

Pedagogical Research Methods of Training in Higher Educational Establishments: A Comparative Analysis

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ABSTRACT

Competent professionals' preparation is a priority objective and purpose of modern education. The problem is that there is a constant change of educational paradigms in developing countries. That hinders formation of an integrated methodology system for individual subjects, which takes into account their specific features. The article analyzes the main teaching methods, shows cause-and-effect linkage. The article proves that paying attention on one particular teaching method and ignoring others creates difficulties in students' comprehensive understanding of the subject. As a result, students can learn the material only to extent the chosen method can provide. The paper also carried professionals' experience generalization in considered issues, conducted interviews with students, in which they gave an assessment of educational program and personal training; statistical survey data are presented in results. Thus, it is necessary to develop methodology system for each subject that will have the greatest explanatory potential to obtain a comprehensive knowledge of the subject and to form students' competence. This article may serve as a theoretical source for future academic lesson plans' formation for higher educational establishments.

KEYWORDS

Research method, comparative analysis,
higher educational establishment, training,
pedagogical diagnostics

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Introduction

Training in modern sense is a continuous process of competences formation (Kuzmina, 1980; Aviram, 2014; Gauntam, 2016). Therefore, the problem of competent professionals' formation in higher educational establishments attracts the attention of scientists, teachers, and members of the public. Availability of competent professionals directly affects social and economic sphere Biesta, 2015;

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Jones, 2016; Roche et al., 2016). New requirements for training organization is based on the fact that norms of a different order come instead of traditional objective of new technologies developing, there is a need to train everyone to learn knowledge that does not harm either man or nature, or society. Modern training must be learner-directed and practically oriented, forming functional literacy, professionalism and students' readiness for life in a rapidly changing world. Specialist must be intellectually skilled, have systematic style of thinking, the ability to foresee the results of their own activities etc. Competence approach implementation means to move from knowledge formation to competencies formation, from knowledge assessment to competencies assessment (Hovakimyan, 1989; Myrhalykov et al., 2012; Jones, 2016).

Higher education modernization is linked with the problem of its pedagogical diagnostics. It is not only the complexity of quantitative measurement and proper diagnostic instrumentarium selection. Competence formation is objectively a stepwise process. Training process frequency must be correlated with this rule, made with due regard to objective laws of formation and personality development. Hence the problem of pedagogical diagnostics.

Training effectiveness studies in higher educational establishments is no exception. Scientific literature of the last years practically do not cover the issue of pedagogical training diagnostics in the aspect of competence approach (Mellingsaeter, 2014; Rudolph et al., 2014; Jones, 2016). There is no specific and universal instrumentarium, methods, procedures, by which it would be possible to measure the level students' competences formation. This issue affects most developing countries, where there is no systematic collection of pedagogical training methods. This negatively affects student's future competence. In developed countries, such as France, Germany, training is aimed at future competence formation, professional growth, which is achieved thanks to a complex of complementary teaching methods. They may vary depending on training direction, thus they are being completed by special training methods (Rudolph et al., 2014).

Proceed to such instrumentarium development must be based on science, performing comparative analysis of pedagogical research methods of training process in higher educational establishment. According to the results of ascertaining stage of the experiment, practicing teachers' problems in advance training technology conditions basically reduce to a lack of class time, absence of methodological instrumentarium for effective training, sustainable mechanisms and clear diagnostic means of students' competence formation at the level of their subject etc. (Ponomarenko, 2014; Sytykh, 2013; Roche et al., 2016). The article provides comparative analysis of pedagogical research methods.

Methodological Framework

The methodological basis of the study: dialectical-materialist philosophy theses on TOK, leading role of activities in personality development, dialectical unity of theory and practice; methodological concept of teacher personality in pedagogical education system.

A complex of complementary research methods was used to achieve objective:

- Theoretical methods: specific philosophical, psychological, educational, scientific and methodical literature analysis and study on research issues; Analysis of methodical documentation, general theoretical methods of analysis, synthesis, theoretical modeling.

