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BOOSTING TEACHING AND LEARNING EFFICIENCY IN TRAINING TEACHERS OF INFORMATION TECHNOLOGY

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Abstract. This paper is meant to propose a methodology for boosting teaching and learning efficiency in training school teachers of Information Technology. It gives an account of some teaching and learning methods that contribute not only to the acquisition of the taught knowledge, but also to the development of skills and habits and their creative putting into practice. Applying this approach leads to achieving those outcomes for the trainee that are related to the adopted definition of higher education in the European communities — "the set of knowledge, skills and/or competences an individual acquired and/or is able to demonstrate after completion of a learning process".

1. Introduction

The strategic goal for the development of the European Union as of 2010, set by the Bologna Declaration of March 1999 and by the Lisbon Summit of March 2000, is "to become the most competitive and dynamic knowledge-based economy in the world" [36, 23]. Implementing these goals is achieved by modernization of education, so that every learner is completely ready for the modern information society. To that regard, the Ministry of Education, Youth, and Science initiated the elaboration of a "Strategy for introducing Information and Communication Technology at secondary school level" [24], according to which the training in Information Technology (IT) has to start in the lowest grades and continue throughout the whole training period.

To warranty the coherence between the two components: real school practice and real outcomes, and to make sure they are comparable with the achievements set forth in these documents, there has to be harmony between the two types of resources.

One of the resources is the updated curricula concepts [27] incorporating the study of modern IT. Thus, in the school year 2001/2002, the 9^{th} grades of the Bulgarian secondary schools studied the subject "Information Technology" for the first time. In the school year 2006/2007, this subject was also introduced to the 5^{th} graders in the Bulgarian elementary schools. To that end, state educational standards for the subject matter content in "Information Technology" were elaborated and enacted [27, 1].

The other resource is the human one. The teachers level of qualification and their motivation to implement quality training is one of the factors that determine the successful outcome of the process of modernization of education in Bulgaria. The professionals who graduated recently have the relevant knowledge and skills, but there are other teachers who did their degrees in the more distant past and require retraining. The Faculty of Mathematics and Informatics (FMI) at Plovdiv University "Paisiy Hilendarski" provides training to teachers and awards the qualification of "Teacher of Informatics and Information Technology" at secondary school level, and in the academic year 2005/2006 it started a Masters program to train teachers of Informatics and Information Technology. The authors of this paper have been actively involved in these training provisions.

This paper puts forward a methodology raising the efficiency in training teachers of Information Technology at school level. Teaching and learning methods are considered, which contribute not only to the acquisition of knowledge, but also of skills and habits and their creative implementation. This approach leads to the achievement of those outcomes with regard to the trainees that are related to the established definition of higher education in the European communities: "The set of knowledge, skills and/or competences an individual acquired and/or is able to demonstrate after completion of a learning process." [37, p. 6].

2. Training methodology

Training, according to M. Andreev, is "a unity of teaching and learning" [2, p. 42], whose main objective is the "equipment of trainees with knowledge, skills, habits, focused on their professional and personal development" [35, p. 252] in order to achieve a "unity of the trainers and trainees activities focused

on a common goal" [35, p. 252]. N. I. Boldirev also takes into account the role of the trainee in this joint activity during which "the teaching professionals, while transferring knowledge, skills and habits, guide the process of their acquisition by the learners " [7, p. 26]. V. V. Kraevskiy, N. A. Menchinskaya, et al. define training as an idiosyncratic cognitive activity in the bilateral process whereby learners, under the guidance of the teaching professionals, acquire knowledge, skills, and habits.

Based on these treatments of the notion of "education", it can be concluded that for all these authors "teaching and learning are the two key points in the unified process of training" [2, p. 42]. As it is known from general pedagogy [40, p. 18–19], this holds true not only of the school level, but also of higher education. However, the characteristic features of teaching university students have to be taken into consideration in terms of "mastering knowledge, skills, and habits in fundamental, special, and social sciences" [20, p. 20]. It is essential that the learners shape their mindset and develop cognitive creative capabilities and skills.

