IT in education is a necessary condition for sustainable socio-economic development

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Abstract. Remembering the old wisdom "we need smart and healthy people", I would like to draw attention to the fact that in our modern world we need young, educated people working with the most advanced technologies. The use of IT in the learning process as an object, means and tool can achieve better results. In the modern global world, it is necessary not only to study some of the basics of science and develop new areas, but also to introduce them widely. We are talking about active international cooperation of scientists on the basis of modern IT. The aim of the multi-year study was to study and test the possibilities of using IT to improve the quality of education. The main idea was a multidimensional study of IT and its impact on the development of the learning process. The main research methods were the analysis of forms and methods of teaching with IT based on multi-dimensional and multi-speed feedback implemented by various tools. The object of study was also IT. The result of the research was some recommendations for changing the course of lectures or classes in high school or lyceums based on ultra-fast feedback. The article originated as a generalization of scientific research of several institutions in Slovakia, Kazakhstan, Russia, Ukraine, the Czech Republic, Hungary and other countries. The article presents some approaches to the use of IT and their impact on the quality of education.

Keywords: IT in education · Object · Means · Teaching tool · Modern technologies · Quality of teaching as a means of development.

1.   Introduction

Sustainable economic and social development of the society is only possible with full support of young and highly educated people. Modern education is based on the application of information technologies (Jurík, 2017) that are to be studied from different angles, not only as an object of learning, but mainly as a learning tool and a means of learning. The basis of development is active application of IT (Fig. 1) in different areas of life: science, mutual communication, exchange of experience (Glatz & Mišota, 2016)

IT as a learning tool solves many problems that were difficult to cope with in the past. This covers the issue of prompt communication of scholars representing different scientific and educational centres, the issue of long-term and one-time scientists' lectures and courses at other universities, student exchange, short-term internships. Of great importance are collaborative remote experiments, real-time exchange of opinions, complementary and virtual reality modelling methods. Specifically, these approaches make it possible to realise virtual excursions even to enterprises that are closed to public in real life (Glatz, Mišota & Zatrochová, 2019). They include numerous food processing plants,

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oil and gas production facilities, mines, high technology workshops or those with harsh temperature conditions, or those requiring high purity of the production process (Rakhimzhanova et al, 2016).

The outcomes presented in this article are a result of long-term collaboration of a great number of specialists from different universities forming an international research team.
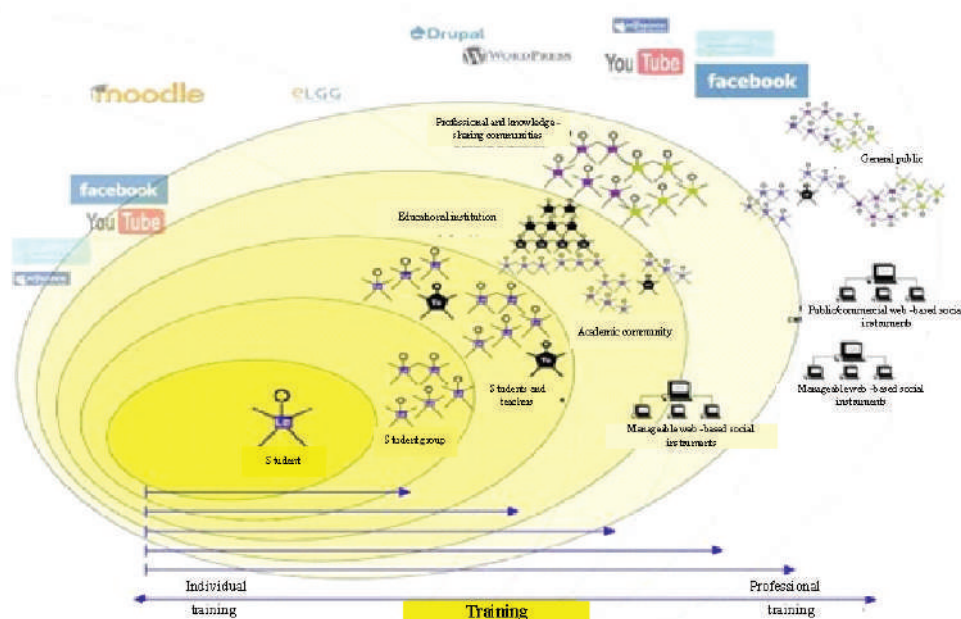

Fig. 1. E-learning environment. Use of IT in teaching and learning.

