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FORMATION OF COGNITIVE AND COMMUNICATION SCENARIOS OF TRANSDISCIPLINARY INTERACTION WITH CONSOLIDATED NETWORK NARRATIVE INFORMATION RESOURCES THROUGH AN ONTOLOGICAL INTERFACE

Andrii Honchar

Abstract*: The article is devoted to the means of providing users with access to a virtual presentation of digital historical, cultural and scientific documentary heritage. A model of an advanced ontological interface is presented, which is considered as a linear operator to expand the list of properties of the set of elements of the ontology of the virtual museum and the formation of new classes of objects displayed in the corresponding states of the 3D panorama. The interaction of the user with the consolidated information resources, which are accessed through an improved ontological interface, is carried out by implementing a cognitive-communicative scenario, which is defined as an ontological excursion route. An infologic model of the ontological excursion route is presented. The algorithm of realization of the method of transdisciplinary consolidation of network information resources and knowledge systems of meaningful reflection of historical and cultural heritage is given. The ontological IT platform of transdisciplinary consolidation of 3D-panoramas with network information resources of historical and cultural heritage content representation is presented. In its environment, the cognitive-communicative scenario of interaction is realized.*

Keywords*: ontology, virtual museum, 3D panorama, taxonomy, narrative.*

ACM Classification Keywords*: I.2 ARTIFICIAL INTELLIGENCE - I.2.4 Knowledge Representation Formalisms and Methods*

Introduction

Global informatisation of education, science and culture is characterized by the rapid activities to transform the accumulated knowledge into digital form: creating electronic archives, libraries, collections, repositories, access to which on the Internet is open to anyone. This trend is characteristic not only of traditional repositories of documentary information, such as libraries and archives but also of museums. In this case, the museum funds cannot be directly transformed into digital form but the descriptions of these funds can be digitized and include complete information about each storage unit, as well as the related information - images, presentations, audio and video data.

Over the last twenty or thirty years, in countries with developed economies, objects of historical and cultural heritage have been intensively digitized and presented in the online environment: archival documents, book collections, museum exhibits, etc. The online access to digitized historical, cultural and scientific documentary heritage started with the creation of the electronic catalogs of the largest collections of archives, libraries, museums, which contained only descriptive information. This information played only the presentation role. The number and variety of projects of national, regional and local level that in theory should ensure the integration of information resources of many heritage objects, led to inconsistency and sometimes contradictions in the way of information presentation, use of description standards for the metadata of the electronic collections, in the formation of the user interface etc.

The process of active use of information resources in the network is characterized by the formation of network-centric transdisciplinary environments in which very large amounts of information circulate, which determines the problem of big data (Big Data) [Dovhyi, 2020; Mayer-Schönberger, 2013; Hariri, 2019]. Transdisciplinarity provides for the interpretation of the whole set of interdisciplinary contextual relations between information resources as knowledge systems, which creates the conditions for the development of cognitive-communicative scenarios of interaction between different topics and formats of thematic network fragments. And the Big Data problem causes

another problem - the consolidation of these cognitive-communicative scenarios.

Consolidated interaction with network information has been actively studied for the last 30 years [Serebryakov, 2014; Kunanets, 2010; Takashima, 2017; Battaglia, 2011; UNESCO, 1978]. Digital formats of information resources, which form the basis of interaction in network environments, determine the problem of their integrated and more consolidated use, and research aimed at solving it is conducted in two directions. Researchers [Serebryakov, 2014; UNESCO, 1978; Kalytych, 2008] define consolidation as a combination of the same type of information based on characteristic attributes. This eliminates the difference between consolidation and integration. The selection of characteristic groups of attributes of information and data is inherent in the integration of databases that characterize the same type of information resources. In fact, this interpretation of consolidation reduces it to the simple use of certain data in the process of solving practical unified problems.

In contrast to this approach, other researchers [Dovhyi, 2020; Kunanets, 2010; Takashima, 2017; Battaglia, 2011] consider consolidation as a certain combination of semantic processes that are realized in the network space. The use of ontological engineering mechanisms is proposed as a construct of consolidation [Dovhyi, 2020; Gomez-Perez, 2004; Palagin, 2016]. The use of the methodology of ontological systems provides a representation of the semantic properties of information resources and realizes the interaction with them and between them.

