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Students'competence assessment methods

Olga Berestneva*, Olga Marukhina, Gleb Benson, Oksana Zharkova

National Research Tomsk Polytechnic University, Tomsk, Russia

Abstract

The problem of establishing methods and technologies for the assessment of students' competence is still relevant. Introduction of competence-based approach at Russian universities (in the framework of the existing State Educational Standards) did not solve the problem. The development of efficient methods and measuring procedures of competence assessment is possible only on the basis of mathematical modeling and system analysis.

Keywords: Competence-based approach; higher education; students' competence model

1. Introduction

Despite numerous theoretical and experimental studies the problem of specialist competence assessment (including students and graduates of a technical university) still requires further study since well-known concepts do not give a definite answer to the issues of consistency and mechanisms of competence formation and development; there is no common opinion regarding competence structure, considerable difficulties in explanation of competence formation mechanisms take place. Therefore, there is a need for system approach to the problem of specialist competence, as well as mechanisms of its formation and development.

The analysis of specialist competence as a system shows that it is present in several interrelated plans: as some relatively independent unit possessing qualitative certainty; as an element of some macrosystem which includes this phenomenon and laws it complies with; as integration of microsystems establishing the structure of a system and having specific regularities which are definitely reflected in the topic under interest – the competence. Thus, it possesses the most significant characteristics of a system: integrity, structural properties, interrelation of the system with environment, hierarchy, diversity of description.

As competence is an integrated characteristic (i.e. it is a new quality acquired as a result of education combining knowledge and abilities with a range of integrated characteristics of quality of education) it is possible

* Olga Marukhina. Tel.: +7-952-891-9609
E-mail address: Marukhina@tpu.ru

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to consider it as some objective reality of the educational process with typical features of complex systems, the study of which implies the solution of the tasks related to their representation and development.

At present there is no definite answer to issues of consistency and mechanisms of competence formation and development, there is no common opinion regarding competence structure, considerable difficulties in explanation of competence formation mechanisms take place. Therefore, there is a need for system approach to the problem of specialist competence, as well as mechanisms of its formation and development.

2. Competence model: approaches for constructing

Competence-based model can be presented as hierarchical functional structure consisting of subsystems, components and measured elements. For the solution of problems related to competence assessment and study it is necessary to define components and elements of student's competence-based model, methods of their measurement and to create mathematical model defining interrelation of competence main components. Let us analyze the existing approaches to the solution of this task. Among Russian competence-based models there is a need to emphasize the model designed by I.A. Zimnaia (Zimnaia, 2003) revealing the presence of key competencies and the model developed by A.G Tatur (Tatur, 2006) and V. I. Baydenko (Baydenko, 2002) that all of to connect the content of competencies with the content of state exams within a technical university. Acmeological studies play a key role in the study related to problems of competence formation. Today acmeology defines professionalism invariants (professionalism of activity, professionalism of personality, standardization of activity and behaviour, efficient "I-concept") which do not depend on peculiarities of professional activity and similar according to their contents. The suggested competence-based model integrates acmeological approach and approaches implemented in Russian and European competence-based models.

