Inovative Pedagogical Intervention Strategies and Social Software Technologies in an e-Learning Project Initiated by the University *Politehnica* of Bucharest (Faculty of Applied Sciences)

BRANDUSA PREPELITA-RAILEANU
Department of Communication in Modern Languages
University *Politehnica* of Bucharest
Splaiul Independenței 313, 77206 Bucharest
ROMANIA
brandusaraileanu@yahoo.com

Abstract: - The paper highlights the links between the educational sector and the further development of the ICT. It presents an e-learning project initiated by the mathematicians from the Faculty of Applied Sciences (University *Politehnica* of Bucharest) in cooperation with McGraw-Hill. The paper describes this project that develops practical methodology, approaches and tools targeted at day-to-day utilization by the teacher trainers and students. Another issue is also discussed : the importance of a close cooperation between ICT and universities (with a special reference to the achievements of the University "Politehnica" of Bucharest) in order to develop the information society as a society with equal chances for everybody .

Key-Words: - learning project, Internet, Mathematics, Physics, technology, information, communication, applications, curriculum

1 Introduction

The world's largest resource in creating an information society is not technology, but young people. Youth are making up more than two-thirds of the population of some developing nations.

Yet young people have too often been seen as a burden rather than an asset, a group to be taught but not to teach, and to receive but not to give.

Youth can change this paradigm [12]. After all, young people, the first European generation to have grown up with computers, have a lot to offer: energy, enthusiasm, and above all expertise to help bridge the digital division. While young people have been at the forefront of almost every innovation in the development of the information society, from the founding of Microsoft to the dot contemporary era, it is only now that we formally recognize their potential in a development context. Youth need to be engaged in decision making process related to the information society – as students, as citizens with affinity for technology, they are informed stakeholders in the evolution of education and innovation [1]. Youth efforts should be supported and engaged in broader initiatives towards achieving digital opportunities and an information society for all.

The practical achievements make us think that more informal approaches to education are also valuable in the information society providing young people with an opportunity to learn through practical experience . Formal education systems need more flexibility to allow students to undertake and gain credit for such activities. Peer based education, where students help students, and student exchange programs are also beneficial and popular [6].

It is important for Universities to develop comprehensive and forward-looking education strategies. Students should be enabled to acquire the necessary skills in order to actively participate in and understand the information Society and fully benefit from the possibilities it offers . They should be engaged in defining their own needs and in the development of programs to meet those needs.

In today's society, students and teachers are, on one hand, confronted with an ever growing load of information and content and, on the other, with increasing demands for knowledge and skills. To cope with this, it is necessary to link content, knowledge and learning, making content and knowledge more accessible, interactive and usable over time by

humans and machines alike [5]. Nowadays, the information society needs wider educational spaces and the internet provides a powerful tool to introduce new educational technologies and to use online applications.

The educational goal of Romanian teachers is to create a broader community of scholars, students, and practitioners. A community that gives all members, irrespective of location and position, an equal opportunity to participate in creating and sharing information. We need a healthy, stimulating academy that embraces fresh ideas, different perspectives, and divergent experiences [2]. We must plan consciously how to use information technology to overcome the shortcomings of the present system so as to permit greater participation by those who have previously been on the extremity. Such an initiative will be presented in the paper. It belongs to the University *Politehnica* of Bucharest and it refers to the use of the Internet to train students in the domains of Mathematics and Physics.

Technological change will progressively require life-long learning and continuous training. The establishment of a fruitful collaborative and co-operative atmosphere is an essential part of learning . Research has shown that social collaboration can boost student achievement , provided that the kinds of interactions that are encouraged contribute to learning . Finally , social activities are interesting in their own right and help to keep students involved in their academic work. Students work harder to improve the quality of their products (essays, projects, artwork etc.) when they know that they will be shared with other students. Teachers can do many things to encourage and facilitate learning. They can assign students to work in groups and assume the role of a coach / co-ordinator who provides guidance and support to the groups. They can create a classroom environment that includes group workspaces where resources are shared [8]. Through modelling and coaching, they can teach students how to co-operate with each other. They can create circumstances for students to interact with each other, to express their opinions and evaluate other students' arguments.

