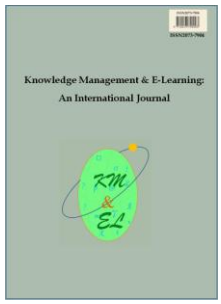
Knowledge Management & E-Learning



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Knowledge management mechanisms in e-learning environment: A conceptual model

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Abstract: The purpose of this study is to design a conceptual framework for application of electronic mechanisms of knowledge management in e-learning environment. A three-step strategy has been adapted in this research. The first step deals with designing an initial framework for the research based on review and analysis of the related literature. The proposed conceptual framework has considered typology of knowledge including the knowledge "from", "for" and "about" the learner to introduce electronic mechanisms of knowledge management. In the second step of research, validity of the suggested framework is evaluated by experts' opinion. Totally, 37 knowledge management mechanisms were confirmed by the experts. Thereby, the most important electronic mechanisms for management of the three major types of learner knowledge were introduced as "electronic community of practice", "learner complaining recording/satisfaction collecting system" and "web seminar". Then, the extent of knowledge management mechanism utilization was explored in four Iranian virtual universities (two state universities and two non-governmental universities) using the conceptual framework of research.

Keywords: e-Learning; Knowledge management; Electronic mechanisms; Learner knowledge; Iranian virtual universities

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1. Introduction

Over the last decade, educational landscape has evolved from a traditional teaching environment to a highly open and dynamic knowledge-based environment. This is mainly due to the large adoption of computers, internet, intranet and instructional software applications on campus (Arntzen, Worasinchai, & Ribière, 2009).

Many institutions have heavily invested in development and deployment of online programs. E-learning has increasingly become a viable, effective way of delivering instruction and training (Khan, 2005a). Moore (1998) states: "Our aim as faculty should be to focus our attention on making courses and other learning experiences that will best empower our students to learn, to learn fully, effectively, efficiently, and with rewarding satisfaction. It is the responsibility of our profession to study ways of maximizing the potential of our environments to support their learning and to minimize those elements in their environments that may impede it."

Nonaka and Takeuchi (1995) have distinguished knowledge management (KM) as a process by which the enterprise adopts to make profit from its knowledge or intellectual capital. They believe that the knowledge management is a process during which the enterprise creates value from intellectual and knowledge-based assets. But surprisingly, KM has not been a high priority for higher education until recently. However, there is a growing recognition that knowledge management can enable higher education to evolve more smoothly to a highly interactive and dynamic educational environment (Robson, Norris, Lefrere, Collier, & Mason, 2003).

Although several researches have been conducted on knowledge management and its role in enhancement of e-learning, there was almost no study on identification and application of knowledge management mechanisms in e-learning environment with the basis of learner. Therefore, this work decides to introduce the concept of "learner knowledge management". This concept includes application of proper techniques and tools of knowledge management for supporting the learner within e-learning environment. The term "learner" is used to address anyone who is taking lessons or training courses in an e-university or e-learning center.

This study provides a set of learner knowledge management mechanisms within the proposed framework called 3 Dimensional Learner Knowledge Management (3D LKM) considering various disciplines including "for", "from" and "about" learner. Different disciplines of knowledge have been introduced in the proposed conceptual framework. Furthermore, electronic mechanisms of knowledge management have been suggested for each learner knowledge area within e-learning environment. Having approved the model, existence or inexistence of these mechanisms has been evaluated as

well as their extent of application in four virtual universities (two state universities and two private universities).

2. Literature review

2.1. e-Learning

Holmes and Gardner (2006) have introduced the history of e-learning as long and rather unclear. This kind of training was initiated by Sidney Pressey in his testing machine at 1920s. The apparatus was a simple device which taught the student, tests him/her and finally calculated the score of him/her. Teaching experienced a significant growth using technology after invention of this apparatus during 40 years with development of machine-based learning. One of the most important contributions of this new idea was publication of Marshal McLuhan's book in 1964 entitled "Understanding Media: The Extensions of Man". Based on the studies of Harasim (2006) at the beginning of 1970s, electronic mail and computerized conferences were invented for the first time. By the mid years of this decade, academic lessons were supported well by these two significant inventions. Meanwhile, researchers were able to constitute virtual working communities. Learning via computers was extensively adopted in work environments; then it was introduced to some schools in Canada and finally used by universities. At the same time, Internet was born in 1989.

With the advent of the Internet and online learning methodologies and technologies, providers of education and training were creating e-learning materials to fulfill the demand. Online learning was becoming more and more accepted in the workplace. Institutions were investing heavily in the development and deployment of online programs. Academic institutions, corporations, and government agencies worldwide were increasingly using the Internet and digital technologies to deliver instruction and training (Khan, 2005 b).

Various definitions of e-learning have been provided by researchers so far, some of which are summarized in Table 1.

Based on the definition of Khan (2001) which viewed e-learning as synonymous with web-based learning (WBL), Internet-based training (IBT), advanced distributed learning (ADL), web-based instruction (WBI), online learning (OL) and open/flexible learning (OFL), open learning has distinct three characteristics, namely being flexible, open and extensive as it is presented in Fig. 1.

According to Calder and McCollum (1998), "The common definition of open learning is learning in your own time, pace, and place" (p. 13). Ellington (1997) notes that open and flexible learning would allow learners to understand how, where, and when learning takes place (Khan, 2005a).

Khan (2005a) believes that learning is in fact extension of a training model which enables teachers, students and contents to be located at decentralized and different locations in order to realize the teaching and learning independent of either time or place.

