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THE FRAMEWORK FOR e-LEARNING2.0 AND ITS PRIMARY FUNCTIONS

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ABSTRACT
By introducing the concept of *Cloud Computing*, the architecture of e-Learning has been changed, So, we propose an autonomous learning support system that encourages learners' interaction by "the Architecture of Participation". We developed learning management system based on SNS. This system has two models that describe 1) learner's acquired knowledge, and 2) learner's participatory attributes. The learner's acquired knowledge is identified by its articles. The learner's participatory attributes are identified by learning activities in the system. Moreover, this system can recommend various learning objects, modules as "sub-contents" and persons based on the learner profile model.

Then, Web-based services, applications/tools and learning contents along with *cloud computing* are utilized for building flexible learning environments. Based on those shared resources, it is possible to create a new Model of Learning Ecology. The principle of learning activities in this new ecology is supposed as followings; the social autonomous leaning- process by a) discover new facts, b) create new artifacts, c) change and/or transform shared web content in learning community.

KEY WORDS
SNS, Cloud Computing, Participatory Learning, Learning Ecology, e-Karte, Knowledge Circulation

1. Introduction

A shift to knowledge-based society requires a new level of educational environment in higher education – the environment that makes possible to continue to learn not only for full-time students but also adult students who have full-time or part-time jobs. e-Learning provides one type of such kind of educational environment because students can learn collaboratively at anytime and at any place using e-Learning technologies and rich multimedia educational content.

At the same time, the Internet technologies have rapidly developed and changed towards social computing and social interactivity, for example, well-known applications such as Twitter, wikis, bookmarking, blogs, add-ins, mash-up, etc. Due to this change the concept of e-Learning shifts from individual learning to group, organization, community and society learning. The main characteristics of this shift are as follows: bottom-up, learner-driven, peer learning and knowledge sharing oriented approaches. Methods of access to learning content include various search engines, RSS (RDF Site Summary) feed, and others. As a result, these days "Web Page" is characterized not only by *read* function, but also by *rewrite*, *add-in*, *share*, *re-use*, *co-built and co-create* functions aimed to create new and meaningful knowledge.

Due to the above described conceptual shift of Internet technologies, there is a need to design an innovative framework of e-Learning system and modify the current educational system at a university.

The goal of proposed research, design and development project on innovative e-Learning is to show great advantages of e-Learning, and, therefore, convince faculty to actively use e-Learning technologies in education. The primary factors that have been used for professional development of e-Learning educators in this project include:

1) organizational collaboration;
2) facilities: e-Learning studio, e-Learning lecture room, learning management system (LMS);
3) content development systems: authoring system, monitoring /mentoring system, supporting system for building a Learning Community, testing/evaluating system, etc.;
4) active faculty development based on innovative instructional design and learning design.

Nowadays, the concept of Web2.0 has been proposed by many researchers and developers who are interested in Internet technologies, social computing/networking, Cloud/Grid computing, etc. As a result, a new concept of e-Learning is already under discussion within e-Learning research and academic communities by faculty, practitioners, researchers, educational technologists, training, virtual universities, etc. The key topics of such a discussion include but are not limited to 1) collaborating and social networking, 2) recommendation and community formation of learning, 3) sharing and re-using of learning content/knowledge, 4) virtual learning environment, and 5) e-Learning 2.0 technology.

2. Research Background

2.1 Organizational Collaboration

In 2004, the University of Electro Communications, in Tokyo, Japan (UEC) founded the Center for Developing e-Learning (CDEL) in order to promote the Good Practice (GP) national project funded by the Japanese government.

The university initiated wide organizational collaboration on e-Learning. The CEDL plays a central role for improvement of Internet-based educational activities. It developed the multi functional intelligent LMS named *WebClass-RAPSODY;* it is aimed at 1) design and development of learning content, 2) promotion and faculty and professional development, 3) management of intellectual property and author's rights, 4) mentoring and coaching.

