

MULTIAGENT ARCHITECTURE FOR DISTANCE EDUCATION SYSTEMS

ANETA A. WIKTORZAK, ROMUALD KOTOWSKI

*Faculty of Computer Science and Food Science
Lomza State University of Applied Sciences, Lomza, Poland*

E-mail: awiktorzak@pwsip.edu.pl

Abstract: Computer technologies (CT) are a set of methods used in educational processes. CT can be used in very different ways in education, according to the vision and methodology imposed. The use of a specific computer technology depends on which learning theory is guiding the designers of the e-Learning solutions. The paper presents three main theories of teaching that determine the method of use of CT in different ways. Behaviourism sees the human mind as a library of concepts and computer technology is designed to support the process of storing and extracting information from memory. Cognitivism expands the perception of learning as a set of very complex information processing processes and interpreting them to build complex mental models. Constructivism is a set of theories pointing to the role of communication as a way to negotiate meanings in collaborative building of new skills and knowledge. In the article the types of remote training as well as the genesis of support systems for distance learning are described.

Key words: e-Learning, distance learning, blended learning ICT, behaviourism, cognitivism, constructivism.

Introduction

Computer technology (CT) can be put into education in two ways. Computers that reinforce and reproduce existing pedagogical practice are treated as a new item added to the accumulated set of tools to assist the learning process. The educational process itself remains unchanged, the only things that are changed are the tools. On the other hand, the introduction of computers that qualitatively change the teaching practice may give technology a transformational role.

The question of whether the educational system should lead, for example, to broadening the development of the intellectual potential, or to prepare the individuals for the job market, seems to dictate the direction of the analysis of the impact of technology on teaching practice and allows one to look at the technology introduced to education as an attempt to solve the problem. These two categories are certainly not opposed, but show a different hierarchy of values attributed to education and at the same time approximately reflect the nature of the discourse in Polish press between the headmasters of state and the non-state colleges. While it is difficult to define the target intellectual level of students, there are more or less episodic evidence that the educational system, for example, in the United States permanently lowers the requirements in this field [1]. Judging from the example above, one may ask what role plays the technology if a student could get a much higher level of knowledge in 1895 than in 2014? On the other hand, the study in 2011 show a statistically small correlation between the results of academic and professional success of students. This correlation is so small that it cannot hold any practical

significance for the students. The research carrying out in Poland would yield similar results. It would be very symptomatic to compare the most sought after skill set of new employees with a set of standard lectures offered by universities. Employers pay special attention to such features as communication skills, information management, creative thinking, problem solving, and interpersonal relations. Courses on such skills, if not non-existent, certainly are rarely offered at Polish universities. Computer technology can better prepare students for entry into the labour markets only to the extent designated by the universality of education courses aimed at the desired skills, therefore one have to consider not only the way in which computer technology may aid its courses but also how to properly develop the courses and to give them the proper focus. The CT used in education can be judged as ineffective, not because of the inefficiency of the technology itself, but as a result of technological support of inefficient and unintentional teaching practices.

Methodological Concepts of Remote Training

Remote learning is related to distinct methodological concepts. Publications devoted to methods of information technology-assisted learning frequently mention the behavioural, cognitive, and constructivist concepts [2]. One can also find a reference to multilateral learning theories in which one finds the correct methodical use of computers and Internet in education process. However, modern information and communications technology (ICT) can be applied in every of the mentioned major theories of learning.

Lecturers have access to a range of educational theories, the use of which will result in different ways of using CT. Each of these pedagogical theories was formulated on the basis of the different psychological assumptions, and those in turn, are based on the various philosophical assumptions, in particular epistemological. Despite the fact that behaviourist psychology is in direct opposition to constructivism and their concepts are theoretically opposed, in practice they always mesh together and the teaching faculty frequently combines solutions from opposing theories into one's own teaching style.

Behavioural psychology defines learning as a result of reaction to stimuli. The repetition of crafted stimuli sequences lead to produce the automatic reaction. Behaviour can be modified and learning can be measured by the observed change in behaviour – such a change is a behavioural definition of learning processes. Stimuli in the form of the chosen method and means of teaching are meant to lead to improved test scores, that is to changes in behaviour resulting from the efficient operation of the memory. Teaching therefore comes down to designing a series of stimuli, reinforcements and penalties and to modelling the desired behaviour, which is to be assessed by reference criteria; hence the overwhelming role of memory in learning. The learning model worked out on the basis of behaviourism emphasizes paradigms, models and principles of action and tasks to be performed. Teaching comes down to modelling (using rewards and punishments) of the desired behaviour, which is to be assessed according to strict criteria. The lecturer fully controls the process of knowledge processing; the learner is the object of the teacher's interaction. Behaviourism emphasizes the role of memory in shaping knowledge. Modern ICT tools allow, e.g., a multimedia presentation of educational materials in an orderly manner, and the systematic verification of knowledge thus providing an opportunity for implementing most of the assumptions of behaviourism.