Table 1
Definitions of e-learning

Author(s)	Definition
Urdan and Weggen (2000)	e-Learning is defined as the delivery of content via all electronic media, including the internet, intranets, extranets, satellite broadcast, audio/video tape, interactive TV, and CD-ROM. Yet, e-learning is defined more narrowly than distance learning, which would include text-based learning and courses conducted via written correspondence.
Waight, Willging, and Wentling (2002)	- e-Learning is "anytime, anywhere, cost effective, have a global reach, be just-in-time, allow personalization and improve collaboration and interactivity". - The acquisition and use of knowledge distributed and facilitated primarily by electronic means.
Khan (2005a)	e-Learning can be viewed as an innovative approach for delivering well designed, learner-centered, interactive, and facilitated learning environment to anyone, anyplace, anytime by utilizing the attributes and resources of various digital technologies along with other forms of learning materials suited for open, flexible, and distributed learning environment.
Li and Masters (2009)	Effective e-learning thrives at the nexus of web usability, communication, relationship, document, and knowledge management tools, and can dramatically enhance a learner's learning experience.
Rosenberg (2001), Alias (2012)	The use of Internet technologies to deliver a broad array of solutions that enhance knowledge and performance.

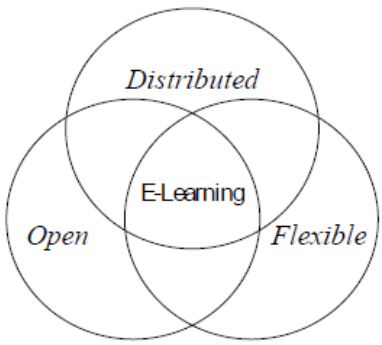

Fig. 1. Open, flexible and distributed e-learning

Zemsky and Massy (2004) suggest there are three major categories of e-learning:

1. e-Learning as distance education: This refers to courses which are delivered entirely, or almost entirely, on the Internet.
2. e-Learning as electronically mediated learning: This category includes any teaching or learning that is mediated by technology.

3. e-Learning as facilitated transactions software: This category includes the software that is used to organize and manage teaching and learning, learning management systems like the commercial products BlackBoard and WebCT, as well as open source products like Moodle.

The main purpose of e-learning is to reduce the time people need to learn by providing specialized up-to-date information (Ivanov & Zabunov, 2003). According to Takalani (2008), e-learning adds the benefit of encouraging learners to take responsibility for their learning in addition to build self-knowledge and self-confidence.

e-Learning components are Instructional Design (ID), Multimedia Component, Internet Tools, Computers and Storage Devices, Connections and Service Providers, Authoring/Management Programs, Enterprise Resource Planning (ERP) Software, Standards, and Server and Related Applications (Khan, 2005a).

Some features of e-learning are interactivity, authenticity, learner-control, convenience, self-containment, ease of use, online support, course security, cost effectiveness, collaborative learning, formal, and informal environments, multiple expertise, online evaluation, online search, global accessibility, cross-cultural interaction, non-discriminatory (Khan, 2005a).

The advantages of e-learning compared to traditional course delivery include flexibility, accessibility and convenience for students, cost and time savings for educational establishments, and the ease and speed with which courses can be updated and revised (Delgado-Almonte, Andreu, & Pedraja-Rejas, 2010).

Mouzakitis (2009) considered advantages of using e-learning in training activities ascost-effectiveness, productivity improvements, faster learning, better retention, customer satisfaction and employee increased satisfaction, and facilitation of self-paced learning.

Irfan and Shaikh (2008) specified two general categories of learning: E-learning by using explicit knowledge and E-learning by using tacit knowledge, as can be seen in Fig. 2.

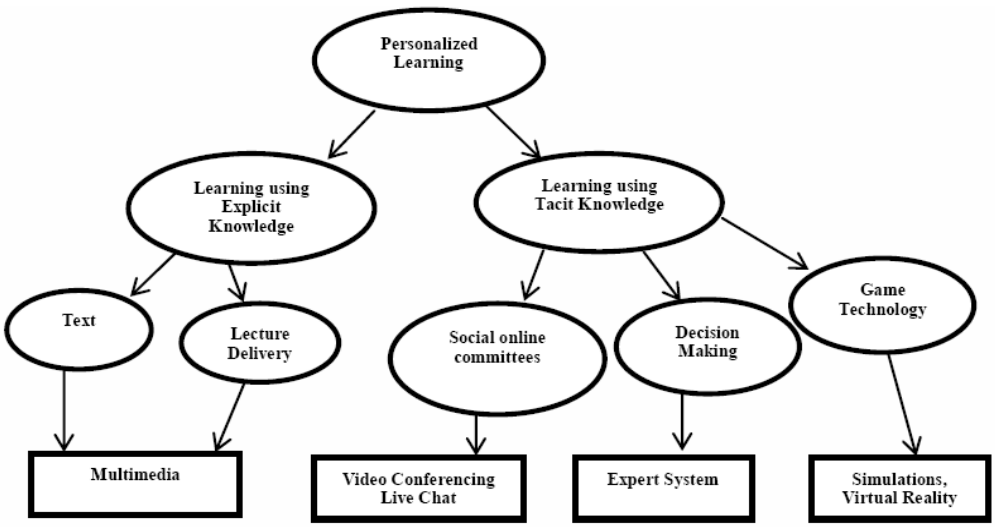

Fig. 2. Personalized learning model

Marshall et al. (2003) proposed three types of EL tools: (1) curriculum tools, (2) digital library tools, (3) and knowledge representation-concept maps tools, which emphasize the different parts of the learning process. Curriculum tools provide a systematic and standard environment to support classroom learning; their functions are particularly helpful in the initiation and selection stages. Digital library tools facilitate effective and efficient access to resources to support exploration and collection, while knowledge representation or concept maps tools focus on formulation and representation (Islam, Kunifuji, Miura, & Hayama, 2011).

2.2. Knowledge management

Taking into account the arguments of some relevant authors, knowledge management is not a new concept but it rather dates back to about 3000 years B.C., although was not anciently called by its current name.

