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STRUCTURAL MODEL OF THE SYSTEM OF DEVELOPMENT OF METHODOLOGICAL COMPETENCE OF IT-DISCIPLINE TEACHERS ON THE BASIS OF CONTINUING EDUCATION

Abstract: The article considers the creation of structural model for the system of development of methodological competence of IT-discipline teachers based on continuing education with the description of the structure of microservices subsystems. To implement the proposed conceptual model the paper proposes a software architecture based on the use of classical service-oriented design pattern “Model-View Separation” (separation of model objects from the graphical interface objects with the user) and provides for interaction with the database, the composition of its main packages is detailed. Logical and physical service-oriented models of basic classes of objects of subject area and auxiliary objects (services) have been developed. The article also proposes a relational database structure based on the use of metadata tables, directories, and operational data in a relational database management system environment.

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Methods and mechanisms for data protection and replication are proposed and justified, considering the specifics of system operation in higher education institutions. The article aims to develop insurgents and mechanisms of creation of information technology improvement of the system of higher education and creation and operation of integrated flexible software tools to support the mixed system of organization of educational process, as well as increasing the effectiveness of the introduction of a mixed system for the organization of the educational process on the basis of the use of the latest technical means of training and documentation, ensuring free access of students to teaching and methodological resources, content and criteria for the assessment of knowledge in disciplines and modules, data recording, and partial compensation for the increased workload of teachers and staff through the automation of assessment, registration and assessment processes. A task-oriented model for managing technical problems in the implementation of the information system for the development of teachers' methodological competence is also proposed, and a conceptual framework for managing these problems has been developed from the perspective of considering projects as a set of objects and subjects. Technical problems in projects are shown to be obstacles to moving in the right direction, created by random events, uncertainties, and changes. A mathematical model of the change in resistance value caused by technical problems has been developed and methods to counteract these problems have been proposed.

Keywords: training, postgraduate education, methodological competencies, databases, structural models of information systems.

Introduction

The development of digitalization at a global level has affected learning programs, where the skills and information provided by traditional learning programs need to be reformatted in a digital environment.

The design of the structural model of the learning system takes into account the presence of three actors: the learner, the teacher and the platform administrator, while the role of the teacher can be subdivided into teacher-designer, teacher-trainer (or tutor-teacher), teacher-corrector, etc. And the following processes have been identified as key features of the platform by scientists from Morocco:

- creating courses, tests and standard courses;
- management of educational documents (indexing, classification, updates, etc.);
- managing the collaborative workspace between learners and/or teachers;
- monitoring the learner's learning and assessment;
- managing the learner's education;
- providing the learner with work tools (special editors, download tools, modelling tools, etc.)
- Providing different actors with communication tools and management procedures (forums, messaging, chat, video conferencing, etc.) [1].

Researchers at the University of Salerno view learning information systems as an organized platform with three fundamental macro components: the Learning Management System (LMS), the Learning Content Management System (LCMS) and the Toolkit for Learning Content Distribution and Interoperability. In doing so, the LMS integrates all aspects to manage online learning; the LCMS offers services that allow content management, focusing on content creation, importing and exporting; the Toolkit represents all services that manage learning processes and interactions between users [2].

Learning systems through IT platforms need to consider pedagogical architecture to create more open, flexible and emergent curriculum models, distancing themselves from the replication of technical strategies commonly found in e-learning, rethinking the role

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VOLUME 12, DECEMBER 2022

of facilitators, promoting a social learning environment, supporting networks and learning between trainees [3].

In order to create an attractive learning environment conducive to competence development, an experimental algorithmic model of e-portfolio was created at Riga Technical University (Latvia). This model, along with the external learning portal information system, provided a process for assessing the development of learners' competences during the study course. This model obliges learners to assess the achievements of their group members and carry out self-assessment, while the learners have an opportunity to see the names of the group members with their achieved assessment results: marks, notes on critical thinking and constructive suggestions [4].

It is not unimportant when creating an information system to include in its architecture a module for quality assessment of the offered online courses. This module should consider the course according to the following criteria: transparency and openness of methods and criteria for evaluating the online course; organization of joint work of students, organization of mutual and self-evaluation, visualization of learning material, etc. [5].

In doing so, the information system success model depends on three main factors: 1) Digital transformation through the application of new technologies to existing organizational resources in new operations to create opportunities and challenges for the organization, 2) Design of information and communication technology applications to be linked to a systematic workflow and 3) Digital leadership with skills, relationships, knowledge and expertise in the above two areas [6].

A collaboration of scientists from Thailand and the USA identified 2 main aspects when developing an information system model:

1) Web-based research and setting up computer frameworks;
2) V-model for designing and developing the research platform:

- Adapted system lifecycle model;
- system analysis;
- system development (design methodology and templates, functional module design, relational database design, application logic development);
- system architecture [7].

To develop soft-skills and social competencies (leadership, conflict management, diplomacy, and emotional intelligence) Fernando Almeida & Zoltan Buzady chose the online game FLIGBY as a model, with the scientists suggesting that the results of the research should be incorporated into university curricula [8].

Nevertheless, the system model in the field of methodological training of university teachers should consider aspects of motivation for knowledge transfer, self-efficacy, learning design, teaching conditions, assignment possibility, positive consequences, trainee support, supervisory support, transfer climate [9].

When exploring the system of competency development [10], the degree of faculty engagement themselves cannot be forgotten, and improving academic staff engagement in faculty and educational quality development [11] requires institutional attention not only to the needs of faculty but also to contextual, community factors [12]. This confirms the need for us to pay attention to the development of methodological competence in teachers in general, and in IT teachers in particular.

Basic material

With the adaptation of the educational process of the university to the basics of supporting the mixed system of the educational process, the task of solving the problem of comprehensive automation of the educational process is relevant.

DOI: 10.37943/12TYUY5628

The main purpose of the creation of information technologies adequate to the task of improving the system of higher education, is the purposeful development of the computer network of the higher educational institution and the creation and operation of integrated flexible software tools to support the mixed system of educational process organization, as well as increasing the effectiveness [13] of the introduction of a mixed system of organization of the educational process on the basis of the use of the latest technical means of training and documentation, ensuring free access of students to teaching and learning resources (including electronic), content and criteria for assessing knowledge in disciplines and modules, data registration, partial compensation for the increased workload of teachers and staff through the automation of knowledge assessment, registration and analysis of progress.

By definition, a structural model is the most general and abstract model of a system, reflecting objects and the relationships between them.

Modern methods of creating large software systems use a service-oriented approach, i.e. using microservices technology, the basic idea of which is to represent a software system through a set of independent entities (services) that interact with each other. Each entity is responsible for preserving the information it needs to live and, in addition, implements its own behavior. The possibility of decomposing a system into a set of separate entities, each of which can be multiplied into any number of instances (services) that have their own characteristics, is the basic idea of the service-oriented approach. Services connected by links via data exchange APIs describe the structure of the system.