Just as behavioural psychology, cognitive psychology is focused on the learner's interaction with the environment, with particular emphasis on perceptive memory as a mechanism for information storing and recalling. According to cognitive psychology the learner processes information like a computer does, hence the metaphor of the computer as a reflection of the learner's mind. During learning process, the information coming from the environment (input) is processed and stored in the memory, and new skill or the information (output) is transferred out to the environment. The cognitive approach to learning process is based on the assumptions of cognitive psychology. In contrast to the behavioural theory it involves conceptualization of the surrounding world and phenomena by building and reorganization of said phenomena into functional models by the human being [3].

Constructivism as a theory of teaching, although not being a theory but rather a coherent set of ideas, is epistemologically and pedagogically at the opposite end of the spectrum of possible methods of integration of technology with the practice of teaching. A common feature of various constructivist theories is the assumption that the learning processes do not involve the transmission of information and support for processing information, but rather focus on the process of building knowledge. This construction is the result of the interpretation of the associated experience of the learner. Learning is thus the search for meanings. The mind of the learner is therefore not an empty vessel" waiting to be filled, but an active agent looking for and associating a suitable sense of meaning to perceptual stimuli. Constructivists are very strongly in favour of the recognition of knowledge not as a representation of the objective reality, but as a result of building the creative perception of a subjective understanding of the world. Knowledge is therefore not a set of information, but a dynamic process of interaction of the learner with the world, as shown in Fig. 1. Social constructivism strongly emphasizes the importance of communication between learners, which is a factor in confirming the reliability of the constructed knowledge. Assumptions about the nature of knowledge, which constructivism is based on, are derived from the Western tradition of philosophical discourse between the elements of the philosophy of objectivism, positivism and modernism and the philosophy of subjectivity, post-positivism and post-modernism. According to

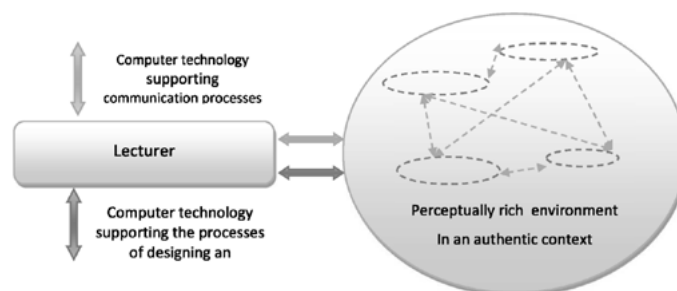


Fig. 1: Representation of an environment conducive to learning based on the richness of perception and communication facilitation

constructivism, the role of technology in the learning process is therefore to support these elements, which allow for active, targeted and authentic action leading to the social construction of knowledge. Designing technological solutions should therefore lead to building an information-rich environment in which learners would have actual or simulated ability to interact with this environment, observe the consequences of these interactions and form their own interpretations - all in collaboration with other members of the learning community. The aim of such actions may not be receiving information, but the constant improvement of one's higher cognitive processes, that is, analysis, synthesis and evaluation. In this case, computer technologies do not

become tools for the transmission of information but rather cognitive tools. Knowledge thus cannot be transmitted, absorbed or acquired – it must be built on the basis of prior knowledge and new experiences, and finally must be negotiated socially. In the constructivist model, it is assumed that a student discovers and constructs the knowledge that is understandable to him. The student is an independent, active entity, using a variety of sources of information. The teacher is not a source of knowledge, but instead creates the conditions for knowledge discovery by the student. The teacher draws attention to the individual learner’s experience and also to interaction and engagement. There is an emphasis on the role of creative problem solving.

The mere introduction of computers into teaching practice depends on the pedagogical approach that the teacher prefers. Lecturers who are inclined toward behavioural and cognitive psychology and who understand teaching as a pedagogically conditioned information transmission process will make use of computers as a school board with extensive functionality. In this case, educational technologies will be transmission tools. Lecturers who are in favour of constructivism pedagogy will perceive pedagogy as creating the conditions in which learners can construct knowledge in a targeted, active and social way. Educational technology in their hands will therefore be a cognitive toolkit. In world literature there appears to be a tendency to move towards constructivism in remote education. Learners have the opportunity to create individual knowledge structures in a virtual learning space. Forming network communities are a place to exchange experiences and verify views. We need to remember that the distance learning system was built on pedagogical theories and information systems are used in designing eLearning solutions. Distance learning puts great emphasis on the creation of cognitive processes by computer-aided cooperative work, which creates a new quality of the educational process. Let us get right to discussing the types of distance learning.

