UDC 378

A history of Computer-Based Instruction and its Effects on Developing Instructional Technologies

[1] Ömer Faruk Sözcü
[2] İsmail İpek
[3] Erkan Taşkın

[1-3] Department of Computer & Instructional Technologies, Fatih University, 34500 Buyukcekmece, Istanbul, Turkey
[1] PhD (Education), Assistant Professor
E-mail: omersozcu75@gmail.com
[2]PhD (Education), Associate Professor
E-mail: ismailipek34@gmail.com
[3]PhD (Education)
E-mail: erkantaskin@gmail.com

Abstract. The purpose of the paper is to discuss instructional and technological developments based on the history of computer-based instruction (CBI). Historically, the development of the CBI movement began in earnest at the end of 1960s and in the early 1970s. At that time, computers, for the first time, began to be used in education, basically for teaching language and mathematics. Historically, CBI emerged from the programmed instruction and teaching machines of the middle of the 1950s. Educational computing began with a few large, government-funded projects on mainframe and minicomputers. At this time, several projects were developed to be utilized in instructional processes, such as PLATO and TICCIT. As a result, the developments after the 1970s will be discussed regarding the CBI process so as to indicate new instructional and technological developments as part of new learning technologies from past to present for students and educators in schools.

Keywords: Computer-based instruction (CBI); learning technologies; instructional design and technology (IDT).

Introduction.

It has been approximately 50 years since educators and computer scientists began using computers for instructional purposes. During this time, remarkable advances have been made in computer technology and its availability for instruction. Computer-based instruction (CBI) emerged from programmed instruction and teaching machines in the late 1950s. There are four distinct phases in CBI development and its search for acceptance in education. Each phase is marked by its attitudes towards hardware and software needs, and towards the psychology of learning, and by its interpretations of barriers to wider adaptation in schools. At this time, we can talk about the age of CBI, the age of engineers, the age of acronyms, the age of titans, including artificial intelligence in CBI and authoring languages and the testing of courseware, and the age of small wonders as intelligent tutoring systems (Venezky & Osin, 1991). Educational computing began with a few large, government-funded projects on mainframes and minicomputers. At this time, several projects were developed to use in instructional process. For instance, the PLATO project at the University of Illinois in 1960 was developed and eventually enabled CBI to integrate text and graphics, providing instructors with one of the first programming environments for CBI (Alessi & Trollip, 2001; İpek, 2001).

After developing new technologies, educational computing created new instructional applications in education. At this time, hundreds of research studies were performed attempting to prove that using computers to teach something is better than using books, teachers, films or traditional methods. CBI has been advocated by reviews of these studies (Kulik & Kulik, 1986). Several meta-analysis studies have been completed by Kulik and colleagues. Intelligent CBI was discussed as a new topic in addition to conventional CBI (Venezky & Osin, 1991). In the field of computer-based instruction, personal computers were first used to support education for individual learners in the 1980s, World Wide Web (WWW) technologies were first used to support

e-learners in the 1990s, and mobile devices and wireless technologies were first used to support education for mobile learners in the 2000s.

A history of CBI and Instructional Methodologies

Computer-aided instruction (CAI) was used interchangeably with CBI and has gained acceptance in educational settings from kinder garden classrooms through to graduate schools. In general, CBI is the process of instruction, as instructional computer programs are defined by a variety of names, as follows: *computer–assisted/aided instruction (CAI), computer-based education (CBE), computer-assisted learning (CAL), instructional applications of computers (IAC)* and *computer-based instruction (CBI).*