Analysis of available global and domestic information Internet resources shows inconsistencies in the choice of accounting standards and the creation of metadata for information resources, as well as software that would allow data entry in an open format for further use in full-fledged databases. Domestic archives, libraries and museums, digitizing their funds and providing access to them, still do not make full use of the opportunities and achievements of modern information technology. They still remain each in its own field, while for the modern user the origin of the information does not matter, he wants to get it

here, immediately and efficiently, rather than looking for the necessary information on the scattered sites of various institutions. Therefore, the urgent task is not only to develop and implement holistic unified requirements for the description of digitized objects and their quality (regardless of origin), but also the use of open source software to ensure compatibility and interoperability of data. This will allow the development and implementation of interactive consolidated information resources that will ensure the efficient search for electronic objects in open databases, and thus provide quality information services to users.

An important step towards ensuring free access to the digitized historical, cultural and scientific heritage is the creation of publicly available online resources (web-sites, portals, etc.), which requires the development of common standards and methodological solutions for their use.

Providing users with access to a virtual presentation of digital historical, cultural and scientific documentary heritage requires the development of models and methods of networking for any institutions that use different types of specific metadata, such as technical, conceptual, procedural, administrative and others.

The purpose of the article is to acquaint readers with the formation of cognitive and communication scenarios of transdisciplinary interaction with consolidated network narrative information resources through an ontological interface, which is a great way to get acquainted with the historical, cultural and scientific heritage of world civilization.

Improved Ontological Interface Model

The information environment of the heritage object is a complex space of user interaction with consolidated information resources about processes, facts, events and phenomena of history and culture. It is therefore a means of accumulation, systematization and classification, structuring large amounts of spatially and thematically distributed information, its formalized representation, aggregation and integration with other information sources and knowledge systems designed to analyze existing and generate new knowledge.

The information environment of digital image of the historical and cultural heritage preservation object (DIHCPO) is considered as a symbiosis of visual and meaningful presentation of historical and cultural processes, facts, events and phenomena, which is realized based on the cognitive means of storage, processing, visualization, analysis of information to meet the information needs of users. This environment includes object with the metadata elements of preservation of historical and cultural heritage, services of the cognitive processing and presentation of consolidated information resources that define the types of metadata and define their values and users.

The implementation of the cognitive-communicative scenario is carried out by user interaction with consolidated information resources, which are accessed through a fragment of the 3D-panorama and is a sequence of its actualized states in the process of the achieving the goals in the environment DIHCPO. Therefore, it is necessary to develop tools and methods that will ensure this interaction.

According to [Popova, 2013] ontological interface user interaction with aggregated and integrated distributed information resources is defined as a linear operator mapping the aggregated status of solving problems using active ontologies:

$$I = \langle T, O \rangle . \quad (1)$$

The ontological interface I provides selection from the active ontology O, term field X of which used to solve a problem, a separate ontology O^*, which is formed by many tautologies X^i from selected concepts-objects x_m and x_n:

$$\langle T,O\rangle \xrightarrow{I} \langle T,O^*\rangle, \quad (2)$$

$$\exists X^i \subset O^* \subset O, \forall X^i \subset O^*, \exists (x_m^i, x_n^i) \quad (3)$$

where O^* – an ontology formed by a set of tautologies of concepts X^i, selected from the active ontology O;

$r_{mn}^i = x_m^i \times x_n^i$ – relationship between concepts x_m and x_n, forming tautologies, $x_m^i \in X^i, x_n^i \in X^i$ [Popova, 2014].

