

**INTELLIGENT TUTORING SYSTEMS AS AN INTEGRAL ELEMENT OF A NEW  
GENERATION OF THE ELECTRONIC EDUCATION SYSTEM**

**Siniša Tomić,  
Branko Latinović,  
Miloš Pašić**

sinisa.m.tomic@apeiron-edu.eu, branko.b.latinovic@apeiron-edu.eu, milos.d.pasic@apeiron-edu.eu

**Abstract:** Nowadays, most of the e-learning systems enable their users to create, organize, and use computer-designed educational contents. After completing required authentication, students choose educational contents independently and of their own free will, e.g. they watch video recordings of lectures held or they solve predefined tests. As much as this concept is good in the sense that students determine their pace of learning by themselves and choose educational contents they consider necessary to overcome, on the other hand, there is a real danger that they could skip some elements of the teaching content or study some too easy or too difficult contents. It is necessary to ensure that e-learning systems guide students through the learning process taking into account the knowledge and the needs of the individual, which personalizes learning. In this way, electronic education systems move from the classical form to a higher “intelligent” level, which has proven to give better results and to make learning more interesting. The individual does not have to adapt to the system because intelligent systems adapt to the individual. It is therefore necessary to extend the functionality of the existing learning management systems (LMS) by introducing some adaptive, narrowly specialized intelligent systems designed for personalization of learning which are called Intelligent Tutoring Systems.

**Keywords:** Intelligent Tutoring Systems, electronic education, artificial intelligence

## **INTRODUCTION**

“In almost all aspects of human activities throughout history man has tried to make dealing with them less difficult. With a view to realize this aspiration of his, he invented different objects, tools, machines, and at the end or a new beginning, he invented the computer. Why is this a new beginning? The invention of computers allows people to transfer a part of their knowledge and “intelligence” to the machine, which qualifies the machine to completely replace humans in certain activities. This opens up an entirely “new book” that is being written.” [3]

“Ideas are always preceded by visions of visionaries who have a far-reaching notion of the desired and foreseeable development of an event or a project. Every day we witness efforts and great success of new technology visionaries, intelligent ICT system, so it is good to know that they are reached through visions. First you must have a vision, then you turn the vision into an idea, and finally you realize your project by using the idea.” [1]

New technologies open up new areas of activity. They again create new technologies, which in turn results in new industries, new markets, and new opportunities. Therefore, the way of development of new IC technologies is often unpredictable. The best example of this is the discovery of the touch screen technology (first used on commercial computers in 1985 HP-150) that has enabled the most direct communication with computers.

“The present time can be declared as the age of information revolution which among other things also relies on artificial intelligence, a branch of science in the scientific field of computing in the area of technical sciences.” [1]

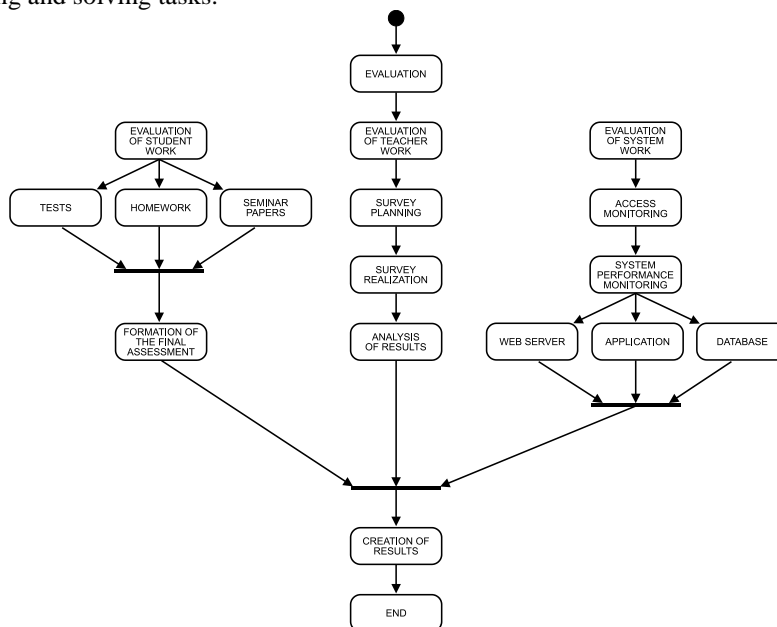
It is now difficult to imagine a world without the use of computers and IC technologies that have significantly shaped our lives, even though just a few decades ago we used to live in a completely different way of life. Children who were born in the 21<sup>st</sup> century are growing up in a digital world where the IC technologies pervade every aspect of their lives. Not even education has remained immune to the development of ICT, on the contrary, the introduction of the ICT in education has become a standard of modern education of the 21<sup>st</sup> century.