In this paper, we prefer to use 'CBI' because our emphasis is on instruction rather than education, and because education is also a broad term. According to this approach, instructional methodologies for effective instruction should cover four phases in presenting information, guiding the student, enabling practice by the student and assessing student learning (Alessi & Trollip, 2001; İpek, 2001). There are several instructional methods in CBI such as tutorials, drills, simulations, games, animations and tests. CBI includes the following developments in history. The period of Plato, Socrates and Aristotle includes perception and thinking for learning as Middle Ages knowledge. When we reach the 20th century, Skinner talked about programmed instruction and a teaching machine in relation to Pressey's work at Ohio State University in the 1920s, construing it as a scoring machine. For this reason, Skinner - who had developed a widely accepted theory of learning based on techniques originally designed for training rats and pigeons - become interested (in the early 1950s) in machines that could implement his approach to instruction and learning strategies. Skinner, for the first time, had the idea to develop CBI. Afterwards, a new aspect of programmed instruction was considered on branching, initiated by Crowder in the 1960s. Thus, the roots of CBI are based on the theory of operant conditioning developed by Skinner. His theory was then applied to human learning (Skinner, 1954, 1963). Of course, and at first, CBI was designed as a poor technique for all instructional processes. Taylor (1980) considered instructional computing activities as a tool for both tutor and tutee. Computers can be used as a tool and teach any content as a private teacher (tutor), and the computer itself can learn from the student (tutee) and then teach content well, such as using Logo for geometry instruction.

CBI Methods and Instructional Programs

According to the model we have so far described, instructional programs include several types of CBI programs. CBI programs are defined as tutorials, hypermedia, drills and practice, simulations, games, animations, web-based learning and tests. There are various close relationships between cognitive psychology and CBI processes. Thus, the constructivist approach as a theory of learning was criticized for using computers and multimedia. Well-known educational technology leaders in the constructivist corner of the triangle include Duffy & Cunningham (1996), Jonassen (1991) and Schank & Cleary (1995). More moderate constructivist approaches have been suggested by numerous educators. In the cognitive corner of the triangle, there are many educators and instructional designers, including Rieber (1992), Reigeluth (1996) and Jacobson and Spiro (1995), who have considered how instructional processes should depend on goals, learners and content. According to them, instructional environments must include a combination of behavioural, cognitive and constructivist approaches. In addition, in the behaviourist corner of the triangle, educators and designers support much a more directed approach to instruction and the use of the instructional systems in their design methodology. Today, designing CBI has changed given technological developments, and changing needs and learning theories. However, conventional CBI from Skinner to the present has seen new improvements such as intelligent CBI methods, expert systems and other technological developments based on the history of CBI. These new techniques can be defined as elements of CBI - for instance, hypermedia, hypertext and also multimedia. Recently, the concept of 'CBI' has changed as interactive multimedia for learning with new technologies has been introduced (Alessi & Trollip, 2001).

Tutorials: Tutorial programs aim to teach a subject in a course. In a tutorial, information is presented and learner is guided through the initial use of information and skills. The learner practices and then learning occurs. Tutorials, in their sequence and structure, include questions, responses, the judgment of responses, feedback or remediation and learner control. It uses

hierarchical, web and matrix structures for organizing skills and effective teaching. There are linear and branching tutorials for the organization and sequencing of program segments.

Hypermedia: Today, hypermedia is becoming a common methodology that is delivered on the Web, on CD, and on other digital media. Hypermedia is used interchangeably with hypertext. Hypertext is a non-linear and non-sequential piece of writing in a text that was first defined by Vannevar Bush in 1935, with the first publication of the idea in *Atlantic* magazine in 1945. Theodor Nelson coined the terms "hypertext" and "hypermedia" in 1965 and he has acted as an evangelist for the concepts ever since. His definition of hypertext is computer-supported non-sequential writing. He created the Xanadu® plan and also sought to serve hundreds of millions of users simultaneously by using a world-wide network (Horn, 1989). Hypermedia indicates the technological point of developing multimedia and linking information resources. This is because hypertext indicates nodes and buttons (links). Buttons represent the function of hypermedia. Multimedia uses these functions to develop instructional materials by using video and sound for presenting and learning content in instructional environments (Alessi & Trollip, 2001; İpek, 2001).