2.   Materials and methods

The main methods used in the research involved the application of various information systems or software that allowed to develop different kinds of tests and surveys or made it possible to build students' work based on collaborative documents, not only textual but also those including presentations, spreadsheets and measurements. The work involved learning management systems which helped to make comprehensive assessment of students' work and bring together the results of research presented by specialists from different countries.

2.1. Information technologies: learning object – means – tool

In teaching, several basic questions normally arise, especially in teaching computer science: What to teach? What tools to use for teaching? How to teach? Based on these questions, information technologies can be viewed in terms of at least three aspects: object of learning, instrument of learning and means of learning. Duly understanding this definition, we can use properly these technologies for their intended purpose. Being grounded on many previously undertaken studies, we can further elaborate the individual aspects of using IT (Fig. 2).

It is this approach to mastering and using IT that can lead to more efficient use of these technologies in practice (Glatz & Mišota, 2018).

2.2. Feedback

One of the research areas was securing feedback which plays a crucial role not only in production but also in the learning process. The role of feedback is to provide information about the level of knowledge and understanding of new material right in the learning process. At a particular point, the teacher has an opportunity to change the ways and methods of his/her work, to explain things that are difficult to grasp in more detail or not to waste time on what everyone already knows. Meanwhile the gained additional time can be used to transfer the knowledge to other areas.
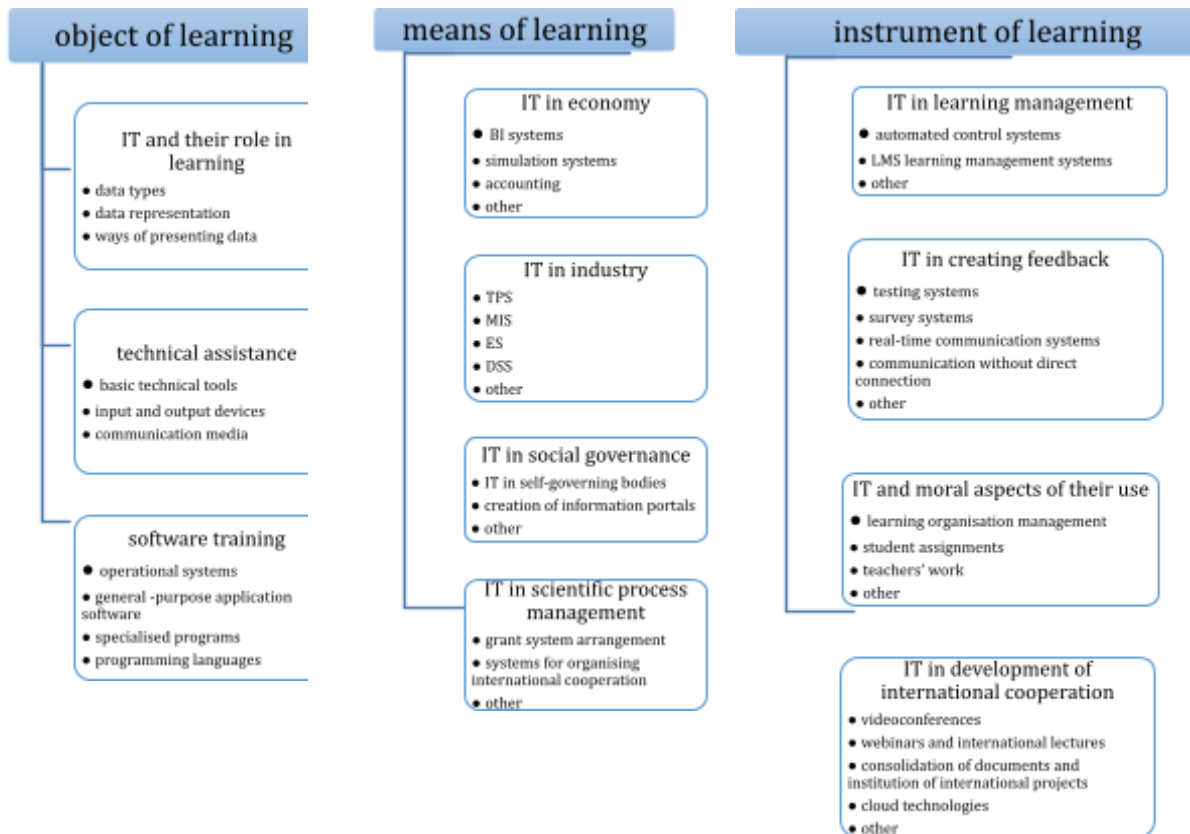