The ontological interface represents the aggregate states of the problem-solving process, provided that there is a non-empty subset of the properties of the objects of the ontology aggregation set $R^i \subseteq R, R^i \neq \varnothing$, each property $r_n^i, r_n^i \in R^i$, of which belongs to the objects of only one ontology $r_n^i \in O_1 \wedge r_n^i \notin O_2$.

$$\exists R^i \subset O_1 \subset O \vee \exists R^i \subset O_2 \subset O, \quad (4)$$

However, this model cannot be applied to DIHCPO, as elements of different historical and cultural heritage sites may have the same property (for example, created by the same author or in the same technique, or in the same period of time, etc.).

Suppose the existence of ontologies O_{vm1} and O_{vm2}, whose objects have a common set of properties R, but describe different DIHCPO. Applying the method of inductive search to all values $r, r \in R$ set of properties R, we obtain a set of matching Cartesian products $R = \prod_i^n X_i$ for both ontologies, which leads to the formation of many functions $F = X \times R$, set over objects as O_{vm1}, so and O_{vm2}. Thus, the elements of the ontology O_{vm1} and O_{vm2} coincide in certain properties. So, the ontological interface as a linear operator ensures that at least one new property is assigned to ontology objects, ie extends the list of properties by at least one.

According to (1), the ontological interface of the DIHCPO information model represents a set of elements of the heritage object, arranged in a certain way according to their properties. Given the assumption of the existence of a subset of the properties of the elements O_{vm1} and O_{vm2}, we assume that there is a subset of properties that does not belong to any element of the two DIHCPO. Then the ontological interface should form a set of Cartesian products with a new set of objects $I_{vm} \Rightarrow \prod_i^n X'$, resulting in undefined elements of the DOICH ontology O_{vm}, reflected in the states of the 3D panorama, forming a new element with a new property. Thus, the use of an ontological interface I_{vm} leads to an expansion of the list of properties of the set of elements of the ontology O_{vm} and the creation of new classes of objects (expositions, exhibitions, halls, etc.), which are displayed in the appropriate states of the 3D panorama.

In the visual representation of the element of the ontological interface of DIHCPO (in this case a virtual museum) I_{vm}, with which the user interacts in the process of implementing a cognitive-communicative scenario, there is a fragment of 3D-panorama with an integrated "unified window" of access to digital narratives of descriptions of this exhibit – consolidated semantically related contexts of physically and thematically distributed information resources created in different formats, according to different standards and technologies, in a unified system-organized museum space. This allows us to present narrative discourse through a cognitive-communicative act, which

simultaneously implements based on the intertextual connections the consolidated use of selected information resources and their interpretation as reflection and representation.

The cognitive-communicative scenario of interaction with the 3D-panorama of the virtual museum, consolidated with the network information resources of the historical and cultural heritage content representation, is represented by a tuple

$$O_{3D} = \langle O_{vm}, I_{vm} \rangle \quad (5)$$

where O_{vm} – ontological model of a virtual museum, in the environment of which research activities are carried out;

I_{vm} – a procession of states of 3D-panoramas of a virtual museum, which are updated during the implementation of the cognitive-communicative scenario in order to achieve research goals

$$I_{vm} = \langle I^0, I^1, ...I^i, ..., I^n \rangle \quad (6)$$

Thus, the ontological interface model is improved I_{vm} and is a means of forming a cognitive-communicative scenario of user interaction with consolidated DIHCPO, reflecting digital narratives of descriptions of exhibits in a single system-organized museum space.

Formation of a Cognitive-Communicative Scenario in the Form of an Ontological Excursion Route

The process of user interaction with several predefined virtual objects of historical and cultural heritage, realized by forming a cognitive-communicative scenario, will be defined as an ontological excursion route. The infographic model of the ontological excursion route can be formally represented by a tuple:

$$O_{route} = \{X, R, F, D_o, D_{GIS}\}, \quad (7)$$

where X, R, F – finite sets, respectively:

X – set of historical and cultural heritage sites included in the route $X = \{X_M, X_L, X_A, ..., X_{obj}\}$,

where X_M – set of museums, $(x_{M_1}, ..., x_{M_n}) \in X_M \mid X_M \subset X$;

X_L – set of libraries, $(x_{L_1}, ..., x_{L_n}) \in X_L \mid X_L \subset X$;