Drill practice: Some methodologies can be defined as more constructivist, whereas others are more objectivist in nature. Drills, like tutorials, more frequently represent objectivist approaches. Drills are frequently used for practice on a course. They are not used for teaching learners. In this way, students try to remember information and knowledge for problem-solving when they use it. Developing a drill structure includes selecting items, questions and responses, judging responses, and feedback in a flowchart. The drill programme should be about fifteen minutes long so as to increase motivation by using games, cooperative learning, competitions, setting reasonable and relevant procedures, displays and short drill sessions.

Simulation: Simulations are developed and perceived as being more interesting and motivating than many other methodologies. They provide a better environment for learning by using the computer technology in a real world situation. Simulations have advantages and disadvantages based on the various types of simulations and conventional CBI design in learning. Today, animations have been developed as a form of feedback in simulations to motivate learner performances and display procedures in learning - that is, they present entertainment facilities as well as learning strategies in classes. The factors in simulations are defined in terms of fidelity, delivery mode, instructional strategy and other components including the objects, precision, type of reality, sequence, solutions, time frame and role of the learner.

Instructional games: Games have a number of advantages for children as learning environments. Many educators around the world consider games to be appropriate for young people. In fact, games can be used at different levels, with very different types of learners. As well as children, they are also used at college level for more mature students. Basically, instructional games should provide clear objectives to make learning a reality and use sensory and cognitive curiosity to maintain motivation. After providing all the necessary information, games offer reward learning rather than luck, recognize the winner, clear the display, and then give a final message at the end. Factors in games are defined in terms of goals, rules, players, equipment, directions, constraints, penalties and choices.

Tools and learning environments: This aspect differs from the conventional methodologies in CBI in three ways. First, the types of software discussed here are more varied and difficult to define than most of the CBI methodologies. Second, much of the software indicated in this paper reflects a more constructivist approach to learning and teaching. The constructivist approach, for the first time mentioned in the 1990s, affects the learning process as a learning theory, not as an instructional design (ID) model. However, without a strict approach, instructional design models can be used to apply the principles of constructivist theory in learning and designing CBI methods (Alessi & Trollip, 2001; Seels & Glasgow, 1998; van Merriënboer, 2007). Third, we do not list and analyse the elements of tools and open-ended learning environments, as indicated by Taylor (1980), such as tutor, tutee, nor the tools for using computers in classrooms. For designing CBI programs, motivation and screen design procedures have been concerned with effective teaching with computers. Recently, computers have been used as a tool for writing, drawing, planning, calculating and communicating. At present, electronic performance support systems (EPSSs), microworlds such as LOGO and learning tools, have become popular and assisted learners in studying, organizing and understanding new skills. Jonassen (2000) has also defined them differently, using a new term 'mindtools'. The term enhances critical thinking and defines their use

in a variety of situations and controlling learner. In addition, mindtools generally provide collaboration and active and constructive learning, and are used in authentic learning contexts. There is also concept mapping, semantic networks, expert systems and simulation tools. They can be used as tools and as examples of learning environments and have been developed by instructional technologists. The term 'open-ended learning environment' (OLES) was defined for solving meaningful problems and learning from errors (Hannafin, Land & Oliver, 1999). The idea was used as part of the constructivist approach at that time.

Tests: Assessment, as a phase of an instructional model, is an essential aspect of all quality instruction as well as of instructional design models. This aspect deals with the construction of tests and their administration. Computers can also assist in test construction by generating items and performing item analysis. Today, computerized tests can be developed with web and Internet tools, with various advantages and disadvantages, as well as for traditional test construction.

Web-based learning: This part discusses the use of the WWW, which is part of the Internet, as a new method for delivering instructional materials for learning and teaching. Before discussing this method, we can ask what the WWW is. We start with technical improvements and explanations. The WWW was first used as part of the Internet which, in the 1960s, was called 'ARPANET' for the Army's Advanced Research Projects Agency Network, to provide communications with computers and people at the different locations in USA. The network began with government and universities and then became commercial for those who wanted to take advantage of it. Today, websites are developed for public or private use. Web-based learning includes network standards, platforms, delivery instructions, communications, methodologies for learning and integrating media or tools for distance learning, and managing and integrating learning activities based on hypertext and hypermedia formats as well as multimedia components.