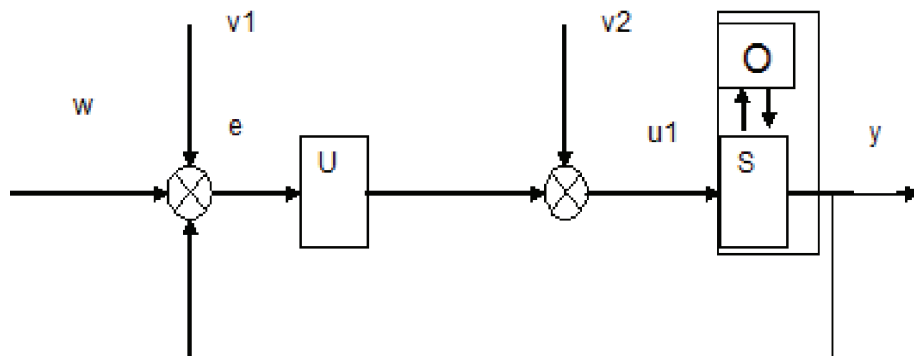**Fig. 2.** IT learning object, means, instrument.

Fig. 3. Learning process management. U – teacher; S – student; w – learning goal; y – learning outcomes; e – deviation; v1 – influence of the environment on the teacher; v2 – influence of the environment on the student; u1 – student activity management
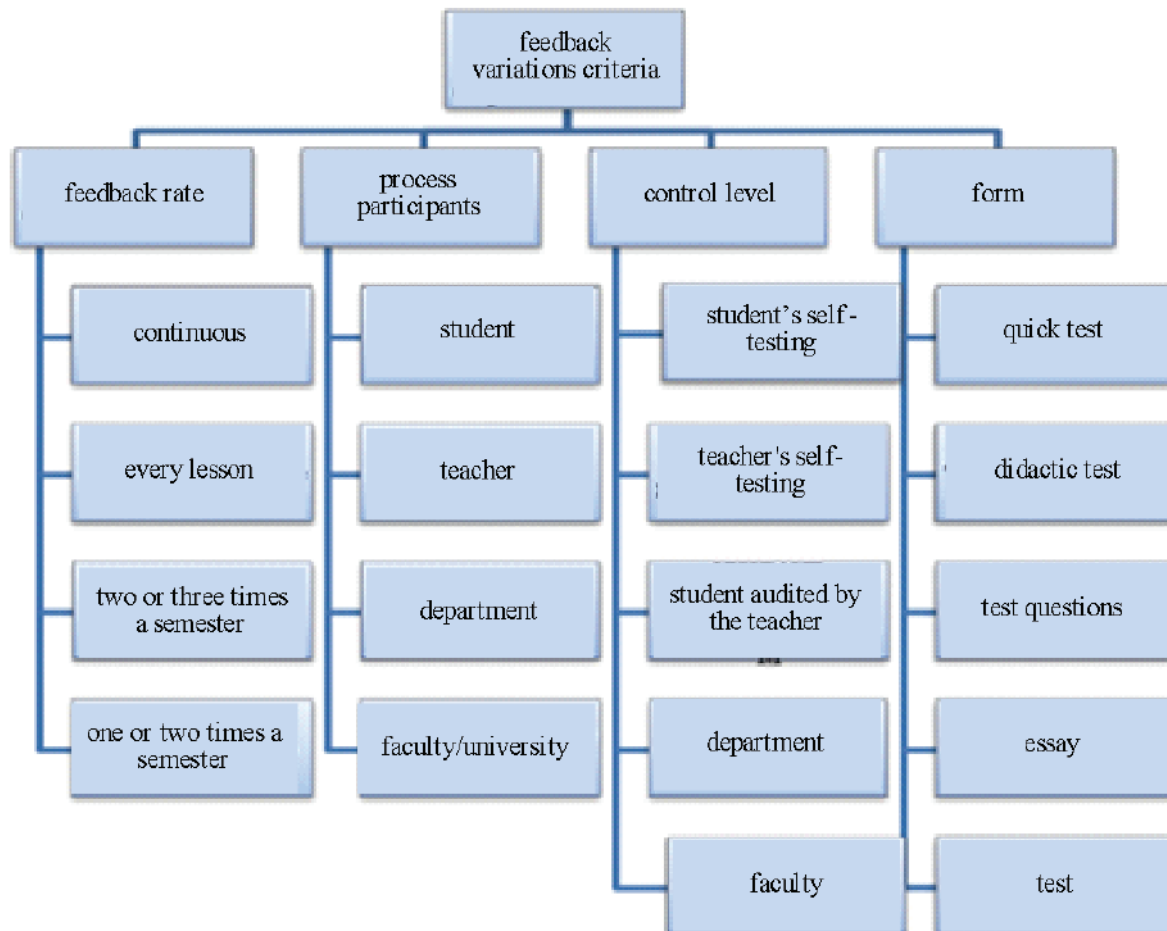

Fig. 4. Different types of feedback.

2.3. The virtual enterprise and educational system

The modern society is characterised by the increasing pace of scientific and technological progress, sophistication of basic engineering activities, increasing dynamics of engineering knowledge accumulation. This leads, on the one hand, to new higher requirements to the quality of education and, on the other hand, to search and realisation of new forms and ways of providing educational services (Schmidt, 2018; Schmidt & Kultan, 2020)

Virtual enterprises represent one of the new corporate organisation forms. The development of new forms of enterprise organisation and management has been influenced to a great extent by the modern market development trends, such as globalisation of markets, growing importance of product quality, price and customer satisfaction, increasing importance of sustainable customer relations, increasing importance of introduction of new information and communication technologies. The term '**virtual enterprise**' is used in different interpretations. It is often regarded as a networked, computer-mediated organisational structure made up of heterogeneous components placed in different locations. 'Virtual' can be interpreted as 'artificially formed' or as 'imaginary, not existing in real physical space'. ***A virtual enterprise is created through the selection of required organisational and***

technological resources provided by different enterprises, along with their integration based on the use of the computer network. These results in the formation of a flexible and dynamic organisational system which is best suited for prompt production and delivery of the company's goods to the market. At the same time, the virtual enterprise is totally customer-oriented since its main characteristics are order fulfilment pace and full satisfaction of customer requirements. The enterprise has a better chance to go on with its suppliers if they are actively involved in the initial development of the company's new products, services and even strategies.

3.   Results

The main results of the long-running work are represented by several conclusions aimed at exploring the use of applying IT in the learning process. In addition to general understanding of the IT role, it is necessary to use such technologies as proper.