Knowledge management (KM) has a fundamental role in managing knowledge assets as managerial tools within current knowledge-based economy of enterprises. Numerous enterprises apply knowledge management strategies to create value, attain competitive advantage and realize organizational goals.

KM, although coined in the early 1980s, deals with how best to leverage knowledge internally and externally in order to stimulate innovation, build a sense of community, preserve the institutional knowledge base, and promote internal and external organizational effectiveness (Liebowitz & Frank, 2010).

Knowledge management in an educational context can be defined as follows: "the systematic process of finding, selecting, organizing, distilling and presenting information in a way that improves a learner's comprehension and/or ability to fulfill his or her current learning objectives" (Okamoto, Nagata, & Anma, 2009). KM oriented EL has become the effective tool that transfers tacit knowledge information into explicit knowledge, as a result, organizations with this system can accomplish knowledge and information delivery in or between organizations (Islam, Kunifuji, Miura, & Hayama, 2011).There are numerous definitions in the literature for KM, the most important of which has been listed in Table 2.

Table 2
Definitions of knowledge management

Author (s)	Definition
Nonaka and Takeuchi (1995)	A process by which the enterprise adopts to make profit from its knowledge or intellectual capital.
O'Dell and Grayson (1998)	Conscious strategy of getting the right knowledge to the right people at the right time and helping people share and put information into action in ways that will improve organizational performance.
Knapp (1998)	The art of transforming information and intellectual assets into enduring value for organization's client and its people.
McCampbell, Clare, and Gitters (1999)	The strategies and processes of identifying, capturing and leveraging knowledge.
Darroch (2003)	The process which creates or locates knowledge and manages the dissemination and use of knowledge within and between organizations.
Liebowitz and Frank (2010)	KM deals with how best to leverage knowledge internally and externally in order to stimulate innovation, build a sense of community, preserve the institutional knowledge base, and promote internal and external organizational effectiveness.

Considering the definitions mentioned in Table 2, knowledge management can be defined as using processes of creation, sharing, storage and application of knowledge in the organization to attain competitive advantage and survive within current knowledge-based economy.

Knowledge management follows three major goals as discussed by Davenport and Prusak (1998) and also Alavi and Leidner (2001):

1. To make knowledge visible and to show the role of knowledge in an organization, mainly through maps, yellow pages and hypertext tools;
2. To develop a knowledge-intensive culture by encouraging and aggregating behaviors such as knowledge sharing (as opposed to hoarding), and also via seeking and offering knowledge proactively;
3. To build a knowledge infrastructure not only as a technical system, but also as a web of connections among people given space, time, tools, and encouragement to interact and collaborate.

In order to realize the goals of KM, it seems inevitable to use practical tools, methods and mechanisms. Knowledge management adopts to create, share, store and apply knowledge using different mechanisms and tools.

KM mechanisms are organizational or structural means used to promote knowledge management. They may (or may not) involve the use of information technology, but they do involve some kind of organizational arrangement as well as social/structural means of facilitating KM. They depend on KM infrastructure and they facilitate KM systems (Becerra-Fernandez & Sabherwal, 2010).

Taking into consideration the technological nature of e-learning, it should be noted that this research has just studied electronic mechanisms of knowledge management. Table 3 provides a list of identified mechanisms with their relevant definitions as a result of analysis on KM resources.

Table 3
Electronic mechanisms of knowledge management

No.	Mechanism	Definition	Author(s)
1	**Reporting Tools**	It provides a tool for making written reports. These reports indicate the extent of learner's participation in various parts of the portal and his/her utilization from the teaching content.	Binney (2001), Maier & Remus (2008)
2	**Press Room**	It provides news about various departments or segments of the virtual university/training center.	Sakhaee, Shahbaznejad, & Shamizanjani (2012)
3	**Link to Other Sites**	Learners could connect to other websites with quick link using this mechanism.	Sakhaee et al. (2012)
4	**Electronic Community of Practice**	It is virtual network of people who share common interests in a specific competitive field of knowledge, while they tend to work with and learn from each other.	Ariely (2006), Tidd (2006), SDC (2009)
5	**Link Website to Friends**	This tool has advertising features, through which learners could introduce website of the virtual university/training center to their friends.	Sakhaee et al. (2012)
6	**SMS**	Short Message Service (SMS) comes with a mobile phone and enables the user to transmit written short messages using mobile phones.	Sakhaee et al. (2012)