New Technologies with Multimedia Instruction

All new technologies for IDT were originally to be used for designing instruction in distance learning, which includes e-learning, email, CD-ROM, DVD, the Web, Internet-based instruction tools and other learning tools. With new technologies, the concept of e-learning as a part of distance learning has developed new roles to define its functions based on different kinds of e-learning. E-learning is an emerging technology for faster and more efficient knowledge management and transfer. The various kinds of e-learning and their methods can be defined as follows below.

Traditional e-learning is the basic way of creating e-learning modules. **Rapid e-learning** emerged as an important trend from the e-learning market with the beginning of the conversion and expansion tools of PowerPoint and Flash in 2003-2004. E-learning has been expanding rapidly over the course of the last decade, with the notable drawback of the complexity of its development. Rapid e-learning is a way to build e-learning courses. It provides for the very quick transfer of knowledge, fast developing processes at a low cost and has a real impact on performance.

Mobile e-learning (or 'm-learning') is e-learning taken mobile. It merges education with mobile technology. Over the last decade, m-learning has moved from a small research field to an array of relevant tools used by schools, workplaces, museums, cities and rural areas around the world. It is also collaborative, like most other forms of e-learning. Interaction is fast and easy, and so feedback and tips are nearly instantaneous. Another advantage of m-learning is compatibility. One of the biggest incompatibilities is that of flash e-learning, with Apple's iPods and iPhones. Flash simply will not run on the iOS. Format design is also an important activity for m-learning as well as CBI screens. Screen and key sizes need to be taken into account, as well as the compatibility of file formats and conventional CBI screen design.

If we are to look at the effectiveness and interactivity for flash e-learning, we may conclude that that it is the way to go for our e-learning modules. Flash e-learning allows individuals to create animated characters and immersive environments, simulate interactions, dynamically test everything that is needed with feedback and create interactive learning games without expensive programming. Companies such as U&I Learning (2012) use and recommend Raptivity for the creation of Flash e-learning modules. This software creates didactic Flash animations based on models, without any programming. There are over 200 animations ready for use or rapid-learning. U&I Learning offers cost-effective, learner-friendly, customized asynchronous Flash e-learning solutions that are globally scalable. These activities can be used effectively in distance education as

a part of intelligent CBI design. The company deals with developing types of e-learning content. Businesses traditionally focus on skills and human performance.

Blended learning, ever more valued by companies, refers to a mix of different learning environments. It gives learners and teachers a potential environment in which to learn and teach more effectively. Teachers can combine multiple teaching methods. For instance, they could give a face-to-face class to present content, and then follow up with materials online. Another possibility lies in integrating e-learning with a Learning Management System (LMS) using computers in a physical classroom, along with face-to-face instruction. In addition to these developments in CBI and distance education, instructional games as a method of CBI – called 'serious games' – can serves as more than pure entertainment. This indicates the use of technologies for industries like defence, education, scientific exploration, healthcare, emergency management, city planning, engineering, religion and politics, as well as military industries because of their higher costs. Rapid production and rapid instructional design models can be used effectively in gaming technology today.

Instructional Design and Technological Issues

In the field of IDT, new trends and issues have been considered recently as well as human performance, rich media and practice. The definition of the field is based on the psychological foundations of instructional design and the audio-visual instruction movement during World War II, including instructional technology developments, films, instructional TV and instructional design models and systems approach in the 1960s and 1970s. At that time, many scholars such as Skinner, Gagne, Merrill, Bloom, Tyler, Briggs, Mager, Finn, Miller, Glaser, Dale and Berlo, have made contributions in developing instructional design (ID) and instructional technology (IT). In recent years, rapid advances in computer and digital technology and new learning technologies in CBI, including the Internet, have led to a rapidly developing interest in - and use of - these media for instructional purposes (Reiser, 2007). In the 1980s and 1990s, several instructional design models and the effects of learning with technology were discussed and effectively used in classrooms and industry. Several ID models introduced by Dick and Carey (2005), Seels and Glasgow (1998), van Merriënboer (2007) (holistic design and complex learning, 4C/ID) and others, have been developed and used in CBI design over the last four decades.