- Pedagogical experience study and generalization on the research problem, conceptualization of educational practice. Application of methodological orientations, certain information paradigm and the theory of self-organization.
- Survey of students of the first and the last courses, statistical data processing.

Results

Pedagogical research methods are divided into methods of empirical, theoretical and comparative-historical in term of the level of scientific knowledge. Empirical methods are directly related to the practice and provide accumulation, fixation, classification and synthesis of feedstock for any particular educational system development (observation, description of obtained results, their classification and systematization, as well as data analysis and synthesis). Theoretical methods (idealization, modeling, promotion of ideas, and formulation of hypotheses) ensure educational system development as a logically structured knowledge of objective laws of reality. Comparative-historical methods are methods comparing the current state of considered pedagogical process, phenomenon and the state that preface it, as well as the main trends of its development, general and particular manifestation features in certain historical conditions (Krajewski, 1994).

The boundaries between these groups of methods are rather conventional. For example, empirical level of research is impossible without theoretical, because it requires reflection, advancing ideas, serious analysis. In turn, developed theory must be based on practice. Comparative-historical level is typical for both the empirical and theoretical levels of research.

All the methods mentioned above were applied in the study of training effectiveness in terms of students' competencies formation in higher educational establishments. Empirical methods were mainly represented by observation, which refers to "purposeful study of objects and phenomena, specific information selection; knowledge gathering about external sides of studied object's properties and attributes" (Kuzmina, 1980). Observation method's value is to study the natural course of the process. For example, training session can be videotaped, collected material then is carefully studied. That will not only allow getting the specific data, but also analyzing all their aspects. In this case, high objectivity of results is guaranteed. The observer should not report about the purpose of observation, nor, moreover, intervene into observed process or influence it in any way.

Observation method's feasibility is determined by the objective. Herewith, the observer should use observation method's advantages as leverage: conformity to plan, systematic nature, as well as, the possibility of gathering information on pedagogical process in vivo.

However, observation method, as well as any other research method, is faulty, it has its own disadvantages. Observation method is limited. That is manifested in the inability to anticipate, predict the appearance of that main point, which is important for finding ways of problem solving. During pedagogical experiment, there were situations in which a variety of reasons is not available



for observation; they have remained unstudied, unaccounted. That significantly affect results' objectivity.

For example, it was noted during one of the events – the round table – on the impact of human activities on the world around us that some students are avoidant, passive, keep their opinions to themselves. On the contrary, students that are actively expressing their position do not always say something that match with what they think and act; observation method does not help to establish the truth in these and similar to these moments. This requires the use of additional research methods.

Another observation method's disadvantage is a variation of results' interpretation, a high degree of subjectivity in observer's position. Situations that cannot receive a clear assessment are quite common. Furthermore, it was necessary to spend quite a bit of time in mathematical treatment of experimental data. This factor is the third disadvantage of observation method. Therefore, observation method was used in our experimental work in combination with other research methods, in particular, with the method of expert assessment.

Method of expert assessment – providing expert opinion, opinion of a competent professional in studied field. Training diagnosis had more than once situations when it was not possible to use not only a problem object as a source of information, but also to allocate it. Such a situation occurred at least three times: in predicting dynamics of the process, in assessing the state of the process in few years; in evaluating some of students' individual character, whose self-esteem rises doubts (Ponomarenko & Bondarenko, 2013).

Specialist with reliable and objective knowledge has the right to act as an expert. The criteria for experts' selection, in addition to competence, position and functions are work experience, level of training, active, indifferent to the problems of higher educational establishment life position, authority and trust of administration, colleagues and students. Experts' special feature in this case was a gradual decrease in number. Thus, method of expert assessment also puts greater demands on correct application in student training diagnosis.

Analysis of methodical documentation had an important role in obtaining empirical data. We are interested in both the general documents (minutes, reports, journals etc.) and documents prepared specifically at our request (abstracts, products of creative activity, test papers, students' statements and others). We also analyzed public and regulatory documents in the field of education following the research: norms of legislation, curricula, official statistics data etc.