No.	Mechanism	Definition	Author(s)
7	**Follow up Service Information**	Follow up request includes information which enables the learner to follow status of his/her request from the virtual university/training center. He/she could also be informed about recent changes in attending the request.	Sakhaee et al. (2012)
8	**Electronic Bulletin Board**	This tool involves informing and publication of news about recent events as well as new products and services on the website. It also enables knowledge exchange, lesson management and content management among learners within e-learning environment.	Chi & Holsapple (2005), Edwards, Shaw, & Collier (2005)
9	**Discussion Forum**	This mechanism is a virtual environment for learners to share their viewpoints and ideas with the professors. This Communication is established as an online community or society.	Dalkir (2005), Edwards, Shaw, & Collier (2005), Becerra-Fernandez & Sabherwal (2010)
10	**Electronic White Board**	This tool benefits from the advantages of white board; it improves discussion and cooperation among members; it simplifies mark-up screen sharing, white boarding, and conferencing.	Ribière & Tuggle (2005), Beerli, Falk, & Diemers (2003)
11	**Virtual Tour**	It provides a virtual environment to display products, their production space, guide to services and etc.	Sakhaee et al. (2012)
12	**Chat**	It is used to address any communication between faculty and learner through the Internet. It mostly deals with face-to-face or text-based communications in a group usually via messengers.	Ribière & Tuggle (2005), Becerra-Fernandez & Sabherwal (2010), Dalkir (2005)
13	**Digital Storytelling**	Digital storytelling utilizes computers to develop multimedia rich stories, while using web environment to share them. It makes virtual university/training center or learners to share their stories with each other through web.	Munkvold (2008), Pereira (2009), Ariely (2006), SDC (2009)
14	**About Us**	It gives general information about virtual university/training center as well as its mission and vision.	Sakhaee et al. (2012)
15	**Web Seminar**	A web-based seminar is a mechanism which is distributed among audience via Internet using technology of streaming media in order to simultaneously publish the content. The content might be published live or upon request.	Sakhaee et al. (2012)
16	**Frequently Asked Questions (FAQ)**	A list of questions usually asked accompanied by their answers.	Chi & Holsapple (2005), Sakhaee et al. (2012)
17	**Knowledge Networks**	Behavioral patterns, official structures and mechanisms which correlates knowledge agents which were not correlated before due to task, hierarchical and legislative boundaries.	Maier & Remus (2008), SDC (2009)
18	**Image & Video Galleries**	Includes s set of images and videos about products, services and their applications. It provides learner with a great deep understanding.	Sakhaee et al. (2012)
19	**Groupware**	It is a kind of soft wares to support teamwork. Electronic group discussions, supporting electronic sessions, group supporting systems, group calendars, automation of workflow and etc.	Ribière & Tuggle (2005)

No.	Mechanism	Definition	Author(s)
20	**Call Centers**	A central office established and used to receive and transmit a great number of requests via telephone.	Chi & Holsapple (2005), Sakhaee et al. (2012)
21	**Search Engine**	Search engine is an application which can find websites, written facts and images in intranet network of the organization and also the Internet.	Stankosky (1999), Zack (1999), Binney (2001), Chi & Holsapple (2005), Edwards, Shaw, & Collier (2005), Ribière & Tuggle (2005), Handzic (2004),
22	**Electronic Help Desk**	It can online answer questions and problems of learners about the e-learning system.	Binney (2001), Becerra-Fernandez & Sabherwal (2010)
23	**Site Map**	A webpage which shows content and structure of the site and helps the learner to find his/her best way through.	Sakhaee et al. (2012)
24	**Knowledge Maps**	A user interface which provides the communication between knowledge and knowledge holders graphically. It is known as a way of offering a great volume of complicated contents for a much better utilization of the learners from knowledge acquisition and application.	Binney (2001)
25	**Web Mining**	Web mining is the process of data extraction from web and their storage in identifiable relationships and patterns. It includes text mining, data mining and skill mining within web environment.	Becerra-Fernandez & Sabherwal (2010), Zack (1999), Dalkir (2005), Chi & Holsapple (2005), Edwards, Shaw, & Collier (2005), Ribière & Tuggle (2005), Handzic (2004)
26	**Weblog**	Weblog can be viewed as a newspaper which is published online. They are usually updated daily by relatively simple software.	Maier & Remus (2008), Sakhaee et al. (2012)
27	**Wiki**	It is used to address a website or a set of hyperlink texts which enable the users to complete its content, while other users can change this content.	Dalkir (2005), Maier & Remus (2008)
28	**Leaner Complaining/Recording Satisfaction Collecting System**	Complaining and satisfactory records can be collected and delivered to the admin by this system.	Sakhaee et al. (2012)
29	**Electronic Interview with Learner**	A mechanism used for knowledge acquisition from learners about services and products of the virtual faculty/institution as well as the competitors.	Sakhaee et al. (2012)
30	**Annotation**	Annotation technologies would enable user(s) to attach short comments in particular sections of texts.	Dalkir (2005)
31	**Cookies**	Cookie (tracking cookie, browser cookie) is a small text stored on computer by the web explorer application. Indeed, they are a tool for tracing the behaviour of learner in the website of virtual university/training center or other favourite websites.	Sakhaee et al. (2012)

No.	Mechanism	Definition	Author(s)
32	**Wish List**	It enables learners to express a set of services interested in or potential to be used in the future.	Sakhaee et al. (2012)
33	**Audio/Video Conference**	A tool which enables participation of two or more people via audio/video media.	Becerra-Fernandez & Sabherwal (2010), Dalkir (2005)
34	**Write to US**	Learners can send their viewpoints to the enterprise through it	Sakhaee et al. (2012)
35	**Electronic Catalogue**	An electronic brochure containing detailed information about applications of product and services which provides comprehensive information for better understanding of learner for decision making.	Sakhaee et al. (2012)
36	**E-Mail**	Sending and receiving mails with various contents on an electronic basis for dynamic and offline communications with the learner.	Sakhaee et al. (2012)
37	**Survey Forms**	These are forms which are completed by students and professors. Thereby, faculty will get useful information about the students and will be able to predict their future behaviours.	Sakhaee et al. (2012)

2.3. Knowledge management and e-learning

Knowledge management and e-learning both include knowledge acquisition, sharing, application and potentially production of it. These two important issues have significant technological elements which finally lead to enhance learning. They both contribute to creation of a continuous learning culture based on either knowledge or learning axes.

Zeng (2008) considers e-learning as a tool to help internalizing tacit knowledge, using it as a way of knowledge acquisition, and application of this novel technique of learning to improve knowledge sharing.

Lamont (2003) declares that some researchers and enterprises look at e-learning as a part of knowledge management while some others suppose knowledge management as a tool used within e-learning process. He also states that e-learning is a static content, whereas knowledge management is able to mutate it into a dynamic process. Thereby, having integrated knowledge management and e-learning, the learning experience would approach much closer to the real job experience.

Morales (2005) contended that KM and EL are closely related because EL users need a suitable KM that can help them to obtain the kind of content they need, together with as correct and complete information as possible (Islam, Kunifuji, Miura, & Hayama, 2011).

