The Development of Software Agents in e-Learning 3.0

Dorota Jelonek

Faculty of Management
Czestochowa University of Technology
Czestochowa, Poland
jelonek@zim.pcz.pl

Abstract— E-learning has significantly changed the process of educating students and employee training. The purpose of this article is to analyze the development trends of software agents used in e-learning. Particular attention is given to selected properties of agents, which can improve the services offered by agents assisting student and agents supporting teachers. Furthermore, the article presents the advantages and disadvantages of e-learning and an evolution of e-learning from the perspective of: e-learning 1.0, e-learning 2.0 and e-learning 3.0.

Keywords — e-learning 1.0; e-learning 2.0; e-learning 3.0; intelligent agents

I. INTRODUCTION

E-learning has been widely used for university-based and enterprise-based education. It is gaining applicability as an educational tool for a cost savings, institution reusability, its ability to enable students to study without the constraints of time and space and learner flexibility. In the literature of subject there is still ongoing discussion over advantages, disadvantages, quality, improvement of technical solutions and efficiency of e-learning application. In the discussion participate such experts from different domains as: education, computer science, information systems, psychology, sociology and educational technology, due to the fact that only multidimensional perception of e-learning can ensure success of such ventures [1].

E-learning appeared at the beginning of 90-ties of XX century and is constantly developed both in traditional e-learning form, hybrid training which is blended learning [2], m-learning (mobile learning) [3], b-learning (bloglearning) [4] and g-learning (game learning) [5].

The development of internet technologies that are used in e-learning allows to describe it from several perspectives: e-learning 1.0, e-learning 2.0 and e-learning 3.0 [6], [7], [8].

For building the e-learning 3.0 systems can be used new technologies as: Big Data or global data repository, linked data, cloud computing, smart mobile technology, personal avatars, 3D visualization, Semantic web and artificial intelligence e.g. intelligent agent.

Intelligent agent can be used in e-learning applications in different contexts. The various agent properties like autonomy, mobility, proactive and reactive behaviors, capability to co-operate and communicate with other agents makes it ideal for use in e-learning.

II. ADVANTAGES AND DISADVANTAGES OF E-LEARNING

The concept of e-learning functions in many contexts and includes a wide range of definitions. In the educational approach, e-learning is a way of teaching, education supported by digital technologies. This aspect is underlined also by the definition: "e-learning is the use of new multimedia technologies and the Internet to improve the quality of learning by facilitating access to resources and services, as well as remote exchange and collaboration" [9]. In many publications there are emphasized technical and technological conditions of e-learning. Such a view is presented by the definition: "e-learning is the use of electronic media for a variety of learning purposes that range from add-on functions in conventional classrooms to full substitution for the face-to-face meetings by online encounters" [10].

Characteristics of a distance learning system [11]:

– Individual learning
– Individual pace
– Arbitrary learning time
– Arbitrary learning place
– Student takes responsibility
– Interactivity
– Physical separation
– Illimitability of time and space
– Self-verification of knowledge
– Student cooperation
– One-to-one consulting.

Therefore, elementary characteristics of distance learning are its practicality, efficiency and flexibility.

Several mentioned above characteristics of e-learning could be perceived as advantages while the others as disadvantages. For comprehensive description of e-learning both advantages and disadvantages will be identified.

The advantages of e-learning can be considered as the follows [12]:

- Student can study anywhere as long as there is access to a computer with internet connection,
- They can work at own pace,
- User can accommodate different learning styles through different activities,
- Flexibility to join discussions any hour of the day,
- E-learning is cost effective.
- Convenience and flexibility.
- Reviewing material.
- Student motivation. Some students may find asynchronous online work more engaging, as they can interact with the material when they are freshest and most productive.
- Fewer pressures on limited space. Online education can reduce pressure on university facilities by freeing up classrooms.
- Analytics and assessment.
- Access and support. Online classes provide vital access to place-bound populations and other groups traditionally underserved by institutions of higher education,

Unlike print media, e-learning can also provide individualized instruction, and instructor-led courses allow clumsily and at great cost. In combination with evaluating needs, e-learning can target specific needs. By using learning style tests, e-learning can help to locate and target individual learning preferences. What is more, synchronous e-learning is self-paced.