Along with empirical TOK methods, we applied theoretical methods in experimental work on identification of students' competences formation conditions in higher educational establishments. For example, we used method of unity of analysis and synthesis. Two interrelated processes – analysis (mental dissolution of single entity) and synthesis (parts connection into a single entity) cannot be separated from each other or oppose. In terms of type not only simple analysis was used (method of classification analysis), but also a difficult (relationship analysis method). Classification analysis was used for pedagogical phenomena and processes ordering and classification based on their comparison.

Classes have been classified in terms of "commitment to forming competent professionals" criterion, one of the indicators of which is the extent of practical and professional orientation of training content. Therefore, there was an opportunity to identify activities that solve the problems mentioned above and do not carry meaning in this aspect (Ponomarenko, 2014).

Classes were also classified according to the degree of work on competences formation on efficiency – from low ("occasionally" insertion of practice-oriented knowledge into educational material) to high (purposeful and systematic insertion of practice-oriented knowledge into educational material structure, as well as special courses' development). Therefore, there was a border between teachers, who designed, planned and carried out these types of activities. Accordingly, a clear idea of preparatory work direction was formed with a group of teachers actively solving problems of students' competences formation, as well as with a group of passive teachers (Myrhalykov et al., 2012).

Synthesis was carried out along with analysis. This led us to new system links novelties, to consideration of students' competencies formation in close connection with other processes, such as complex and multidimensional process of analytical skills' development.

Modern training is impossible without the use of information technologies. Sure, they play an important role in the future professionals' competence formation. However, application of the method of analysis and synthesis has helped us to establish that it is dangerous to exaggerate the role of imagery, visualization in training, achieved by means of multiple program products.

For example, positive aspects of information technologies use are often referred to creation of conditions for right brain neurodevelopment capable of simultaneously processing of different information, forming, in turn, a habit to consider the problem in general. However, this process is not accompanied by in-depth analysis. This adversely affects the formation of abstract, theoretical thinking proper for students' age. In addition, if constantly offer students ready images created by someone else, students will not make them by their own. Sytykh O.L. noticed this circumstance: "Synonymity does not involve too much thinking. It defines the problem with the solution: when there is a solution, then thinking is not necessary" (Stykh, 2013). Thus, it is possible to scientifically substantiate the limitations in the use of program training – no more than 30% of class time.

Literature analysis showed that the quality of students' knowledge, for example, in physics, depends largely on the quality and effectiveness of lecture demonstrations. University Students were offered to make projected assumptions about the outcome of lecture demonstration immediately after it and in a short time later. The experiment showed that one in five responses does not match the actual results, however, students, who possessed the theoretical knowledge before supervision of demonstration, have memorized and interpreted the results better (Mellingsaeter, 2014). Powerful means in training support is the use of interactive methods. Confirmation of this is found in a number of scientific publications. For example, it is proved that interactivity is an essential component of training, as it leads to an increase of its effectiveness and students' training motivation (Rudolph et al., 2014).



It is desirable to give preference to analytical work, teaching students the basics of analysis. There are many types of analysis – from the analysis as a research means to analysis as its object. That analytical work is the basis of intellectual work. It is necessary to acquaint students with the types of analysis, its possibilities purposefully and systematically. Problem analysis helps to identify the problem, create the problem field, make a classification; system analysis helps to observe the object following system approach as a certain system, which has its own structure and function. Praxeological analysis aims to identify the processes of optimization methods of operation, while prognostic analysis helps to predict situation development. Because of cause-and-effect analysis, causes that led to this situation will be determined. Finally, situation analysis implementation will lead to situation modeling, definition of its conditions and possible consequences.