The tools must meet the following basic requirements:

- be universal, flexible in operation and development, i.e. based on the use of metadata base (metabase) for parametric adjustment to the requirements of specific users, modern methods and tools for integration of software applications and electronic resources;
- Support the maintenance and general use of a reference database on higher education institutions (structure, electronic addresses, network identifiers, websites, additional links to teaching and learning materials within the higher education institution and on the Internet, timetables) using a database navigation tool that is natural for the end user;
- maintain operative databases of the results of various forms of students' knowledge control by specialities;
- take into account significant differences in the technical characteristics of individual computers of higher education establishments;
- ensure reliability and security of data storage, strict regulation of access rights to data for individual groups of users, identification of users through software implementation of electronic signature mechanisms;
- ensure preparation and use of computer tests for various purposes using texts, graphics, formulas, audio and video materials on electronic media;
- support electronic document flow on the basis of XML-documents [14], which will provide a relatively painless adaptation of software tools to new software and hardware platforms, and also allows taking into account the heterogeneity of the characteristics of technical and software tools of the computer park;
- support the creation of Microsoft Office-compatible documents on electronic media, with the ability to expand the document set relatively easily by creating and registering new document templates in the database, printing documents on printers using Microsoft Office and embedded report printing facilities;
- provide integration with curriculum planning software, integration mechanisms with existing software tools for distance learning and computer-based testing.

Formulated depending on the functional purpose requirements for a software package for automation of educational process management in academic units of a higher education

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VOLUME 12, DECEMBER 2022

institution allowed to define a conceptual model of the university, largely stipulated the requirements for functional and technical characteristics of the system and features of its software implementation (service-oriented and structural models and algorithms obtained in the process of conceptual, logical and physical modeling).

For the implementation of the developed software tools a necessary condition is the ability to use Internet technologies and the availability of a corporate computer network of universities, which would provide the maximum speed and efficiency of use.

Fig. 1 shows a conceptual model of tools for the formation of a complex information and educational environment, which has a multilevel distributed structure [15], the main components of which are remote database servers, application servers, profile automated workstations of teachers, students, employees, WEB-servers and WEB-applications, and auxiliary – software services for the construction and interpretation of computer tests, regulation of access and performing other special functions.

The conceptual model of tools for developing an information system for the development of teachers' methodological competence, including a graphical user interface and interaction with databases, is usually considered in terms of several levels: two-, three- or multilevel. For service-oriented information systems for teaching competence development, we recommend using a classical three-level structural model (Fig. 2) [16], which, after decomposing the level of application logic into several smaller levels, becomes a multilevel structural model without explicit level boundaries.

To implement the conceptual model in view of the requirements, a structural model of the software package is proposed, based on the use of the Model-View Separation design pattern (separation of model objects from graphical interface objects with the user) and provides interaction with the database, models and projects (stored data level).

The levels are represented by corresponding packages in graphical notation of the Unified Modeling Language (UML): subject area objects and service objects (services). The first belong to the classes that directly describe the concepts and models (artifacts) of the domain and most fully reflect the specialization of the information system. Service objects are designed to perform auxiliary functions, such as a variety of transformations of domain objects (high-level services), interaction with the database, report generation, etc.

DOI: 10.37943/12TYUY5628

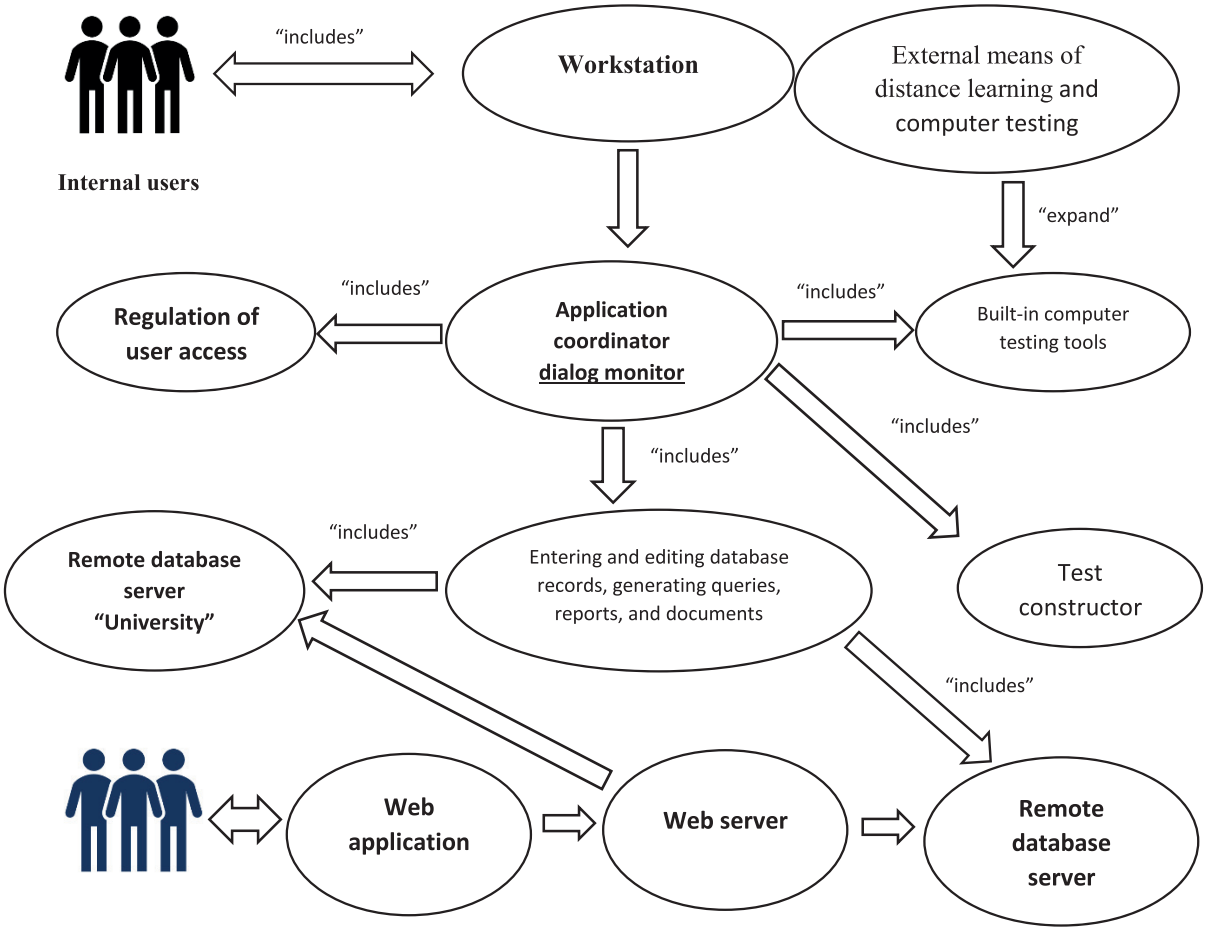

Figure 1. Conceptual model of the information system tools for the development of teachers' methodological competence