Types of Distance Education

Distance education (DE) is conducted on three ways:

- Technology-based training (TBT), also referred to as e-learning.
- Computer-based training (CBT) using computers in the educational process to transmit knowledge, execute exercises and do simulations. Within this concept courses are also delivered on CD.
- Web-based training (WBT) taking place on the Internet via TCP/IP. It involves the transmission of knowledge, as well as its verification, communication between the users and the management of the educational process with the use of Websites and Web applications [4].

The types of distance learning described above are associated with the use of specific technologies. The most common educational model, however, is one that combines computer technology with a traditional way of conducting classes at university. Consequently, one can distinguish:

- Instructor-led training (ILT) means the teaching process in which the teacher teaches a group of students. Classes are held mostly at schools. Traditional teaching can also take the form of classes, during which the teacher communicates with students via the Internet.
- Synchronous learning (SL) means that activities take place in real time, but are realized over the Internet. Both the students and the teacher are logged into a single system, so-called “the virtual learning space” (as opposed to the traditional learning space, which is referred to the university).
- Blended learning (BL) is also called the hybrid learning. This is a method linking the traditional model of education with remote education. In this model lecture content is transferred mostly in a remote manner and on-line consultations are held, while exercises and practical lessons are performed during meetings at the university. Complementary education is currently the most common non-stationary model of learning in higher education [5,6,7].



Rysunek 2: The relationships between the extent of the concepts in distance education

The relationships between the concepts associated with distance learning are illustrated in Fig. 2. Field of distance education covers a wide area of technologies and methods of education. This is due to inter alia, the need for continued training in more and more areas. Depending on the transmitted content (e.g., the course in English of use the software package), different tools and different techniques of teaching are used [4].

In the next section one will find a brief description of the distance education tools.

The Development of Supporting Systems for Remote Education

Systems supporting distance learning were initially designed for computer-assisted instruction (CBT) and used during classes on campus or at home. Due to the need to learn specialized computer programs used in nearly every occupation, such tools are constantly developed. With the spread of the Internet many tools that support education via the Web (WBT) have emerged. Originally they were static Websites with educational content. The dynamic Web pages for user interaction were the next step, e.g., enabling a discussion on the Internet forum. These were Internet services that cooperated with databases containing teaching content, tests to check the students' knowledge as well as the contents entered by users. User activity statistics were saved on the server. Such services therefore allowed learning and communication in asynchronous mode. Teaching materials could be continuously updated by teacher and stored in an electronic database. Direct communication between the student and the teacher was also established thanks to e-mail. The next step in the development of systems to support online distance education was the emergence of synchronous communication tools, such as chat, audio and video conferencing, the whiteboard, application sharing, and in a later stage – combining them into an application that works as a virtual classroom. Fig. 3 shows the evolution of the systems supporting distance learning. While the tool called Web 2.0 has been tested and adapted to e-learning, it is worth also to pay attention to the study of the effectiveness of teaching tools of Web 3.0. The growing interest in effective methods

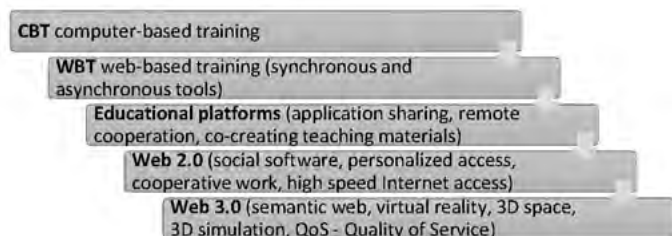


Fig. 3: The development of support systems for distance learning

of distance learning in conjunction with the achievements of modern computer science and cybernetics lead to the application of more interactive methods and tools. An example of such a tool is the so-called organizer of the learning path – a system using artificial intelligence, which adapts learning content delivery rate to the suitability of the learner (adaptive system) [8, 9]. Another example would be the use of the so-called educational agents – applications that, on a user request, can search for educational materials or organize one's time and learning times [10, 11]. One should also highlight the so-called intelligent tutoring system (ITS) which use artificial intelligence techniques and heuristic algorithms [4].

Conclusions

The use of computer technology depends on which learning theory is guiding the designers of e-learning solutions. There are three main theories of teaching that determine the method of use of these technologies in different ways: behaviourism, cognitivism and constructivism and.