2.2 Facilities

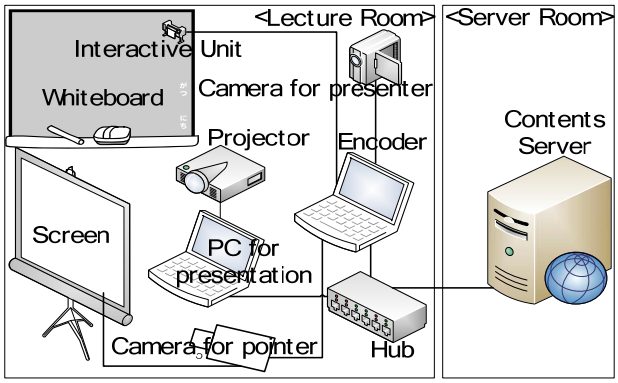

Figure.1 Authoring tools in lecture room

The CEDL has e- Learning room, e-Learning studio and the *Webclass-RAPSODY* LMS. A faculty can use e-Learning studio in order to create educational movies along with presentations and other related documents on PC, as well as handwritten notes or manuscripts on a white board. Furthermore these authoring tools can be used in traditional lecture rooms as shown in Figure 1.

3. Organizational Knowledge-Circulated Management (OCM)

3.1 Mission of CDEL

The mission of the CDEL is based on two major types of activities: research and services (Figure 2) that include:

Research:

a) active research on educational and technological issues of advanced e-Learning and active collaboration with international partners;
b) standardization in e-Learning (ISO/IEC-JTC1 SC36);
c) Information and Communication Technology (ICT-based) improvement of education;
d) design, development, storage, and re-use of learning content, systems, tools and applications.

Services:

a) faculty consulting on e-Learning;
b) rent e-Learning lecture room, e-Learning studio, and various types of corresponding systems;
c) open seminars, forums, international conferences;
d) management of learning content's intellectual property and author's rights.

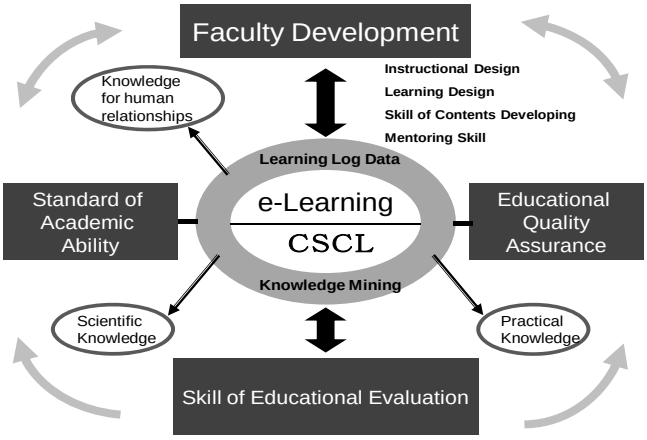

Figure 2. Mission and main activities of the CDEL

The higher individual faculty's teaching and development abilities are, the higher standard of academic abilities and educational quality assurance of the entire UEC is. As a result, the CDEL provides active and comprehensive professional and faculty development of UEC faculty on various relevant topics including 1) instructional design, 2) learning design, 3) learning content's development skills, 4) mentoring skills. Additionally, by using log data of Computer-Supported Collaborative Learning (CSCL) in the Webclass-RAPSODY LMS, the CDEL personnel can standardize academic abilities and assure educational quality using various types of educational assessment and evaluation tools.

In this paper, we introduce recently developed systems top support the above-mentioned CDEL mission, specifically: 1) developed mentoring system for support of faculty (in terms of technological issues), and 2) developed methodology for instructional and learning design (in terms of pedagogical aspects).

3.2 Organizational Knowledge Circulated Management (OKCM) System

In order to manage both technological and pedagogical issues, the CDEL designed and developed the OKCM system (Figure 3).

