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Problems and methods for Forming Educational Results in the Implementation of Engineering Education in the Digital Economy

Speacker's

Svetlana Makarova,

Alena Zaitseva

Authors:

- S.Yu. Makarova
- A.A. Zaitseva
- V.V. Martynov

Federal State Budgetary Educational Institution of Higher Education "Ufa State Aviation Technical University" "FSBEI HE USATU", Ufa, Russia

Relevance of the problem of forming a competence model

- updating Federal state educational standards of higher education in terms of requirements for the formation of digital economy competencies and developing recommendations for updating the approximate main educational programs by 2024;
- creating conditions for the formation of the labor market by qualified and competitive personnel of the digital economy through the transformation of all levels of education systems;
- correlation of new versions of the FSES in 3++ with the introduced professional standards;
- lack of methods for optimizing the competence model based on various criteria, such as the level of competence formation and/or the complexity of implementation to ensure high-quality training of graduates who are able to compete in the modern labor market.

Problem statement

To choose the optimal complexity and **levels of competence** the set of disciplines, allowing most effectively to implement a set of competencies of graduates with a given (by the employer) of the **level of competence** and limitations of the curriculum.

To develop a method of formation of the competence model, then the Main Educational Program(MEP), the optimal competence level and/or complexity of implementation to ensure quality training of graduates to meet the dynamic requirements of employers and able to compete in the modern labor market.

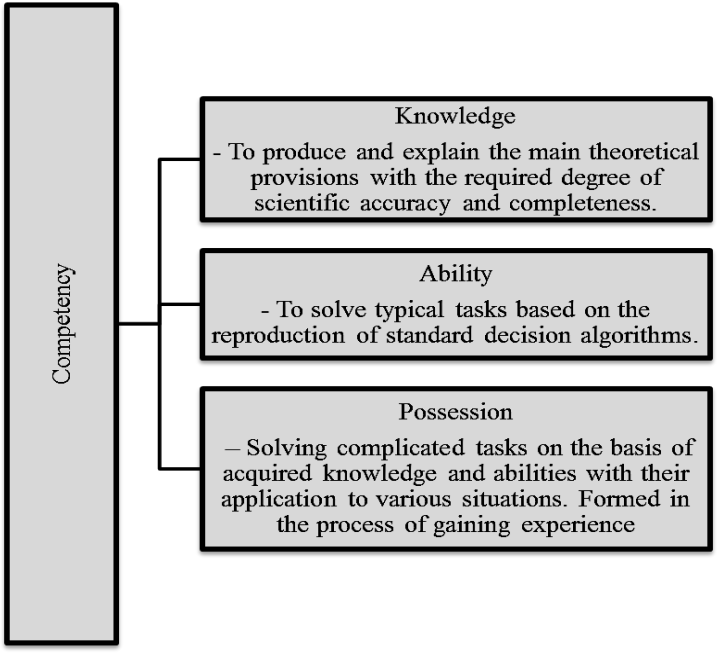
The competency-based approach

We take the following definitions as a basis in the framework of the competency-based approach:

- **competency** – technology or methodology, the possession of which, along with other competencies, allows a specialist to define or manage business processes within the scope of his competencies with the required level of competence;
- **the competence** is a measured quality of the specialist in a solution of a specific objective or to management business processes. The specialist has a certain competence in the field of its competencies

Learning outcomes

Learning outcomes are the expected and measurable structural components of competence: **k**nowledge, **a**bilities, **p**ossession (**KAP**), practical skills, experience that a student should gain and be able to demonstrate after mastering a discipline or module of disciplines. The planned learning outcomes for each discipline (module) are knowledge, abilities, possession and (or) experience of activities that characterize the stages of formation of competencies and ensure the achievement of the planned results of mastering the educational program.



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Levels of the higher education	Level (description)
Bachelor degree	1 – Recognition – Knowledge acquaintance.
	2 – Reproduction – Knowledge copy.
	3 – Application – Knowledge ability.
Master's degree	4 – Creative activity – ability to create objectively new information

Mathematical model. Initial data

D – set of educational modules (disciplines, dimension N), including basic disciplines and disciplines for choice.