The disadvantages of e-learning training are represented from different aspects [13] [12]:

- Lack of personal community and connection (not for blended learning),
- Its a banking model of education (which is partially inevitable),
- Not necessary based on the best science regarding How People Learn,
- Tech, toys, and teaching over learning,
- Focus on memorization over learning core competencies,
- Better aligning of incentives of teachers and learners,
- Downtime plus mobile as well as "play" are issues to consider as well,
- Underutilized talents and facilities;
- No way to ground social networking and web 2.0 tools; •
- Social isolation,
- Community. Online courses may not be able to replicate the vibrant intellectual and social community fostered by in-person education,
- Instructor workload,

- Student support - some students, including those with disabilities, may struggle to use online tools and will likely need technological support.
- Access –some students have limited or no access to computers, the Internet, and/or assistive technology.

Various types of e-learning can be distinguished. In terms of communication and learning style there are two types of e-learning synchronous and asynchronous. In synchronous instruction the teacher and students meet at the same time. In face to face instruction this means that everyone is in the same room at the same time. In online instruction synchronous instruction occurs through the use of technologies such as chat, two-way video conferencing, or audio conferencing. Online instruction is more likely to be asynchronous allowing students to access and participate in the course when they choose [14].

Synchronous e-learning is defined as Computer-assisted training where the instructor and participants are involved in the course, class or lesson at the same time (synchronized).

Asynchronous e-learning refers to learning materials that the learner can use whenever and wherever he or she wants. It connotes "on-demand" e-learning; e-learning that the learner can use when needed or when time is available [14].

There are also other types of e-learning such as mobile learning, blog learning and game learning.

Mobile learning is defined as the delivery of training by means of mobile devices such as mobile phones, PDAs and digital audio players, as well as digital cameras and voice recorders, pen scanners, etc. [3]. The potential of blogs as learning spaces for students in the higher education sector was presented by Williams and Jacobs [4]. Model g-learning was considered by Schwabe and Göth, who describe the design of the MobileGame prototype, exploring the opportunities to support learning through an orientation game in a university setting [5].

The evolution of e-learning (e-learning 1.0, e-learning 2.0 and e-learning 3.0) is related to the three generations of the Web (Web 1.0, Web 2.0 and Web 3.0).

With the advent of the Web, the major change was to have content available online. In this direct-transfer model, the instructor is the distributor of learning material in a media-rich way and addresses learners through various communication channels. This era is usually referred to as e-learning 1.0 [6].

The use of Web 2.0 technologies for teaching and learning is describing as e-learning 2.0. Web 2.0 is defined as "a space that allows anyone to create and share information online – a space for collaboration, conversation, and interaction; a space that is highly dynamic, flexible, and adaptable [15]. Web 2.0 and the associated technologies such as: wikis, blogs, podcasts, and other social web tools are well established and accepted by the students and the prevalence of these in e-learning is common. E-learning 2.0 is a collaborative model where knowledge may be socially constructed and communication is multi-directional.

The main features of the Web 3.0 technologies which differentiate it from its earlier generation, Web 2.0 are given as follows: semantic Web, openness and interoperability, global

repository of data, 3D virtualization, collaborative intelligent filtering, increased and reliable data storage capacity, higher screen resolutions, multi gesture devices and 3D touch user interface, Cloud Computing and intelligent agent systems.

One of the big things of e-learning 3.0 will be the ubiquitous access to learning resources with the use of mobile devices to virtually access anything, anytime and anywhere. [16]. Personalization is another very important trend. Personalization is seen as the key approach to handle the plethora of information in today's knowledge-based society." [17]

The usage of educational technology started from ICT education spreads into e-learning, m-learning, e-learning 2.0, e-learning 3.0 and SMART learning as the development of technology. A history of development of e-learning is presented in figure 1.

