WAY OF STUDYING GENERAL LAWS OF NATURE IN UNIVERSITIES

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Abstract. The high mobility of modern specialists forced them to have universal background. Such background permits them to be adapted to the different social and professional environment. That is why it is necessary to introduce some basic laws of nature into the studied subjects. The optimal choice of these laws is a complex problem. The universities need to create new special education strategies and generate special concepts to transform the traditional curriculum to a new effective form. The main obstacle for new educational strategies is connected with the high abstraction of the general laws of nature which have to be included in the new scientific background. The most perspective way for solution of this problem is the high diversity of all practical classes and text-books which would be interesting for different students.

Keywords: universal background; educational environment; main laws of nature; curriculum core; life-long education.

XXI century Universal curriculum core

Individual competences – Knowledge, Sills, Abilities or KSA, are created at the whole period of education. The learning technology on each level is built on KSA created on the previous level – Fig. 1. It means the KSA on the tertiary level are based on the KSA which were created on the secondary level. In each case the knowledge and the skills can be conceptualized as a dual pair [1; 2]. Firstly, in order to acquire knowledge, one has to possess learning skills; that is, to put it simply, one should be able to learn. These skills will be referred to below as *basic* skills. Basic skills and basic knowledge are the main core which has to possessed by each individual with any professional qualification. This core is the starting point if the individual has decided to correct his or her professional qualification, certainly. Acceleration observed in technological environment in the last decades creates the need to correct professional KSA both at the period of active lifespan and after turning the critical gap of 50-60 years old. That is why each professional educated individual has to return back to his or her curriculum core several times at the period of actual work. It means the demands to this core are more serious nowadays than at previous time. At first these demands say this core must be universal to be useful in all possible real situations. We can refer such a pack of KSA as *universal curriculum core - UCC.* The general concept of UCC assumes that there is a uniform body of knowledge that all students should know. Presumably, UCC helps produce educated and responsible graduates which can find a good job in all states which are the parts of a single education area. Unfortunately, there is not often much consensus about the demands to professional KSA, in different zones of area we treat them as to be single one. In fact, there is a growing conflict about what topics a core curriculum should contain. That is why the UCC must be more complex than it is usually supposed. The traditional simple concept is to limit the UCC content to basic academic subjects like foreign languages, math, statistics and introduction parts of natural sciences [3]. It is known that the main goal in creating of UCC is to help any individual to find information about a wide set of theoretical and practical knowledge ideas and concepts. The real diversity of the demands to KSA in different education zones forces to include in UCC an additional pack of skills and knowledge such as problem solving, critical thinking, teamwork and community service. Such KSA are universal. Such advanced UCC we shall call *Advanced core* or *AC*. In contrast with UCC, additional knowledge and skills of AC are more general. These KSA we denote as underlying ones. In the first order additional universal skills implemented in AC must generate customs of self training and self learning technologies. The knowledge included in the AC theoretical part must be treated as advanced knowledge. This advanced knowledge on any educational level is the base knowledge on the next educational level, Fig. 1. It is the theoretical background of educated individual at the farther period of long life education. There are some general ideas of the principal conceptual structure of the knowledge pack of AC. We shall discuss it below.

Difference between AC and traditional UCC

In the single education area the standard educational strategy is based on curriculum which is built on a mandated core. The content of UCC is defined and designed outside the classroom certainly. As a result all students learn a common set of knowledge, skills, and abilities. All universities and colleges use the same performance indicators of UCC. The widely spread indicators in all education areas are credits. Students sometimes struggle in one or more core areas. Some students believe that they can increase their background struggle in different knowledge areas and taking several electives. Unfortunately, in some cases the students do not understand that scoring well in an elective is not valid in the universal criteria of education performance. Sometimes the electives are taken in account at the national level only. The supra-national policy is still not ready for uniform scoring of electives. In a common situation the academic content remains the primary focus of UCC. Nevertheless, we hope the higher education systems in Europe move quickly toward quite similar patterns.