Discipline: D: $\{D1;\ D2;\ \{D_{enter}\};\ \{K_j\};\ \{f_j\}\}$,

where:

- *D1* – the name of discipline,
- *D2* – the labor input expressed in credit unit (c.u.),
- {*D*_enter } – set of the entering (previous) disciplines, *Denter* $\subseteq D$,
- {*K_j* } – set of the competencies created by this discipline,
- {*f_j* } – private the weight (forming levels) of the competencies created by this discipline.

Mathematical model. The set of competencies

Let's designate a set of competencies K (dimension m):

$K: \{K1;K2\}$,

where: *K1* – the name of competency,

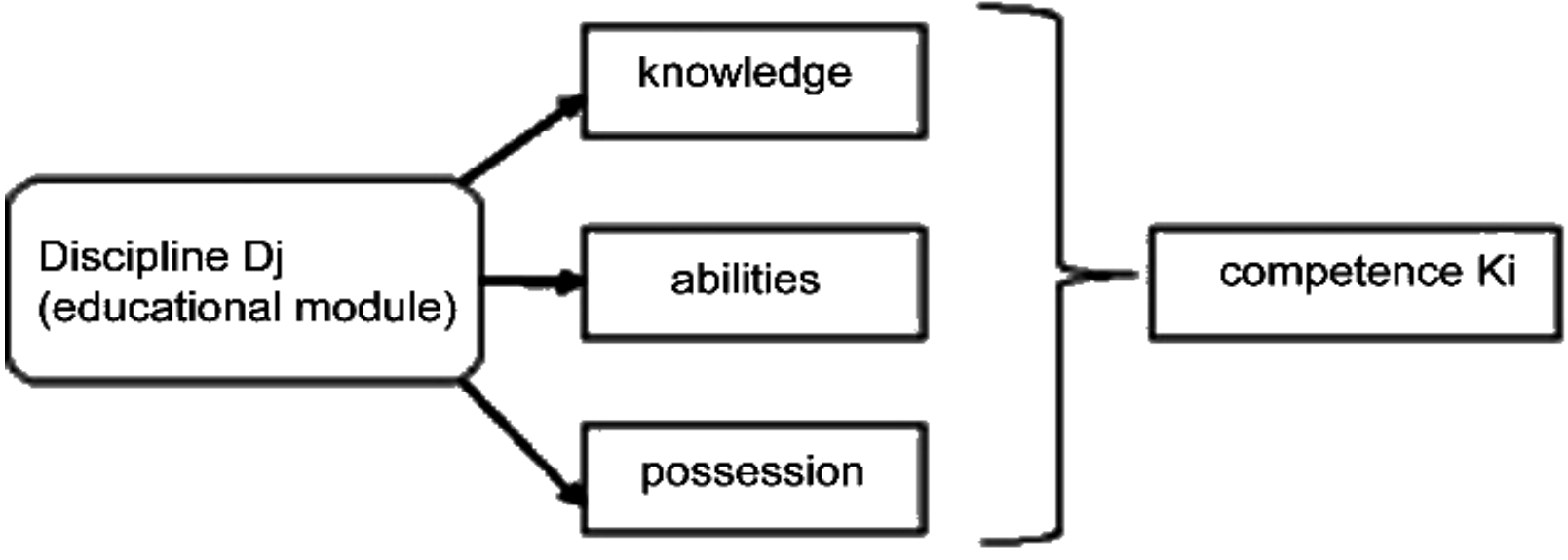
K2 – the integrated weight (level of formation of competency).

To – a set of competencies (the dimension m), includes:

It is necessary to consider the logical sequence and coherence of disciplines (previous - the subsequent disciplines) in the course of forming of competency.

The private weight (forming levels) we will designate f_i on components of competence so: f_1 – knowledge, f_2 – abilities, f_3 – possession.