Don't limit a child to your own learning,  
for he was born in another time.

Chinese proverb

In our country, classical education is increasingly giving way to electronic education, while in the world we often have examples of full electronic systems of education which are equal to the classical teaching or to a hybrid form which is a mixture of classical and electronic education. Traditional concepts definitely lose their dominant role, while e-learning is becoming a new paradigm of learning. The digital age has brought new technologies and concepts and they all lead us to the fact that e-learning focuses on the individual, the individual user and their individual needs. However, there is a big danger hiding in the form of an associalization of learning and feelings of

loneliness trying to be alleviated by a variety of electronic services and concepts that encourage discussions, exchange of ideas, and teamwork. It is therefore necessary to give students additional motivation, mentoring help and support in learning and solving tasks.



Picture 1. Course evaluation process [8]

The introduction of artificial intelligence (AI) in electronic education has made teaching materials become more interesting, more interactive, and more useful. Therefore, it is important to raise the existing electronic education system to a new level which may eventually evolve into intelligent information systems of electronic education. These solutions should primarily be implemented in closed learning management systems for the management and delivery of educational contents because they represent the most important resource for learning and students have the highest expectations from them.

### ARTIFICIAL INTELLIGENCE

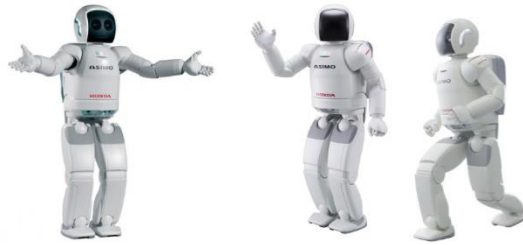
“In simple words, artificial intelligence is the study of the making of machines that express human qualities including the ability to think.” [3]

The term “artificial intelligence” has been used since the mid-fifties. It is believed that the most responsible person for the introduction of this term was John McCarthy. The term artificial intelligence was heard for the first time in the summer of 1956 at a meeting of the five leading scientists in the field of computer science of that time. The meeting was held at Dartmouth College in Hanover, New Hampshire. The meeting was attended by: Claude Shannon, Marvin Minsky, John McCarthy, Alan Novel, and Herbert Simon. The term itself was introduced in order to emphasize as much as possible and to explain as easily as possible the possibilities of future computers and computer programs. [4]

Some of the possible definitions of artificial intelligence:

- Artificial intelligence is a branch of science in which calculations are studied in order to enable perception, reasoning, and acting by those calculations.
- Artificial intelligence is a branch of science which examines how to create computers that would successfully do things that are now done better by humans.

Intelligent machines have preoccupied the imagination of ordinary people and scientists for a long time. It is interesting that from the beginning man has imagined intelligent machines in a human-like physical form. The development of information technologies has made possible that today fantasy is seriously turning into reality, and the best example of that is the humanoid robot ASIMO.



*Picture 2. ASIMO – The most advanced humanoid robot in the world*

ASIMO is a humanoid robot that can walk, talk, and recognize people in its surrounding environment. It is the only humanoid robot with the ability to climb the stairs. Professor Miomir Vukobratović (26 December 1931 – 11 March 2012) studied the zero moment point of human locomotion, which is the point where the total of horizontal inertia and gravity forces equals zero. Based on his work, all walking robots use the zero moment point on the basis of which corrections are made that allow humanoid motion.