To implement the educational function of training, learning and teaching have their own methods and techniques. For students trained at a higher school, the road to acquisition of knowledge is characterized by a creative quest and by relating the knowledge to solving particular real-life problems. Thus, the learning process is facilitated and allows students to penetrate deeper into the essence of the phenomena and facts to be learned, provided that the general rules of learning cognition are followed. Based on research by L. S. Vygotski [42], I. Ganchev et al. [13, p. 7–14] consider the cognitive process in terms of the activity of the nervous system with its two functions — management of all systems in the body and the relationship between the body and the environment and in terms of the brain features. During an individuals communication with the environment, part of the brain formations are produced, which is used in that humans training. The relationship with the surrounding environment is implemented via the sensory systems, i.e. they are the way of impacting the human nervous system. According to this research, there does not exist a cognitive process without unity of the sensory and logical levels, as the goal in training at higher educational institutions is to reach the "scientific notion" (in Vygotskys terms).

The teaching methods are ways of knowledge transfer, guided direction of students scientific and cognitive activity, and the learning methods reflect students scientific and cognitive activity, are focused on the creative mastering of knowledge, building skills and habits for putting into practice in real-life settings. Teaching has as its main subject the training of learners for their

realization and is "unthinkable outside the context of binarity (unity of teaching and learning)" [2, p. 79]. In an educational context, learning according to T. Prodanovich and R. Nichkovich is: "a goal-oriented and rationally organized process for the acquisition of social experience in its generalized and systematized form" [31, p. 100–101], it is the acquisition of new knowledge and behaviour, as thereby the time for building capabilities is reduced. Learning can be considered as a process of "adaptation, cognition, and development, which is designed and coordinated both in its internal and external aspects and makes headway by successful regulation and self-regulation in compliance with certain goals geared towards acquisition of knowledge and social experience" [26, p. 34]. In psychology, in the context of learning, there is the thesis of the "cognitive style", whereby an individual learns and operates in terms of certain cognitive categories. G. Piryov [30, p. 25–34] considers two major varieties of learning: perceptive-motor (learning by trials and errors) — assumes the existence of a problem situation and a stimulus for solving the problem, and associative learning, which is implemented by the mechanism of conditional reflexes. According to the author, the main factor in the process of learning is the insight, which creates the opportunity to penetrate into the problem situation, to direct the solution along a certain direction, utilize all trials made to arrive at the right decision [30, p. 110]. The term insight was introduced by V. Koeler [8, p. 430] to determine the typological behavior of the individual in problem situations. The stipulation of the mechanisms of this process will considerably be benefitted by the further elaboration of the reflection theory, confirmed by S. Grozdev [14, p. 40], in that three processes characterize the insight: selective decoding (becoming aware of the contradictions), selective combination (overcoming the contradictions), and selective comparison. Overcoming the contradictions is the most essential of these processes. This process is most closely related to the system of factors that the insight depends on: previous experience, frequency of solving the set problems; the level of motivation; the emotional tension on the personality. The previous experience, its actualization and activation, as well as the "emergence" of the implicit knowledge are all closely related to reflection. The notion of the insight can be related to the other underlying concept of the Gestalt psychology — the structure and its totality — the handling of new situations, the solving of new problems take place thanks to the generation of new forms of behavior; in the allowed situation every object has its place in the general structure [30].

From the point of view of didactic tasks implemented at a certain stage of development, B. P. Esipov considers the methods for: building new knowledge; forming skills and habits; application of knowledge in real life settings;

reinforcement of knowledge, skills and habits; testing and assessment of the knowledge, skills and habits. M. I. Mahmutov, from the point of view of the social tasks and functions of training, provides a rationale for the classification of the interaction between the teachers and the learners activities as a combination of the teaching methods with the relevant learning methods. I. Y. Lerners and M. N. Skatkins concept is that the teaching methods be defined as: "ways of organizing the learners knowledge, providing mastering of the knowledge, the cognition methods, and the practical activity" [23, p. 117], which gives grounds for the hierarchy of the learners cognitive activity according to the following classification: explanatory-illustrative or reproductive; problem; research and quasi-research.

Those who train pre-service teachers appreciate the significance of the teaching and learning methods applied in higher education. According to S. A. Arhangelskiy, these methods express the system of guided knowledge in the students academic and research activity [4, p. 201]. As I. I. Kobiylyatskiy notes, the teaching methods in higher education are not just a means for conveying and acquisition of knowledge, but also a form of organizing knowledge [20, p. 74]. He proposes the following classification [20, p. 82–83]:

- Methods providing transfer, perception and acquisition of knowledge and forming beliefs (lecture, independent work by the student, lesson observation, tutorials);
- Methods for application and reinforcement of knowledge, for developing skills and habits (seminars, practice sessions, quizzes);
- Methods for testing and vocational training (colloquia, interviews and tutorials, term projects, semestrial exams, state exams, thesis defense).