Mathematical model. The scheme of formation of competences disciplines



The level of formation of knowledge, skills and knowledge of educational modules that make up the competence.

KAP / Educational module	K1			K2			Km
	K1	A1	P1	K2	A2	P2	…
EM1	f11	f12	f13	f14	f15	f16	…
EM2	f21	f22	f23	f24	f25	f26	…
	f31	f32	f33	f34	f35	f36	…
EM	…	…	…	…	…	…	…
EMn	fm1	fm2	fm3	fm4	fm5	fm6	…

Mathematical model. Competence model

Competency is stated in the course (s) of one or more academic disciplines in order to form it in the student.

Competency K_i forms the number of disciplines $L_j \leq n$,

Where n – the size of disciplines set

The set of the competencies that are formed by discipline

$$D_{\text{j}} \longrightarrow K_{lj} \subset K_i,$$

Competency K_i is formed by disciplines $D_{l_{k_j}}$,

$$K_i \longrightarrow D_{l_{k_j}}$$

$$\forall\, i\ \exists \left\{l_{k_j}\right\}, \text{где } \mathrm{k}_j = \overline{1..L_j}$$

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Formation level (integrated weight) of the competency created by EM, one or several – the numerical coefficient accepting values from 0 to 3

$$K2_i = \sum_{k_j=1}^{L_j} f1_{i=l_{k_j}} + \sum_{k_j=1}^{L_j} f2_{i=l_{k_j}} + \sum_{k_j=1}^{L_j} f3_{i=l_{k_j}}$$

the sum of knowledge, skills and possessions should meet the requirement :

$$K2_i \geq Z_i \, , i = \overline{1..m}$$

Z_i – the level of formation of competency set (employer).

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Curriculum P:

$$\mathrm{P}: \left\{ \{D_j\}; \sum_{q=1}^{S} \mathrm{TP}_q \right\},$$

where $\{D_j\}$ – a set of disciplines,
$\sum \mathrm{TP}_q$ - the sum of requirements of FSES 3++ in the direction of training, N -the number of requirements, FSES is determined by the specific direction.

S - the number of requirements determined by the FSES for a specific direction of training.

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The complexity of the curriculum R:

$$R = \sum_{j=1}^{n} D2_j$$

R = 240 credits - for undergraduate courses
R= 120 credits - for master's degree courses

Competence model:

$$\text{КМ} = \{\{K_i\} \to \{Z_i\}\}, \text{i} = \overline{1..m},$$

где Zi – the level of formation of competency set (employer).

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$$КМ = \sum_{i=1}^{m} K2_i \rightarrow max,$$

$K2_i$ - values of integral weights of formed competencies

$$\max \geq \sum_{i=1}^{t} Z_i, \quad t \leq m,$$

m – dimension of the set of competencies implemented in the competence model

provided that $D2_j \rightarrow \min$ - minimum labor intensity of disciplines

Z_i – the levels of competencies formation set by the employer;
t – number of employer's requirements submitted.