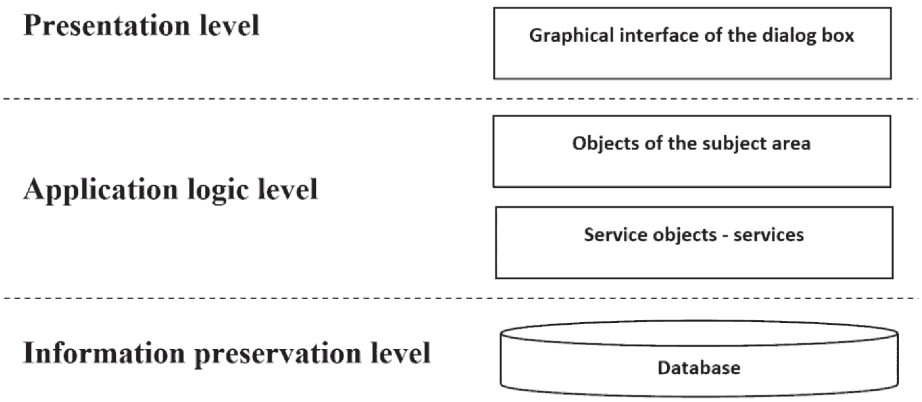

Figure 2. Three-level structural model for the formation of a comprehensive information system for the development of teachers' methodological competence

The presented conceptual model of software tools made it possible to define the composition of the software package and the attributes of all the constituent blocks of the integrated information and education system. Detailed representation of the structure of a typical information environment architecture (Figure 3.)

To represent subsystems or groups of elements UML uses the mechanism of packages, which can be classes, precedents, cooperation diagrams or nested packages. A system can be

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VOLUME 12, DECEMBER 2022

thought of as a single top-level package, where each element can be a nested package. In UML package terms (package architecture diagram and dependencies between packages) Figs. 4 and 5 show the composition of "Application Logic Layer" packages.