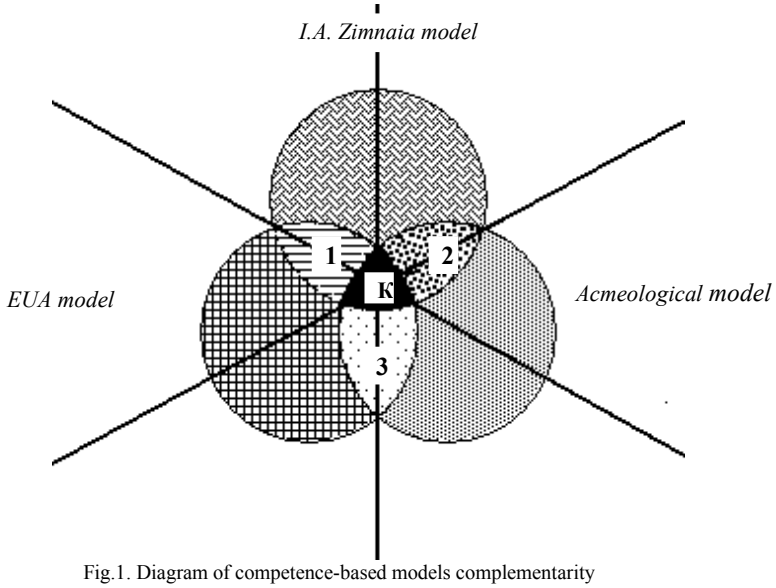

Fig.1. Diagram of competence-based models complementarity

Figure 1 shows the diagram reflecting complementarity of models which include key (general professional) competencies where three main groups are specified: social (1); axiological (2) and information-technological (3) which are considered further as part of student's competence-based model.

Competencies considered above turn out to be complex in terms of their measurement and assessment within the general plan of competency-based approach to education (CBE). It is almost impossible to carry out direct

diagnostics of competence as complex and dimensional quality of the personality during tests in the form of subject-matter or even interdisciplinary examinations.

3. Students' competence model as a hierarchical structure

Students' competence model can be presented as a hierarchical structure, which is shown in fig. 2 (Berestneva, 2007).

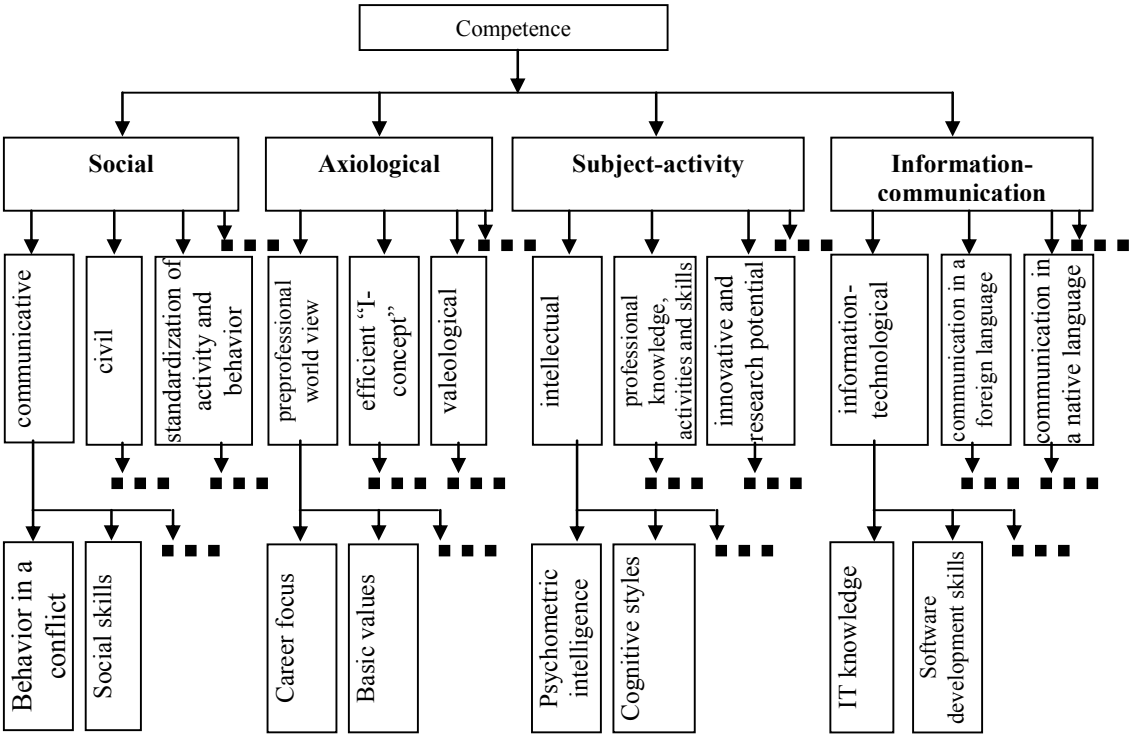

Fig.2. Student's competence model

Since the model of specialist-graduate defines what personality should be developed during the educational process this provides the opportunity to clearly set the objectives of education and to follow them while organizing the educational process. When selecting quality indicators there is a need to take into account the requirements of State Educational Standards of Higher Professional Education expanded with a university component, recommendations of Educational and Methodological Association, as well as demands of employers. The list of indicators according to every characteristic allows to develop the system of quality indicators for specialist-graduate education, which in its turn contributes to the development of qualitative (conceptual) model of specialist's activity.