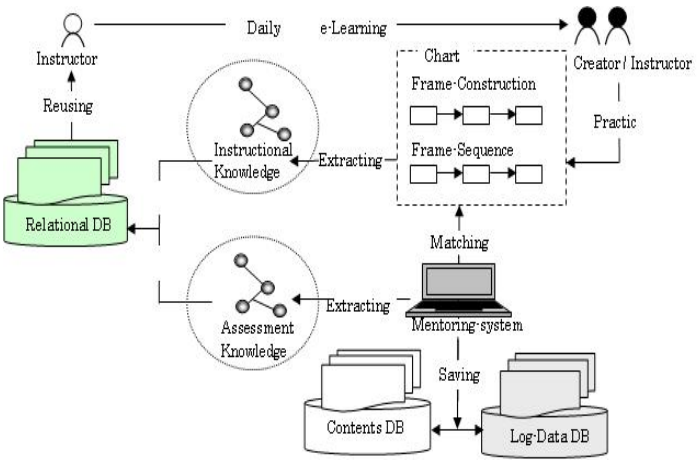

Figure 3. OKCM system

A system to extract frame-construction and frame-sequence has been developed so far. In order to do so, the instructors need to prepare knowledge charts first.

4. Mentoring System and its Architecture

It is difficult to maintain advanced e-Learning activities. Thus, regular mentoring and assistance for students/learners is important to keep their motivation to learn high. However, it requires a lot of lecturer/faculty's time and efforts to provide all students/learners comprehensive advices constantly and on time (on demand); as a result, it is necessary to automate mentoring activities. This is the main reason that the CDEL developed the *auto-mentoring system to support lecturers* – a system which makes possible 1) to extract targets by learning log data from LMS, and 2) send mentoring messages automatically.

The first version of the developed auto-mentoring system supports learners just in one course; this version is explained below. (It is good to mention here that our ultimate plan is to develop a system to support learners to complete all their courses by providing automatically-generated answers to learner's questions and/or pointing out probable learner's weak points in his/her knowledge base as well). An architecture of the current version of the auto-mentoring system is presented at Figure 4.

First of all, an instructor should develop rules of 1) classification of learners, and 2) construction of messages. Technically, those developed rules are stored in the system as 1) production rules of learner classification and 2) production rules of construction of messages. The Extracting Target Module matches leaning log data (or, a request) with existing production rules of learner's classification and extracts a list of learners who need some mentoring messages.

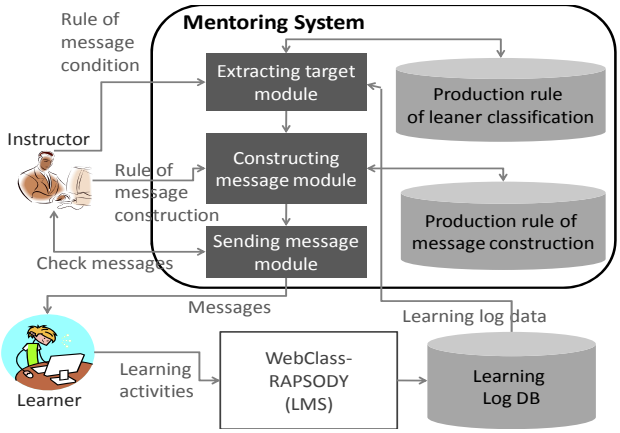

Figure 4. Architecture of the auto-mentoring system

Then, the Sending Message Module automatically 1) creates appropriate mentoring messages for targeted learners and 2) asks an instructor to check correctness of developed messages. If an instructor approves the automatically developed messages, then the Sending Message Module sends those approved-by-instructor messages to targeted learners. Corresponding learning activities of each learner are recorded in the Leaning Log Database through the WebClass-RAPSODY LMS. An example of e-Karte that reflects how students/learners get through this process is shown in Figure 5.

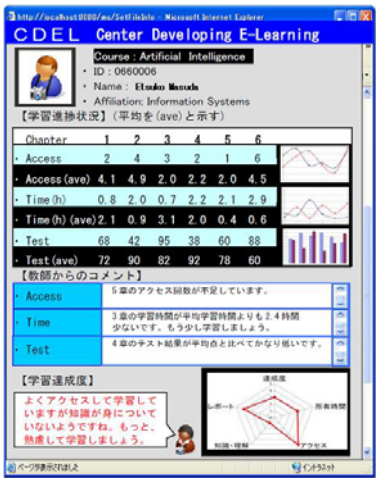

Figure 5. Example of e-Karte

Based on provided data and outcomes, students/learners can 1) evaluate their own academic progress and learning outcomes, and 2) reschedule and/or modify their learning activities (if needed).