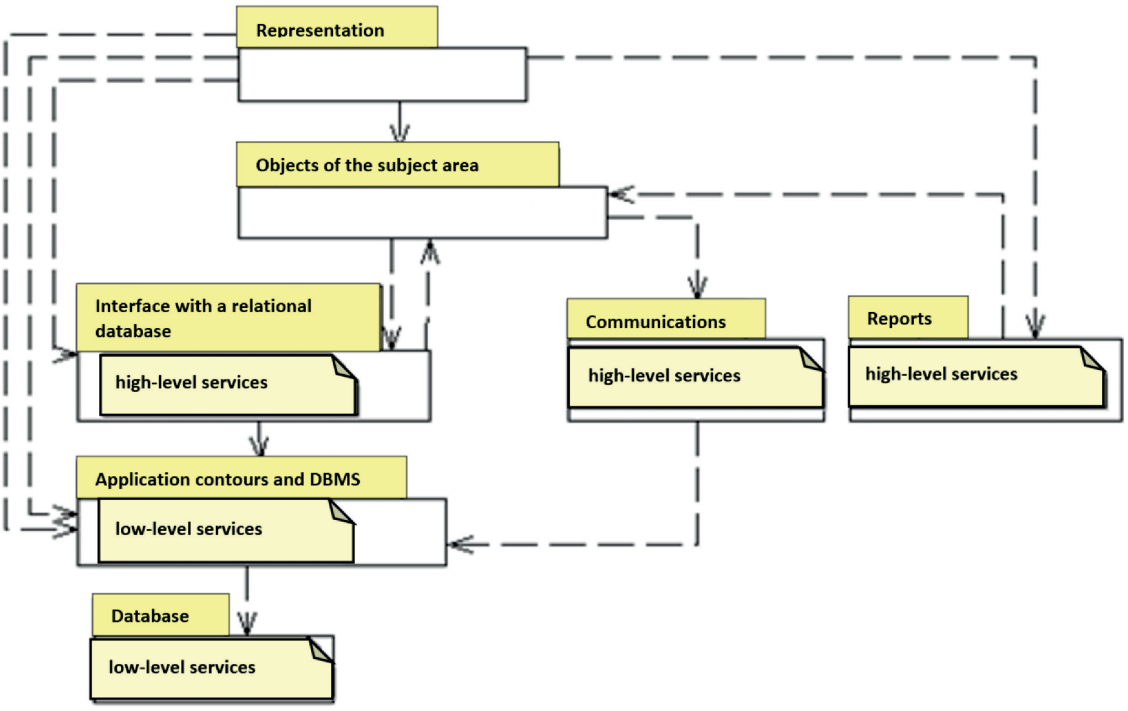

Figure 3. Detailed representation of a typical IE architecture

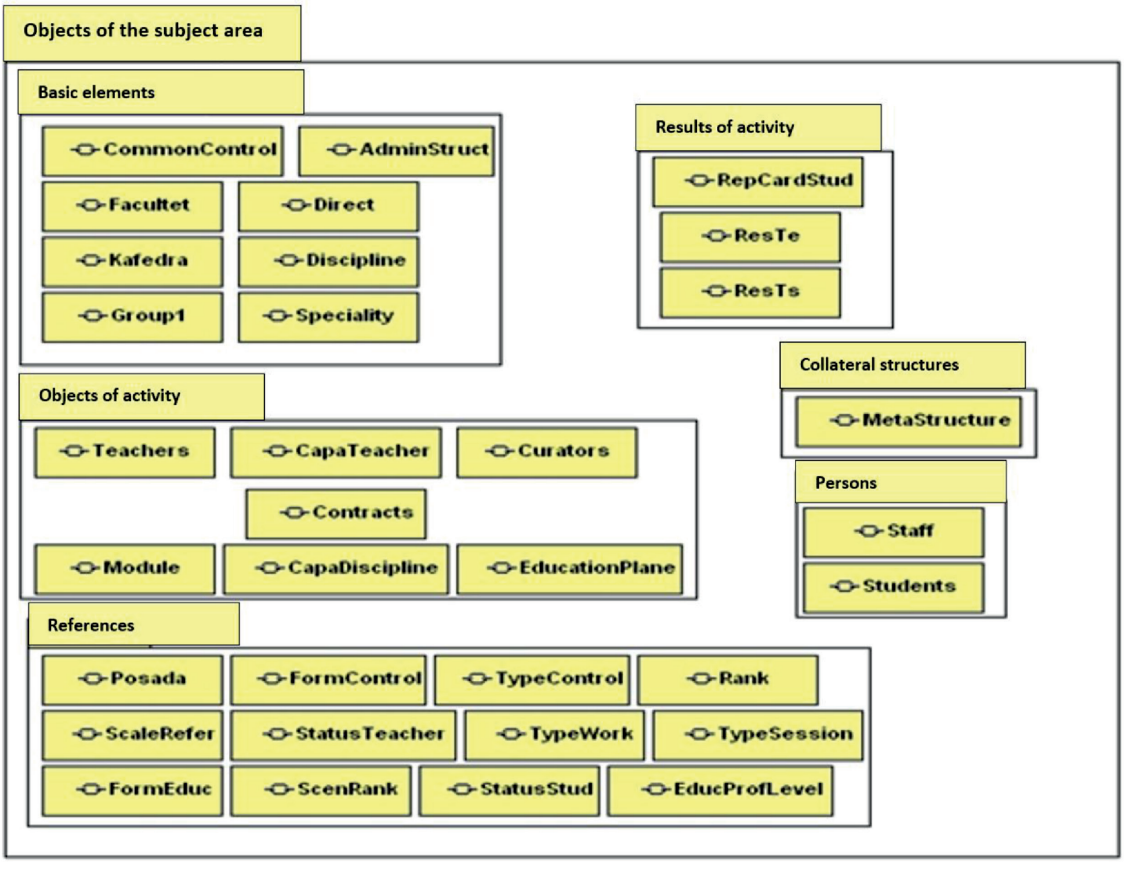

Figure 4. Composition of the "Subject Area Objects" package

DOI: 10.37943/12TYUY5628

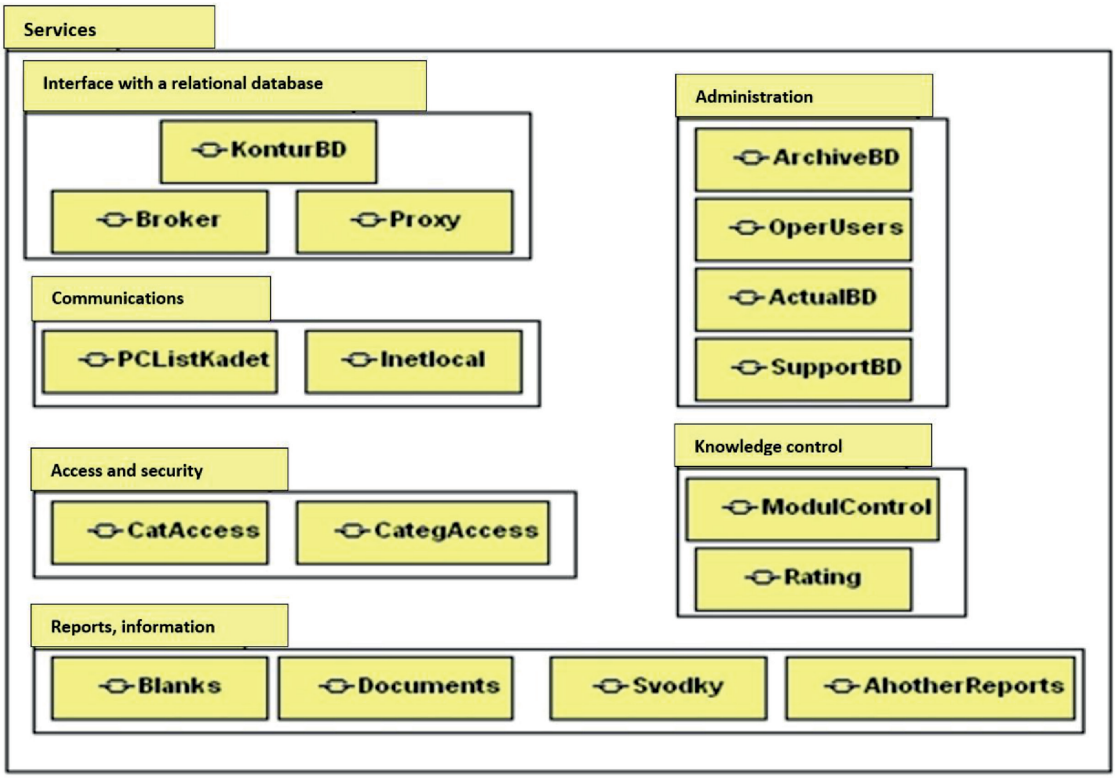

Figure 5. Composition of the "Service Objects – Services" package

In order to implement the training of IT teachers, a blended learning information system based on the structural model for the development of methodological competence should be developed as shown in Figure 6.

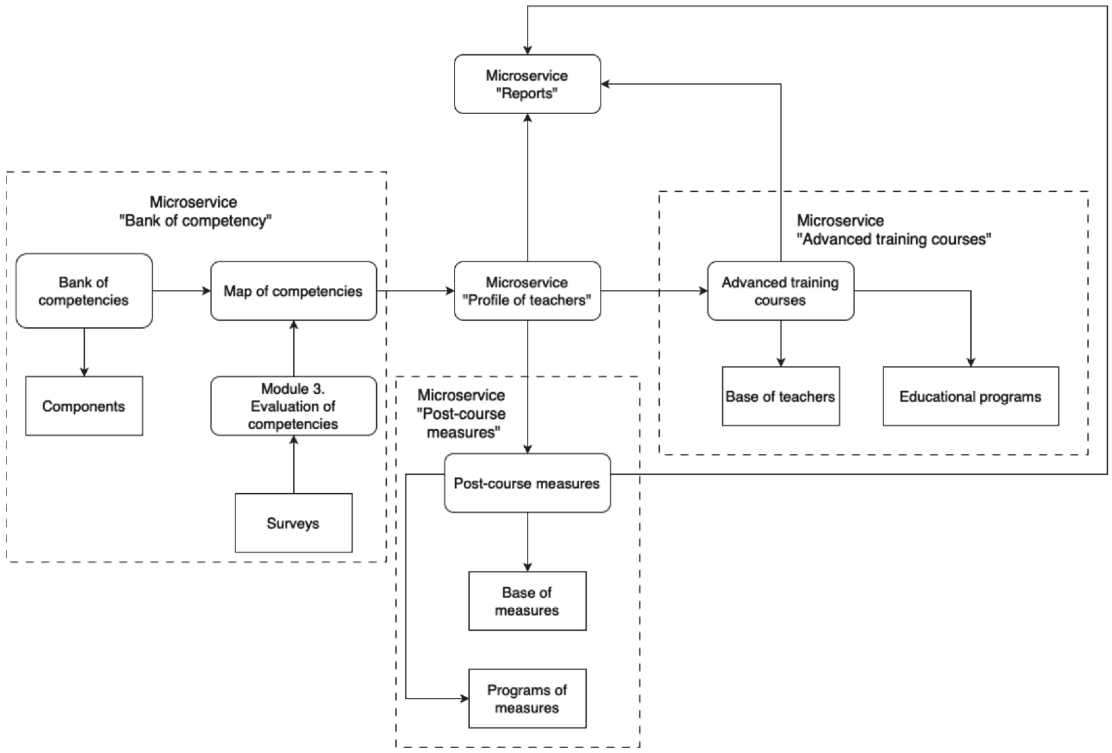

Figure 6. Structural model of methodological competence development system for teachers of IT disciplines

Scientific Journal of Astana IT University
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VOLUME 12, DECEMBER 2022

At its core, it will consist of a set of microservices which will ensure the dynamic development of the system under development, namely:

The "Competence Bank" microservice solves the tasks of collecting and analyzing teachers' competences, based on questionnaires.