In general, modeling method has a special place in the field of pedagogical diagnostics. Problem actuality of modeling didactic possibilities identification and analysis in university students training is related to practice need of university teachers to provide themselves with objective planning methods, organization methods and assessment of three main areas: training in general, their own pedagogical activity and students' educational activity. Modeling is an accurate quantitative method in terms of its nature; it has predictive capabilities and allows studying a variety of teaching situations on the basis of a model experiment.

Diagnosis begins with a purposeful information gain about the objects (1). Scientific study, in addition to information gathering, performs qualitative or quantitative relationships' ordering and establishment, as well as ratios and dependence. Modeling necessity of training arises only in the case of accumulated information, when there is a need of transition from quantity to quality.

Literature analysis shows that the issues of modeling of training were studied in various directions: general methodological, psycho-physiological, didactic etc. There were various attempts of training models generation, specific ideas for their further development and improvement, results analysis of modeling (Larchenkova, 2013). There is an important conclusion that diagrams or verbal descriptions consideration as models reduces the chances of a serious study of the phenomenon (Ponomarenko, 2014). There was indicated a systematic error, when properties, qualities or indications list is used as a model, which are difficult to designate as algorithmic descriptions.

Model is known as the result of schematization, the degree of which depends on analysis general objective and purpose of analysis, expected completeness and accuracy of solution (Hovakimyan, 1989). However, purposive model should reflect the most significant features of phenomenon. In other words, quantitative analysis always has to deal not with a real phenomenon in all its complexity, but with a concrete result of schematization. The relationship between theory and model has interdependent nature; there is no theory without the model and no model without the theory.

Taking into account that mathematical methods currently are widely used in pedagogical experiments' planning and organization, the relationship between the model and experiment is of great interest.

Experiment in the field of scientific knowledge is held to theoretical understanding, revealing the essence of things, interpretation of phenomena (Archangelsky, 1974). To this end, the means and methods of experimentation are continuously improving, observation character is modified and initial information fixation becomes particularly important. Experiment and modeling have a complex relationship that can be described as inverse and interdependent.

Dialectical understanding of irreversible changes is major and determining factor in the need of model study of training, as well as the lack of data availability on the same students. In other words, each data collection reveals irreversible changes in personal sphere, in the nature of students' cognitive activity. Re-identification of the same state on the same student body is almost impossible. In this case, the use of modeling method significantly expands the possibilities of pedagogical diagnostics, because it makes it possible to study analogic processes on models in addition to observation and experimentation with the following transfer of research results to the prototype.

Modeling is used in training for quantitative assessment of the following factors: effectiveness of training planning and organization in general and students' teaching and learning activities in particular; methods and forms of education; effectiveness of employed materials (from training programs and study letter's structure to certain instructions, tasks, systems and content of audio-visual aids); quality of teaching aids and other indicators.

Modeling also allows identifying the trend and establishing a characteristic interdependence, which can be an integral part of higher educational establishments' didactics. Conclusions obtained on modeling are essential for a better understanding of studied phenomenon. In other words, modeling suggests insertion of models into theory creating process; models are preliminary stage in theorization.

In our study, this thesis may be adequate: modeling acts as theoretical and methodological basis of training as models are inextricably linked with scientific hypotheses. On the one hand, hypotheses may be considered as the initial stage of modeling, and on the other, the model should be considered as a form of hypothesis (Ponomarenko & Bondarenko, 2013). Models' informative value is that they can predict phenomenon or process development in synthesizing already learned pattern, obtain previously unknown information on the basis of logical and mathematical conclusions.

Modeling of training is not a formality, not a goal in itself, but a means of knowledge, a necessary stage of any pedagogical research. Since the person is an open self-organizing system, a synergy effect of all its components can be observed in transferring of knowledge obtained during the modeling to the prototype.

Modeling of training structure as an integrated multi-level formation with known autonomous of its components' functioning is not without interest for diagnose of effectiveness of training modernization. Modeling is necessary for training activities analysis, as well as their organization at different stages of learning, including the relationship of training with students' creativity and independence development.