3.1. IT – object, means, instrument of learning

In the learning process, teachers sometimes do not make difference between the potential of diverse IT technologies. It often happens that some pedagogues unduly require of the students to be in command of sophisticated technical characteristics of IT, particularly as concerns their use for office work, preparing papers for seminars, e.g. in biology, chemistry or other subjects. On the other hand, the learners need to be able to handle the challenges in the field of architecture, construction or other areas where it is necessary to know not only the CAD software but also the computer's technical parameters in order to use it. IT should be also considered as a tool for communication, group work pooling or other forms of interaction. An important factor in using IT is problem solving acceleration, database creation or other problems.

3.2. Using feedback

Using the generated feedback, it is possible to select a type of control signal enabling one to achieve the sought results with a minimum of outlay and energy. The drawings below show different forms of the control signal and the way to achieve the result.
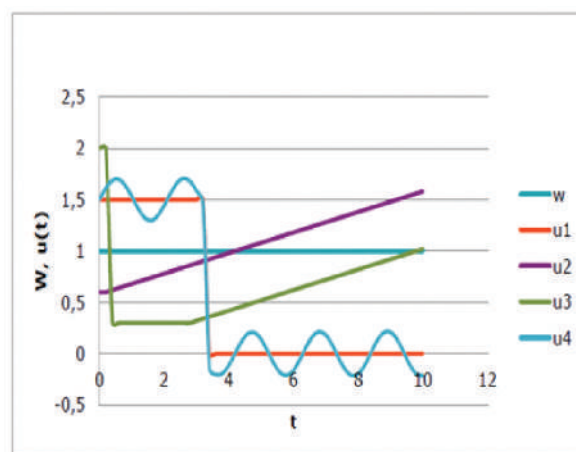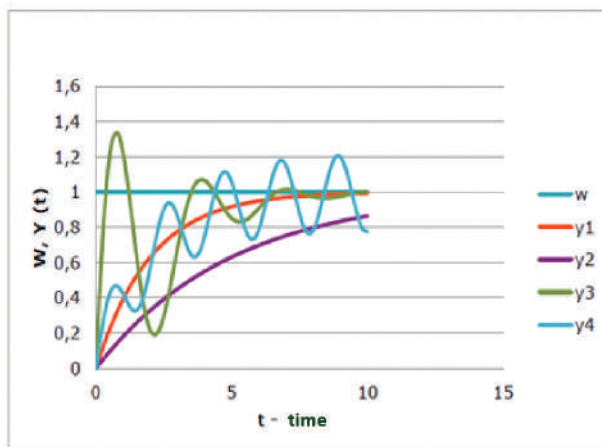

Fig. 5. Control signal.

Fig. 6. Management impact result.

The main objective of the control theory is selection of the most appropriate impact (Fig. 5) on a particular system. Naturally, only some simplest examples of impact on the system and its response have been demonstrated (Fig. 6). In engineering, there exist a large number of techniques for choosing the right impact with the purpose to maintain stability and achieve the objectives. It often happens that we achieve only the first objective – stability – and then try to change slightly the goal and achieve the modified goal. Depending on the system, strength and duration of such impact as well as the deviation rate, several outcomes can be achieved (Fig. 6). The most pleasing result is a gradual, noticeable shift of the system towards the desired result.