Behaviourism sees the human mind as a library of concepts and computer technology is designed to support memory processes and extract information from memory.

Cognitivism expands the perception of learning as a set of very complex information processing and interpreting processes and building complex mental models. Computer technology used under the influence of cognitive sciences is therefore a tool for organizing information.

Constructivism is a set of theories pointing to the role of communication as a means of negotiating meanings in collaborative building of new skills and knowledge.

Distance learning with the use of Internet technology is a rapidly evolving field. Initially more emphasis was put on teaching methodology, leaving open the perspective of technology. This has led to a lack of consistency in the operation of these various tools, and the lack of opportunities for cooperation between them [12, 13]. Today, most universities seek to integrate the e-learning systems, studies and university management systems and the repository of learning resources together. With the development of Internet technology the form of educational materials is also changing. Educational content is becoming more multimedia and interactive, taking up more and more resources. Changes also include the support systems for distance learning. It is expected that in the coming years, suppliers of e-learning tools and systems will be simplifying the complex infrastructure through virtualization and integration. This simplification will allow optimizing resources and making the infrastructure safer and more accessible [14,15]. This in turn will help maintain the competitiveness and rapid response to upcoming changes. Increasingly, software will be available via the Internet on an outsourced basis.

One should remember, however, that the teacher and the learner have the final word on how to teach and learn. It is important that decisions regarding the use of e-learning solutions are made consciously.

Literature

- [1] Pascarella E.T., Terenzini P.T. How College Affects Students. Findings and Insights from Twenty Years Research. San Francisco: Jossey-Bass, 311-312, 1991.
- [2] Bednarek J., Lubina E. Kształcenie na odległość. Podstawy dydaktyki, Wyd. Nauk. PWN, Warszawa, Poland, 2008.
- [3] Juszczak S. Wybrane aspekty konstruktywistyczne i kognitywistyczne edukacji na odległość. *Kognitywistyka i Media w Edukacji*, 1(2), 43, 2006.

- [4] Kopiał P. Analiza metod e-learningowych stosowanych w kształceniu osób dorosłych. *Zeszyty Naukowe Warszawskiej Wyższej Szkoły Informatyki*, 9, 79-99, Warszawa, Poland, 2013.
- [5] Mayer R.E. *Multimedia Learning*. Sec. Ed., Cambridge University Press, Cambridge, 2009.
- [6] Meger Z. Kooperatywne uczenie się w warunkach e-learningu, *e-mentor*, 4, 2008.
- [7] Michałowicz B., Sidor D. Metody aktywizujące w konstruktywistycznym środowisku uczenia się na zajęciach. In: *E-learning w szkolnictwie wyższym – potencjał i wykorzystanie*, (red.) M. Dąbrowski, M. Zając (Eds.), Fundacja Promocji i Akredytacji Kierunków Ekonomicznych, Warszawa, Poland, 2010.
- [8] Organero M.M., Kloss C.D., Merino P.M. Personalized Service-Oriented E-learning Environments, *IEEE Internet Computing*, 14(2), 62-27, 2010.
- [9] Ostyn C. *Service Oriented Architecture for Competency-based Lifelong Learning and Personal Development*, Ostyn Consulting, 121, 2006.
- [10] De Arriaga F., El Alami M., Arriaga A. Multi-agent architecture for intelligent E-learning. *10th IEEE International Conference on Electronics, Circuits and Systems ICECS*, 87, 2003.
- [11] Dorca F.A., Lopes C.R., Fernandes M.A. A multiagent architecture for distance education systems, *Proceedings of the 3rd IEEE International Conference on Advanced Learning Technologies*, 368-369, 2003.
- [12] Wiktorzak A.A. ICT and students' skills, BOS2014, *XIII Conference, Polish Operational and Systems Research Society*, September 24-26, 2014, Warsaw, Poland, 48-49, 2014.
- [13] Wiktorzak A.A., Kotowski R. Modelowanie i predykcja w edukacji. *XXI Warsztaty Naukowe PTSK, International Conference*, May 21-24, 2014, Białowieża, 67, 2014.
- [14] Wiktorzak A.A. Badania systemowe i obliczenia inteligentne w edukacji. Konferencja Technologie Informacyjne i Komunikacyjne w Edukacji TIKE'2012, Łomża, Poland, 98, 2012.
- [15] Wiktorzak A.A. Technologie informacyjne a edukacja językowa. *Conference Towards better language teaching – diverse influence, infinite opportunities*, Łomża, Poland, 43-44, 2013.

Received: 2017

Accepted: 2017