X_A – set of archives, $(x_{A_1}, ..., x_{A_n}) \in X_A \mid X_A \subset X$;

X_{obj} – set of other sights (monuments, historical complexes, architectural ensembles, etc.), $(x_{obj}, ..., x_{obj}) \in X_{obj} \mid X_{obj} \subset X$;

R – set of relations between the objects of preservation of historical and cultural heritage, which determine the direction and sequence of inclusion in the route $R = \{R_M, R_L, R_A, ..., R_{obj}\}$;

F – set of interpretation functions X and/or R;

D_o – set of ontological descriptions of the steps from which the route is formed;

D_{GIS} – set of descriptions of actions performed in the GIS environment to synchronize the display of the ontological tour route.

The basis of the ontology of the excursion route is a taxonomy represented by a set of bipartite graphs $G=(N,E)$, the vertices of which are the names of objects of preservation of historical and cultural heritage N, $(N_{obj_1},...,N_{obj_n}) \in N_{obj} \mid N_{obj} \subset N$, grouped into classes (according to the type of heritage object - museum, library, archive, etc.), and arcs - the semantic relationship between them E, based on which objects are grouped into classes according to their properties

$$(G_M,G_L,G_A,...,G_{obj}) \in G_{route} \tag{8}$$

Since in real life the tour route is not homogeneous, ie one that includes heritage sites of only one type (for example, only museums, or only monuments), there is a dynamic redistribution of objects during the tour, which can lead to the formation of new classes of taxonomic objects:

$$G_M \cup G_L = G(N,E) \mid N_M \subseteq N, N_L \subseteq N; E_M \subseteq E, E_L \subseteq E \tag{9}$$

$$N_M \cap N_L = \{N \mid N \in N_M, N \in N_L\} \tag{10}$$

The process of forming a tour route in the environment of taxonomy is reduced to solving the travelling salesman problem on the graph, and then displayed in the environment of GIS.

Method of Transdisciplinary Consolidation of Network Information Resources and Knowledge Systems of Meaningful Reflection of Historical and Cultural Heritage

Cognitive-communicative scenario of interaction of users of 3D-panoramas with network information resources of the historical and cultural heritage content representation through the improved ontological interface (Fig. 1) requires the

development of a method of transdisciplinary consolidation, which would implement the process of forming a single system-organized museum space.

The method of transdisciplinary consolidation includes several stages (Fig. 2).

