In-House Monitoring over Student Competence Formation

Veniamin V. Koshkin*, Aleksandr S. Maslennikov, Liudmila A. Steshina, Natalia N. Starigina, Igor V. Petukhov

Volga State University of Technology, Yoshkar-Ola, Russia

Abstract

The paper offers a special model of monitoring over dynamics of student competence formation that deals with the connection between the study performances of a student and/or a student group and the quantitative assessment of the student competence level being formed during the whole training period of the major educational program. The methodological approaches to the competence formation assessment in the Final Certifying Examination of graduates have been considered in many researches. However, the control over competence formation within a coursework, search for the tools effecting on a timely correction of teaching methods and techniques aiming at individualization of a competence-based portrait of a student also make an essential task of a higher education institution. Such a task can be solved on the base of the competence-oriented curriculum with the main component being a matrix of the competences to be formed and the subjects to be studied. The model of monitoring system over competence formation is founded on integration of the subject study performances (including their weighted contribution) into competence formation. The monitoring over a competence formation level is an integrated part of an education system and fulfills two main functions. The first one is a control function over provision of educational performances, i.e. dynamics of competence formation in the mastery of an educational program. The second one is a forecasting function for a qualification level after completion of the educational program. The model of the assessment of the competence formation level on the different stages of education allows to assess the performance both of a student and a student group, to build up an individual curriculum, to improve the efficiency of an employer-sponsored education.

Keywords: matrix of competences, credits/units, results of proof-testing in disciplines, assessment rate setting, monitoring over competence formation level.

* Veniamin V. Koshkin. Tel.: +5-987-897-987.
E-mail address: laboratory502@yandex.ru
1. Introduction

Nowadays the traditional education paradigm has accumulated the experience in assessment of students' knowledge (i.e. assessment of the level of learning achievements in subjects). Skills and automation of skills are also assessed, but more rarely. The assessment of competence is a new task for a higher education system. It cannot be solved only with traditional control techniques and assessment tools. Besides, currently general methodological recommendations for building and application of tool funds for assessment of competences have not developed yet. Each of higher educational institutions tries to solve this task in its own way. As a rule, higher educational institutions adapt the existing student knowledge assessment systems for assessment of a competence formation level. At the same time, it is evident that the available knowledge assessment tools do not allow to meet the requirements of the federal state educational standards for a higher education in regard of assessment of learning performance in the main educational program in full.

The methodological approaches to the competence formation assessment in the Final Certifying Examination of graduates have been considered in many researches (Wass, et al., 2001; Busawon, Penlington & Perera, 2012). Assessment methods of students' skills (including technological equipment operation skills) are also investigated (Petukhov, and Steshina, 2014; Tervo, Palmaroth & Koivo, 2010).

However, the control over competence formation within a coursework, search for the tools effecting on a timely correction of teaching methods and techniques, choosing of a individual educational path make an essential task of a higher education institution (Lisichko, Postnikova & Tverdokhlebov, 2013; Sekerák, 2010). Such a task can be solved by complying to three main conditions. The first one is a competence -oriented curriculum with the main component being a matrix of the competences to be formed and the subjects to be studied. The second important condition for solving the task of competence formation control through the subjects to be learned is a database of subject learning performances. Such third condition must be development of both a model and an algorithm of subject integration into competence formation. It should be noted the abovementioned task can be solved through a constant monitoring over competence formation during an education process.

The purpose of the paper consists of constitution of a competence formation monitoring system.

2. Competence Assessment Model

The purpose of the paper consists of constitution of a competence formation monitoring system.

The competence assessment model is based on integration of subject learning performances (including their weighted contribution) into competence formation.