Creation of quantitative (formal) model includes definition of quality standards for every indicator within the assessment scale. Setting standards of quality indicators implies determination of minimum values of indicators where the level of graduates' training meets employers' demand. Measurement of a certain professional ability and some personal characteristic includes assignment of some numbers to qualitative features of ability or characteristic. Hence, certain abilities and personal characteristics to a different extent impact the level of specialist-graduate competence. Introduction of the degree of importance for every ability or personal

characteristic (weight ratio) is possible. However, the reality is that at a large number of assessed characteristics the introduction of indicators weight ratio is not reasonable.

There are two more important points which should be considered when developing the competence-based model: 1) competence-based model of a specialist is not a graduate's model; 2) there is a need to reduce competence-based model of a specialist for its use as the requirement to a graduate.

4. Existing approaches to competence assessment

According to J. Raven (Raven, 2002) the areas of people competence can be determined by filling the cells of two-dimensional matrix where significant types of behavior (achievement, collaboration, influence) are placed horizontally, and competence components (cognitive, affective, volition, skills and experience) are placed vertically. J. Raven suggested to form descriptive characteristics in the language similar to the language of chemistry. In his opinion, such model would force us to fix human values and competencies which they spontaneously and steadily demonstrate long side with corresponding significant characteristics of their environment. J. Raven claims that the suggested approach allows to create, first, the model of transformational processes which failed to be developed neither in age psychology, nor in pedagogics, and, secondly, to cope with problems which situational conditionality of behaviour sets around the general notion of "abilities". However, at present there is no at least the initial version of more or less complete table of "human elements". Therefore, practical implementation of the Raven's model for the solution of the problem related to competence assessment of university graduates is impossible without clear definition of certain components of competence and development of the corresponding algorithms of competence integrated assessment.

The approach similar to the Raven's model was offered by I.A. Zimnaia (Zimnaia, 2003) pointing out that if key competencies are represented as actual competences it is obvious that the latter ones will include such characteristics as: a) readiness to demonstrate a competence (i.e. motivational aspect); b) knowledge of competence content (i.e. cognitive aspect); c) experience of competence demonstration in various standard and non-standard situations (i.e. behavioral aspect); d) relation to competence content and object of its application (axiological aspect); e) emotional-volitional regulation of the process and result of competence demonstration.

Almost all researchers identify complex nature of competence, both in its definition and assessment. As there is no information in literature regarding the assessment technology of students' competence we will talk in detail about assessment models in technology of Final State Certification (FSC) within higher educational institutions.

Qualimetric models applied in FSC technology are classified by classes, which include the following: class of expert assessment models (examination models) – models of expert qualimetry, class of taxonomical assessment models– model of taxonomical qualimetry, class of probabilistic and static assessment models– model of probabilistic and static qualimetry, class of test assessment models– model of test qualimetry, etc. according to typology of special qualimetries (Subetto, 2004). Qualimetric model of assessment includes: system of assessment indicators (assessments, measures) measured (presented) in a certain qualimetric (assessment) scale; model of criteria (indicators) summarization; scale of presenting final (integrated, generalized) assessment; summarization of criteria – indicators, assessments; choice of assessment model.

The requirements to specialist's competence are often presented in indistinct concepts, for example, "organizing skills", "knowledge of computer technology", etc. It is difficult to measure directly the level of possession of such characteristics, therefore instead of measurement it is better to talk about assessment or calculation of quality indicators using indirect indicators.