This classification of the teaching methods reflects in more detail not only the process of teaching (acquisition of scientific knowledge), but also takes into account the other side of the binary process of training — learning (the learners activities for acquisition of the taught knowledge, skills and habits). Taking into account the dissimilarities in the forming activity of the education scientist and the cognitive activity of the student at the higher school, these methods can be bundled into two groups:

- Curricular activity — this group includes the teaching methods in terms of the two forms: lectures and practical sessions, testing methods and vocational training;
- Extracurricular activity — independent work by the students for reinforcement of the acquired knowledge, skills and habits; information retrieval from textbooks, books, and other sources; self-assessment.

3. Teaching and learning design

In the higher school, as highlighted by S. Zinoviev, E. Baykova, I. Kobiylyatskiy, I. Gyudzhenov and others, teaching takes place in two established forms: lectures and practice sessions (seminars, laboratory practicals). The lecture as a "system of activities" [16, p. 99] is "logically sound, systematically consistent presentation of a scientific issue" [43]. The lecture should provide the students first encounter with the scientific and theoretical essentials in a given domain and "development of skills for independent acquisition" of this knowledge [20, p. 91]. Even though the students are apt to independence in reasoning, "to analytical interpretation of the lecturers philosophy and concepts, a strong influence is exercised by the lecturers precise and clear standpoint" [20, p. 106]. Thus, the lecture is the leading method in the comprehensive formation of the young specialist through the teaching and learning process.

The versatile training presupposes not only the building of knowledge, but also the acquisition of practical habits, the development of skills for creative application of the theoretical knowledge in practice, especially in the professional domain. The knowledge, skills and habits result from the performance of activities. Such an approach is also touted for by S. I. Zinoviev [43, p. 206]. This is achieved by means of the other established form of teaching and learning design in the higher school — practice sessions (seminars, laboratory practicals). They are a method for active application of knowledge, which is preceded by an independent study of various sources and aids. Learners active involvement in a certain activity "provides its successful and long-lasting acquisition" [16, p. 123], leads to systematized and thorough knowledge, to developing key intellectual skills and habits. Since ancient times, practical sessions have been offered in parallel with the lectures. In the old days, they were in the form of a dialogue between teacher and disciple or disputes as a way of defending the achieved and convincing in the truthfulness of what one had acknowledged to be the dogmatic truth.

The efficiency of a lectures impact grows with the introduction of a problem-oriented construct of the lecture course. Two types of lectures have been established in the higher school practice [5]:

- Information (traditional) — present a strict system of scientific knowledge; it has a logical construct and consistent presentation of the content material to stimulate the attention of the audience through tested techniques;

- Problem — combines the lecture presentation with elements of problem and situational methods and/or project-based learning; the trainer provides directions towards independent inquiry into a specific manifestation of the theory in various practical situations.

Project-based teaching and learning is "an authentic instructional method or strategy in which students plan, implement and evaluate projects that have real-world applications beyond the classroom" [32, p. 6]. These are projects developed through learning by doing and by using the available theoretical knowledge based on self-guided planning of the work and on learners taking the responsibility. Under this treatment of the essence and role of a project, the process is related to the content knowledge and includes practical activities. The topics are interdisciplinary, related to the content domain and comply with the goals set for the training. They give learners the opportunity to work relatively independently for long periods of time and end up with feasible products or presentations. Project work aims at "combining life, learning and work in such a way that a significant problem corresponding to the learners needs be handled (PROCESS) and led to a result (PRODUCT)" [28, p. 66].

John Dewey is believed to be the first theoretician of the so called "project method", as he introduced the concept of "active social activities" at the experimental school he founded in 1896. John Dewey justified the necessity for applying this method and was a proponent of the "learning by doing" concept, i.e. the relation between the new knowledge and the already familiar knowledge can be implemented by various means. In project-based training, experience is not derived from a systematic presentation of knowledge, but is acquired in the deliberately designed process of activity not accidentally, but as a consequence of the teaching professionals influence [10]. The rethinking of the notion of "project" was done by all accounts by Prof. W. Kilpatrick in his essay "The Project Method" [19, 319-335], describing the project method as a "whole-hearted purposeful activity proceeding in a social environment", while spontaneity and expressed interests and needs are the major distinctive features of project work. W. Kilpatrick considers four steps in the development of a project: goal-setting, planning, conducting, evaluation, as according to him, success depends on the goal-setting. According to J. Dewey, project training should be well planned, the trainers role should be clear in the provision of direction and guidance in order to achieve the educational goals.