Chen and Hsiang (2007) investigate importance of creating communities based on knowledge through e-learning as a crucial element to implement knowledge management policies. Moreover, they have also introduced the followings as the key factors of a successful community on the basis of e-learning:

> *"Participation of key personnel in creation and development of knowledge strategy, designing a procedure to complete current work and contribute to form a knowledge sharing cycle, learner-based technology, participation of knowledge community to realize business objectives, new strategies and marketing for business, creation of a learning environment, providing*

substantial rewards for achieving the objectives, providing extensive time and place of learning inside organizations, and establishment of a mutual trust among team members".

Del Peso and de Arriaga (2008) demonstrated that combination of knowledge management and e-learning via use of intelligent systems is likely to improve organizational performance.

3. Research methodology

A three-step strategy has been used in this work. A schematic view from different steps of research has been depicted in Fig. 3.

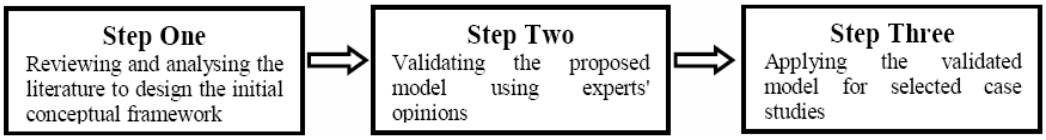

Fig. 3. Schematic view of research steps

An initial conceptual framework was designed for electronic mechanisms of knowledge management in e-learning environment at the first step of this research based on review and analysis of the related literature. In the second step, a questionnaire was designed for confirming the initial framework. This questionnaire was comprised of two parts, where different types of learner knowledge ("about", "from" and "for" learner) and electronic mechanisms for each of them were assessed by experts in first and second parts, respectively. This questionnaire was distributed among 44 experts of knowledge management and e-learning. Purposive method and snowball sampling technique were employed at this step of research for identification of experts in this field.

At the third step, four Iranian universities (two state universities and two non-governmental universities) were selected to examine their status using the model.

Table 4
Universities under study

University	Type	Foundation year	Number of questionnaires	Professors		Students of last semester		High level personnel of universities	
				F	Percentage	F	Percentage	F	Percentage
A	State	2004	20	9	45%	4	20%	7	35%
B	State	2001	25	6	24%	8	32%	11	44%
C	Non-governmental	2005	39	10	26%	17	43%	12	31%
D	Non-governmental	2005	19	4	21%	6	32%	9	47%

In order to determine existence or inexistence of the electronic mechanisms for knowledge management as well as the extent of using each of these mechanisms in the four universities, a second questionnaire was designed. The questionnaire was distributed among "professors", "last semester students" and "high level personnel of universities". 103 questionnaires were filled totally. The numbers of questionnaires are listed in Table 4

according to the universities. All of the selected universities hold their virtual courses for Master of Science degree.

4. Data analysis

4.1. Data analysis on first step of research

As mentioned earlier, the initial framework of research was designed for the electronic mechanisms of knowledge management in e-learning environments at the first step using literature review and analysis. This framework has been nominated as "3 dimensional (3D) framework of learner knowledge management" in this study. Based on this framework, different types of learner knowledge, "about", "from" and "for" learner, have been considered to introduce the electronic mechanisms of knowledge management.

Fig. 4. 3D framework of learner knowledge management

Knowledge "about" learner is a kind of knowledge (also analysed and interpreted data or information later transformed to knowledge) which is acquired by a virtual university/training center for better recognition of its learners and their needs. This type

of knowledge involves "current learner information" and "prospective learner information".

Knowledge "from" learner is a kind of knowledge (also analysed and interpreted data or information later transformed to knowledge) which is acquired by a virtual university/training center for improvement of its educational services for learners. This aspect of knowledge incorporates "virtual university/training center-related information" and "competitors-related information".

Knowledge "for" learner is a kind of knowledge (also analysed and interpreted data or information later transformed to knowledge) which is acquired by learners for achievement of a better recognition from the university/training center they are studying in. This aspect of knowledge includes "virtual university/training center's service information", "virtual university/training center's environment information" and "virtual university/training center's general information". Fig. 4 illustrates the initial conceptual framework offered here.

4.2. Data analysis on second step of research (Validation of initial framework)

The second step of research was implemented for validation of the proposed framework. The questionnaire was sent to 6 experts to evaluate reliability and validity of the research. It should be noted that this questionnaire involves two sections: the first section is related to different types of the learner knowledge (i.e. knowledge for learner, knowledge from learner and knowledge about learner), while the second section deals with different management mechanisms of the learner knowledge. The questionnaire is presented in Appendix 1.After confirming the validity by them, the reliability was also verified considering the value of 0.948 for Cronbach's alpha in some 61 questions.

4.2.1. Kolmogorov-Smirnov (K-S) test

As shown in Fig. 5, Kolmogorov-Smirnov (K-S) test has been used to assess the normal behaviour of data distribution.