	ITC in education	e-learning	m-learning	Social learning (e-learning 2.0)	SMART learning (e-learning 3.0)
Features	Computer Assisted Instruction (CAI) Web Based Instruction (WBI)	Learning Management System (LMS)	Mobile – learning (m-learning)	Just in time learning	Intelligent adaptive learning
Main services	Cyber textbook	Cyber home study EBS Internet broadcasting	Mobile contents, Augmented Reality	App service	Online grade, smart textbook Individual portfolio
Main devices	Desktop PC	Internet PC	Mobile notebook PDA, PMP	Smart phone, Smart TV	Smart device
Time	1996	2003 -	2005 -	2010 -	2012 -

Fig. 1. A history of development
Source: Own ellaboration based on [18]

'SMART' in SMART learning means that self-directed(S), motivated (M), adaptive (A), resource free (R), technology embedded (T) education [18]. It focuses on activating online education with digital contents using smart devices. Noh, Ju, & Jung (2011) defined SMART learning as learner initiated learning which has various materials for learning and supports learner-teacher interaction [19].

Development of new solutions using intelligent agents technologies is important for the further evolution of e-learning 3.0 (smart learning).

III.   CHARACTERISTIC AND PROPERTIES OF AGENT

In the literature of the subject, there are many definitions of software agents, which emphasize various features of this software. An agent can be defined as "An encapsulated computer system that is situated in some environment and that is capable of flexible, autonomous action in that environment in order to meet its design objectives." [20]. M. Woda and P. Michalec, describe that: "Agent is a process which operates in the background and performs activities when specific events occur" [21] .

Software agents are attributed with a number of properties that clearly distinguish them from other types of software. Agents' characteristic is that, they act on behalf of others. Agent can be a delegate to a user, a program, another agent and it performs its tasks on behalf of them.

Agents are capable of relieving human intervention significantly and help in proper functioning of the system. From the various characteristics of agents the most frequently mentioned are: [22] [20] [23]:

1. Autonomy: Autonomy corresponds to the independence of a party to act as it pleases. Autonomous agents have control both over their internal state and over their own behavior.
2. Reactive (sensing and acting): the agent responds based on the input it received and according to the environment. It responds in timely fashion to changes in the environment.
3. Proactive: A proactive agent is one that can act without any external prompts. It acts in anticipation of the future goals
4. Flexibility: the agents are dynamic as their reaction is dynamic and varies according to the environment. Actions are not scripted.
5. Communication: It can be defined as those interactions that preserve the autonomy of the parties concerned. Communicates with its user and other agents.
6. Mobility: it is important for the agents to be able to move to other location (machine or environment) and to continue their tasks there.
7. Temporally continuous. It is continuously running process.
8. Learning. Changes its behavior based on its previous experience.

Agent software can be classified according to their functionality. Examples of very diverse agent's activities are presented below:

Agent supporting user. Its task is to help the user to use applications, devices or websites. This type of software often gives the impression of a contact with a real person.

Agent as an assistant which role is for example to manage the calendar of meetings or to search some information online according to the user's interests.

Email agent that performs the initial selection of e-mail which include spam rejection, sorting e-mails, checking for viruses, prioritizing messages.

Agent that search the Internet resources in order to gather information that is potentially necessary to the user.

Agent that manages network, supervises computer networks, detects failures and responses to threats. It also monitors networks and creates statistics.

From this wide selection of agent software, for the purpose of these considerations, the most important solutions will be those that can be used in e-learning.

Dynamic development of specialized software agents has stimulated the creation of multi-agent systems. The direction of changes exposes the skills of communication and cooperation of specialized agents. Important matters of multi-agents software include division of tasks between agents, selection of communication method, interaction between agents, protocols and system architecture. E-learning is an area in which the effective solutions of specialized autonomous agents and multi-functional multi-agent systems are expected.

IV. THE CONCEPT OF A MULTI-AGENT INTELLIGENT SYSTEM FOT E-LEARNING

Multi-agent systems are computer system that use the agent software. Agents can offer various services, customized to the needs of both students and teachers.

Agents as assistants can support the distance learning process. Student's assistant can be used to search educational materials and to monitor the user's progress in the online course. Teacher's assistant can help to distribute the course materials among students and can observe the learning progress of students.

Various roles of agents in e-learning systems were identified, therefore, only the concept of a multi-agent system can be used to fulfill such a complex task. The concept of an intelligent multi-agent system for the distance learning is presented in Figure 2.

