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TEACHING OF PROGRAMMING BY THE UTILISATION OF ARTIFICIAL INTELLIGENCE

THESES OF THE DOCTORAL DISSERTATION

PhD School of Informatics
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Basics of informatics and its methodology

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Introduction

The feature of this research is educational-methodological and it focuses on the development of problem-solving skills.

The logical programme languages (e.g. Prolog) are especially available for problem-solving and thus for the development of programme solving skills. The operations of these languages are based on rules and facts. These languages are the most important tools of programming and of expert systems that apply artificial intelligence.

During my research I generated case studies and intelligent educational materials that are of great use for solving different problems of natural science (electron structures of elements, binding types) with the utilisation of Prolog programme language. Solving these examples requires natural intelligence, which I solved by means of logical programme language.

The computer-based solution of these concrete examples also provides adequate basis for the methodological questions of teaching programme languages (e.g. Prolog). Thus the teaching of programming including elements of artificial intelligence is supported by an efficient tool.

Motivation of choosing the theme

The respect and admiration of logical thinking was always crucial for me. I myself experienced the developing effects of chess and of mathematics on developing my own problem-solving skills. I met Prolog programming language first during my university years and its strange way of thinking raised my interest.

I have been working as a lecturer since 2001 at the Department of Business Mathematics and Informatics, at Károly Róbert College, Gyöngyös. Besides the basic courses of informatics I also teach database management and different programme languages. Since the spring of 2008 I teach the course of Artificial Intelligence as an optional course. This course provides an insight into expert systems, robotics and logical programming. During my teaching activity I also launched the results gained through my research. Together with the students we developed special expert systems with the help of Prolog language. These case studies proved to be extremely useful for developing the students' problem-solving skills.

At Károly Róbert College I also joined the distance education programme. This has provided me the possibility of obtaining the direct investigation of methodological questions of distance education. The wide-spread methodological branches of e-learning raised my interest. In 2010 we established the E-learning Methodological Unit (Hungarian acronym: ELME) at Károly Róbert College with my colleague, László F. Mucsics. The primary aims of this unit are to realise e-learning courses of the college, to develop e-learning projects and to provide professional background for fellow lecturers and professors.

Events preceding the research plan

1. I usually take part in different conferences (conferences of informatics, of education-methodology, of e-learning and of artificial intelligence) (Informatika Szakmódszertani Konferencia – INFODIDACT [Informatics – Methodology Conference], Informatika a felsőoktatásban – IF [Informatics in Higher Education], Matematikát, fizikát és informatikát oktatók konferenciája - MAFIÓK, MOODLEMOOT konferencia [Conference for teachers of mathematics, physics and informatics], Intelligens Rendszerek – Fiatal Kutatók Szimpóziuma – IRFIX [Intelligent systems]).
2. Since 2004 I have been organizing the local and regional competition of informatics for the students of secondary education in Gyöngyös. I am responsible for creating the exercises and also fill in the position of the jury. I obtained direct experiments on the problem-solving skills and on the knowledge of informatics of students. I managed to establish good personal and scientific connections with the colleagues of secondary schools based on the active cooperation.
3. At Károly Róbert College I joined the distance education training programme. I have always been interested in what ways the distance education training should be developed. I have done methodological experiments for making the training even more efficient.
4. During the years I spent in education I experienced that the later generations of students (both in secondary grammar schools and in higher education) show less and less efforts in acquiring the natural sciences. I am especially interested in how their interests should/could be raised towards these subjects.

Objectives

1. Making the natural sciences more popular among students by creating intelligent education materials that make the understanding and acquisition of natural laws easier to learn.
2. Establishing e-learning supported courses and making the courses of Artificial Intelligence and of Logical Programming easier to acquire and easier to teach. Making logical programming accessible for those students who had never thought they would be able to learn such subjects.
3. Launching new methodological commendations for distance education with the help of new technological achievements (e-learning, web 2.0) that make the educational processes even more efficient.
4. Developing the problem-solving skills of students by teaching logical programming in blended learning. Performing a pedagogic experiment and evaluating its efficiency.

Applied methods

1. Creating intelligent educational materials with the application of logical programming that make the understanding and acquisition of natural laws easier to learn. These secondary materials may serve the basis for expert systems.
2. Performing a combined, two-group pedagogical experiment in 3 educational institutions is Gyöngyös. (Vak Bottyán János Catholic Secondary School of Technology and Economics, József Attila Secondary Vocational School, Károly Róbert College). The statistical analysis of the input and output results with SPSS programme.
3. Realising and developing the e-learning courses of Artificial Intelligence and Logical Programming at Károly Róbert College.
4. Developing the course of Logical Programming and introducing the course as a pedagogical experiment in secondary education.

Theses of the dissertation

Thesis 1: The problem-solving thinking can be efficiently developed by teaching logical programming.

The development of problem-solving thinking is crucial at all levels of education. Logical programming languages (e.g. Prolog) prove to be suitable for developing problem-solving skills. The operations of these languages are based on rules and facts. These languages are the most important tools of programming and of expert systems that apply artificial intelligence.

Proving this statement I performed a combined, two-group pedagogical experiment in 3 educational institutions in Gyöngyös (Vak Bottyán János Catholic Secondary School of Technology and Economics, József Attila Secondary Vocational School, Károly Róbert College). Each educational institution contained an experimental and a control group. The following table shows the number of the members involved in the experiment.