The practical importance of modeling of training is that it is possible to establish significant relations between the components, to identify the cooperation



between the levels. In model study of training, there is a possibility to move beyond verbal descriptions to quantitative relations, to determine the effectiveness, identify optimal conditions for training organization that achieve a specified level of studied academic content acquisition with certain properties. Practical value of modeling is determined by ability to review educational process before final results.

Training complexity and diversity requires the use of mathematical apparatus that would lead to the progress in the study of many different phenomena that occur on the basis of a large number of factors that are interdependent in a little extend, a relatively small influence of each does not yield to individual account.

Studying didactic capabilities of modeling of training, characterized as a stochastic process, it was found that description forms and training characteristics will be complete under modeling of training if they embody the unity and interdependence of objective quantitative and qualitative indicators. The main one is the reflection of qualitative side; quantitative aspect is taken into account later then. Considering different levels of training description promoting regularization, revealing their recurring features, qualitative verbal descriptions were highlighted showing cognitive modeling capabilities as a form of reality reflection, as a cognitive method required to streamline accumulated information and knowledge development.

Highlighting cognitive capabilities of quantitative descriptions (possibility to express training properties and their relations in the form of analytical dependences; the ability to predict in the light of established quantitative characteristics and dependencies, possible changes etc.), we agree that adequate mathematical apparatus that allows describing and indicating learning patterns, analytically representing them, is a unit of probability theory.

According to the experience, it is necessary to apply probabilistic and statistical concepts; scientific-theoretical basis of these phenomena requires reliance on dialectic of possible and actual. The reality is reflected in particular events that depend on a variety of reasons. Empirical research of events' frequency allows displaying an increasing number of real-world phenomena that are resistant and characterizing the essence of training. Numerical assessment of events' probabilities in probability theory is just done with this frequency.

Practical use of theoretical results

Analysis of international experience and standards of transnational education has allowed developing our own training programs on the basis of competence-oriented professional model. To this end, the layout of competences was drawn up. Ten Bachelor's programs in technical specialties were developed on their basis; they take into account world experience in assessing the quality of engineering education and fully meet training requirements of accreditation system of member states of the Washington Agreement, the European Association for Quality Assurance in Higher Education (ENQA) and European Accreditation of Engineering Programs EUR-ACE. Educational outcomes are based on requirements imposed by the professional community to graduates of higher

education establishments and coordinated with Dublin descriptors, designed to create a single European Higher Education Area (Anon, 2004).

Assessment was made based on the following principles:

1. formulation of clear and achievable goals of training programs (as in the field of training and in the field of education and development), taking into account its specific direction and profile of training, features of the school of science, labor market needs etc.;

2. subject specifics' integration of a particular profession with a common basic training, as well as with applicational (industry) orientation of specialists' preparation;

3. undertake a self-examination system on the basis of criteria and indicators confirmed by all participants of training process and employers' representatives with a view to a more objective assessment of educational activities (training strategy) in comparison with the results of other educational institutions (Ponomarenko & Bondarenko, 2014).

In the course of experiment, we have revealed the following:

1. all the programs have formulated and documented objectives, fully coordinated with state educational standard (2010), university's mission, academic research areas and demands of potential customers;

2. Unit of Natural Sciences and Mathematics provides fundamental training, serves as the basis for the study of general and special disciplines;

3. quality indicators of trained student academic performance is in 6.4% higher than the average in university;

4. level of graduates' employment of pilot programs is 92%; this is 12% above average (at the university) level; level of employers' satisfaction reached 75%.

Further studies were aimed at determining the structure of professional competencies of engineering profile. More than 300 students of first and last courses attended the experiment. We developed monitoring system and efficiency assessment system of competency approach in training. Understanding competences as a set of interrelated personality qualities (knowledge, abilities, skills, ways of life) defined with regard to a certain range of subjects and processes necessary for qualitative productive activities, opening measurement units' features (complex character defined by degree individual indicators' formation) helped to define methodology of diagnosis, by means of which experiment results were considered.