3.3. Motivation for the use of ultra-fast feedback

Every student's answers can be saved for each assignment (Fig. 7). The results obtained in every training class can be stored in a database; the activity of each student can be evaluated on the basis of the stored data. The obtained data stimulate the students to perform better. Every student knows the content of his/her correct and incorrect answers; thus it is possible to rate the overall performance of each student on the basis of the above (Fig. 8).
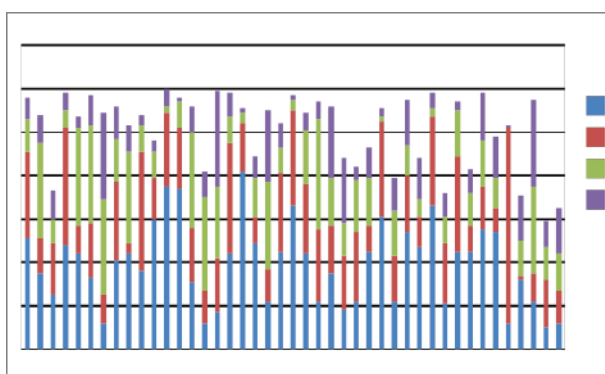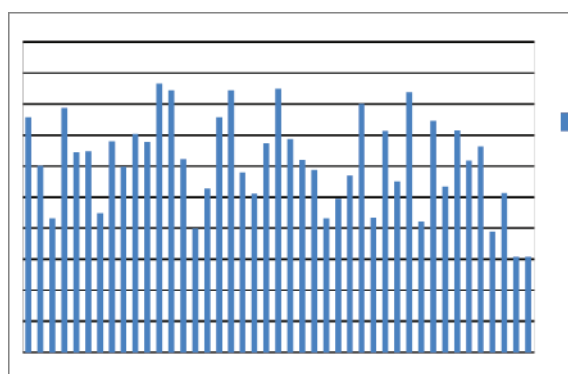

Fig. 7. Problem solving progress.

Fig. 8. Overall student performance.

It is the knowledge of own performance that encourages the students to prepare better for the next session. Naturally, this system evaluates the intermediate progress only. The teacher uses several more methods to assess the students' knowledge in order to make the final evaluation. The realisation of the fact that all answers, among other things, are recorded by the system has an impact on final

assessment, encouraging the students to prepare for the class and give correct answers. Even a wrong answer is a testimony of the student's presence at the lecture and his/her active work.

3.4. New quality – new methodology

The use of the given system of assessing students' knowledge and their attention during the class allows for a *qualitative change in teaching methodology*. One of such aspects is *changing the way of teacher's preparation for the class*.

The teacher should familiarise the students with the content of the lectures in advance, provide them with his/her own methodological materials on the Internet or in a different way. The student explores the assigned topic and prepares for the forthcoming lecture or class.

The lecture programme differs from the usual exposition of the learning subject area. The teacher draws a partial pattern of a new machine / mathematical model, certain social relations, scheme of some activity, .../ and asks questions like: what does it mean?, what for is it needed?, which mathematical model is correct?,.. . Simultaneously he/she suggests, for instance, 4 answer options which can be expressed by verbal answers, drawings, schemes and definitions. The students choose the correct answer. After that, by means of discussion based on the results displayed on the screen, the students defend their decision. The teacher orchestrates this discussion and finally draws a conclusion (which may be delegated to a selected student).
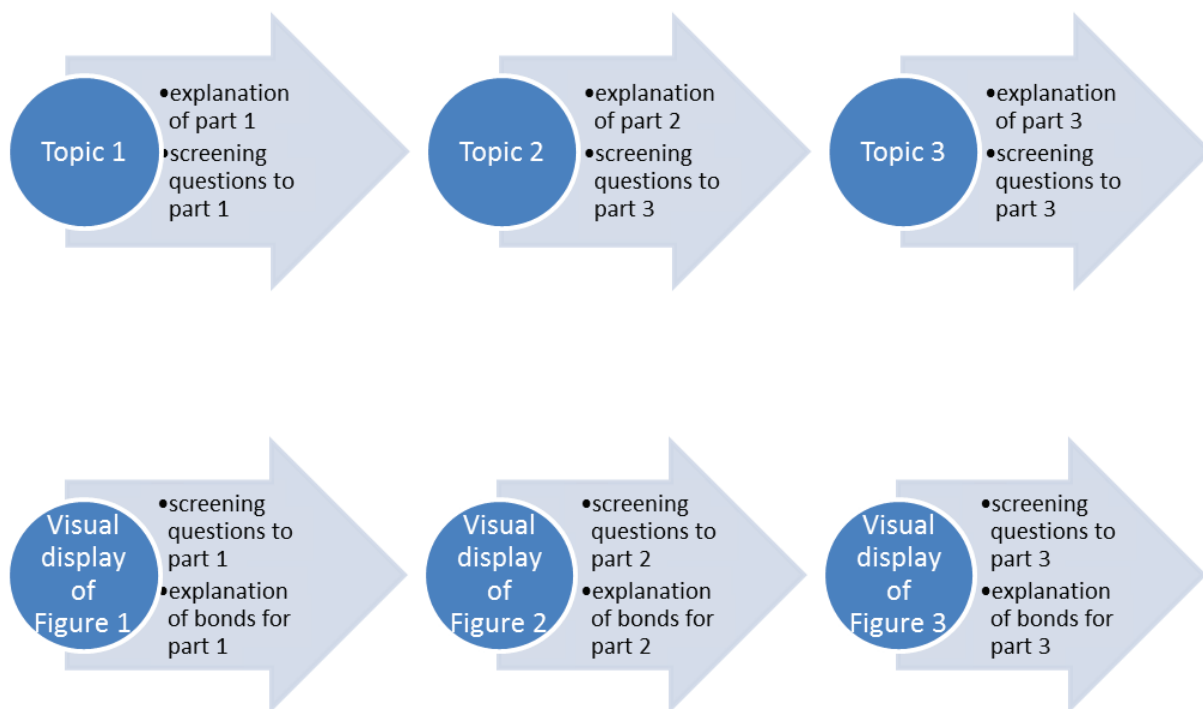