5. System's Functionality

In order to implement new ICT-based systems for e-Learning, the developed OKCM system provides five major functions as described below.

1) *Authoring function:* Information Technology and instructional methodology for design and development of high quality learning content.
2) *Supervising function:* Management and statistics/evaluation functions of learning objects and learner's profile (including learning log data).
3) *Learning support function:* Diagnosing, mentoring and evaluating through learning process.
4) *Collaborative & active learning/working function:* Indicator of request/referring information. Mail & chat. Collaborative learning/working field. Knowledge hunting.
5) *Knowledge mining/reusing management function:* Data/knowledge mining. Knowledge sharing/reusing. Knowledge systematizing.

In addition, there are nine evaluation criteria for OKCM system; they should be used in case of university-wide OKCM systems.

1) One access to data/information (a portal);
2) Top level of security;
3) Stock/circulation of know-how and innovative technology for development and improvement of learning objects and content;
4) Learning objects (Los) and a repository of LOS;
5) Assessment technology;
6) Logical integration between academic performance data and learner's information such as profile, curriculum, syllabus, registration status, record, mentoring, supervision, etc.;
7) Data and links relevant to faculty development;
8) Data and links relevant to pedagogical activities without e-Learning;
9) Cost and overall performance.

The organizational activities of e-Learning practice in this model are related to faculty development which is an important mission of the CDEL. The developed 1) auto-mentoring system and 2) methodology of Instructional Design and Learning Design strongly support UEC faculty to perform his/her activities in Context, Content and Personalization areas, especially in terms of *Behavior and Usage Analysis*.

The "Organizational Collaborative Management" part for e-Learning practices will be based on the proposed model. "e-Learning Community" part of this project is based on Social Computing conceptual model and it is still in progress.

6. Participatory Learning Environment based on Social Networking Services (SNS)

SNS is a service of Web2.0 that is proposed by O 'Reilly (2004). In a service that is related to Web2.0, the value of that service rises by obtaining a contribution of the user. Consequently, it often leads to the development of the service. Therefore, obtaining the contribution of the user becomes an important factor for a growth of that service. O 'Reilly defined an environment designed to obtain the contribution of the user as "Architecture of Participation" model; in this paper, we will pay attention to the "Architecture of Participation" model. We introduce an SNS-based learning environment, where both learners and teachers can create learning content. If number of learning modules or objects (components of learning content) increase, then there is a greater number of learners who use those learning modules. Therefore, a learner actively communicates with other learners in such a learning environment.

Thus, the value of the entire learning environment rises because the user contributes to the learning environment. In this paper, we define the learning environment as "the participatory learning environment". The participatory learning environment is based on the concept of "Architecture of Participation". A learning cycle in this environment is as follows. First, a learner studies some learning content, web pages and so on. Next, he/she publishes articles to explain what he/she understood. Other users read the article and give some comments to his/her published article. Their comments and advices help the author of the article to improve his/her understanding (or, knowledge). The other learners also can reflect their own understanding by discussing a designated topic with the author of published article. Some educational institutions have reported practices of teaching/learning with tools such as blog, Wiki, and SNS. However, these tools might be used only for the information exchange in some practices. In that practice, the learning log data are not used efficiently for supporting learners.

The primary features of Web2.0 are;

1) Web format services (not package software);
2) Participatory architecture;
3) High scalability;
4) Data and possibility for re-construction of data sources;
5) Device independent;
6) Collective knowledge;
7) A set of possible self-services.