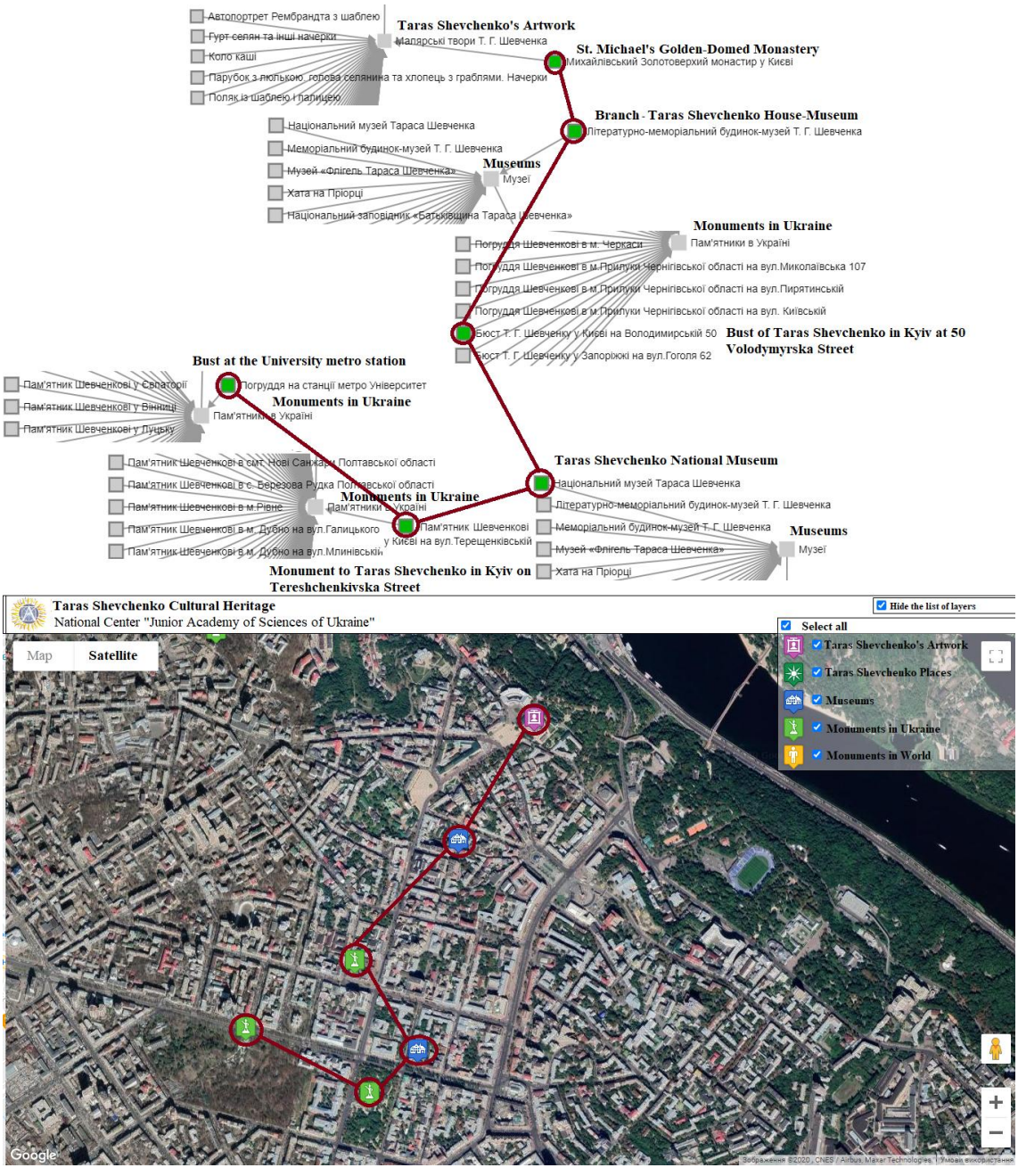

Fig. 1. Implementation of the cognitive-communicative scenario in the form of an ontological excursion route