Location	**Experiment group (number of participants)**	**Control group (number of participants)**	**Total (number of participants)**
Vak Bottyán János Catholic Secondary School of Technology and Economics	26	35	**61**
József Attila Secondary Vocational School	23	38	**61**
Károly Róbert College	29	38	**67**
Total (number of participants)	**78**	**111**	**189**

I taught the experiment groups twice a week through 11 weeks between 05/09/2011 and 18/11/2011. My educational activity was supported by e-learning and the course of Logical Programming was available for all participants of the experiment groups at the portal **http://patronus.karolyrobert.hu**.

I had all the students solve tests both at the beginning and at the end of the course (input and output tests) at the three locations. I analysed the results of the input and output tests with the help of SPSS programme. The experiment groups performed better than the control group at all locations. I measured significant difference in the results at two secondary institutions.

I also experienced the beneficial effect of the course at the 3rd location (college) but significant difference could not be measured between the results of the experiment group and the control group. The combined results of the 3 locations also show significant difference between the results of the experiment group and the control group, thus I managed to prove the beneficial effect of logical programming in developing problem-solving skills.

Thesis 2: The education of Artificial Intelligence and of Logical programming is expedient to support by e-learning, especially in case of students of non-informatics.

The course of Artificial Intelligence is an optional C course at Károly Róbert College. Our students may obtain insights into the topics of artificial intelligence and its most important fields in two lessons a week. Our students may gain insights into robotics; they may get acquainted with the latest technologies and with the motivation and problems of their development. Furthermore, students may meet the procedure of creating expert systems and also get acquainted with logical programming as the highest level of programming.

The course of Logical Programming is also an optional C course. Its aim is to develop the problem-solving skills of students. Another aim of the course is to get the students acquainted with the mysteries of declarative programming, with the help of Prolog programme. The course reviews the theoretical base of Prolog programme and the practical programming as well as the solution method of practical examples. I use example-oriented method through the course. I also apply the method used with the model example to present case studies and to solve the large number of exercises. Since the acquisition of logical programming is not an easy task I believe it is crucial to process lessons as programmed teaching units.

The most important elements of blended learning:

- Lessons are built up based on the methodology of programmed education,
- Own videos help the utilisation of the software,
- Self-evaluation tests are available at the end of all major topics,
- Forums, online consulting hours are used to make the course live.

Thesis 3: The efficiency of distance education in e-learning system can be significantly increased by the methods of constructivist pedagogy and of programmed education.

Nowadays, the ratio of distance education (and thus the number of students in distance education) is facing a decline in Hungary. However, examining the info-communication tools of Hungarian households it must be noticed that the achievements of technological developments give serious possibilities for applying distance education trainings with the help of e-learning.

We arrived at a paradox situation when the number of students in distance education sharply decreases but the circumstances have never been better for its significant growth. I think, in the long run we are going to experience the expansion of the distance education in Hungarian higher education.

Distance guidance has significant role is distance education. One of the best methods for the direct guidance of acquiring educational material for the individual is programmed education. Well-planned and programmed materials contain useful feedbacks during the process of learning.

Examining the advantages and disadvantages of different programmed educational forms it may be stated that the programmed education proves to be an eligible method for teaching a more complex and complicated unit in simple and small-step process. It can be expressly efficient in the following two cases: students whose preliminary knowledge is intensely defective and the economic realisation of teaching large number students groups.

Mention must be made about the drawbacks of programmed education as it is not an exclusive method. However, e-learning systems (e.g. Moodle), which effectively support constructivist pedagogy, help in the elimination of these problems.

Of the large number of tools of e-learning systems (e. g. Moodle) supporting constructivist pedagogy, the forum, wiki, collection of basic terminologies, database and messages possibilities by means of which knowledge sharing and the pooling of technical experience must be accentuated.

In e-learning systems constructivist pedagogy, together with the large selection of multimedia possibilities, enables the active participation of teachers, knowledge sharing and the pooling of technical experience which accelerate the intellectual activity of students, require creative thinking, this way intellectual rigidity and unidirectional education decrease in the teaching-learning process.

Based on my research I advise the method of programmed education accompanied with e-learning environment and constructivist pedagogy for increasing the efficiency and popularity of distance education. The deficiencies of programmed education can be handled by help of e-learning and that is the reason why I strongly emphasize its utilisation.

Thesis 4: It is necessary to create rule-based expert systems while teaching the rules of natural laws especially when working together with students.

Student motivation can be increased by intelligent curriculum in the training of natural sciences.

In my dissertation I introduce an intelligent curriculum that can be used in teaching chemistry. These intelligent study materials methodize the principles of elements (structure of electrons, oxidative numbers, electronegativity). The rules and the facts create a rule-based system.

The most important feature of the intelligent educational curriculum is that it motivates students to create similar own rule-based systems.

The aim is to present study materials that facilitate the creation of achievable targets and enable students to produce similar materials. I think the greatest virtue of curriculum is that it motivates students to create similar rule-based systems. It also means that students draw useful conclusions after obtaining the relevant knowledge. This enables the lecturer to achieve one of the most important educational aims which is to develop problem-solving skills of students.

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