An information society is about much more than laying telephone lines and installing computers in schools. Creating equitable access to technology is vitally important, yet we also need to determine what type of society we are trying to create with these tools – both in terms of how its characteristics are different from the model of society that came before and in terms of the principles and philosophies underlying our commitment. Local cultures are revitalized as people create local content. In the industrial society, culture was relegated to institutions – art galleries, museums, movies, theatres and mass media. It was controlled by a small number of major companies, editors, and producers. Less sources of content meant less cultural and linguistic diversity [9]. In the Information Society the tools to record preserve and distribute culture are easily accessible. Indeed, entertainment and culture are seen increasingly as a participative rather than passive activity [14].

2 A Few Preliminary Details

The education in Mathematics and Physics has been basic for the training of Romanian higher technical staff during all its history in Bucharest, even since *Royal Academy of St. SAVA* (1694) and the first Romanian *Higher Technical School* (1818). At the *St. SAVA College* (1832) one of the four offered curricula was in *Exact Sciences*. The first experimental laboratory equipment of Physics and Chemistry and Geometrical and Mechanical Instruments were bought in 1833 and the first Physics Laboratory was created in 1850.

The Faculty of Applied Sciences was established in 2005 (the International (U.N.O., U.N.E.S.C.O.) and World Year of Physics, and the year of implementation of the European Higher Education Reform in Romania). It includes the Departments of Mathematics and Physics and the curricula they have been offering in U.P.B. for all three academic cycles: Bachelor, Master and Doctoral ones and their offer of basic education in Mathematics and Physics to all U.P.B. students.

The present curricula have been offered: since 1955 - Engineering Physics - within the Faculty of Electronics and since 1991 - Engineering Mathematics - within the Faculty of Electrical Engineering. They have continuously been improved.

Starting with 1994 Advanced Study Programs have been offered in Technical Physics, Photonics, Optical Technologies, Dynamical Systems, Differential Geometry and Optimization, Models in Decision Theory, Risk and Forecasting.

Professors of the Departments of Mathematics and Physics have been doctoral supervisors of doctoral curricula offered by U.P.B. and by some Romanian Academy Research Institutes. Since 1998 the *Department of Mathematics and Physics* has been established to offer doctoral curricula in the field of *Exact Sciences*: Mathematics and Physics.

In order to highlight the extent of the initiative to which we refer to, some major research domains are mentioned such as:

- In Mathematics - analytical and numerical methods in boundary value differential equations problems, probabilistic models in reliability studies, stochastic phenomena statistics, applied functional analysis, fractal theory, optimization, perturbations and asymptotic analysis, biometrics, complex analysis in technical applications, differential geometry, geometrical dynamics modelling, statistical analysis of experimental data, nonlinear dynamics and chaos, mathematical economics, systems and control theory;
- In Physics - optoelectronics, laser and plasma, superconductivity, interaction laser - substance, scanning laser confocal microscopy, atomic force microscopy, magnetism, condensed state physics, liquid crystals, holography, hologram interferometry, optical processing of information, holographic manufacturing, holographic techniques in visual arts, physical models in social and human sciences.

There are three Research Centres as part of the Faculty of Applied Sciences:

- FOCUM (Academic Centre for Optical Engineering and Photonics)
- CCSFA (Scientific Research Centre in Applied Physics")
- CMMPI (Centre for Microscopy - Microanalysis and Information Processing)

Also in the Faculty of Applied Sciences the following international reviews are being edited:

- Series A - Mathematics and Physics - Scientific Bulletin of University POLITEHNICA of Bucharest (hard issue)
- Balkan Journal of Geometry and Its Applications (hard and electronic issue)
- Applied Sciences (electronic issue)
- Differential Geometry & Dynamical Systems (electronic issue)
- BSG Proceedings (hard and electronic issue)

3 A Virtual Collaborative Learning Environment

Starting from the idea that many students learn best working together on structured, self-directed projects. The mathematicians from the Faculty of Applied Sciences in cooperation with McGraw-Hill have created software that links students and other social software tools to a virtual collaborative learning environment.

The researchers of the Faculty of Applied Sciences (University *Politehnica* of Bucharest) wanted to create software tools that would let university students and teachers work together on structured, self-directed learning projects regarding both their training for entrance to the University and later the specialized training in the domains of Mathematics and Physics. The project offers the opportunity to use the Internet to collaborate with students outside regional boundaries. Using the Internet, a group of students can simultaneously learn the same subjects. A virtual research team can rapidly exchange findings and insights and collectively advance knowledge on a large frontier. The Internet is ideal for coordinating such a study. Professors and the future students from the Faculty of Applied Sciences set out to close the gap between existing educational software tools – usually rigidly structured and teacher-controlled – and the free-wheeling, self-directed social software that students use in their spare time, such as blogs, messaging, feeds and other social networking services.