All above-mentioned caused the need to create new information technologies for the assessment of students' competencies, including technologies to measure certain elements (Table 1 - 3). Tables 1 – 4 show that solving the tasks of analysis and assessment of students' competence on the basis of the designed model there is a problem of data diversity. It is caused by the fact that initial characteristics are measured in different scales (nominal, ordinal and quantitative scales). Besides, while solving semistructured tasks (including competence assessment) the requirement of strong equivalence (an element either belongs or does not belong to a class) is not

fulfilled. There is a need to consider cases when an element can belong at the same time to two and more classes. Two approaches are developed for the description of such situations.

Table 1 Subject-activity (special) competence

Competence components		Measuring tools
Professionally important qualities	Physiological Psycho-physiological	Historical data; Questionnaire; Laboratory study results; Electrophysiological signs; Functional tests
	Integrated psychological attributes Personal business attributes	Psychognostic tests, expert assessment, self-assessment
	Motivation Emotional-volitional	Psychognostic tests Expert assessment
Professional knowledge, abilities and skills	Theoretical knowledge	Assessment (ranking) according to educational disciplines, pedagogical tests
	Practical knowledge (experience of application)	Expert assessment, pedagogical tests, psychognostic tests, analysis of activity outcomes
Intellectual competence	Psychometric intelligence , creativity, cognitive styles	
	Innovative and research potential	

Table2. Social competence

Competence components		Measuring tools
Tolerance and interpersonal communication skills	Tolerance Style of behaviour in conflict situations	Psychognostic tests, expert assessment, self-assessment
Legal competence	Motivation Emotional-volitional	Psychognostic tests, expert assessment
Entrepreneurial abilities	Theoretical knowledge	Assessment (ranking) according to educational disciplines
	Practical knowledge (experience of application)	Expert assessment, psychognostic tests, analysis of activity outcomes
	Personal qualities	

Table3. Axiological competence

Competence components		Measuring tools
Cultural competence	Theoretical knowledge Practical knowledge	Assessment (ranking) according to educational disciplines, expert assessment, questionnaires, self-assessment

Competence components		Measuring tools
Maturity of axiological and motivation environment	Pre-professional world view. Basic values and drivers	Psychognostic tests, expert assessment
Need for continuous education	Personal qualities defining this component of competence	Expert assessment, psychognostic tests, analysis of activity outcomes

Table4. Information-communication competence

Competence components		Measuring tools
Information-technological competence	Theoretical knowledge Practical knowledge (experience of application)	Assessment (ranking) according to educational disciplines; Expert assessment; Analysis of activity outcomes
Communication in a native language	Theoretical knowledge Practical knowledge (experience of application)	Assessment (ranking) according to educational disciplines; Expert assessment; Analysis of activity outcomes
Communication in a foreign language	Theoretical knowledge; Practical knowledge (experience of application)	Assessment (ranking) according to educational disciplines Expert assessment Analysis of activity outcomes

The first approach includes the fact that distributions of probabilities of classified variables can overlap. Making the decision on the fact that the value belongs to either class we split the area of variables into distinct classes, therefore there are probabilities of mistakes.

The second approach is based on the theory of vague (indistinct) sets. In this theory the assignment to a class is described by a membership function, which characterizes the degree of confidence with which we assign the object to a certain class.

Thus, while solving the task of competence assessment there is a problem of diversity and uncertainty of indicators characterizing components of competence. It is possible to solve this problem by applying fuzzy methods and data standardization methods.

It is possible to identify three groups of methods to measure competence components:

1) traditional measuring procedures (measurement of physiological and psycho-physiological indicators, as well as definitions of students ranking according to educational activity outcomes).

2) testing technologies (pedagogical and psychognostic tests);

3) methods of expert assessment (including examination assessment and final ranking on subject matters).

For the last five years in Tomsk Polytechnic University, Tomsk State Pedagogical University and Irkutsk State Technical University focus on the study and introduction of the suggested approach, methods and procedures of measurement and assessment of competencies into the educational process. A prototype of the information system implementing this approach is developed at Tomsk Polytechnic University (Maruhina, 2005).

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