In his famous book “The Mighty Micro” in 1979, Dr. Christopher Richie Evans defined the concept of intelligent systems as follows: “Intelligence is the system’s ability to adapt to changes in the world, and the bigger this ability, i.e. the more refined the power of adjustment, the more intelligent is the system.” [2]

There are three main directions of artificial intelligence development:

1. Application of existing AI techniques
2. Improvement of existing AI techniques
3. Development of new AI techniques

From the very beginning, artificial intelligence seeks to understand the functions of the human brain and the way how it works in order to simulate human behavior. Computers can be programmed to provide answers similar to human ones, but they cannot have consciousness.

“The characteristic of human reasoning is creativity, the ability of association, generalization, and the possibility to overcome the informational basis of decision-making by originality and new ideas.” [3]

The main difference between the conventional and AI processing is that the conventional processing is based on numbers and algorithms, and AI processing is based on the symbolic analysis and heuristic.

Areas of commercial application of artificial intelligence:

- Expert systems
- Natural language processing
- Speech understanding
- Robotics and sensor systems
- Processing based on neural networks
- Fuzzy logic
- Computer visualization
- Smart training with the help of computers
- Machine learning (neural computing, fuzzy systems, genetic algorithms, etc.)
- Hybrid systems

According to [3], there are three aspects of creating artificial intelligence:

1. Creation of artificial neural networks – a simulation of natural neural networks.
2. The evolutionary aspect – implies an artificial evolution of intelligence that will be faster than the natural one.
3. Heuristic programming – development of computer programs that behave intelligently.

Alan Mathison Turing, a famous mathematician and cryptanalyst, a pioneer of artificial intelligence, was the first who applied mathematical logic on a machine. He developed several techniques for breaking codes. His best-known work is related to the breaking of Enigma ciphers of the German Enigma machine, which has significantly shortened the Second World War (by one year according to some studies). The Turing test called “imitation game” defines a

standard for a machine to be called intelligent. It was conceived in 1950 and introduced by Turing in his paper, “Computing Machinery and Intelligence”. The test puts a human interrogator, a machine, and a human in separate rooms. If the interrogator cannot reliably tell the machine from the human, the machine is said to have passed the test and can be called intelligent (it has done well in the imitation game). An additional difficulty is that the topic of conversation is not pre-defined. No computer has passed this test yet.

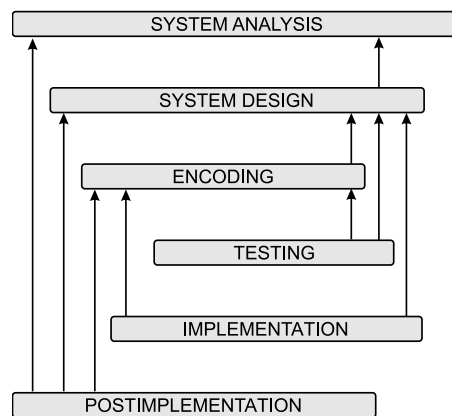
### INTELLIGENT TUTORING SYSTEMS

Nowadays, modern education prefers the individualistic approach to the learning process. In the context of learning through electronic educational systems, it is essential that the system knows each student, i.e. that it knows their habits, learning style, intellectual capacity, as a teacher would know in the classical mode of teaching (this refers to classical one-to-one teaching or work in small groups), would adapt to the student, and enable progress in accordance with the capabilities of the student. Users of the electronic educational system expect customized learning materials and different types of interaction in courses.

Actual results show that systems for the creation and management of electronic learning materials, or simply learning management systems, either do not have the ability to personalize learning and to monitor the progress or this ability is very weak. It is therefore necessary to extend the functionality of the existing LMS by introducing adaptive, highly specialized intelligent systems designed for personalization of learning that are called Intelligent Tutoring Systems – ITS. These systems can also be described as personalized because they create and deliver courses for each individual person and provide interaction and the necessary support for each student who can now manage the content, pace, and extent of learning.

The introduction of these systems brings electronic education to a higher level and solves a lot of problems related to the classical teaching methods with a larger number of students in the classroom, where students have to adapt to the teaching material and the teacher does not have enough time to pay special attention to each student individually.

On the other hand, adaptation of educational multimedia contents and activities to individual customers often causes serious problems for the creators of personalized educational forms, which directly affects high costs and the time of ITS implementation.