AC differs from standard UCC by its primary interest to general laws of nature and generating skills in which some core teaching is moving toward application and problem solving. The Laws of Nature are to be distinguished both from Scientific Laws and from Natural Laws. Neither Natural Laws, as invoked in legal or ethical theories, nor Scientific Laws, which some researchers consider being scientists' attempts to state or approximate the Laws of Nature. There are many laws of nature. The main problem of modern time is the best choice of these laws included in AC. This choice depends both of the area of the students' interest and on their educational level, too. For instance, on the second education level the student learns the laws of Elementary science. On the tertiary level these laws are replaced into the laws of Intermediate science. It is known that real mental behaviour of individuals depends on creativity, culture and education. AC produce different abilities which are affected on all three components of mental behaviour. Yet, the value of these components depends on the area of professional interests. That is why the pack of additional KSA introducing in AC is different for engineers, scientists and humanitarians. The difference is connected not with its set. All distinctions are going on from the field of professional interests. Correspondingly, there are three different types of AC. These types define real theoretical and mental background of an educated individual. Simultaneously with upgrade of the background AC has an additional goal which is consolidation and practice of fundamental skills and abilities. This additional upgraded background is called *Conceptual background.* Its KSA are created as a result of hidden technologies [1,2]. The conceptual background is continuously upgraded all the life span of an individual. The main general abilities created on the conceptual background level are: the ability of a learned individual to focus on abstract concepts; the ability to use holistic as opposite to linear approach and the ability to acquire and utilise new knowledge.

The process of upgrading is required for all graduated individuals. One of the ways of this upgrading is informal learning and self-training. There are special educational strategies invited for adult learners to engage in life-long learning. The general concept of these strategies is the idea that the process of learning can occur with or without formal institutional education. Their occupational studies are important as well.

Conceptual structure of advanced knowledge pack

The characteristic type of development of the human knowledge undergoes periodical massive changes and fundamental internal and external restructuring. We can recollect several periods at which the main vector of investigations was oriented to detailed study of different special areas. These periods are the time of gathering and storage of facts and simple primary theories. The second type of development is connected with generalization of special knowledge. The most part of the general laws of nature were found at these periods. One can observe the transition to the second style of knowledge development from the second half of the XX century. This transition transforms the structure both of the UCC and AC knowledge content. The additional effect of the demands to the main pack of basic knowledge is connected with noticeable increase of storage of new knowledge and creating of new skills in modern time. So, it is possible to say: modern time needs to create a modern pack of basic knowledge learned on all educational levels. In order for this concept to maintain any analytical usefulness, it must be defined and examined.

The basic pack of knowledge consists of several parts. The first part includes the main skills which help students develop the methods of searching and ordering new facts. The second part teaches students to effective processing with new facts. The third part familiarizes students with the general laws of nature. Once the basic skills reach a certain level of maturity, they can be used in applications. The applications are very different as they depend on the future professional activity of the individual. There is a limit of new conceptions which the student can study at the university period. That is why the pack of basic KSA depends on the area of professional interests. It depends on personal behaviours of the students, too. As a result the pre-diploma period of all educational strategies has to be strongly individualized. For this purpose some part of the basic pack must have a possibility to be partially changed. There are some problems which are necessary to be discussed to build a successful knowledge basic pack. The experienced faculties must define all concepts, set of practical skills and the time in the schedule which is the best for their practical development.

Creating of special skills necessary for successful practical work

The list of the skills usually included into UCC are devoted to developing of professional abilities. Yet, there is the second set of skills which are useful in all possible professional areas, too. These skills are connected with technology of qualified processing of experimental, observational and theoretical data. The main of them are the skills in estimation of experimental errors, understanding of features of modern and classical experimental tools and finding the reliability of different data. Some additional skills are devoted to improve students in handling instrumental tools. It is necessary to give some preliminary theoretical instructions to develop these skills. Yet, the most effective learning strategy is to develop a special set of exercises which results are discussed in reciting classes.