The environment of the system includes agents' management system. The second essential element is the channel of communication between agents which is used to exchange information between agents. The communication between agents is carried out by sending messages using the standard ACL (Agent Communication Language). Figure 2 highlights a catalog of services provided by software agents.
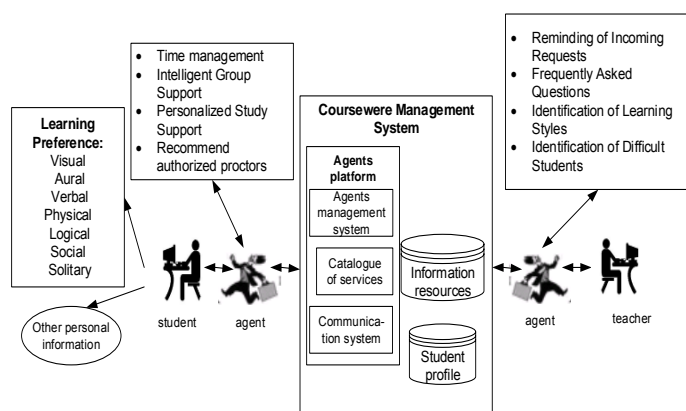

Fig. 2 The concept of an intelligent multi-agent system for distance learning
Source: Own ellaboration based on [24]

Everybody learns in a different way, therefore when possible people try to adapt the most suitable learning style to their needs. One of the services offered by the multi-agents software is identification of students' learning style. In literature there are many typologies of styles of learning. One of the most popular is Memletics Learning Styles that differs seven basic methods [25].

− Visual (spatial). Student prefers using pictures, images, and spatial understanding.
− Aural (auditory-musical). Student prefers using sound and music.
− Verbal (linguistic). Student prefers using words, both in speech and writing.
− Physical (kinesthetic). Student prefers using your body, hands and sense of touch.
− Logical (mathematical). Student prefers using logic, reasoning and systems.
− Social (interpersonal). Student prefers to learn in groups or with other people.
− Solitary (intrapersonal). Student prefers to work alone and use self-study.

TABLE I. EXAMPLES OF SOFTWARE AGENTS USAGE AS ASSISTANTS TO TEACHER AND STUDENT IN THE DISTANCE LEARNING

Functionality	Description
Student support	
Time management	The agent helps students to manage their time effectively by notifying students of due dates of assignments and appointments and develops right progress schedules based on students' activity schedules
Intelligent group support	The agent helps students by organizing study groups based on their study interests to achieve the best learning performances
Personalized study support	The intelligent agent recommends right learning styles to students based on their learning preferences to improve their learning effectiveness
Recommend authorized proctors for students to take exams	The intelligent agent searches the nearby proctor centers to find the best ones where each student can take his or her exam
Teacher support	
Reminding instructors of incoming requests	Through short messages on the cell phone, intelligent distance education systems alert instructors that new questions are awaiting responses.
Frequent asked questions (FAQ) management	The intelligent system builds a frequently asked questions case base for instructors to retrieve and adapt in the future
Identification of student's learning styles	The intelligent agent helps to identify student learning styles, helps instructors develop right teaching strategies, and offers personalized suggestions.
Identification of difficult	The intelligent systems help instructors to identify students with difficulties learning

students	in order to develop personalized teaching strategies.

Source: Own elaboration based on [23]

V DEVELOPMENT TRENDS OF SOFTWARE AGANETS

Most important properties of software agents have been enumerated in Tables 2 and 3, while in the columns services offered by agents for students and teachers were mentioned. The meaning of each property was estimated in comparison to the effective realization of the service.

In order to evaluate the properties of software agents a team of 5 experts was appointed (4 co-workers of the author and the author). Each expert has a degree in computer science, a certificate of training in the field of e-learning teaching and has organized e-learning classes. Every expert made an independent assessment. Basing on the collected assessments the final mark was given.

Three levels scale was taken into account: very important property (VIP), less important property (LIP) and meaningless property (MP).