The promoters of this project believe that students gain new knowledge and skills most readily by working together with others on projects that they themselves define and manage, facilitated rather than controlled by teachers. This training project prepares them to be more self directed, teamwork oriented, and technologically adapted later in life. Because students need to be competent in self direction, social networking and collaboration in technologically mediated environments.

The project was initiated by a team of McGraw-Hill in co-operation with professors of Mathematics and Physics from the Faculty of Applied Sciences of the University *Politehnica* of Bucharest for the training of the entrance examination. The project will

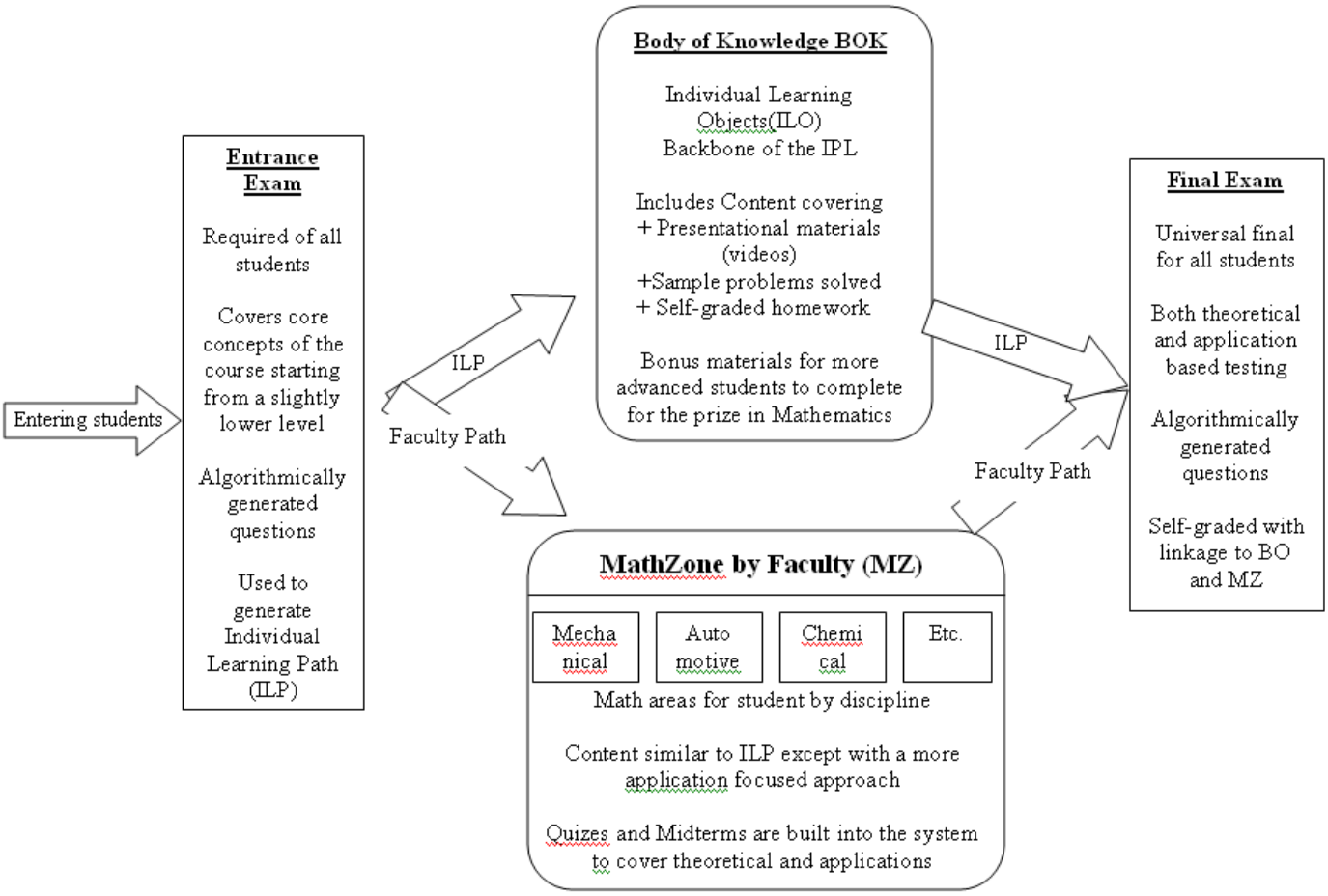

Fig. 1

be online. The students will have access to the database of the project and they will be able to learn both by themselves and under the supervision of teaching staff, with feedback from the computer and/or from the professor.