Fig. 9. The process of changing the teaching procedure

The student is not a passive listener but an active creator of new knowledge.

3.5. Virtual chair as a form of international cooperation

Based on the above, a few years ago the authors came to the long-cherished idea to create a form of cooperation that would combine the positive aspects of the existing systems and reject some of their weaknesses.

In order to deliver joint lectures or have collaborative lecture traineeship, a lecturer should have an insight into the work of his/her foreign colleagues. In addition, the faculty and staff from several universities can meet regularly.

With this in mind, the authors devised an idea of international virtual chair, as far back as 5 years ago. This idea found its expression in the application of VRVS Caltech system. At that time, the teachers involved in the experiment used a communication programme that displayed their presence at the workplace. If necessary, it was possible to call a teacher directly or start a video conversation. In addition, a meeting of participants / a chair meeting was held once a week.

Regretfully, this programme has not been realised in the countries of Eastern Europe. But, on the other hand, a number of social networking programmes, video conferencing programmes, conference organisation programmes and learning management programmes have become available (Glatz, Mišota & Zatrochová, 2019).

Fig. 10. International Centre of Education.

All of the above systems became a basis for the institution of the International Centre of Education. The International Centre of Education – INTERCEDU – is a new form of a virtual chair. It can include teachers from different universities and those representing different disciplines. Originally, five areas were chosen: economics, computer science, power engineering and ecology, pedagogy and didactics, production processes and innovations. The main idea of creating a virtual chair was bringing together the teachers from different universities, attracting production specialists, creating educational, scientific and specialised developments. The cooperation of a great number of specialists from different fields of knowledge makes it possible to form virtual research groups.

A library of basic and supplementary educational materials has been compiled for the students. Using modern communication systems, it is possible to organise lectures accessible to students throughout the world, as well as international lectures with involvement of specialists from different universities.

This department has all resources to organise international conferences. It was a co-organiser of the 'Electronic Kazan on the Danube' conference; meanwhile new ones are impending.