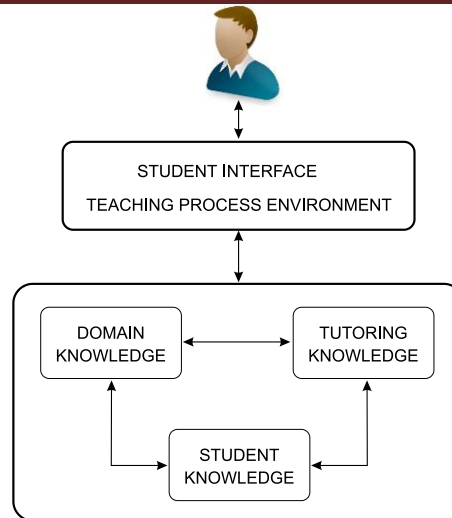


Picture 3. State of intelligent system development [1]

Intelligent tutoring systems perform dynamic adaptation of the learning process to the individual. From this point of view, the intelligence of a tutoring system could be measured by dynamic adaptation of the system to the user. This would make the ITS a personal “computer teacher” in front of whom students do not hide their ignorance and with whom they communicate “naturally”.

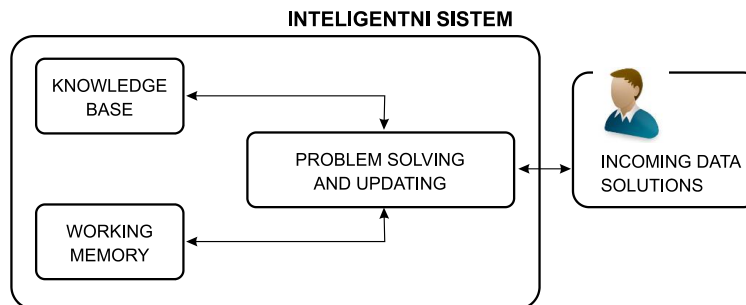
„The design and implementation of intelligent tutoring systems have systemically contributed to the development of artificial intelligence methods and techniques. In this sense, the ITSs have been a good testbed for the development of artificial intelligence projects, ...” [6]

“The ITSs demonstrate a high degree of interactivity with the user (student) guiding the student precisely through the space of knowledge. Frequent implementations include a personalized agent in the form of a virtual tutor in order to obtain better psychological effects – closeness between the system and the student.” [7]



*Picture 4. Structure of an intelligent tutoring system*

- The student interface and the teaching process environment represent a model of communication between the student and the ITS.
- The domain model (also known as expert model) is a model of knowledge with which the student communicates during the learning process.
- The tutoring knowledge – a model that simulates a “real” teacher.
- The student knowledge – a dynamic model that monitors the student’s knowledge level and carefully makes a knowledge diagnostics.



*Picture 5. Structure of intelligent systems*

Modern intelligent systems often do not come to solutions through computer algorithms, which clearly and unambiguously define possible conditions and prescribe the steps that lead to a solution, but instead of that they use heuristic. “Heuristic is a set of rules of educated guesses which direct and limit the area of searching for a solution.” [4]

By using the methods of artificial intelligence, the new concept of intelligent e-learning systems [5] has to provide intelligent bidirectional communication between the intelligent system of tutoring learning and the student. According to this concept, the e-learning system contains intelligent methods for the analysis, evaluation, assessment of user’s knowledge and skills, as well as for the control, monitoring, and optimization of e-learning.

## CONCLUSION

Computers are basically suitable for mechanical calculations, if we take into account previously defined algorithms and programmed rules. For that reason, they perform simple tasks cheaply, reliably, and efficiently. However, when it comes to more complex problems that require understanding of specific situations and adapting to new situations, things become much more difficult. It is the goal of artificial intelligence to improve computer behavior in such complex tasks in a way a human would deal with them. Electronic education systems are also evolving today

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because they use artificial intelligence, in particular intelligent tutoring systems that raise teaching to a new level and make it interesting.

New generations of students are growing up in a time of intensive development and in the presence of information technology in all spheres of their lives. Therefore, they easily and very naturally accept innovative educational concepts of the digital age. This is a process that is unstoppable and inevitably on the rise in the world.

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