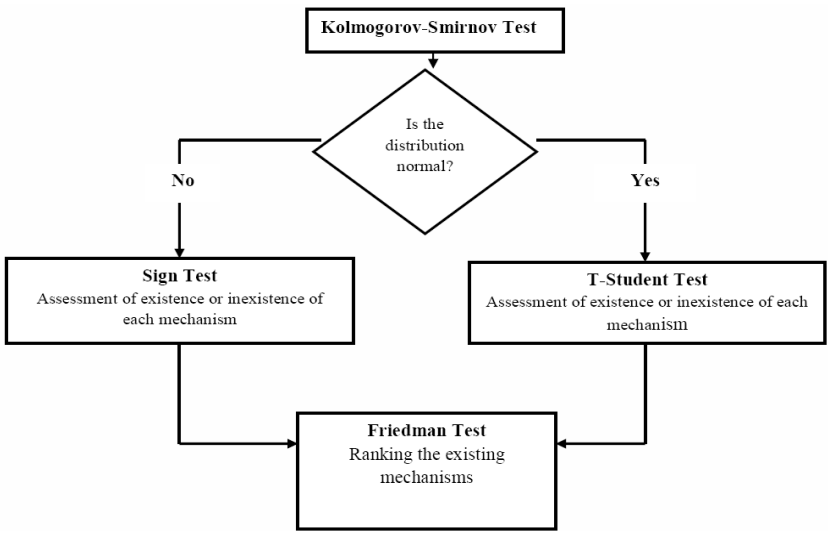

Fig. 5. Methods of statistical analysis in second step of research

Hypotheses of this test are listed below:

H_0: *Data follow a normal distribution*

H_1: *Data do not follow a normal distribution*

If the amount of Sig. is smaller than 5%, then the hypothesis H_0 is rejected and the claim of normal distribution will not be accepted.

According to the obtained results, data distribution of all variables including all aspects of the learner knowledge and also mechanisms of knowledge management, except two variables related to "cookies", "Knowledge map" and "web mining" in "knowledge about learner" and also "email" and "chat" in "knowledge for learner" with normal distribution, all other variables revealed anon-normal distribution. Parametric (T-student) test and non-parametric (sign) test have been used according to the type of data distribution in order to determine whether these variables have been effective or not.

4.2.2. Sign test

4.2.2.1. Sign test for studying various types of learner knowledge

A non-parametric sign test was utilized in order to examine different kinds of the learner knowledge. These hypotheses are summarized below:

H_0: *Experts did not agree about different types of learner knowledge (P=0.5).*

H_1: *Experts agreed about different types of learner knowledge (P≠0.5).*

Since the significance level is below 5%, the results of this study imply that the H_0 hypothesis cannot be accepted. In other words, all different types of the learner knowledge were confirmed by the experts. The results of this test are reported in Tables 5, 6 and 7.The results of sign test indicates that all introduced types of learner knowledge including knowledge "about" learner (current learner information and prospective learner information), knowledge "from" learner (virtual university/training center-related information and competitors-related information), and knowledge "for" learner (virtual university/training center's service information, virtual university/training center's environmental information and virtual university/training center's general information) have been confirmed by the experts.

Table 5
Results of sign test for "knowledge for learner"

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
virtual university/training center's service information	Group 1	<= 3	2	.05	.50	.000
	Group 2	> 3	38	.95		
	Total		40	1.00		
virtual university/training center's environment information	Group 1	<= 3	8	.20	.50	.000
	Group 2	> 3	32	.80		
	Total		40	1.00		
virtual university/training center's general information	Group 1	<= 3	6	.15	.50	.000
	Group 2	> 3	34	.85		
	Total		40	1.00		

Table 6
Results of sign test for "knowledge from learner"

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
virtual university/training center-related information	Group 1	<= 3	6	.15	.50	.000
	Group 2	> 3	34	.85		
	Total		40	1.00		
competitors-related information	Group 1	<= 3	5	.13	.50	.000
	Group 2	> 3	35	.88		
	Total		40	1.00		

Table 7
Results of sign test for "knowledge about learner"

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
current learner information	Group 1	<= 3	1	.03	.50	.000
	Group 2	> 3	39	.98		
	Total		40	1.00		
prospective learner information	Group 1	<= 3	3	.08	.50	.000
	Group 2	> 3	37	.93		
	Total		40	1.00		

4.2.2.2. Sign test for examination of electronic mechanisms

Sign test is used to address the effect of each variable of the electronic mechanisms with non-normal distribution. Hypotheses of this test are defined as below:

H_0: Experts did not agree on effect of different electronic mechanisms (P=0.5).

H_1: Experts agreed on effect of different electronic mechanisms (P≠0.5).

Table 8
Results of sign test for each mechanism in "knowledge for learner"

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
Reporting tools	Group 1	<= 3	5	.13	.50	.000
	Group 2	> 3	35	.88		
	Total		40	1.00		
Press room	Group 1	<= 3	4	.10	.50	.000
	Group 2	> 3	36	.90		
	Total		40	1.00		
. . .						
Weblog	Group 1	<= 3	5	.13	.50	.000
	Group 2	> 3	35	.88		
	Total		40	1.00		
Wiki	Group 1	<= 3	1	.03	.50	.000
	Group 2	> 3	38	.97		
	Total		39	1.00		

Table 9
Results of sign test for each mechanism in "knowledge from learner"

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
Leaner Complaining/Recording Satisfaction Collecting System	Group 1	<= 3	3	.08	.50	.000
	Group 2	> 3	37	.93		
	Total		40	1.00		
Write to us	Group 1	<= 3	6	.15	.50	.000
	Group 2	> 3	33	.85		
	Total		39	1.00		
.						
.						
.						
Weblog	Group 1	<= 3	8	.20	.50	.000
	Group 2	> 3	32	.80		
	Total		40	1.00		
Wiki	Group 1	<= 3	9	.23	.50	.001
	Group 2	> 3	30	.77		
	Total		39	1.00		

Table 10
Results of sign test for each mechanism in "knowledge about learner"

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
Write to us	Group 1	<= 3	6	.15	.50	.000
	Group 2	> 3	34	.85		
	Total		40	1.00		
Discussion forum	Group 1	<= 3	2	.05	.50	.000
	Group 2	> 3	38	.95		
	Total		40	1.00		
.						
.						
.						
Weblog	Group 1	<= 3	5	.13	.50	.000
	Group 2	> 3	35	.88		
	Total		40	1.00		
Wiki	Group 1	<= 3	5	.13	.50	.000
	Group 2	> 3	34	.87		
	Total		39	1.00		

Since the significance level is below 5%, the results of this test indicate that the H_0 hypothesis cannot be accepted. In other words, all the mechanisms with non-normal distribution were confirmed by the experts. A brief history of the obtained results is given in Table 8, 9 and 10.

