IEEE 2007 International Conference on Parallel Processing Workshops (ICPPW 2007)*, 2007, pp. 67-72.

[23] Mingfei Wang, Linlin Ci, Ping Zhan, Yongjun Xu, "Applying Wireless Sensor Networks to Context-Awareness in Ubiquitous Learning", *IEEE Third International Conference on Natural Computation (ICNC 2007)*, 2007, Vol. 5, pp. 791-795.

[24] Peng Chen, Anbo Meng, Chunhua Zhao, "Constructing Adaptive Individual Learning Environment Based on Multi- Agent System", *IEEE International Conference on Computational Intelligence and Security Workshop (CISW 2007)*, 2007, pp. 374-377.

[25] Stefan Dietze, Alessio Gugliotta, John Domingue, "Addressing Context-Awareness and Standards Interoperability in E-Learning: A Service-oriented Framework based on IRS III".

[26] Sun Microsystems, "*E-learning Framework*", 2003.

[27] Tzone-I. Wang, Kun-Te Wang, Yueh-Min Huang," Using a style-based ant colony system for adaptive learning, *Elsevier Journal on Expert System with Application*, 2008, Vol. 34, No. 4, pp. 244-246.

[28] Xinyou ZHAO, Fumihiko ANMA, Toshie NINOMIYA, Tishio OKAMOTO, "Personalized Adaptive Content System for Context

Aware Mobile Learning", *IJCSNS International Journal of Computer Science and Network Security*, Vol. 8, No. 8, 2008, pp. 153-161

[29] Yang. S. J. H, "Context Aware Ubiquitous Learning Environment for Peer- to- Peer Collaborative Learning", *Educational Technology and Society*, Vol. 9, No.1, 2006, pp. 188-201.

[30] Yang S. J. H, Irene Y.L. Chen, "Providing Context Aware Learning Services to Learners with Portable Devices", in proceedings of *2006 IEEE International Conference on Advanced Learning Technologies (ICALT ' 06)*,2006, pp.840-842.

[31] Yevgen B., Hamidreza Baghi, Igor Keleberda, Michael Fleming, "An adjustable personalization of search and delivery of learning objects to learners", *Elsevier Journal on Expert System with Application*, 2009, Vol. 36, No. 5, pp. 9113-9120

[32] Yuan Fan Zhan, Laurence Capus, Nicole Tourigny, "A Learner Model for Learning- by- Example Context", *Eighth ACIS International Conference on Software Engineering, Artificial Intelligence, Networking, and Parallel/Distributed Computing*, 2007, pp. 778-785.

[33] ZHU Zhen,"Design and Implementation of Web-Services based E-Learning System", *IEEE 2009 First International Workshop on Education Technology and Computer Science*, 2009, pp. 233-237.