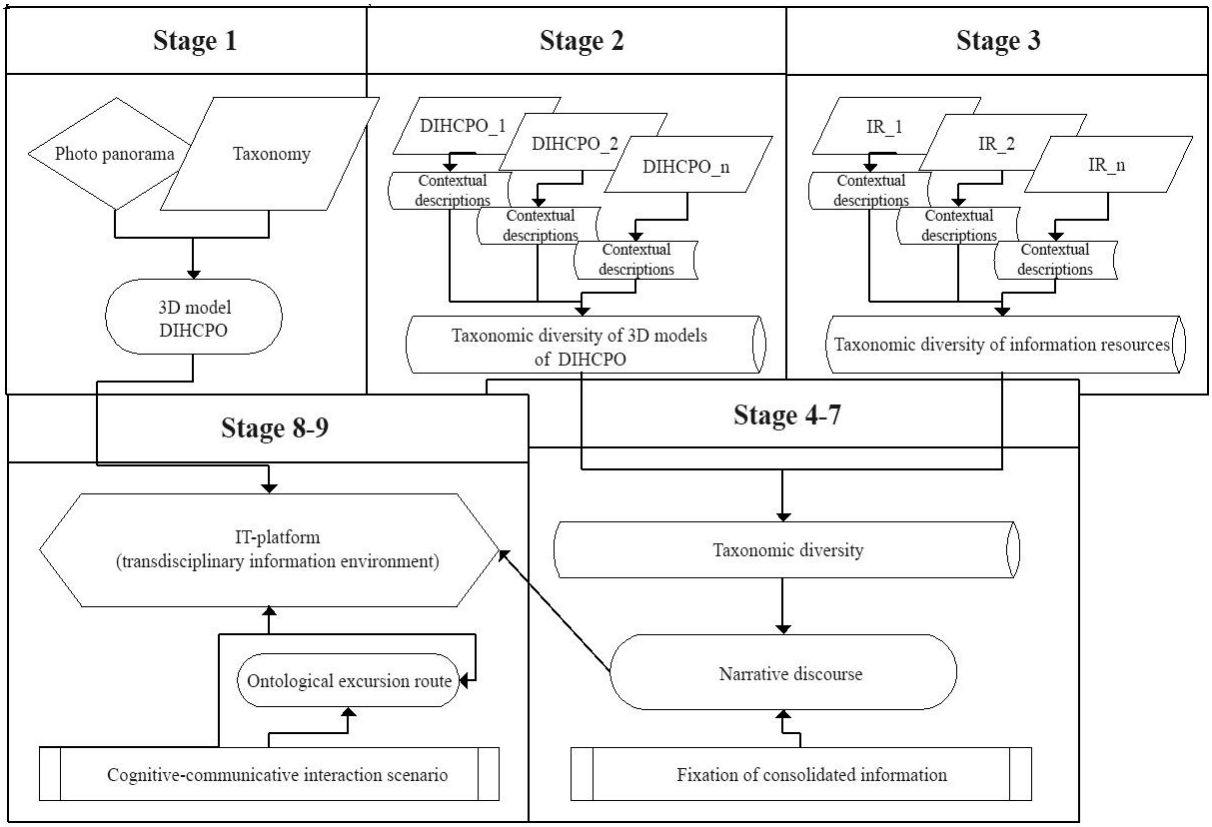

Fig. 2. Method of transdisciplinary consolidation of network information resources and knowledge systems of meaningful reflection of historical and cultural heritage

1. Creation of the 3D-models of heritage objects with photo panoramas and corresponding taxonomies of their structural representation.

The presentation of the object of preservation of historical and cultural heritage begins, first of all, with its visualization with the subsequent construction of a three-dimensional model. This process consists of photographing the object, processing and arranging images, creating final files, after which equiangular projections to form a continuous seamless panoramic image are created, and then stitching a series of original photos: bringing them to a form suitable for stitching (cylindrical or spherical projection); the process of stitching itself (combination of identical elements in adjacent common areas of images);

mixing images to equalize their brightness, contrast and color tone. The last stage of 3D-modeling of the object of preservation of historical and cultural heritage is the combination of a series of ready-made 3D-panoramas in so-called virtual tours or walks, where the transition from one panorama to another is through active zones placed directly on images as navigation elements and/or floor plan.

In parallel with the process of visualization of three-dimensional DIHCPOs, taxonomies of structural representation of their content are created. At this stage, from the narratives of nature-language descriptions of the meaningful reflection of historical and cultural heritage by means of semantic-linguistic analysis of texts the concepts that feature the elements of heritage preservation (exhibits, artifacts, documents, etc.) and are based on common properties are derived. The knowledge presented in the taxonomy acts both as a structure and as a meaningful content of the information model of the object of heritage preservation.

To record the acquired knowledge, it is necessary to determine the appropriate formalism that provides their visual and convenient presentation, as well as methods that allow this formalization. Such a formalism is a combination of algebraic-logical and axiomatic methods.

2. Formation of taxonomic diversity from contextual descriptions of DIHCPO.

Since the three-dimensional model of the heritage object may consist of several 3D panoramas, each of which visualizes the elements represented by a particular taxonomy, their totality forms a variety, i.e. a certain hyper-set of taxonomies, each of which in the formation of ontology DIHCPO is characterized by the inclusion of certain sets of axioms which differ from each other. These axioms are defined on the basis of the interpretation of the meanings of contexts, which in turn define the concepts of taxonomy and later ontology. Since we define the contexts of taxonomic nodes as elements of

certain knowledge, then their totality reflects the knowledge of the object of preservation of historical and cultural heritage, which is a holistic system of knowledge about the processes, facts, events and phenomena of history and culture.

3. Establishing intertextual relationships between taxonomies of 3D panoramas and the taxonomic diversity of relevant information resources.