4.2.3. Average test (t-student test)

The average test (t-student test) is used to determine weight of each variable (electronic mechanisms) of normal distribution. The hypotheses of this test are listed below:

H_0: Experts did not agree on effect of each electronic mechanism ($\mu \leq 3$).

H_1: Experts agreed on effect of different electronic mechanisms ($\mu > 3$).

Taking into account the smaller than 5% significance level, the results of this test indicate that the H_0 hypothesis cannot be accepted. In other words, these two mechanisms were approved by the experts. The results of this test are listed in Table 11.

The same procedure was adopted for assessment of the proposed mechanisms in each of the subsets. The results of both average test (for normal data) and sign test (for non-normal data) in this section indicate verification of them all by the experts.

Table 11
T-student test results for normal data

		Test Value = 3					
						95% Confidence Interval of the Difference	
		T	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Knowledge for learner	**E-mail**	8.101	39	.000	1.025	.77	1.28
Knowledge for learner	**Chat**	8.034	39	.000	.975	.73	1.22
Knowledge about learner	**Cookie**	5.791	38	.000	.897	.58	1.21
Knowledge about learner	**Knowledge map**	7.415	39	.000	.975	.71	1.24
Knowledge about learner	**Web mining**	8.062	39	.000	1.000	.75	1.25

4.2.4. Friedman variance analysis test

Afterwards, Friedman test was used to rate the importance of each electronic mechanism of knowledge management proposed within a conceptual framework from experts' point of view. The hypotheses of this test are defined as below:

H_0: There is no significant different between importance of each knowledge management mechanism.

H_1: There is a significant different between importance of each knowledge management mechanism.

The obtained results show that the H_0 hypothesis is not confirmed at 95% confidence level. Thus, Friedman variance analysis tests can be used to rank importance of each knowledge management mechanism.

The results of this test have been summarized in two following tables. Table 12 provides the most important and the least important electronic mechanisms for each aspect of the learner knowledge separately, while Table 13 performs this comparison on all the mechanisms.

Table 12
Results of Friedman variance analysis test for different types of learner knowledge

Importance	Knowledge for learner	Knowledge from learner	Knowledge about learner
The most important	Electronic community of practice	Learner complaining recording/satisfaction collecting system	Annotation
	Discussion forum	Annotation	Survey form
	Knowledge network	Web mining	Wish list
The least important	Site map	Digital storytelling	Cookies
	Link website to a friend	Knowledge network	Web mining
	About us	Wiki	Digital storytelling

Table 13
Results of Friedman variance analysis test for all mechanisms altogether

Importance	Mechanism	knowledge Aspects
The most Important From experts viewpoint	Electronic community of practice	Knowledge for learner
	Learner complaining recording/satisfaction collecting system	Knowledge from learner
	Annotation	Knowledge for learner
	Web seminar	Knowledge for learner
	Discussion forum	Knowledge for learner
The least important from experts viewpoint	Audio/video conference	Knowledge from learner
	Wiki	Knowledge from learner
	Digital storytelling	Knowledge about learner
	Follow up service information	Knowledge for learner
	Link website to a friend	Knowledge for learner

4.3. Data analysis on third step of research (Application of framework)

The extent of application for each electronic mechanism of knowledge management was evaluated in four selected Iranian virtual universities using the second questionnaire. The second questionnaire was designed based on the conceptual framework of research. This questionnaire first adopts to determine existence or inexistence of each electronic mechanism in these universities and then, it evaluates the extent of using each of them. Having confirmed validity of the questionnaire by the experts, Cronbach's alpha was measured for assessment of reliability which was reported to be 0.867.

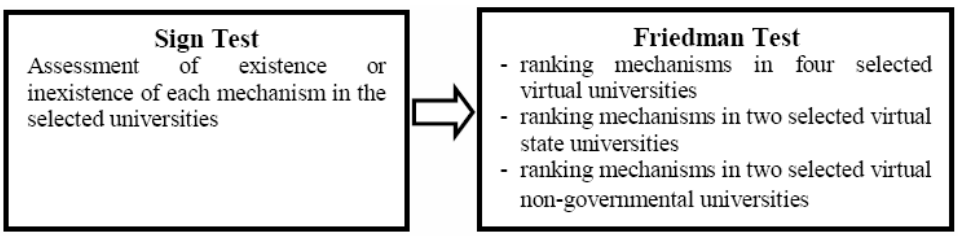

Fig. 6. Methods statistical analysis in third step of research

Structure of the second questionnaire is similar to the first questionnaire, except for the questions of "extent of success with mechanisms" to "extent of use from mechanisms".

Therefore, sign test was used to assess existence or inexistence of the mechanisms within selected virtual universities (Fig. 6). Then, the extent of application for each existing mechanism was examined in four virtual universities altogether using Friedman test.

Table 14 provides the existing electronic mechanisms in terms of the degree of use or utilization ranging from "most used" to "least used" in each university for different types of learner knowledge.