TABLE II.   PROPERTIES AND SERVICES TO BE DEVELEP IN THE FUTURE OF SOFTWARE AGENTS SUPPORTING STUDENTS

Properties of software agents	Services offered by agents for students			
	Time management	*Intelligent group support*	*Personalized study support*	*Recommend authorized proctors for students to take exams*
Autonomy	MP	VIP	LIP	LIP
Reactivity	LIP	VIP	VIP	VIP
Proactivity	VIP	VIP	VIP	VIP
Flexibility	MP	LIP	LIP	LIP
Communication	VIP	VIP	VIP	LIP
Mobility	MP	MP	MP	MP
Temporally continuous	VIP	LIP	VIP	LIP
Learning	MP	VIP	VIP	VIP

Source: Own elaboration

It turns out that the services offered by software agents such as time management or reminding instructors of incoming requests are implemented efficiently enough therefore there is no need to further developed agents for this services (the largest number of ratings as meaningless property MP). For the improvement of identification services (recommend authorized proctors for students to take exams, identification of student's learning styles and identification of difficult

students) properties such as reactivity, proactivity and learning are very important.

TABLE III.   PROPERTIES AND SERVICES TO BE DEVELEP IN THE FUTURE OF SOFTWARE AGENTS SUPPORTING TEACHERS

Properties of software agents	Services offered by agents for teachers			
	Reminding instructors of incoming requests	*Frequent asked questions (FAQ) management*	*Identification of student's learning styles*	*Identification of difficult students*
Autonomy	MP	MP	LIP	VIP
Reactivity	LIP	LIP	VIP	VIP
Proactivity	VIP	VIP	VIP	VIP
Flexibility	MF	LIP	LIP	VIP
Communication	VIP	VIP	LIP	LIP
Mobility	MP	LIP	MP	MP
Temporally continuous	VIP	VIP	LIP	VIP
Learning	MP	VIP	VIP	VIP

Source: Own elaboration

CONCLUSIONS

Identification of the desirable properties and services of every specialized group of software agents supporting students and teachers will help to target the research and improve the existing solutions in this area.

The research shown that for both, agents supporting students and agents assisting teachers, the most desired properties, which should be develop in the future, are proactivity and communications.

The development of the learning property of the agent is valued as very important for six out of eight offered services. It is only valued as meaningless for time management and reminding instructors of incoming requests.

Mobility understood as being able to transfer itself from one machine to another is not a property of agent that is important for e-learning. Out of eight services, only in the case of FAQ Management it was evaluated as with little importance, while the remaining seven were evaluated as meaningless.

It was estimated that the flexibility in the development of software agents in e-learning is rather of a small importance. Only in the case of identification of difficult students it was rated as very important, because depending on the currently presented subject, a group of students who have difficulties is being created

E-learning is a teaching method that is gaining a growing number of supporters among both teachers and students. For

the further development of e-learning, eg. in the direction of learning 3.0 it is essential to effectively adopt new solutions, such as software agent technology supporting both students and teachers.

REFERENCES

[1] D. Jelonek, A. Nowicki, and L. Ziora, "The Application of e-Learning in the Didactic Process at the Faculty of Management in Czestochowa University of Technology. Organization. Tools. Model", Proceedings of Informing Science & IT Education Conference (InSITE), pp.143-156, 2014. http://proceedings.informingscience.org/InSITE2014/InSITE14p143-156Jelonek0467.pdf (2014-12-20).

[2] C. D Dziuban, J.L. Hartman, and P.D. Moskal, "Blended learning", ECAR Research Bulletin, 7. Retrieved April 27, 2008 from http://net.educause.edu/ir/library/pdf/erb0407.pdf (2014-12-10)

[3] D. Keegan, "The future of learning: From elearning to mlearning", Fern Universitat –Hagen, November 2002.

[4] J. B. Williams, and J. Jacobs, "Exploring the use of blogs as learning spaces in the higher education sector". Australasian Journal of Educational Technology, 2004, vol. 20(2), pp. 232-247.

[5] G. Schwabe, and Ch. Göth, "Mobile learning with a mobile game: Design and motivational effects", Journal of Computer Assisted Learning, 2005, vol. 21(3), pp. 204–216.

[6] F. Hussain, "E-LEARNING 3.0 = E-LEARNING 2.0 + WEB 3.0?", IADIS International Conference on Cognition and Exploratory Learning in Digital Age (CELDA 2012), http://files.eric.ed.gov/fulltext/ED542649.pdf (2015-01-05).

[7] S.-L. Huang, and J.-H. Shiu, "A User-Centric Adaptive Learning System for E-Learning 2.0." Educational Technology & Society, 2012, 15 (3), pp. 214–225.