There is an initial (baseline) questionnaire for each teacher, which is used to determine his/her initial level of competences, in order to create a basic competence map. This questionnaire is generated by the administrator and stored in the competence database.

The initial questionnaire is created during teacher registration and the questionnaire data is copied from the Competence Bank. The components of the questionnaire and the questions included in it are defined by the system administrator when adding the data to the Competence Bank.

After a teacher has completed the initial questionnaire, all answers are stored in the database, the initial competence level is formed based on them and displayed on the basic competence map in the teaching staff profile.

Administrators have a functional possibility to add new questionnaires to the competence bank. A teacher's competence level changes depending on the scores (grades) after completing each questionnaire, survey, etc.

The "Faculty Profile" Microservice stores personal information about registered users – teachers and their competency map. Users can edit their personal data in their account settings.

The Competency Map is modified based on the teacher's completion of questionnaires, surveys and other types and forms of knowledge identification and testing.

Microservice "Competence assessment" is responsible for processing the results of questionnaires, surveys and other forms of identification and testing of users' knowledge, and calculates the final average grade, which is saved in the database and updates the competence map of this user based on this grade [17].

Microservice "Professional Development Courses" is a component of the system designed for professional development of teachers on the courses uploaded to the system.

Administrators create courses for which a specific trainer is assigned. A database of trainers, formed when new users register, is confirmed and added by the system administrators.

Trainers, in turn, fill in the course with training materials, form a questionnaire for the final assessment and determination of the level of competence. Trainers can modify, edit and add course data, except for questionnaires and certificates.

To take a course, the trainer (user) sends a request for training. The administrator reviews the request and decides to accept or decline the training request. After receiving the invitation to the course, the trainer takes the training. Upon completion of the course, the trainer needs to take a final test, the results of which are entered into his/her competency card and a certificate with his/her training results is generated.

The microservice "Reports" is responsible for storing and displaying information on the teacher's competence levels (average grade) and the courses completed. This microservice allows you to get complete information on the progress of a particular teacher, the results of his/her testing and questionnaire. This section also provides summary information on all teachers, competency levels by city and educational organizations.

A microservice "Post-course activities" is a component of the system containing courses, trainings, master classes and seminars for informal education. Users can request to take these courses, on completion of which they also take a final assessment, the results of which are entered into the competence map.

The formation and structure of a distributed database.

For effective use in terms of local, corporate, and global computer networks with any university, taking into account the varying degrees of computer equipment units and the

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possibility of information integration of existing and newly created software components based on client-server model of interaction between them, developed mechanisms for regulating access and security methods the following scheme of the relational database is proposed.

Organization of information interaction between all components (information integration) is carried out through tables of remote databases, and the adaptability of software tools is provided by parametric adjustment of individual components to the conditions of use (rating scales, division into training periods, other essential features of the mixed system of the educational process based on meta-data descriptions and components) Figure 7.

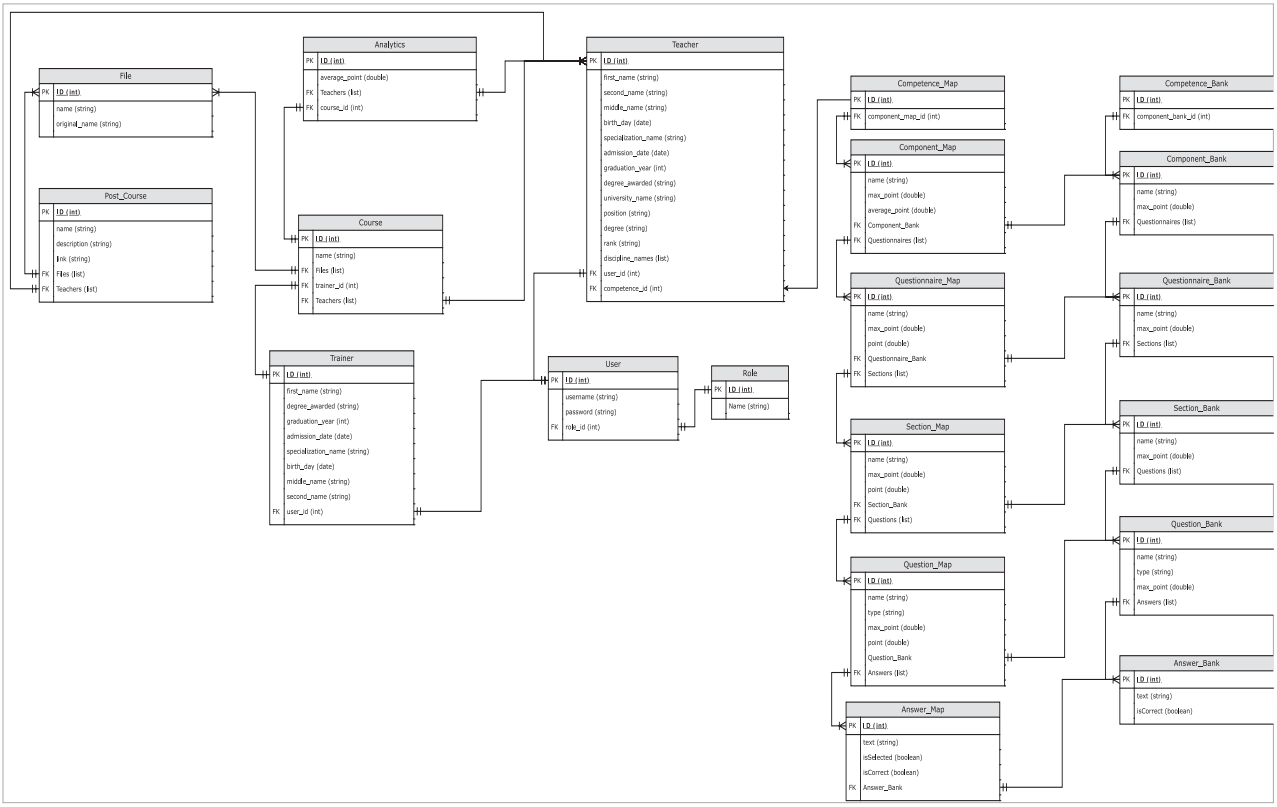

Figure 7. Structural model for organising a distributed database of the information system for the development of teachers' methodological competence

The basis of active software and hardware methods to ensure the use of information is the delimitation of access rights. This applies not only to the data, but also to the system software itself.