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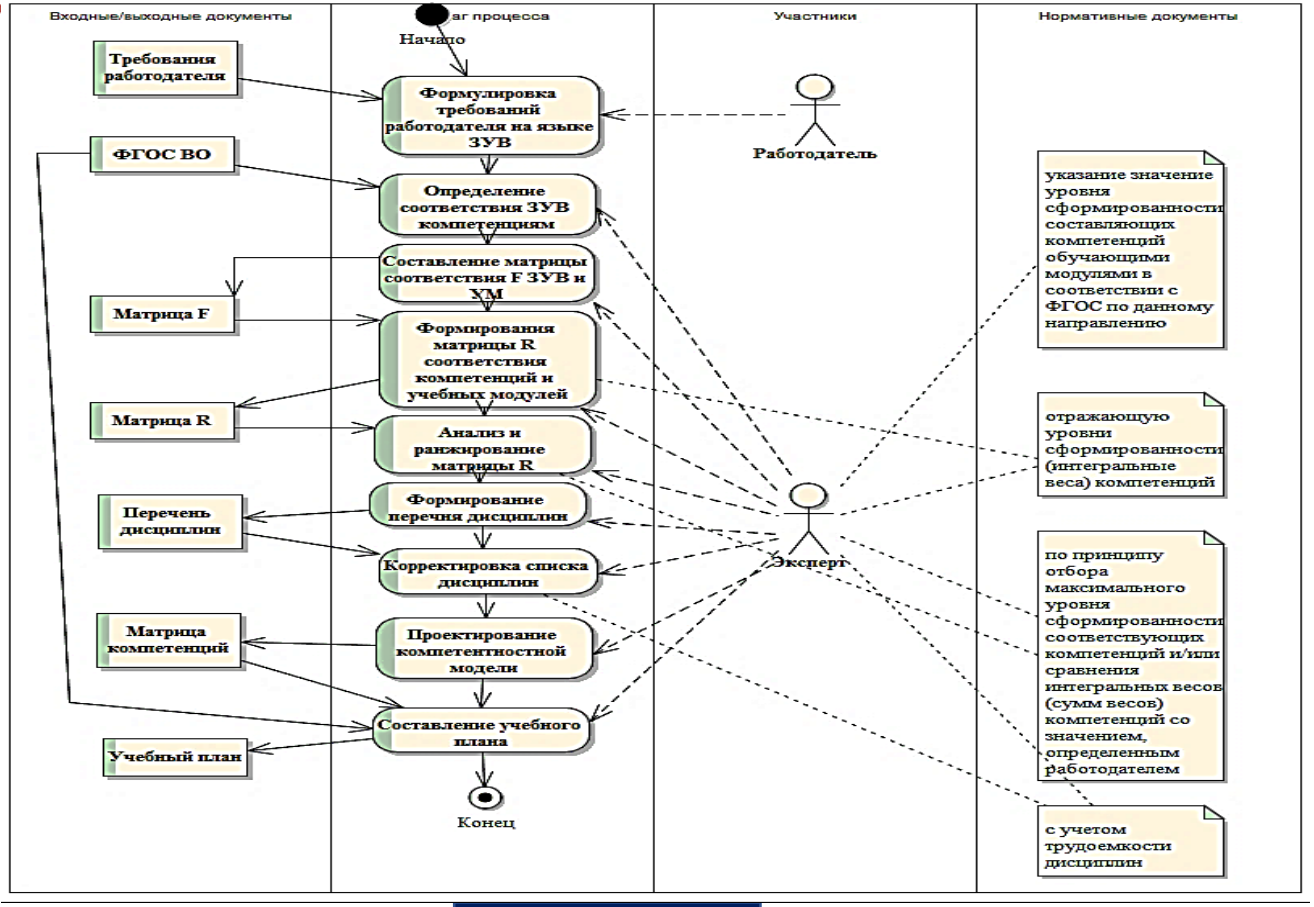

CONCLUSION

This approach allows us to develop an optimal competency model of the graduate, taking into account the requirements of the Federal state educational system for the field of study and the requirements stated by the employer. The optimality of the competence model is determined by the maximum value of the integral weights of competencies, provided that the minimum labor intensity of the disciplines that make up the model.

The resulting competency model can be quickly (annually) adjusted according to the existing norms for making changes to the curriculum in accordance with the changed requirements of employers, adding to the restrictions the labor intensity of already passed disciplines.

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Thank you for attention!

Speacker's contacts:

Svetlana Makarova,

Federal State Budgetary Educational Institution of Higher Education "Ufa State Aviation Technical University" "FSBEI HE USATU",

Ufa, Russia

e-mail: svet_makarova1@mail.ru

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Alena Zaitseva,

Federal State Budgetary Educational Institution of Higher Education "Ufa State Aviation Technical University" "FSBEI HE USATU",

Ufa, Russia

e-mail: alenazaitseva@yahoo.com

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