Consolidation of distributed network information resources of meaningful reflection of historical and cultural heritage is realized on the basis of inter-contextual relations established between the concepts of their taxonomies, which, in turn, form a taxonomic diversity. That is, the consolidation of information resources is a verbal-active function that implements the interpretation of many binary relationships between all contexts, which reflect the meanings of concepts that form the content of subject areas whose information resources are involved in network interoperation.

Thus, the contexts of the concepts of the thematically defined set of distributed network information resources of meaningful reflection of the historical and cultural heritage are consolidated in the form of the novel taxonomic diversity.

4. Encapsulation of interactive taxonomies of the 3D panoramas in the taxonomic diversity of information resources.

Taxonomic diversity of consolidated taxonomies of the 3D panoramas with taxonomic diversity of thematically defined information resources of meaningful reflection of historical and cultural heritage forms a knowledge base that combines narratives of descriptions of processes, facts, events and phenomena of history and culture. Therefore, in the environment of such a knowledge base, the encapsulation of interactive taxonomies of 3D panoramas into the taxonomic diversity of information resources is realized by establishing

intertextual connections between the contexts of the concepts of taxonomies of DIHCPO and taxonomies of information resources.

5. Encapsulation of taxonomies reflecting thematically defined network information resources to taxonomic diversity.

Similarly to the previous stage, the encapsulation of taxonomies that reflect thematically defined network information resources to the novel taxonomic diversity, formed by consolidating the contexts of the concepts of taxonomies of DIHCPO and taxonomies of information resources, is implemented.

6. Generation of the format of narrative discourse on the basis of the formed novel taxonomic diversity.

Verbal-active reflection, on the basis of which taxonomic diversity is realized, is a narrative discourse that determines the inter-contextual coherence of the concepts of taxonomies of DIHCPO and thematically defined network information resources of meaningful reflection of historical and cultural heritage. Thus, the discourse is represented through a cognitive-communicative act that simultaneously implements the consolidated use of narratives describing taxonomic diversity and their interpretation in the form of visualization in the 3D panoramas. Thus, the cognitive-communicative scenario of interaction with the consolidated network information resources of meaningful reflection of historical and cultural heritage is realized by the means of taxonomic diversity and the format of narrative discourse.

7. Fixation of consolidated information based on integrated taxonomic diversity.

New knowledge about the processes, facts, events and phenomena of history and culture generated during the implementation of the cognitive-communicative scenario of interaction with consolidated network information resources of meaningful reflection of historical and cultural heritage can be

recorded in the context of taxonomic diversity concepts and included in narrative discourse format.

8. Formation of a transdisciplinary information environment in the format of narrative discourse based on the implementation of a cognitive-communicative scenario of interaction with consolidated network information resources of meaningful reflection of historical and cultural heritage.

Since the use of consolidated network information resources and knowledge systems of meaningful reflection of historical and cultural heritage during the implementation of cognitive-communicative scenario of interaction is considered in the format of system-integrated various information resources, which together are endowed with completeness, integrity, consistency and subject areas, and the format of narrative discourse in some way implements their systemological organization, it allows to form a single transdisciplinary information space DIHCPO.

9. Synchronization of an ontological 3D-model with functions of network service, in particular geo-information environment, with the purpose of the ontological excursion route formation.

The nodes of the concepts of taxonomic diversity of DIHCPO, grouped into classes based on the certain properties, correspond to the geographical objects in the environment of the geographic information system, which belong to the thematic layers of the map. In this case, the names of the concepts are identical to the corresponding names of geographical objects, and the names of the classes are identical to the names of the thematic layers. Actually, the taxonomy (or its fragment) can serve as a legend of the map. Thus, the elements of the knowledge base of the ontological 3D-model DIHCPO are visualized in space due to the functionality of the consolidated network service, in this case - geo-information. In the process of realization of the cognitive-communicative scenario of interaction with the consolidated DIHCPO the

taxonomy of the ontological excursion route is visualized in the environment of geographic information system, and access to network information resources is carried out through a fragment of a 3D-panorama of a three-dimensional model of a heritage object. In the case of regeneration of the ontological route due to the update of taxonomic diversity, the concepts of taxonomy of the ontological 3D-model DIHCPO are synchronized with the map objects in the GIS environment.