In this paper, we propose an educational system that encourages learner interaction by "the Architecture of Participation". We developed learning management system based on SNS. Our system has two models that describe 1) learner's acquired knowledge, and 2) learner's participatory attributes. The learner's acquired knowledge is identified by its articles. The learner's participatory attributes are identified by learning activities in the developed system. Moreover, the developed system can recommend other students various learning objects or modules as "sub-contents" based on a model of a particular student/learner. Sub-contents are constructed of user's entries and comments for those entries

7. Learning Activities in SNS-based Learning Management System

Learning activity in the SNS-based learning management system (for learning mode) is presented at Figure 6. First of all, if the user creates a learning course, then a learning community for this course is formed. At this time, the course creator participates in that learning community as a teacher. Other users are registered as learners by participating in the community. The learners acquire knowledge by taking the developed course. Next, if an assignment is given by a teacher, then learners publish the learning outcomes by posting blog entries. Learners and teacher post comments to entries, and evaluate them. A learner who publishes an entry occasionally provides a reply to posted comment. It is possible for learners to reflect their own understanding via interaction with other learners or a teacher. One can observe such a system as "an entry with a set of comments" system or a system with "sub-content".

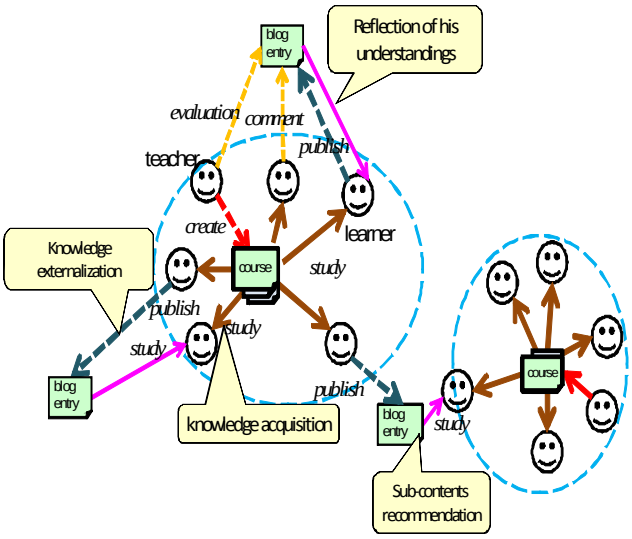

Figure 6. Learning activities in the SNS-based learning management system

The developed system stores learner's sub-content as well as developed-by-teacher content in a database. Those learning objects (or, modules) can be used by other learners to obtain new knowledge. The learning process is based on learning cycle -- 1) an acquirement of knowledge, 2) an externalization of knowledge, and 3) a reflection of their understandings. The more learners participate actively in this environment, the more learning objects/sub-contents exist, and, as a result, the learning environment gets multiple benefits such a process.

8. Recommendation Functions of SNS-Based LMS

A configuration of the SNS-based learning management system is given at Figure 7. The system is composed of three modules: 1) Keyword Extraction Module, 2) Learner Modeling Module, and 3) Sub-Content Recommendation Module. The Keyword Extraction Module extracts important (or, key) words from posted learning content and sub-content. The important words included in learning content are registered in the Keyword Database. Those keywords are considered as important components of learning content. The Learner Modeling Module generates Learner Knowledge Model and Participation Characteristic Model based on learners' activities in the system. The additional sub-content may be recommended for a learner by the Sub-Content Recommendation Module based on the learner's current knowledge. An example of the MyPage of the developed system is presented at Figure 8.