A finite collection (Δ) of subjects to be learned in accordance with a curriculum should be formed for each student. The composition of such finite collection is enlarged from year to year:

$$\Delta = \{\Delta_1, \Delta_2, \Delta_3, \ldots, \Delta_k\}$$

where k is a number of subjects learned by a student at a certain moment of time (for example, a semester, a year or a module). Each element of this finite collection {Δi}, (i = 1 – k) has a corresponding element \(\Omega\) with a numeric value, a number of points gained by a student for learning an i- subject.

$$\Omega = \{\Omega_1, \Omega_2, \Omega_3, \ldots, \Omega_k\}, (i = 1 – k).$$

The quantitative assessment of a subject learning level for a certain period of time can be obtained as a result of accumulating of Ω-multiplicity values

$$\Omega_{res} = \sum_{i=1}^{k} \Omega_i.$$

The task of the assessment model offered is to redistribute the \(\Omega_{res}\) value between the elements of some Δ multitude, \(\Lambda = \{\Lambda_1, \Lambda_2, \Lambda_3, \ldots, \Lambda_m\}\), (i = 1 – m), groups of competences determined in accordance with a competence distribution matrix. In its turn, each competence group composes a finite collection of primary competences, \(\Lambda_i = \{K_1, K_2, K_3, \ldots, K_p\}\), (i = 1 – p), where p is a number of \(\Lambda_i\)-multitude competences.

The \(K_i\) multitude of primary competences intercrosses the \(\Omega_i\) multitudes. This intercrossing of multitudes can be defined through weighted coefficients of credits appointed for each subject of the curriculum.

In the Volga State University of Technology a point-rating system for a current student performance control (the RITM) has been applied for many years. This system is oriented on assessment of students' knowledge of subjects included into the curriculum. By the present time Volgatech has accumulated a great database of student learning
performances and methodological developments in this direction. With the experience available, this allows to create a system of quantitative assessment of competence formation level for a certain period of a education program mastering, to gain an integral characteristics of dynamics of both a certain student work and processes characteristic for certain competence formation per semesters and years in student groups. Thus, the RITM allows to organize in Volgatech a current monitoring over the educational process, the results of such monitoring can be used in the operative correction of curricula and selection of the subjects which make a larger contribution into formation of certain competences. It is appropriate to correlate the results of monitoring at the final stage of teaching students with an independent assessment of learning performance realized by using corresponding measuring materials from the fund of evaluating and diagnostic tools.

Students' learning performances are stored in the information system of the university not only in the form of "excellent", "good" or "satisfactory" marks, but also in the form of points (a 100-point rating) according to the RITM. It helps within a competence formation monitoring to use a multipoint assessment rating and to forecast a competence formation level.

Thus, monitoring over a competence formation level is an integral part of an education system and fulfills two main functions:
- a control function over educational performances, i.e. dynamics of competence formation in the mastery of an educational program;
- a forecasting function for a qualification level after completion of the main educational program.

In the Volga State University of Technology a monitoring procedure over competence formation with the use of a RITM database was successfully approved in the groups studying in selected majors (Article 3). The experimental results proved efficiency of the developed methodology for assessment of a competence formation level.

So, each $K_i$ competence is assessed as an amount of contributions made by the subjects studied $\Delta$ into this competence formation,

$$K_i = (K_i(\Delta_1) + (K_i(\Delta_2) + (K_i(\Delta_3) + \ldots +(K_i(\Delta_j) + \ldots +(K_i(\Delta_m))),$$

where $m$ is a number of subjects participating in the $K_i$ competence formation and including results of a certain competence formation assessment taking into account the time of their learning. Each student performances presenting the $K_i$ competence formation level are united and thus general performance of competence mastering can be calculated for a student group.

### 3. Investigation results

The developed monitoring system over competence formation was approved in the Volga State University of Technology.

The current learning performances of a professional competence group (PC 1 - PC 9) are shown in the Table which indicates that a student was mastering the competences rather successfully. The accumulation of a numeric value was made taking into account weighted coefficients of credits appointed in each subject of a curriculum. The Table shows assessment of certain competences with regard to the time of their mastering.