In University *Politehnica* of Bucharest, Calculus is applied to a pilot course of Mathematics. It is common to thirteen faculties of the University *Politehnica* of Bucharest and it will extend to the courses of Mathematics and Physics of the first and second academic years.

The objectives of the project are:

1. General objectives

- to establish a hierarchy of the students according to their level of knowledge using a wide range of subjects and problems
- to ensure the admission of examination candidates with considerable knowledge and chances of development
- to operate a selection and an elimination of those candidates who are not well prepared.

2. Specific objectives:

- as the result of the examination to establish for each admitted candidate the gaps in his/her knowledge
- elaboration of ILP (Internal Learning Path)

The Body of Knowledge (BOK) contains the part of the syllabus which is the same for all faculties, needed by the internal logic of the discipline. It is made of ILO (Individual Learning Objects – sections of the curricula on distinct subjects)

The curriculum is divided into these sections, each containing theoretical presentations, commentaries, proposed problems, sample problems solved, applications, indications of the prerequisites of the sections, presentations of materials, self-graded homework.

Periodically tests are given. Their purpose is to highlight possible deficiencies in the students'

knowledge and to indicate extra ILOs necessary to the elimination of these deficiencies.
So ILPs (Internal Learning Path) have dynamic and flexible characteristics.
Also, the same ILOs (Individual Learning Objects) contain bonus materials for more advanced students, designed:
- to complete superior preparation with the purpose of participating in mathematical contests at different levels:
- Local (University *Politehnica* of Bucharest)
- National
- Balkan region
- European Union
- to elaborate papers on Applied mathematics for Students' Communications Sessions organized
- Locally (in University *Politehnica* of Bucharest)
- Nationally (with students from technical, mathematical and informatical faculties in Romania)
- In cooperation with faculties abroad

Besides BOK (Body of Knowledge, which is common to all the faculties), the second part of the body of the project is Math Zone by Faculties.
This part contains chapters on mathematics with applications which are specific to technical curricula of each type of faculty (Electrical faculties, Mechanical faculties, Chemical faculties, Applied Sciences faculties)
It has a content similar to ILP except for a more focused approach to applications.
Quizes and Midterms are included into the system to cover theory and applications
Students' preparation in ILP and in Math Zone is done in the final examination which has the following features:
- universal final for all students
- both theoretical and application based testing
- algorithmically generated questions
- self-graded with linkage to BOK (Body of Knowledge) and MZ (Math Zone)

If the candidate fails, depending on the deficiencies indicated by the students' answers, a new ILP (Internal Learning Path) to redo the students' average is generated algorithmically.

The project will create next-generation support and advice services to enhance individual and collaborative building of competences and knowledge creation in educational and organizational settings.

The project makes extensive use of language technologies and cognitive models in the services.

The learning activities are enveloped by activities that ensure common ground in use cases and pedagogically sound scenarios that steer the design and development of the processes and guide the validation.

The research in the project is organized in 3 themes, each leading to particular types of services and infrastructures:
- services are developed to establish the current position of the learner in a domain. Services will offer semi-automatic analysis and comparison of learner portfolios to the domain knowledge and continuous modelling and measurement of conceptual development.
- support and feedback services are developed based on the analysis of the interactions of students - using Natural Language Processing (NLP) and Social Network Analysis (SNA) and textual output of students - using Latent Semantic Analysis with contributions from NLP.
- a knowledge sharing infrastructure is construed that allows comparison and sharing of private knowledge to give rise to new common knowledge and social learning.

The services are expected to result in improved appreciation of learner requirements, leading to better recommendations on study plans and resources. Progress monitoring based on learning activities, rather than on formal assessments, will improve recommendations for further competence building and improved co-construction of knowledge in social and informal learning.