The following data was obtained by the experiment: Undergrads have more expressed personal and socio-organizational competencies: desire to work with people (85%), obtaining managerial skills (47%) interest in the work (54.3%). Every second person (approximately 49.7%) is able to creatively solve tasks; more than 60% are able to make right decisions. At the same time, only 12.3% of graduates note special professional knowledge. However, 45% of these students believe that university gives knowledge. Regarding practical acquaintance with the production, the role of the university was positively rated by 35.5%, the role of production – 15.7%.

Students highly rated the university role in forming their research skills (65.5%). However, only 22.2% of undergrads believe that these skills are demanded by society. As a result, only 18.6%-mark research qualities in



themselves. Analogic situation is observed with quality assessment of "ability to know scientific and technical problems". Students, as they suggest, have such qualities as "readiness for management activities" and "environmental behavior". Preparation for innovation activity and its inner monitoring are rated lower.

First-year students in general have knowledge of general subjects; they are partly familiar with production and have decision-making skills. Graduates also noted the quality growth in all competencies. However, there is a more critical attitude regarding readiness for innovation activity and its inner monitoring. Quality assessment is significantly increased in the field of environmental behavior, business communication, social interaction and training for professional work. Low degree (about 12.3%) of indicator formation – "availability of professional knowledge" – may be related to the fact that competencies should be preset by professional standards and labor market needs.

Discussions

Experimental work, the basis of which was an elaborate system of pedagogical diagnostics, comparative analysis of research methods, made it possible to determine new format of competence-oriented training courses, subjects, disciplines (modules) for educational training programs' development of a certain profile.

The article fully describes methodology of teaching with clearly traced cause-and-effect link. Taking into account these factors, it is possible to develop curriculum that will allow student an opportunity to comprehensively study the subject combining theoretical and practical knowledge.

Modern training concepts and theories are divided into two parts:

1. Certain teaching methods are provided (Maria et al., 2016). In this case, the main attention is paid to teacher's selected method, under which the rest of teaching methods will be underutilized or ignored completely. As a result, student gets knowledge about the subject not in complex manner, but only in the extent that the chosen method can provide.

2. Attention is paid to the concept of learning ideas (Zvoleyko, 2016). Common training concept is the competent specialist formation, but there are also other concepts ecological identity formation, spiritual personality formation etc. The problem is that there is no methodology systematization in concepts' formation.

Methods system formation with cause-and-effect link has to be individual for each discipline. It is necessary to take into account every feature of both the method and the subject. In developing methods system, it will be possible to optimize the training process, to raise the level of knowledge, as well as students' interest in science.

Conclusion

Choice of a method of students' training pedagogical diagnostics in higher educational establishments by itself is a complex pedagogical research, methodological problems of which are reduced to two major issues' solution: how to implement organic synthesis of theories and how to ensure adequate application. Selection of certain techniques and methods aimed at a comprehensive study of the subject, is undertaking according to its purpose. On

the one hand, it is necessary for selected method to avoid duplication, and on the other, to provide the possibility of mutual supervision. Therefore, an essential condition of integrated pedagogical research is to clearly define the role of each method at different stages of research.

Comparative analysis of pedagogical research methods of students' training in higher educational establishments was conducted based on literature analysis and our own research. We have concluded that problem solution of competent pedagogical diagnostics of students' competence formation in higher educational establishments should be carried out carefully and comprehensively. This approach will lead to professional training improvement of future specialists, their systematic preparation for professional activity and analyze its consequences in relation to nature, society and man. Modeling methodology of training system should apply scientific approach, taking into account that complex phenomena and processes characterizing the training allow probabilistic units.

Obtained results are useful for teachers, teachers in higher education, research scientists, who seek the best possible way of effectiveness assessment of training. Results' generalization will allow developing adequate goals and objectives of research methodology for students' competencies diagnosing the formation; expected socio-economic impact will clearly indicate the benefit of ongoing scientific research on various aspects of training modernization higher educational establishments.

Disclosure statement

No potential conflict of interest was reported by the authors.

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