The most common method of data protection today is to create a secure interface to the data warehouse. Its obvious advantage is that such a system may be divided into two independent layers. The lower layer is responsible for accessing data on physical media, using all modern indexing and retrieval algorithms, and is independent of security features. The second layer provides secure access to the lower layer.

All modern databases (DB) allow sharing of user access rights to a greater or lesser extent. The basic operation of the information system for development of teachers' methodological competence in terms of checking access rights has the following order:

1. The beginning of the work is authentication. In this process, a user account is used, which is formed by a public username and an encrypted password. Each user account can be stored in a different form. For example, Windows uses what is known as a database of accounts stored on domain controllers. When performing the authentication procedure, the user enters their

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VOLUME 12, DECEMBER 2022

name (or chooses from a list suggested by the system) and password, which is then checked by the security subsystem for correctness.

2. If the user completes the first step, a session with the server is opened. All subsequent actions are carried out in the name of the account for which he successfully entered the password.

3. When accessing the database, the server checks whether the current user has the right to the information they are requesting. If so, the information is provided to the user. If not, the user is denied access.

The total user rights consist of the privileges and access rights of the groups to which he/she belongs and the privileges and access rights assigned to him/her personally Figure 8.

The main user of the information system for the development of teachers' methodological competence, who has the highest administrative privileges in the database, is the super-administrator. This account is created by the developer or the server (automatically), so that later this user has access to add, edit or delete administrator accounts, which are stored in the database of system administrators and users.

The system administrators form and update the Competence Bank (this Bank is stored in a separate database). These data are questionnaires, surveys and other types of knowledge identification and testing, in which competence levels of IT subject teachers are determined.

DOI: 10.37943/12TYUY5628

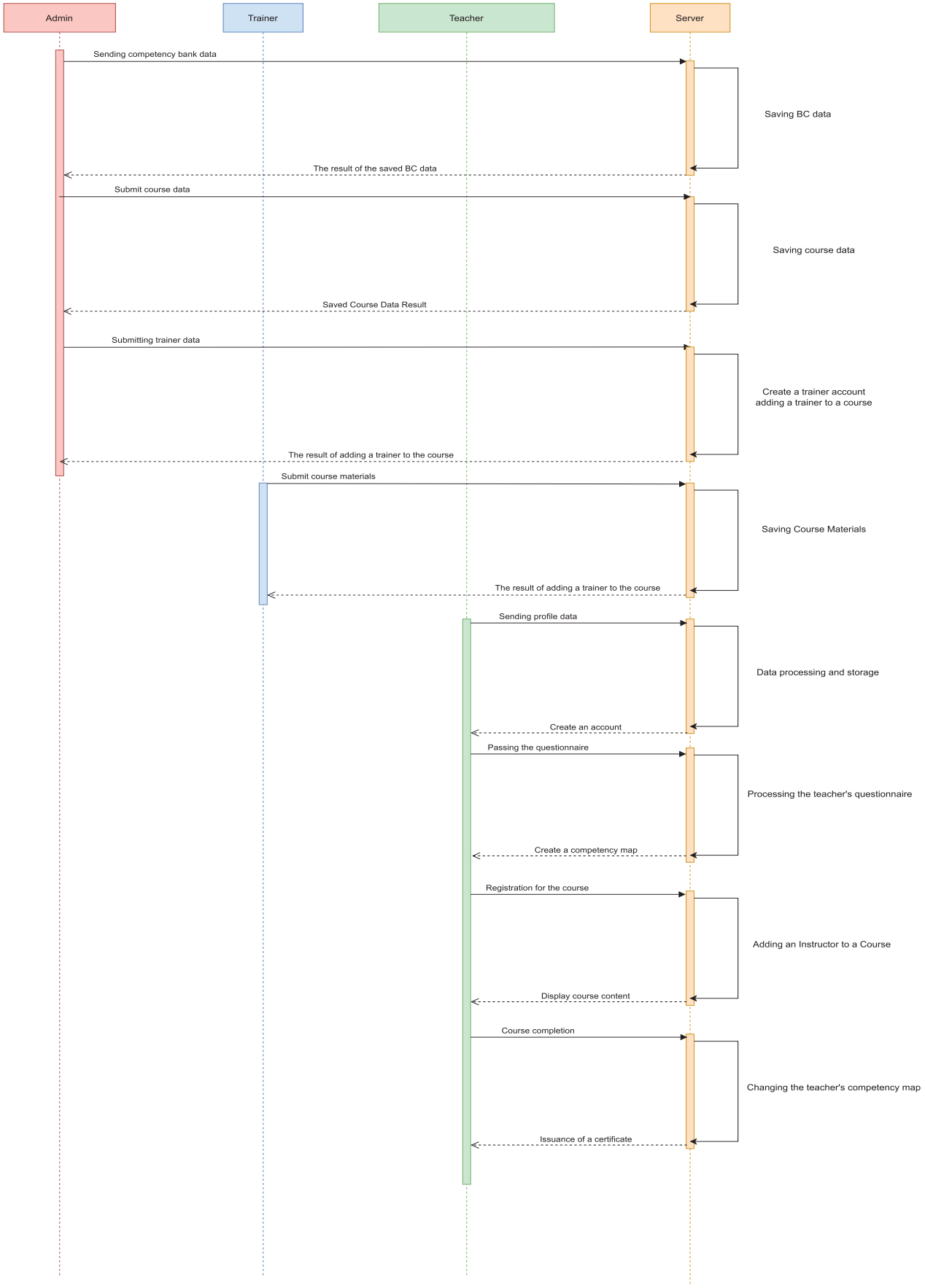

Figure 8. Roles and access rights to the information system for the development of teachers' methodological competence.

Scientific Journal of Astana IT University
ISSN (P): 2707-9031 ISSN (E): 2707-904X
VOLUME 12, DECEMBER 2022

For a detailed representation of the mechanism of division of access rights in a system consisting of: information stored in the database; applications included in the system software package; commands and functions in applications that can be used with different levels of access, the list of access to information management in the database of the information system for the development of methodological competence of teachers, which is prepared for: a specific type of information (individual properties); a certain area of the document (for example, statistical information); a separate document; a separate group of documents belonging the to same type; a separate database, which is part of the information system for the development of methodological competence of teachers; a server.

The response to checking user availability can be in the form of:

- hidden denial, where the user simply does not see those objects to which they do not have access rights. This response can be in an application that dynamically builds its menu depending on the user's permissions;
- an unacknowledged denial, where a user trying to access an object is prompted with a denial-of-access message. Such refusal is not logged by the system;
- a logged denial, where the system logs the denial in a special log;
- the refusal with notification. The user is denied access and the system notifies the administrator or other authorized person of the denial. Information on the most important actions performed by users during operation is reflected in the operation log. The log contains: date and time of operation; user code; task ID; user station ID; name of the database table on which the operation is being performed; log message code. The log is viewed through the administrator utility. The system log is used as the main log for the administrator utility. The system service tables contain information encrypted using one of the cryptographic algorithms about: users, user groups; privileges; access rights to database objects.