The ISD approach includes, analysis, design and development phases. The analysis phase is often called 'front-end analysis'. During front-end analysis, a *needs assessment* or analysis is performed to determine and articulate the business unit or customer's learning, training and performance needs (DeSimone, Werner, 2012). In addition to a generic model, the ADDIE model has five phases, including analysis, design, development, implementation and evaluation steps. The ADDIE model is widely used in designing CBI lessons. Basically, each ID model in the field of IDT uses similar steps for instruction and CBI programmes. ADDIE first appeared in 1975. It was created by the Centre for Educational Technology at Florida State University for the US Army and was then quickly adapted by the entire US armed forces. Thus, we also attended our first presentation on CBI given by Merrill and his colleagues in 1989 at the University of Pittsburgh, which dealt with learning emergency help for the Army during war by using interactive video and CBI design programs. The presentation was very interesting for the field of IDT. Today, new learning technologies support more and more instructional design procedures so as to develop efficient and effective learning environments for schools and industries as well as military education.

Conclusion.

Instructional technologies and their use at different educational levels and in different sectors are to be started effectively for different working areas. In this way, there are so many high quality materials that are used in our classrooms. Conventional CBI generates new learning environments with instructional design approaches and e-learning technologies. Elements of CBI, including hypertext, hypermedia and multimedia, produce effective learning strategies as a part of artificial intelligence and expert systems. The IDT field helps in developing new learning materials in schools, industries and the military as well. Although teaching and learning conditions have changed, the effects of CBI continue to develop human performances and learning characteristics by the use of new learning technologies in classrooms and businesses. Today, traditional CBI has

extended to knowledge management systems to develop web-based learning, e-learning, distance education and online systems, from face-to-face learning to virtual classrooms. As a result, instructional developments based on CBI theories will continue, in lifelong learning programs, to solve instructional or non-instructional problems in schools and societies. IDT approaches may produce new methods of instructional design by means of e-learning tools and rapid instructional design with technologies for multimedia learning and future network design systems.

References:

1. Alessi, S. M., & Trollip, S. R. (2001). *Multimedia learning: methods and development*. (3rd ed.), Boston: Allyn and Bacon.
2. DeSimone, R. L., & Werner, J. M. (2012). *Human resource development*. Mason, OH: South-western College Pub.
3. Dick, W., Carey, L., & Carey, J. (2005). *The systematic design of instruction*. (6th ed.), Boston: Allyn & Bacon.
4. Duffy, T. M., & Cunningham, D. J. (1996). Constructivism: implications for the design and delivery instruction. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 170-198). New York: Simon & Schuster Macmillan.
5. Gustafson, K. L., & Branch, R. (2007). What is instructional design? In R. A. Reiser and J. V. Dempsey (Eds.), *Trends and Issues in Instructional Design and Technology* (2nd ed.), Columbus Ohio: Pearson Education, Inc.
6. Hannafin, M. J., Land, S., & Oliver, K. (1999). Open learning environments: foundations, methods, and models. In C. M. Reigeluth (Ed.), *Instructional – design theories and models: a new paradigm of instructional theory* (Vol. 2). Mahwah, NJ: Lawrence Erlbaum.
7. Horn, R. E. (1989). *Mapping hypertext*. Lexington, MA: The Lexington Institute
8. İpek, İ. (2001). *Bilgisayarla öğretim: Tasarım, geliştirme ve yöntemler*. Ankara: Tıp ve Teknik Kitabevi Ltd. Şti. Yayınları.
9. Jacobson, M. J., & Spiro, R. J. (1995). Hypertext learning environments, cognitive flexibility, and the transfer of complex knowledge: an empirical investigation. *Journal of Educational Computing Research,* 12(4), P. 301-333.
10. Jonassen, D. H. (1991). Objectivism versus constructivism: do we need a new philosophical paradigm? *Educational Technology Research and Development*, 39(3), 5-14.
11. Jonassen, D. H. (2000). *Computers as mindtools for schools: engaging critical thinking*. Upper Saddle River, NJ: Merrill.
12. Kulik, C. L., & Kulik, J. A. (1986). Effectiveness of computer-based education in colleges. *AEDS Journal*, 19, P. 81-108.
13. Merrill, D. M. (1983). Component display theory. In C. M. Reigeluth (Ed.), *Instructional–design: Theories and models: an overview of their current status* Hilldale, NJ: Lawrence Erlbaum. P. 279-334).
14. Rieber, L. P. (1992). Computer-based microworlds: a bridge between constructivism and direct instruction. *Educational Technology Research and Development*, 40(1), 93-106.
15. Reigeluth, C. M. (1996). A new paradigm of ISD? *Educational Technology*, 36(3), P. 13-20.
16. Reigeluth, C. M. (1999). *Instructional – design theories and models: a new paradigm of instructional theory* (Vol. 2). Mahwah, NJ: Lawrence Erlbaum.
17. Reiser, R. A. (2007). What field did you say you were in? In R. A. Reiser & J. V. Dempsey (Eds.), *Trends and Issues in Instructional Design and Technology* (2nd ed.), Columbus Ohio: Pearson Education, Inc.
18. Schank, R., & Cleary, C. (1995). *Engines for education*. Hillsdale, NJ: Lawrence Erlbaum.
19. Seels, B., & Glasgow, Z. (1998). *Making instructional design decisions* (2nd ed.), Upper Saddle River, NJ: Merrill/Prentice Hall.
20. Skinner, B. F. (1954). The science of learning and the art of teaching. *Harvard Educational Review*. 24(2), P. 86-87.
21. Skinner, B. F. (1963). Reflections on a decade of teaching machines. *Teachers College Record 3*: P. 168-177.