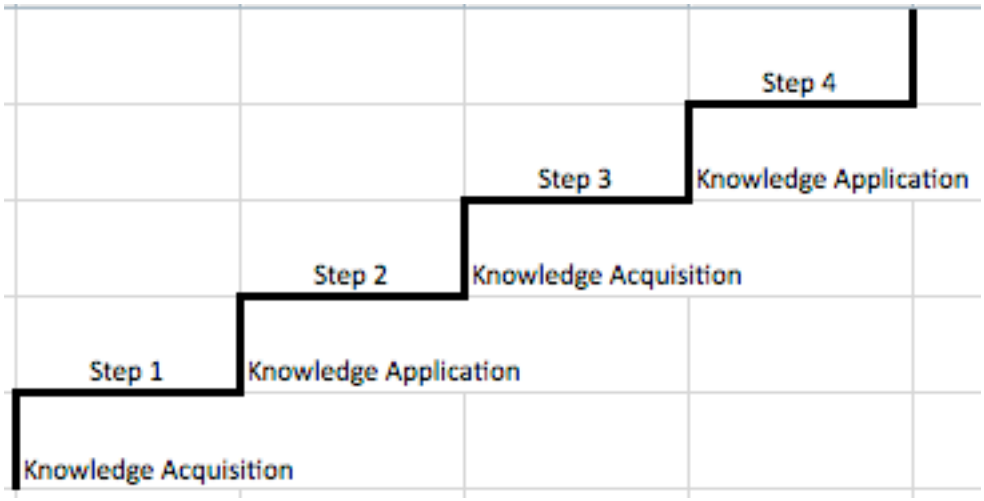

Fig. 1. **Connection between knowledge on different educational levels**

One of the most serious problems in creating basic skills comes from the fact some of these skills are created in so called hidden processes [1,2]. The skills of this group can be developed under constant guidance of experienced instructors. This strategy is very effective in the field of creating special skills in searching, storing and processing of professional and educational information [4,5]. It is hardly possible to keep effective instructor's control after every student's step as his or her experiment is in progress. Consequently, inaccuracy of the student's actions remains missed. It generates some misconceptions in students' behaviours. Improving is possible under computer watching. In general, computerized methods of creating skills is one of the most effective ways in educational strategies of developing the core KSA [6].

The choice of general laws and learning strategies for universal curriculum

High speed of development of modern science and technology demands to introduce in the base KSA some general laws of nature. The most difficult part of this educational strategy is to find the necessary set of these laws. It is clear that the number of basic laws cannot be too large. At the same time the pack of laws to choose to be learned has to be universal and clear both to the future engineers and scientists and to the future writers, artists, lawyers and so on. The best way to find the optimal

choice is generation of a special group of faculties with good experience. The basic laws must generate the theoretical base for creating integrative lecture courses. These courses can generate content-specific skills making possible the connection between different ideas and conceptions of modern science. Our experience says that the general laws of evolution, technologies and achievements in Natural science can be learned at the period of two-three semesters. Instructional imitation technologies are one of additional scenario which helps create general scientific background of the students. It is also useful in supporting the students' competence and adaptability in the applications. The well educated individual must have experience in building and assembling the final product from different parts. He or she must have abilities which use specific methodologies, equipment, or materials. The educated individual must understand the client requirements and must develop system specifications from these requirements. He or she has to have experience in testing and debugging a prototype and process using appropriate tools to satisfy the requirements. This strategy includes quizzes to discuss the basic tenets of the engineering enterprise and fundamental design and analysis techniques. At the period of the senior projects and undergraduate research instruction, imitation of good education strategy generates additional students' ability to collect, analyse, and interpret data, and to form and support conclusions and submit serious reports.

Conclusions

The basic laws of nature selected for UCC must be taught carefully. This means that for each law there should be found the optimal strategy of explanation of its sense. All possible technologies of its study have to be used. Citing of these laws is necessary to be included in the most part of professional oriented lectures and practice. The form of the main laws of nature depends on the level of education. Returning for several times to the content of these laws at the education period is the pledge of success in formation of excellent modern background of a qualified expert in all possible areas of life.

References

1. Abramovich S., Nikitina G., Romanenko V. Spreadsheets and the Development of Skills in the STEM Disciplines – (2010) e-journal Spreadsheets in Education v.3, iss. 3, article 5.
2. Abramovich S., Nikitina G., Romanenko V. Developing Practical Competence of Future Engineers within a Theory-oriented Curriculum at the Tertiary Level. - Herald of Education and Science Development of Russian Academy of Natural Sciences (special issue in English), (2002) v. 4. pp. 24 – 30.
3. Anonime. Learning Standards for Carrier Development and Occupational Studies. – May, 200.5 The University of State NY. Access at *http://www.emsc.nysed.gov* .
4. Lane C.A. Naked in Cyberspace. How to find professional information online. 2-nd ed. - problem solving, critical thinking, teamwork, and community service. Medford, NJ: CyberAge Books 2002, 587 p.
5. Teishler U. Changing Structures of the Higher Education Systems: The Increasing Complexity of Underlying Forces Access at: http://unesdoc.unesco.org/images/0014/001467/146736e.pdf .
6. Abramovich S.(Editor) Computers in Education - NY.: Nova Sci. Publishers, 2012. (In two volumes).