<table>
<thead>
<tr>
<th>Competence</th>
<th>Semester</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC-1</td>
<td></td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>35.59</td>
<td>55.72</td>
<td>76.99</td>
<td></td>
</tr>
<tr>
<td>PC-2</td>
<td></td>
<td>15.30</td>
<td>25.86</td>
<td>37.75</td>
<td>45.90</td>
<td>58.19</td>
<td>65.22</td>
<td>75.49</td>
<td>79.01</td>
</tr>
<tr>
<td>PC-3</td>
<td></td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>4.91</td>
<td>22.13</td>
<td>44.28</td>
<td>68.49</td>
<td>83.68</td>
</tr>
<tr>
<td>PC-4</td>
<td></td>
<td>15.26</td>
<td>27.80</td>
<td>28.90</td>
<td>35.17</td>
<td>48.97</td>
<td>66.20</td>
<td>74.62</td>
<td>74.62</td>
</tr>
<tr>
<td>PC-5</td>
<td></td>
<td>16.90</td>
<td>34.04</td>
<td>40.98</td>
<td>51.88</td>
<td>62.90</td>
<td>73.92</td>
<td>73.92</td>
<td>78.51</td>
</tr>
<tr>
<td>PC-6</td>
<td></td>
<td>4.74</td>
<td>16.07</td>
<td>27.53</td>
<td>40.42</td>
<td>49.20</td>
<td>57.48</td>
<td>69.55</td>
<td>74.28</td>
</tr>
<tr>
<td>PC-7</td>
<td></td>
<td>27.65</td>
<td>58.40</td>
<td>68.97</td>
<td>68.97</td>
<td>68.97</td>
<td>68.97</td>
<td>68.97</td>
<td>72.85</td>
</tr>
<tr>
<td>PC-9</td>
<td></td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>16.98</td>
<td>35.20</td>
<td>52.53</td>
<td>66.78</td>
<td>78.67</td>
</tr>
</tbody>
</table>
Initial data for the experiment was taken from the knowledge assessment base of the RITM system.

For example, the professional competence (PC 2) formation level of one of the students (Student 8) of the experimental student group was assessed for 79.01 points that corresponds to a good mark. In the calculation the "contribution" of all 29 subjects indicated in the matrix of competences into this competence formation was accounted, i.e. interim attestation (exams and tests) results according to a 100-point assessment system adopted in the university were used. The final competence formation assessment was received by accumulation of points for the whole period of teaching this student.

The dynamics of professional competence assessment for the certain student is shown by Fig. 1.

![Fig. 1. Example of changes in the assessment of three competences formation level of one student.](image1)

Integrating of the results of PC-2 competence formation level assessment within the model described herein allows as well to analyze the level of competence mastering by a student group of the same major, Fig.2.

![Fig. 2. The level of PC-2 competence mastering by a student group of the same major.](image2)

The diagram shows that there is no big divergence in the results of competence mastering by students, though the absolute level of assessment is not high.

4. Conclusion

The proposed model for assessment of a competence formation level at the different stages of education process gives an opportunity to assess the work of both a student and a student group.
The curves in Figure 1 (changes of a competence formation level) show some problems in distribution of subjects aiming at formation of a certain competence in regard of semesters: there are intervals when competence formation is not observed. A timely correction of a calendar schedule of an education process as well as of subject distribution, elimination of such intervals can improve the efficiency of competence mastering during the whole period of teaching.

Thus, the model offered by and being implemented in the Volga State University of Technology allows to organize a current monitoring of an education process, the results of which enable an operative correction of curricula, a choice of subjects that lead to a more effective formation of certain competences. It is appropriate to correlate the results of monitoring at the final stage of teaching students with an independent assessment realized by using corresponding measuring materials.

Acknowledgements

The study results were obtained by the support of the grant project under the title the Development of the Theory, Models and Methods of Personalization Human-Computer Interaction With the Use of Mining Ergatic Control System in the State Space.

References