To organize automatic backups, the mechanism of database replication to a dedicated server is used.

All replication sessions are automatically logged by the server, so the administrator always has complete reports on the backup progress, the amount of information transferred and the lists of databases involved in the backup. Since the backup process is based on replication, the network traffic is not overloaded – not the whole database is archived, but only the part that has changed since the last replication session and is recorded in the work log. In this case not only the database information is involved in replication, but also the operation logs etc.

For the successful launch of the information system for the development of teachers' methodological competence it is necessary to develop tools to manage the technical problems of the implementation of our IT project.

Technical problems in projects in the interpretation of project vector management methodology are obstacles to moving in the right direction, created by random events, uncertainties that create great resistance to system implementation and changes that need to be made in cases of insurmountable resistance to system implementation [18].

In any case – the technical problems in an IT project are the additional resistance encountered along the way towards the target points. This resistance (analogous to physical space) can result in:

1) The target implementation points of the IT project will never be reached;

2) Need to change the trajectory of the IT project (project plans);

3) Additional resources are needed to overcome resistance to successful IT project implementation;

4) Time will be wasted and results (end points) will be achieved at a later date.

DOI: 10.37943/12TYUY5628

We propose to implement a task setting model to adjust the trajectory of the movement in case of additional resistance. Indeed, the force of resistance to movement

$$F_{\mathrm{i}}^{\mathrm{jk}} = \gamma_{\mathrm{i}}^{\mathrm{jk}} \cdot \left(\mathrm{v}_{\mathrm{i}}^{\mathrm{kj}}\right)^2,$$

where γ_{i}^{jk} – coefficient of resistance to movement of the object/subject of the implementation of the information system for the development of methodological competence of teachers Q_j of the project Π_k in the direction N_i;

$\mathrm{F}_{\mathrm{i}}^{\mathrm{kj}}$ – resistance to the object/subject of the implementation of the information system for the development of methodological competence of teachers Q_j of the project Π_k in the direction of N_i;

$\mathrm{v}_{\mathrm{i}}^{\mathrm{kj}}$ – the speed of the object/subject of the implementation of the information system for the development of the methodological competence of teachers Q_j of the project Π_k in the direction of N_i.

$$e_{\mathrm{i}}^{\mathrm{jk}} = F_{\mathrm{i}}^{\mathrm{jk}} \cdot s, \tag{1}$$

where $e_{\mathrm{i}}^{\mathrm{jk}}$ – the energy (resources) needed to overcome the resistance of the object/subject of the implementation of the information system for the development of methodological competence of teachers Qj of the project Пk in the direction of Ni;

s – The path taken by the site to implement an information system for the development of teachers' methodological competence.

Problems in projects are characterized by an increase in the resistance coefficient to movement γ_{i}^{jk}. If

$$\overline{\gamma_i^{jk}} > \gamma_i^{jk} \Rightarrow \overline{F_i^{jk}} = \overline{\gamma_i^{jk}} \cdot \left(v_i^{kj}\right)^2 > F_i^{jk} = \gamma_i^{jk} \cdot \left(v_i^{kj}\right)^2, \tag{2}$$

or if

$$\overline{F_i^{jk}} = \overline{\gamma_i^{jk}} \cdot \left(\overline{v_i^{kj}}\right)^2 = F_i^{jk} = \gamma_i^{jk} \cdot \left(v_i^{kj}\right)^2 \Rightarrow \overline{v_i^{kj}} < v_i^{kj}, \tag{3}$$

where $\overline{\gamma_{\mathrm{i}}^{jk}}$ – the resistance coefficient of the object/subject of the implementation of the information system for the development of the methodological competence of teachers Qj of the project Пk in the direction Ni, considering the technical problems in the project;

$\overline{\mathrm{F}_{\mathrm{i}}^{\mathrm{kj}}}$ – resistance to the object/subject of the implementation of the information system for the development of methodological competence of teachers Qj of the project Пk in the direction Ni, considering the technical problems in the project;

$\overline{\mathrm{v}_{\mathrm{i}}^{\mathrm{kj}}}$ – the speed of the object/subject of the implementation of the information system for the development of methodological competence of teachers Qj of the project Пk in the direction Ni, which allows for the same project costs, even considering the additional resistance.

Based on the analogy of motion in physical space and formulas (2) and (3), three classes of methods can be distinguished for solving technical problems.

1. Create a reserve of resources to overcome those areas of space where additional resistance occurs. Indeed, as follows from formulas (1) and (2), in order to keep the speed of motion, additional energy is needed. From (2)

$$\overline{F_{\mathrm{i}}^{\mathrm{jk}}} = \overline{\gamma_{\mathrm{i}}^{\mathrm{jk}}} \cdot \left(\mathrm{v}_{\mathrm{i}}^{\mathrm{kj}}\right)^2 > F_{\mathrm{i}}^{\mathrm{jk}} = \gamma_{\mathrm{i}}^{\mathrm{jk}} \cdot \left(\mathrm{v}_{\mathrm{i}}^{\mathrm{kj}}\right)^2$$

Scientific Journal of Astana IT University
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VOLUME 12, DECEMBER 2022

Substituting in (1), we obtain

$$\overline{F_{\mathrm{i}}^{\mathrm{jk}}} > F_{\mathrm{i}}^{\mathrm{jk}} \Rightarrow \overline{e_{\mathrm{i}}^{\mathrm{jk}}} = \overline{F_{\mathrm{i}}^{\mathrm{jk}}} \cdot s > e_{\mathrm{i}}^{\mathrm{jk}} = F_{\mathrm{i}}^{\mathrm{jk}} \cdot s, \quad (4)$$

where $\overline{e_{\mathrm{i}}^{\mathrm{jk}}}$ – the energy (resources) needed to overcome the resistance to the movement of the object/subject of the implementation of the information system for the development of methodological competence of teachers Qj of the project Пk in the direction Ni, considering the additional resistance.

Additional energy (resources)

$$de_{\mathrm{i}}^{\mathrm{jk}} = \overline{e_{\mathrm{i}}^{\mathrm{jk}}} = e_{\mathrm{i}}^{\mathrm{jk}},$$

where $de_{\mathrm{i}}^{\mathrm{jk}}$ – additional energy (resources) needed to move the object/subject of the implementation of the information system for the development of methodological competence of teachers Qj of the project Пk in the direction of Ni, at the same speed (fulfilling the plan).

2. Create a time reserve to overcome those areas of space where additional resistance occurs. As it follows from the formula (3), if the energy (resources) is unchanged, the speed of IT project development decreases when problems arise, so additional time Δt is needed to overcome it. If there is such a time reserve – the project results will be obtained in time (the target point of implementation of the information system of development of teachers' methodological competence will be reached in a given time).

This task-setting model will allow successful implementation of the information system for development of teachers' methodological competence as it relates to problem management in IT projects.