4 Enhanced Information and Communication Technology Skills

With regards to the technological advancements the main focus in this project has been set on social software technologies and its usage and adaptations for specific educational needs. A set of tools, including ready to use elements, up to rather experimental technologies that need further research before they can be implemented in practice, have been developed. The project team has committed itself to an open source policy and has published all code developed during the project under creative common licence at McGraw-Hill. Finally, from the practical experience of applying innovative pedagogical intervention strategies in combination with social

software technologies we derived a handbook that is mainly targeting educational practitioners in higher education. One of the main strengths of the project is definitely the large fieldwork that will be performed.
Especially because the University Politehnica of Bucharest (UPB), founded in 1886, is the largest technical university in Romania, with more than 22000 students, 4500 full-time staff (2000 full-time faculty and 2300 research staff and auxiliary personnel) and 1800 part-time staff. The UPB has 12 faculties – five of Mechanical Eng., three of Electrical Eng., one of Power Eng., one of Metallurgy and Materials Science, one of Chemistry and the recently founded (1991) Faculty of Engineering Sciences – with all the courses in modern European languages (English, French and German).

The undergraduate curriculum covers four years of studies and leads to an Engineer

Diploma. At the end of the undergraduate studies, the graduates have to defend their
final "Diploma" projects and to pass a "License" examination.
A second cycle, consisting of two years of study and a Master degree thesis, leads to the Master of Science title. The studies can be continued with the preparation of a doctoral thesis in Engineering Sciences (900 Ph.D. students in 90 specialties).
The research activity takes place both in the chairs of the faculties and in research centres
– working on long term contracts in all the fields of expertise of the departments.
Knowing the extent of the domains of education and research we should specify that the students of the Faculty of Applied Sciences have the advantage of competitive and creative environment (mathematics, physics, management, student research teams and sport contests), free access to all UPB facilities and to a system of national and international grants of mobility for study and research, including, through European Union Socrates Program, Bilateral Agreements with the following institutions: Ecole Polytechnique in Paris and I.N.P. in Grenoble (supplemented by Double Diploma agreements); Polytechnics in: Stockholm, Milan, Torino, Helsinki, Tampere, Mikkeli, Lisbon, Darmstadt; Universities in: Heidelberg, Berlin, Copenhagen (*Niels Bohr* Institute), Uppsala, Barcelona, Madrid, Lisbon, Rome, Genova, Torino, Brescia, Gand, Paris VI, Lyon 1, Grenoble 1, Versailles, Siegen, Compiegne, Messina, Thessaloniki, Munchen. Through the agreements „European Mobility Scheme for Physics Students" all about 200 academic partners recognize the Applied Sciences Diplomas and Certificates granted by UPB.

Teachers' Project which we referred to evolves practical methodology, approaches and tools targeted at day-to-day utilization by the teacher trainers and students.

The concrete aims of the project are:

- to edit a teacher trainers' and teachers' Methodological Handbook of practical methods, methodological tools, and software instruments to support students in building enhanced ICT skills and competences;
- to design a teacher training curriculum for using the Handbook methodology & teaching enhanced ICT skills;
- to create an online content repository with methodological and learning resources for teachers;
- to disseminate the project findings, results, and materials both nationally and throughout Europe.

The expected main project results are:

- to produce Methodological Handbook, tools and instruments for enhanced ICT skills teaching;
- to develop teacher training sample curriculum for applying the developed methodology;
- to train teacher trainers and teachers to apply the developed methodologies;
- an online content repository open to the Romanian educational communities of practitioners, containing a variety of the Handbook-model learning materials.

The general aim of the project is to identify the role and impact of creativity and innovation in a Mathematical and Physical Programme and stimulate further process.

5 An Interdisciplinary Effort

The project will follow a service-based approach i.e. the services will be integrated in existing e-learning environments and build on the results of open source projects in the area of e-learning and language technologies [17]. This will enable professors to concentrate on their key tasks i.e. the design creation of a set of next-generation support and advice services. The services will be the result of an interdisciplinary effort bringing together researchers in the areas of language technology, mathematics and physics, technology enhanced learning and pedagogy.
The University Politehnica of Bucharest is the largest technical university in Romania, having over 22,000