Table 14
The existing mechanisms in each selected university for different types of learner knowledge

University / Knowledge Type	A	B	C	D
Knowledge for learner	reporting tool, press room, SMS, call center, discussion forum, chat, FAQ, follow up service information, email, link to other website, electronic white board, about us, web seminar, electronic bulletin board, site map, electronic community of practice, audio/video conference, image & video gallery, search engine	electronic bulletin board, discussion forum, email, web seminar, electronic catalog, search engine, wiki, press room, SMS, FAQ, about us, reporting tool, knowledge network, groupware, chat, Follow up Service Information, call center, electronic community of practice, audio/video conference, image & video gallery, link to other website	email, electronic white board, chat, press room, about us, web seminar, FAQ, electronic catalog, audio/video conference, image & video gallery, call center, reporting tool, electronic community of practice, SMS, follow up service information, electronic bulletinboard, discussion forum, knowledge network	Discussion forum, call center, press room, email, SMS, link to other website, about us, discussion forum
Count.	**19**	**22**	**19**	**8**
Knowledge about learner	survey form, discussion forum, annotation	discussion forum, survey form, weblog, annotation, cookies, wiki	survey form, annotation, wish list, discussion forum	survey form
Count.	**3**	**6**	**4**	**1**
Knowledge from learner	discussion forum, call center, audio/video conference, survey form, learner complaining recording/satisfaction collecting system, annotation	learner complaining recording/satisfaction collecting system, call center, discussion forum, survey form, weblog, annotation, audio/video conference, wiki	call center, annotation, audio/video conference, electronic interview with learner, survey form, discussion form, learner complaining recording/satisfaction collecting system	Call center, discussion forum, Learner complaining recording/satisfaction collecting system
Count.	**6**	**8**	**7**	**3**
Overall Count.	**22**	**27**	**23**	**10**

Another analysis was done by consolidating all data of four selected cases in order to produce a general awareness of Iranian virtual universities. Table 15 lists the existing electronic mechanisms in four virtual universities ordered by the extent of application.

Table 15
Existing electronic mechanisms of knowledge management in four virtual universities according to their extent of application

Learner Knowledge Types	Mechanisms (ordered by the extent of application)
Knowledge about learner	Discussion forum, survey form.
Knowledge from learner	Call center, discussion forum, survey form, learner complaining recording/satisfaction collecting system, annotation, audio/video conference.
Knowledge for learner	Discussion forum, SMS, press room, email, reporting tool, web seminar, call center, electronic bulletin board, chat, weblog, FAQ, follow up service information, about us, electronic catalogue, search engine, link to other website, electronic white board, electronic community of practice, audio/video conference, image &video galleries.

5. Conclusions

This work introduced some 37 electronic mechanisms of knowledge management for e-learning environment after reviewing and analysing the previous researches. Having defined and classified different types of learner knowledge ("about", "from" and "for"), these electronic mechanisms were provided and confirmed in the form of a 3D conceptual framework. Thereby, the most important electronic mechanisms of knowledge management within e-learning environment from experts' point of view include "electronic community of practice", "learner complaining recording/satisfaction collecting system", "web seminar", "annotation" and "discussion forum" in order of significance.

In the next step, a conceptual framework was utilized for studying the extent of using knowledge management mechanisms in four virtual universities of Iran. The obtained results were indicative of the fact that electronic mechanisms of "link website to friends", "virtual tour", "digital storytelling", "knowledge networks", "groupware", "knowledge maps", "web mining", "wiki", "write for us", "electronic interview with learner", "cookies", "weblog", and "wish list" are not available in the selected universities. On the other hand, "call centers", "discussion forum", "SMS", and "press room" have the most applications among 23 existing electronic mechanisms in these universities.

From analysis and comparison of the results obtained here one can conclude that the state universities outperform non-governmental universities employing electronic mechanisms of knowledge management especially in "knowledge for learner". The state universities use "electronic community of practice", "follow up service information", "electronic white board", "web seminar", "knowledge networks", "electronic help desk" and "site map" in this type of learner knowledge. Noteworthy here is that despite existence of some mechanisms like "site map", "electronic help desk" and "weblog", they

were identified as those mechanisms which do not exist at all due to their poor introduction and instruction for being used.

Furthermore, comparing the most used and the least used mechanisms between state and non-governmental universities uncovers that the variety in the most used mechanisms is much greater than that of non-governmental universities. In state universities, there are just three mechanisms of "discussion forum", "survey forms" and "electronic white board" which are known as the mostly used. However, non-governmental universities benefit from "electronic bulletin board", "call centers" and "e-mail" additionally.

Comparison of important mechanisms from experts' point of view and mechanisms used in the selected universities indicates that two mechanisms of "wish list" and "web mining", which are rated as important by the experts, are not utilized in these universities. However, the available mechanism of "electronic community of practice" is among the least used applications in these universities.

Application of electronic mechanisms seems useful for improvement if different learner knowledge ("about", "from" and "for"). Thereby, recommendations of this research for development of the virtual universities are as follow:

1. The electronic mechanisms of knowledge management which are rated as important from experts' point of view but are not available in the selected universities, i.e. "wish list" and "web mining", must be used.
2. The existing electronic mechanisms of knowledge management must be introduced properly for professors and students.
3. The existing electronic mechanisms of knowledge management with the least application, i.e. "audio/video conference" in the knowledge "from" and "for" learner and "image and video galleries" and "chat" in the knowledge "for" learner must be improved through all the four universities. Moreover, mechanisms of "about us", "web seminars", "knowledge networks", "electronic catalogue", "search engine" in the knowledge "for" learner among state universities, while "reporting tools", "groupware", "call centers" and "link other sites" in the knowledge "for" learner and also "annotation" in the knowledge "from" learner among non-governmental universities should be enhanced to increase their application.
4. Taking into account the fact that only two electronic mechanisms are used in order to provide the knowledge "about" learner in these universities, further application of electronic mechanisms of knowledge management in this kind of knowledge would lead to a better recognition of current and prospective learners as well as their needs. This can consequently improve their satisfaction.

The following suggestions are also made for further studies:

1. The proposed model can be completed by adding some non-electronic mechanisms of knowledge management within e-learning environment.
2. The electronic mechanisms can be identified for each subset of different kinds of learner knowledge.
3. A model can be developed to use the social software considering different kinds of knowledge within e-learning environment.

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