J. Thomas [39, p. 3-4] considers five criteria a project should meet in order to be considered as such:

- centrality — projects are the curriculum; the central concepts of a discipline are learned by means of the project;

- driving question — "the definition of the project (for students) must "be crafted in order to make a connection between activities and the underlying conceptual knowledge that one might hope to foster."; "The questions that students pursue, as well as the activities, products, and performances that occupy their time, must be "orchestrated in the service of an important intellectual purpose" [6, 369-398].
- involving students in a constructive investigation — "An investigation is a goaldirected process that involves inquiry, knowledge building, and resolution. Investigations may be design, decision-making, problem-finding, problem-solving, discovery, or model-building processes. But, in order to be considered as a PBL project, the central activities of the project must involve the transformation and construction of knowledge (by definition: new understandings, new skills) on the part of students";
- student-driven — "projects are not, in the main, teacher-led, scripted, or packaged"; they "incorporate a good deal more student autonomy, choice, unsupervised work time, and responsibility than traditional instruction and traditional projects."
- realistic — "projects embody characteristics that give them a feeling of authenticity to students; these characteristics can include the topic, the tasks, the roles that students play, the context within which the work of the project is carried out; the products that are produced, the audience for the project's products, or the criteria by which the products or performances are judged."

Project-based teaching and learning involve real-life challenges where the focus is on authentic (and not simulated) problems or issues, where the solutions have the chance to be implemented. One of the great innovations in project-based teaching and learning is in that, in order for learners to succeed, they have to apply higher-order reasoning, including creative solution of the problems, project management, oral presentations, ability to retrieve and organize information in multiple disciplines, and ability to work on a team in order to achieve a certain goal. Thus, when the responsibility for the solution of the problem is with the learner, students ownership and motivation for learning are boosted. Motivation is a key psychological notion and is considered as "needs and aspirations, mindset and interests, striving and goals of the personality" [22, p. 57]. Major determinants of the motivation according to Kalyutkin, are the significance of the goals (expected result by the individual); the probability for achieving this result.

The essence of project-based teaching and learning presupposes a thorough analysis of the acquired knowledge in working on the project and discussions

of the fundamental principles and concepts. The process of debriefing after gaining some experience reinforces what has been learned and guarantees that this experience has been reflected on. This is how the reflection approach is implemented in training: "the reflections through which the individual selects the needed and most appropriate knowledge in order to execute a certain practical activity; the reasoning procedures through which it is prepared regulate and supervise the transformation of this knowledge into means ... for solving professional and real-life problems" [41, p. 60].

In most classical disciplines, the introduction of the essential part of the knowledge takes place during lectures, while the practical sessions just facilitate the acquisition of the new conceptual apparatus and its operationalisation. In IT training, the trainees practical activities are of special importance. Along with grasping the notions in compliance with the new State Educational Standards [27, 1], the learners have to master skills in working with various software applications, including the processing of various kinds of information. IT teachers are those who are expected to assist the school administration in the development of a number of teaching materials and documents. Practical activities are especially necessary for adults. The strive in their training is solving various types of problems for constructing their own knowledge. This knowledge will allow them to act in contexts where knowledge is constructed at the moment, i.e. they should acquire skills to transfer what they have learned to new situations. In the andragogic model of education, the learning individual (not just the taught individual) plays a central role. They have a certain experience, pragmatic attitude towards the acquired knowledge, show aspiration for independence and self-actualisation.

For the implementation of the training goals ("Every learner, according to their ... interests, conscious or unconscious needs should be able to ... acquire the maximum amount of scientific knowledge and develop their intellectual and practical skills" [13, p. 22]), in training teachers of IT at FMI, the authors apply an appropriate combination of traditional methods with the method of project-based teaching and learning. Trainees are acquainted with the essence of the project method by examining particular projects, both ones that have been adapted to our educational standards [34], and ones we developed ourselves [12].

4. Boosting teaching and learning efficiency in training school teachers of information technology

Regardless of the fact that in the higher schools practice first comes the information function of the lecture, along with other educational means, the lecture combines, coordinates and manages various ways of information transfer

(textbooks, teaching aids, and educational technology). The didactic principle of visualization, however, is equally important. It depends on the degree of inclusion of all sensory organs in the perception, with proponents, such as Jan Komensky [21], J. H. Pestalozzi [29] and others. In [33], a treatment is given of modern information technology for storage and presentation of instructional information and for managing the training process. The goal is the acquisition of knowledge and skills by the trainees for proper selection and appropriate use of various kinds of teaching methods, media and materials in the training process, during their future teaching careers.