students. More than 2000 students are enrolled in the Computer Science and Engineering department, in Bachelor, MSc and PhD programs of study. The department also runs the National Center for Information Technology (NCIT), which is an EU Center of Excellence (EU-CIT). It has 18 full professors and 34 teaching assistants, researchers and PhD students. The mission of the Center is to promote advanced and inter-disciplinary research, to sustain the development of human resources in postgraduate educational programs. The Centers activity relies on a collaborative virtual environment using high-performance computing resources and computer-supported cooperative work tools. The Center is actively involved in international cooperation with similar centers, partnerships with IT companies and development of national and international projects (EU-NCIT, COOPER, SINTEC, CoLaborator, IKF, AGCOR, EGEE, SEEGRID, RoGRID, CODESTAR, REASON). The main role of the PUB-NCIT team in the project is to contribute to WP5 and WP6. Moreover, PUB-NCIT will take the lead in WP5 "Support and feedback during learning". Additionally, PUB-NCIT will take an active role in WP7 "Validation".

The thematic area of expertise includes:

- Industrial Logistic and Suplly Chain Management
- Operations Management (Lean manufacturing, Just in Time, Productivity and Competivity, Manufacturing, Kanban, Forecasting, Planning, Job Design and Work Measurement, Inventory Systems, Materials Requirement Planning, Job scheduling and Control, Materials management and Purchasing, Benchmarking, , ERP, SMED, Hoshin, Poka-Yoke, Risk Management..)
- Total quality Management
- ISO 9001-2000
- Autoquality and autocontrol
- Data acquisition and analysis, process monitoring and control
- Modelling and simulation
- Tribology- Surface Engineering
- Technology of new materials products

We should highlight the fact that learning does not occur in isolation, but in a context involving various actors and resources. In such a learning environment, technology can enhance learning in a direct way e.g. by selecting content to be presented to the learner, or in an indirect way by enhancing support processes, such as tutoring. LTfLL (Language Technologies for Lifelong Learning) uses language technologies in educational settings to make support processes more efficient and effective [18].

The services developed in LTfLL will result in:
• an improved appreciation of the requirements and current profiles of the learners that will bring forward recommendations to better plan their studies and their choice of study resources.
• an improved support of (and therewith access to) contemporary pedagogical models such as computer supported collaborative learning.
• improved co-construction of knowledge in social and informal learning.

The LTfLL (Language Technologies for Lifelong Learning) [13] project will create next-generation support and advice services to enhance individual and collaborative building of competences and knowledge creation in educational and organizational settings. The project makes extensive use of language technologies and cognitive models in the services.

The research activities are enveloped by activities that ensure common ground in use cases and pedagogically sound scenarios that steer the design and development of the services and guide the validation; a technical infrastructure for the creation and integration of the services and a validation structure that ensures rigorous evaluation in realistic settings, with several languages supported [19].

The research in the project is organized in 3 themes, each leading to particular types of services and infrastructures:

In theme 1 services are developed to establish the current position of the learner in a domain. Services will offer semi-automatic analysis and comparison of learner portfolios to the domain knowledge and continuous modelling and measurement of conceptual development.

In theme 2 support and feedback services are developed based on analysis of the interactions of students - using Natural Language Processing (NLP) and Social Network Analysis (SNA) and textual output of students - using Latent Semantic Analysis with contributions from NLP.

In theme 3 a knowledge sharing infrastructure is construed that allows comparison and sharing of private knowledge to give rise to new common knowledge and social learning. Ontologies for formal

domain representation are combined with social tagging.

The services are expected to result in improved appreciation of learner requirements, leading to better recommendations on study plans and resources. Progress monitoring based on learning activities, rather than on formal assessments, will improve recommendations for further competence building and improved co-construction of knowledge in social and informal learning.

In the learning process, one of the major tasks is to familiarise the learners with the devices that are needed for effective communication through the medium of writing.

Thus, the main video focuses on the practical aspects of teaching, aiming to:

- activate and build on students' existing knowledge;
- create a dynamic and interactive learning environment;
- improve performance competence and fluency through a range of practical techniques and activities;
- provide strategies for using ICT appropriately in a range of situations;
- sensitise students to the implications of intercultural contact;
- encourage students to use the newly acquired knowledge in real world contexts.

What is a mixed – ability class ? The answer is complex in its implications. In this context different ways of teaching were analysed.