[8] C. Safran, D. Helic, and C. Gütl, "E-learning practices and web 2.0", Paper presented at the 2007 International Conference on Interactive Computer Aided Learning, Villach, Austria, September 2007.

[9] F. Alonso, G. López, D. Manrique, and J.M. Viñes, "An instructional model for web-based e-learning education with a blended learning process approach", British Journal of Educational Technology, 2005, 36(2), pp. 217-235.

[10] S. Guri-Rosenblit, "Distance education and e-learning: Not the same thing", Higher Education, 2005, Vol 49(4), pp. 467-493.

[11] B. Nikolić, and L. Ružić-Dimitrijević, "Distance Learning – from Idea to Realization", Proceedings of Informing Science & IT Education Conference (InSITE) 2010. http://proceedings.informingscience.org/InSITE2010/InSITE10p369-384Nikolic806.pdf (2015-01-02).

[12] V. Nedeva, E. Dimova, and S. Dineva, "Overcome Disadvantages of E-Learning for Training English as Foreign Language", The 5th International Conference on Virtual Learning ICVL 2010 (2015-01-10).

[13] Challenges and Disadvantages of E-learning and Distance Learning, 2009, http://compassioninpolitics.wordpress.com/2009/09/26/

[14] N. Al-Taie, "The Effect of Using E-Learning Curriculum And Traditional Classroom Curriculum: Comparison &Merits", ICIT 2013 The 6th International Conference on Information Technology, http://icit.zuj.edu.jo/icit13/index.html (2015-01-10).

[15] K.A. Coombs, "Building a library web site on the pillars of Web 2.0", Computers in Libraries, 2007, Vol. 27 No. 1, available at: www.infotoday.com/cilmag/jan07/Coombs.shtml (2014-12-18).

[16] D. Baird, "Learning 3.0: Mobile, Mobile, Mobile Barking Robot", 2007, Retrieved March 21, 2012 http://www.debaird.net/blendededunet/2007/02/learning_30_mob.html (2014-12-16)

[17] M. Ebner, S. Schön, B. Taraghi, H. Drachsler, and P. Tsang, "First steps towards an integration of a Personal Learning Environment at university level", In R. Kwan et al. (Eds.), ICT 2011, CCIS 177 (pp. 22–36), Springer-Verlag Berlin.

[18] K. Soon-Hwa, S. Ki-SSang, and P. Se-Young, "Exploring the Technological Factors in SMART Learning Affecting Creativity, Advances in Educational Technologies", Proceedings of the 2014 International Conference on Education and Modern Educational Technologies (EMET 2014, Edited by N. Mastorakis, P. Dondon, P. Borne, Santorini Island, Greece, July 18-20, 2014, pp.161-166.

[19] Noh, Ju, & Jung, "The conditions of SMART Learning", digital policy study, 2011, 9(2), 79-88.

[20] N. Sivakumar, K. Vivekanandan, B. Arthi, S.Sandhya, and V. Katta, "Incorporating Agent Technology for Enhancing the Effectiveness of E-learning System", IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 3, May 2011, ISSN (Online): 1694-0814, www.IJCSI.org 4.

[21] M. Woda, P. Michalec, "Distance Learning System: Multi-Agent Approach", Journal of Digital Information Management-September 2005.

[22] D. Jelonek, and A. Chluski, " The role of software agents in distance education (Rola agentów programowych w nauczaniu na odległość)", Business Informatics, 2011, No 17, pp. 86-93.

[23] E. Kaasinen, "Usability Challenges in Agent Based Services", in: H. Zuidweg(ed.), Intelligence in Services and Networks. Paving the Way for an Open Service Market: 6th International Conference on Intelligence and Services in Networks, IS&N'99, Barcelona, Spain, April 27-29, 1999, Proceedings.

[24] L. Xiaoqing, "Intelligent agent – supported online education", Decision Science Journal of Innovative Education, 2007, Vol.5, No.2, pp.311-331

[25] Memletics Learning Styles Inventory. Free publication provided by www.memletics.com;   http://www.crs.sk/storage/memletics-learning-styles-inventory.pdf (2015-01-06).