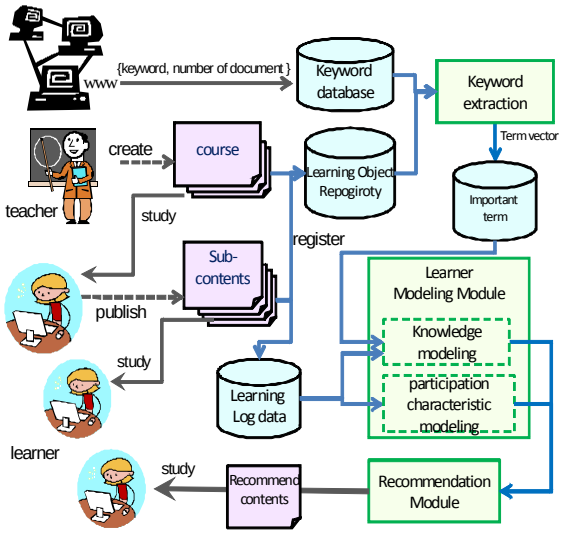

Figure 7. SNS-based architecture of LMS

8.1 Keyword Extraction

Keyword set W is extracted from learning content and sub-content. The developed system is not limited to any specific area of study. Therefore, it needs to deal with a wide variety of different technical terms. A preparation of a technical dictionary for each specific area is difficult task. Therefore, the developers of the system use data from Wikipedia, a free online encyclopedia, for each technical dictionary. Wikipedia covers terms from various fields and is generally up-to-date. The concepts which have an entry in Wikipedia are extracted as keyword set W_w; this set is obtained from data of stored Japanese version of Wikipedia.

The developed system extracts important (or, key) term sets W_c from learning content. The key terms in the W_c are those which are included in W_w and the learning

content. The developed system calculates *a weight coefficient* of each term in the set W_c by applying *the tf-idf method*. The *tf-idf weight* (*term frequency – inverse document frequency)* is a weight often used in information retrieval and text mining. This weight is a statistical measure used to evaluate how important a word is to a document in a collection or corpus. The *tf-idf weight* is calculated by *tf-idf*(t,d)=*tf*(t,d)***idf*(t,d). Term frequency, formulated as *tf*(t,d) stands for the number of times the term t appears in the document d. The inversed document frequency can be formulated as *idf*(t)= log(|D|/*df*(t)+1), where *df*(t) is the number of documents in which term t appears. |D| is the total number of documents on the corpus. In this research, the value |D| is considered as the total number of all pages in the Internet. The value of |D| has been set by systems' developers as 35 Billion. Additionally, *df*(t) is considered as the number of pages that includes term *t* on the Internet. The value of *idf*(t) is identified by the retrieval result of a search engine.

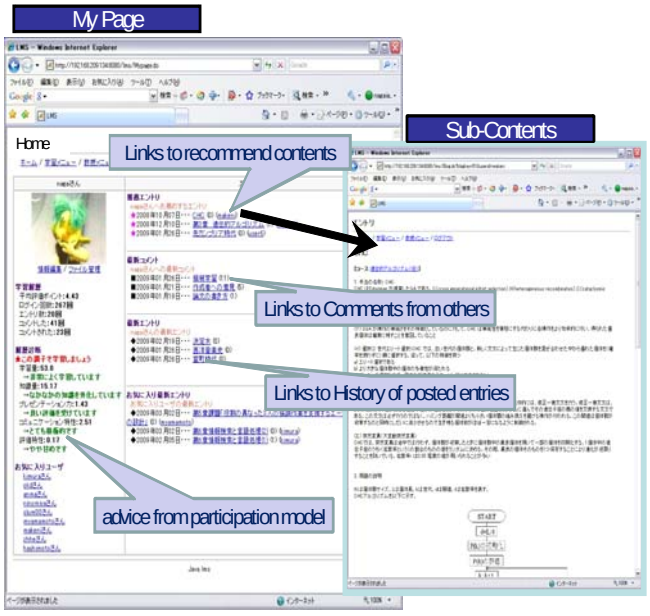

Figure.8 The example of MyPage in the developed system

8.2 Knowledge Model and Participation Characteristic Model

In order to provide a learner with efficient way to reflect his/her knowledge, a system should recommend appropriate sub-content according to learner's requests. The developed Sub-Content Recommendation Module is aimed to support a creation of suitable sub-content for a learner. The Learner Modeling Module generates learner's model based on his/her activities in the system. From this, the Recommendation Module generates learner's preferences based on learner's model and makes a decision regarding a list of recommended sub-content for that particular learner. Learner's model is composed of 1) Knowledge Model, and 2) Participation Characteristic Model. The Knowledge Model describes what concepts a learner is interested in and what concepts a learner has studied so far. The assumption used is that learners' interests can be identified based on a set of keywords extracted from learner's entries. The Knowledge Model is developed based on extracting 1) key terms from learner's entries, and 2) posted-by-learner comments. The Participation Characteristic Model creates a set of learner's social characteristics based on learner's activities in the developed system.