22. Taylor, R. (Ed.). (1980). *The Computer in the school: tutor, tool, tutee*. New York: Teacher College Press.

23. U&I Learning (2012). ICT Training, Retrieved September, 14, 2012, from *http://www.uni learning.com/index.php?lang=en&p=1&s=17*

24. van Merriënboer, J. J. G. (2007). Alternate models of instructional design: holistic design approaches and complex learning. In R. A. Reiser & J. V. Dempsey (Eds.), *Trends and Issues in Instructional Design and Technology* (2nd ed.), Columbus Ohio: Pearson Education, Inc.

25. Venezky, R., & Osin, L. (1991). The Intelligent design of computer-assisted instruction. White Plains, NY. Longman.

УДК 378

История компьютерного обучения и его влияние на развитие технических средств обучения

[1] Омер Фарук Созку
[2] Исмаил Ипек
[3] Эркан Ташкин

[1-3] Кафедра компьютерных и технических средств обучения, Университет Фатих, Турция 34500 Buyukcekmece, Стамбул
[1] Кандидат пед. наук, доцент
E-mail: omersozcu75@gmail.com
[2] Кандидат пед. наук, доцент
E-mail: ismailipek34@gmail.com
[3] Кандидат пед. наук, доцент
E-mail: erkantaskin@gmail.com

Аннотация. Цель данной работы – изучить образовательные и технические разработки, основанные на истории компьютерного обучения (КО). Исторически, развитие движения КО началось в конце 1960-х – начале 1970-х гг. В то время компьютеры стали впервые использоваться в образовании, в основном для обучения языкам и математике. Исторически, КО развилось из программируемых обучающих машин середины 1950-х гг. Обучение с помощью компьютеров началось с нескольких крупных проектов центральной ЭВМ и мини-ЭВМ, финансируемых правительством. В это время несколько проектов, такие как PLATO и TICCIT стали разрабатываться для использования в процессе обучения. В результате, разработки после 1970х гг. будут обсуждаться в отношении процесса КО для определения новых образовательных и технических разработок как часть новых образовательных технологий для студентов и школьных учителей.

Ключевые слова: компьютерное обучение (КО); образовательные технологии; педагогическое проектирование и технология (ППТ).