In a class there are many kinds of learners: visual learners, auditory learners, kinaesthetic learners, individual learners, group learners, concrete learners, analytical learners, communicative learners, authority-oriented learners. There are also preferred learning styles. There are active learners, reflective learners, theorising learners, experimental learners. Good classroom management skills are absolutely essential in the mixed-ability class. It ensures that all students are involved in the lesson. Motivated learners are easy to recognize because they have a passion for achieving their goals and are ready to expend a great deal of effort. This influences the amount and quality of what is learned. All teachers want to have motivated learners in their classrooms. How can they achieve this ? Teachers have to focus on instructions, they have to set a time limit for the activity before the students begin, monitor while the students are working, find things to do with fast finishers, make sure everyone benefits from feedback. They also have to use encouraging statements that reflect a honest evaluation of learner performance.

The term of 'autonomous work' [16] was used to indicate students' ability to monitor their own learning, to understand when they are making errors, and to know how to correct them. Autonomous work involves the development of specific strategies that help learners evaluate their learning, check their understanding and correct errors when appropriate.

Reflection can develop through lectures and debates, where students are encouraged to express their opinions. Teachers can help students to become self-regulated and reflective by providing opportunities to plan how to solve problems, to design experiments and to read books; to evaluate the statements, arguments, solutions to others problems, as well as of oneself; to check their thinking and to ask themselves questions about their understanding; to develop realistic knowledge of themselves; to know what are the most effective strategies to be used and when to use them.

New learning environments that are responsive, personalised and intuitively adaptable to the learner's and teacher's needs can motivate, engage and support the development of skills and competences [3]. Conscious of this reality, we mention the necessity of a continuous ability to access, use and understand today's digital information in the future, through systems and tools for digital preservation.

Until better tools appear, there are opportunities for us to take advantage of existing information technology . The Internet could be used to distribute a course on how to transfer documents[4;7]. An associated bulletin board could provide answers to questions from novice users. Professors could create and test a clear set of instructions for use of a standard set of tools and make these instructions and tools available to the students' community [10]. The goal is clear – professors and researchers must harness the Internet to increase the community's capacity for collaboration.

6 Conclusions

The practical achievements make us think that more informal approaches to education are also valuable in the information society providing young people with an opportunity to learn

through practical experience. Formal education systems need more flexibility to allow students to undertake and gain credit for such activities. Peer based education, where students help students, and student exchange programs are also beneficial and popular.

Following the same line of thought what is significant for the Faculty of Applied Sciences (University "Politehnica" of Bucharest) is that the learning curriculum will continue to modernize with a view to the requirements of the international academic community. The structure and the services in informatics of the faculty will be modernized.

Thus, in the course of the research activity several components will be developed:

- the research abilities at the level of departments and research centres;
- taking part in competitions for projects in the National Program of Research and Development or to obtain grants from the Education and Research Ministry , the Romanian Academy etc ;
- the development of an international collaboration with well-known European Universities to take part in mutual research themes;
- supporting the national industry of products and services in the field of automatics and computers by offering new concepts, solutions, technologies, prototypes;

The scholarly communicative potential of electronic networks is revolutionary. A number of surveys in the domain of the labour market identify as crucial and essential for the knowledge-based economy [15], the ICT-skills and the so-called *soft skills*, such as information and knowledge articulation and presentation, information search, gathering, evaluation, and effective use, project working, team working, problem solving, and skills for life-long learning. These soft skills can be considered to be an essential part of the ICT skills of every citizen and worker, and in this respect we can speak about enhanced ICT-skills.

Education is one of the core elements in the development of the Information Society . We have demonstrated that University "Politehnica" of Bucharest has promoted links between the educational sector and the further development of the ICT .

The project which I have analysed is giving a high priority to the use of ICT for more equitable and pluralistic development in education.

The broad questions on which the project focuses are:

- How can one use ICT to accelerate progress towards education for all and throughout life?
- How can ICT bring about a better balance between equity and excellence in education?
- How can ICT help reconcile universality and local specificity of knowledge? and
- How can education prepare individuals and society to benefit from ICT that increasingly permeate all realms of life?

Several points must be borne in mind as one pursues these questions. First, ICT are only a part of a continuum of technologies, starting with chalk and books, all of which can support and enrich learning. Second, ICT, as any tools, must be considered as such, and used and adapted to serve educational goals. Third, many ethical and legal issues intervene in the widespread use of ICT in education, such as ownership of knowledge, the increasing exchange of education as a commodity, and globalization of education in relation to cultural diversity.

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