The parameters of the Participation Characteristic Model include 1) learning quantity, 2) presentation skills, 3) communication level, and 4) evaluation tendency; they are defined as follows:

1) learning quantity: How much did the learner study?
2) presentation skills: How well did the learner explain the concept that he/she understood?
3) communication level: Is a learner's nature positive or passive when learner communicates with other learners?
4) evaluation tendency: Whether a learner's evaluation to others severe or not?

9. New Model of Learning Ecology

Web-based services and learning content along with corresponding software and hardware are shared in learning environment built-on *Cloud Computing* concept. Based on those shared resources, it is necessary to create a new Model of Learning Ecology (Figure 9). The principle of learning process is *learning activity* -- a process to a) discover new facts, b) create new artifacts, c) change and/or transform shared web content in learning community. Those learning activities lead to new autonomous and collaborative learning *gestalt* – the so-called *knowledge constructivism*.

A schema of mashing-up a learning environment on "Problem Tasks" for "Self-directing" and "Collaboration/social networking" is given in Table 1, where Personal Learning Environment (PLE) should be communicated (or, linked) in order to generate learners' a) preferences, b) needs/readiness, c) adaptability and d) current status. In this sense, it is challengeable to solve such a problem that has ambiguous conditions for a design of dynamic learning/teaching process.

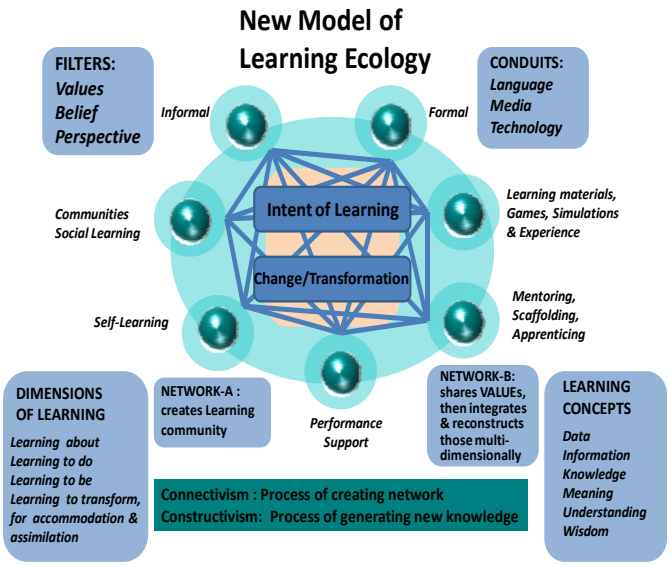

Figure 9. New Model of Learning Ecology/Technologies

Table1 Features of learning environment on self-directing, collaboration and networking

Self-directing	Problem tasks	Collaborative and Social networking
Planning and self-directing individualized learning activities	Tools for visualizing learning activities and tool preference	Grounding for learning activities in group and regulating group activities
Planning personal Learning environments (PLE) using social and other software	Sets of interoperable Social software and LMS	Grounding for and Assembling shared group environments with PLEs
Assembling PLEs, and LMS systems beyond Institutional borders	Learning and teaching highly ambiguous settings, experiencing the change	Involving study partners beyond institutional borders

10. Conclusion and Future Steps

In this paper, a new framework for e-Learning 2.0 and its have been introduced. The proposed architecture should encourage greater interaction between learners due to the used "Architecture of Participation" concept and active sharing of resources. The gestalt of learning ecology should be used among individuals, groups, organizations and social learning. A SNS-based learning management system has been developed. It provides recommendations for learners on learning objects in order to encourage active interaction among learners. In the future, additional functionality on knowledge discovering/constructive editing for knowledge sharing/collaborative building activities will be needed.

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