Conclusions and prospects for further studies

In order to implement the proposed conceptual model, the paper proposes a software architecture based on the classical service-oriented design pattern "Model-View Separation" (separation of model objects from the graphical interface objects with the user) and provides interaction with the database; the composition of its main packages is detailed.

The structural model of the system for the development of methodological competence of IT teachers, based on the continuity of education, is designed; the structure of microservices subsystems is described. Logical and physical service-oriented models of basic classes of subject matter objects and auxiliary objects (services) are developed.

The structure of relational database based on the use of metadata tables, directories and operational data in the context of relational database management system has been developed. The methods and mechanisms of data protection and replication are proposed and justified taking into account the specifics of the system operation in higher education institution.

The subsystems of WEB-access to information resources of a higher educational institution, which includes a query builder, focused on the user with an initial level of knowledge and skills in the practical use of information technology, are developed.

A model of task-setting for managing technical problems in the information system of development of teachers' methodological competence is proposed, and conceptual foundations for managing these problems from the perspective of considering projects as a set of objects and subjects are developed. It is shown that technical problems in projects are the obstacles to moving in the right direction, created by random events, uncertainties, and changes. A mathematical model of change in the magnitude of resistance caused by technical problems has been developed and methods of confronting these problems have been proposed.

In further research, a method will be developed to assess the effectiveness of the implementation of the information system for the development of teachers' methodological competence based on the method of hierarchical analysis, for which a hierarchical system of criteria will be developed.

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References

1. Ouadoud, M., Rida, N., & Chafiq, T. (2021). Overview of E-learning platforms for teaching and learning. *International Journal of Recent Contributions from Engineering Science & IT (iJES)*, *9*(1), 50-70. https://doi.org/10.3991/ijes.v9i1.21111
2. Colace, F., De Santo, M., & Vento, M. (2003, January). Evaluating on-line learning platforms: a case study. In *36th Annual Hawaii International Conference on System Sciences, 2003. Proceedings of the* (pp. 9-pp). IEEE. https://doi.org/10.1109/HICSS.2003.1174342
3. Fernández-Díaz, E., Rodríguez-Hoyos, C., & Calvo Salvador, A. (2017). The pedagogic architecture of MOOC: A research project on educational courses in Spanish. *International Review of Research in Open and Distributed Learning*, *18*(6), 18-35. https://doi.org/10.19173/irrodl.v18i6.2964
4. Gorbunovs, A., Kapenieks, A., & Kudina, I. (2013). Competence development in a combined assessment and collaborative e-portfolio information system. *Procedia Computer Science*, *26*, 79-100. https://doi.org/10.1016/j.procs.2013.12.009
5. Mahmutova Regina Ramzilovna, & Nuriev Nail' Kashapovich (2018). Proektirovanie IS jekspertizy kachestva onlajn-kursov [Designing an online course quality assessment IS]. *Obrazovatel'nye tehnologii i obshhestvo*, *21* (2), 381-389.
6. Tungpantong, C., Nilsook, P., & Wannapiroon, P. (2021, March). A conceptual framework of factors for information systems success to digital transformation in higher education institutions. In *2021 9th International Conference on Information and Education Technology (ICIET)* (pp. 57-62). IEEE. https://doi.org/10.1109/ICIET51873.2021.9419596
7. Chansanam, W., Tuamsuk, K., Poonpon, K., & Ngootip, T. (2021). Development of online learning platform for Thai university students. *International Journal of Information and Education Technology*, *11*(8), 348-355. https://doi.org/10.18178/ijiet.2021.11.8.1534
8. Almeida, F., & Buzady, Z. (2022). Development of soft skills competencies through the use of FLIGBY. *Technology, Pedagogy and Education*, *31*(4), 417-430. https://doi.org/10.1080/1475939X.2022.2058600
9. Beufse, M., & Hartz, S. (2021). Ein Instrument zur Messung von Lerntransferbedingungen im Kontext der hochschuldidaktischen Weiterbildung [An instrument assessing the conditions of learning transfer in the field of university teachers' didactic training]. *Zeitschrift für Erziehungswissenschaft*, *24*(1), 155-184. https://doi.org/10.1007/s11618-021-00993-x
10. van Bruggen, L., Ten Cate, O., & Chen, H. C. (2020). Developing a novel 4-C framework to enhance participation in faculty development. *Teaching and Learning in Medicine*, *32*(4), 371-379. https://doi.org/10.1080/10401334.2020.1742124
11. Loaiza-Aguirre, M. I., & Andrade-Abarca, P. S. (2021). Análisis de programas de desarrollo profesional del profesorado Universitario [Analysis of university faculty professional development programmes]. *Revista Virtual Universidad Católica Del Norte*, (63), 161–195. https://doi.org/10.35575/rvucn.n63a7.
12. Tomàs-Folch, M., & Duran-Bellonch, M. (2017). Comprendiendo los factores que afectan la transferencia de la formación permanente del profesorado. Propuestas de mejora [Understanding the factors affecting the transfer of in-service teacher education. Proposals for improvement]. *Revista Electrónica Interuniversitaria de Formación del Profesorado*, 20(1), 145–157. https://doi.org/10.6018/reifop/20.1.240591

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VOLUME 12, DECEMBER 2022

13. Otradskaya, T., Gogunskii, V., Antoschuk, S., Kolesnikov, O. (2016). Development of parametric model of prediction and evaluation of the quality level of educational institutions. *EasternEuropean Journal of Enterprise Technologies*, *5*, 3 (83), 12 – 21. https://doi.org/10.15587/1729-4061.2016.80790
14. Adamkó, A. Rapid Web application development and modeling, based on XML and UML technologies. (electronic access) http://icai.ektf.hu/pdf/ICAI2007-vol2-pp163-172.pdf
15. Morozov, V., Kalnichenko, O., & Liubyma, I. (2017, July). Managing projects configuration in development distributed information systems. In *2017 2nd International Conference on Advanced Information and Communication Technologies (AICT)* (pp. 154-157). IEEE. https://doi.org/10.1109/aiact.2017.8020088
16. Ranaei, S., Suominen, A., Porter, A., & Carley, S. (2020). Evaluating technological emergence using text analytics: two case technologies and three approaches. *Scientometrics*, *122*(1), 215-247.
17. Andrashko, Yu., Biloshchytskyi, A., Kuchansky, A., Biloshchytska, S., Lyashchenko, T. A. (2017). Review of methods for evaluating the results of the activities of scientific and pedagogical workers of universities. *Management of Development of Complex Systems*, *29*, 151-159.
18. Kuchansky, A., Biloshchytskyi, A., Andrashko, Yu., Biloshchytska, S., Shabala, Ye., Myronov, O. (2018). Development of adaptive combined models for predicting time series based on similarity identification. *Eastern-European Journal of Enterprise Technologies*, *1/4* (91), 25-28.