To boost the teaching and learning efficiency, the authors of this paper take into consideration the role of the didactic principle of visualization. The lecture materials for our courses are thereby developed in the form of multimedia presentations, as provisions are made to allow students to use the Internet [17, 18]. Within a lecture, real-world problems are discussed, ways of their development are sought, and a system of activities is demonstrated to reach the solution using relevant software applications.

During the practical sessions, students work on various educational tasks. They differ in terms of the objectives that have to be achieved by means of their solution. A certain type of tasks bring about the need for mastering specific knowledge and skills related to the acquisition of the technique of performing certain activities. In this way, the teacher discusses with the learners the core components that are to be elaborated in solving the problem. A demonstration is made of part of the processing related to the new knowledge obtained from the course. Students are provided with didactic materials with some initial data (text to be formatted, a base in terms of a table of data), which constitutes the starting condition of the problem. The intention is to avoid (at the beginning of the training sessions) the mixed levels of keyboard skills, which is of importance in training teachers and to establish a shared pacing. Trainees are given specially designed source materials with a description of the activities involved in solving the problem in order to learn the technique of performing these actions.

To motivate the intrinsic-cognitive need for knowledge and skills, another type of tasks are used. These are tasks related to the application of a multitude of actions. They involve the performance of already formed activities, i.e. the final outcome is reached by a suitable grouping of the tasks-components (in Ivan Ganchevs terms) or baseline training tasks [15]. There is no ready scheme for solution in the trainees existing knowledge and skills, so each of them has to set up their own system of actions after analyzing the instructions to the task. Students are provided with materials containing the end state of the task

(the final appearance of the document), as the constituent elements and ways of producing them under the trainers directions are discussed. Tasks of this type contain elements for which no knowledge has been provided. We strive to have our students reach a solution to the set problems by means of heuristic approaches, using the cognition methods: analysis and synthesis, analogy, and modeling. The trainer provides facilitation, so that everyone can arrive at the correct solution following their own ways in the implementation of the outlined plan.

The other component of the binary process of training is learning. This is not just perception and acquisition of new knowledge and skills in the classroom sessions, but it also involves extracurricular activities. The latter takes place as independent work by the students without immediate participation of the trainer and consists of transformation of the acquired information into knowledge, skills and management of this activity. Self-guided learning is promoted by specially designed didactic means and aids [3, 11]. They contain the theoretical knowledge that is to be learned and a system of tasks of various types to be performed. Every trainee can work at their own pace according to their personal abilities. Thus, they are able to define the strong points and the weak points in their training and undertake appropriate corrective actions.

5. Conclusion

The contemporary stage of development offers new challenges in all domains of social life. Education and training are no exception, as their paramount social function is to prepare all the human resources available in the country in compliance with the strategy adopted at the Lisbon summit [38]. Therefore, one of the tasks of higher education is to provide students with opportunities not only to accumulate knowledge, but also to be actively involved in the training process. The approach offered by the authors in training teachers of IT makes it possible to focus trainees knowledge on development of skills for independent knowledge acquisition, supplement and update after graduation from the higher schools. Favourable conditions are established for a more flexible management of the training process by means of independent practice work. The interest in self-education is growing, i.e. the four main principles laid out in the report by the International Commission on Education for the Twenty-first Century are met [9, p. 93]: learning to learn (to know); learning to do (to act); learning to live together; learning to be (to move forward).

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ПОВИШАВАНЕ ЕФЕКТИВНОСТТА НА ОБУЧЕНИЕТО ПРИ ПОДГОТОВКА НА УЧИТЕЛИ ПО ИНФОРМАЦИОННИ ТЕХНОЛОГИИ

Евгения Ангелова, Асен Рахнев

Резюме. В настоящата статия се предлага методика, повишаваща ефективността на обучението при подготовка на учители за преподаване на предмета “Информационни технологии” в училище. Разглеждат се методи на преподаване и учене, които допринасят не само за усвояване на предаваните знания, но и за придобиване на умения и навици и тяхното творческо прилагане. Чрез този подход се достигат онези резултати по отношение на обучавания, свързани с възприетото определение за висше образование в Европейското пространство — съвкупност от знания, умения и/или компетентности, придобити от индивида, които той е способен да демонстрира след завършване на своето обучение.