4.   Discussion

This section aims at analysing a number of possibilities for applying IT in learning (Schmidt & Kultan, 2020). The use of IT makes it possible to modify the teaching process with a view to improve the quality of learning.
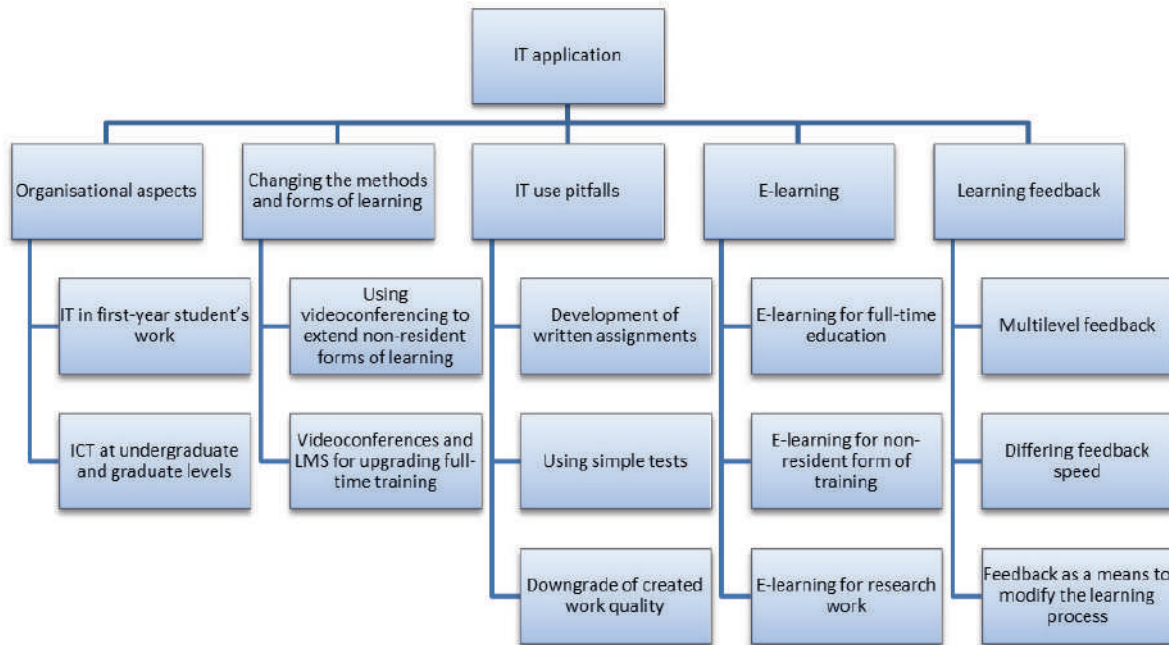
Fig. 11. Use of IT in learning.

The above scheme provides the basic information about the possibility for innovative application of IT with a view to improve the learning process. One of the areas for upgrading the learning process is represented by organisational aspects. IT can be used to provide necessary information to first-year students on the learning method, study timetable; to provide additional information on the training mode at a particular university. In the following years, IT are used to a great extent to replace academic record books, to structure examinations and other necessary learning processes.

5.   Conclusion

This paper presents some results of collaborative theoretical research, along with the practical research outcomes. The main achievements include the development of a parallel computing system applied at Kazakh university (Rakhimzhanova et al., 2016), elaborated during the Bratislava internship; evaluation of student performance in the same programme based on the Moodle system, practiced in Bratislava, Almaty, Atyrau, Makhachkala; joint publications including the monograph 'Energy of the Present and the Future', 'Analysis of Corporate Economic Activity' based on the 'Database' course; many publications in the area of pedagogy and on efficient use of renewable energy sources.

One of the results of this cooperation is the work aimed at achievement and application of ultra-fast feedback. A proposal was made, on the basis of the research in this area, to change the conventional education scheme in terms of its units and to dynamically alter the ways of organising new learning materials.

All these achievements became possible only through enhanced cooperation using the form referred to as the International Centre of Education – Intercedu. The activities of this centre encompass a broad range of cooperation based on a virtual enterprise concept.

The main result of the long-running work of a large number of scientists and educators is the creation of a virtual educational environment. It does not focus on internships, guest programmes, trips, joint articles – this is an organisation bringing together a large team represented by a group of

students from different universities, research and production specialists. This is the kind of environment making it possible to train professionals meeting the demands of the society. Alongside with the international corporations, enterprises and networking trade associations, a due educational network must be created. The network we have developed is in fact a virtual educational enterprise.

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