Ontological IT platform for transdisciplinary consolidation of 3D-panoramas with network information resources for meaningful reflection of historical and cultural heritage

On the basis of the offered models and the method the cognitive-communicative scenarios of interaction with the consolidated DIHCPO (fig. 3) in the environment of the ontological IT platform of display of virtual museum expositions "Museum Portal" are implemented. Its elements are:

- Three-dimensional models of historical and cultural heritage sites, including virtual tours of 3D panoramas of DIHCPO.
- Taxonomies and taxonomic diversity of narrative descriptions of elements of historical and cultural heritage preservation sites with consolidated thematically defined network information resources in the format of narrative discourse.
- Cognitive-communicative scenario of interaction with consolidated DIHCPO and network information resources of meaningful reflection of historical and cultural heritage through an improved ontological interface.
- Consolidated network services of analysis of information resources (their indexing, categorization and selection of the most relevant user queries), the formation of cognitive-communicative scenario and visualization of its stages in the form of interface elements and objects in the GIS environment.

The ontological IT platform for displaying virtual museum expositions "Museum Portal" provides increased efficiency of research tasks during the

implementation of cognitive-communicative scenario of interaction with network information resources of historical and cultural heritage content representation by consolidating them and using analytical capabilities of consolidated network services, in particular geographic information systems of various levels and purposes, in a single transdisciplinary multifunctional ontological-controlled system.

Consolidation of network information resources of meaningful reflection of historical and cultural heritage ensures the efficiency of the user's relationship with the source of information, adaptation of its presentation to the speed of its assimilation by the user, taking into account the thematic profile and individual characteristics of the latter. In particular, the thematic certainty of consolidated information resources ensures the minimization of information noise, appropriate dosing of information and its usefulness, accessibility (clarity) of its presentation, which significantly increases the efficiency of information use. The speed and quality of solving research problems during the implementation of the cognitive-communicative scenario of interaction in the environment of the ontological IT platform for displaying virtual museum expositions "Museum Portal" increases by presenting not only information that directly describes the objects of historical and cultural heritage, but also narratives descriptions of processes, facts, events and phenomena from other fields of knowledge.

The use of the ontological IT platform for displaying virtual museum expositions "Museum Portal" in the process of implementing cognitive-communicative scenarios of interaction with consolidated DIHCPO allows to significantly expand the image of world civilization, interdisciplinary links between history and culture, science and technology, science and modern technologies by generating new knowledge by means of consolidated network information resources and services of multi-criteria analysis and search of semantically connected information arrays, and visualization of their results, in particular in GIS. This combination allows creating a single transdisciplinary environment for user interaction with consolidated network information resources of meaningful reflection of historical and cultural heritage, which provides automatic encapsulation of the latest DIHCPO.

The ontological IT platform for displaying virtual museum expositions "Museum Portal" provides support for interaction with consolidated network information resources in the process of acquaintance, study and research of historical and cultural events, facts and phenomena in the format of a single scientific and educational environment "Museum Planet" provides:

- consolidation of distributed narrative descriptions of objects of preservation of historical and cultural heritage and their presentation in a single environment of the "Museum Portal", which reduces the search time and increases the efficiency of information use;
- seamless integration of information systems of objects of preservation of historical-cultural and documentary heritage (electronic libraries, archives, descriptions of museum funds, thematic web-portals, etc.) for the purpose of creation of the uniform environment of research activity;
- ontological management of information arrays, the narratives of which form a single information space - an IT platform for displaying virtual museum expositions "Museum Portal";
- localization of objects of historical and cultural heritage in the environment of geographic information system for formation of ontological virtual routes of excursions;
- visualization of DIHCPO by means of the improved ontological interface for realization of cognitive-communicative scenarios of interaction with 3D-panoramas of the museum expositions consolidated with network information resources.

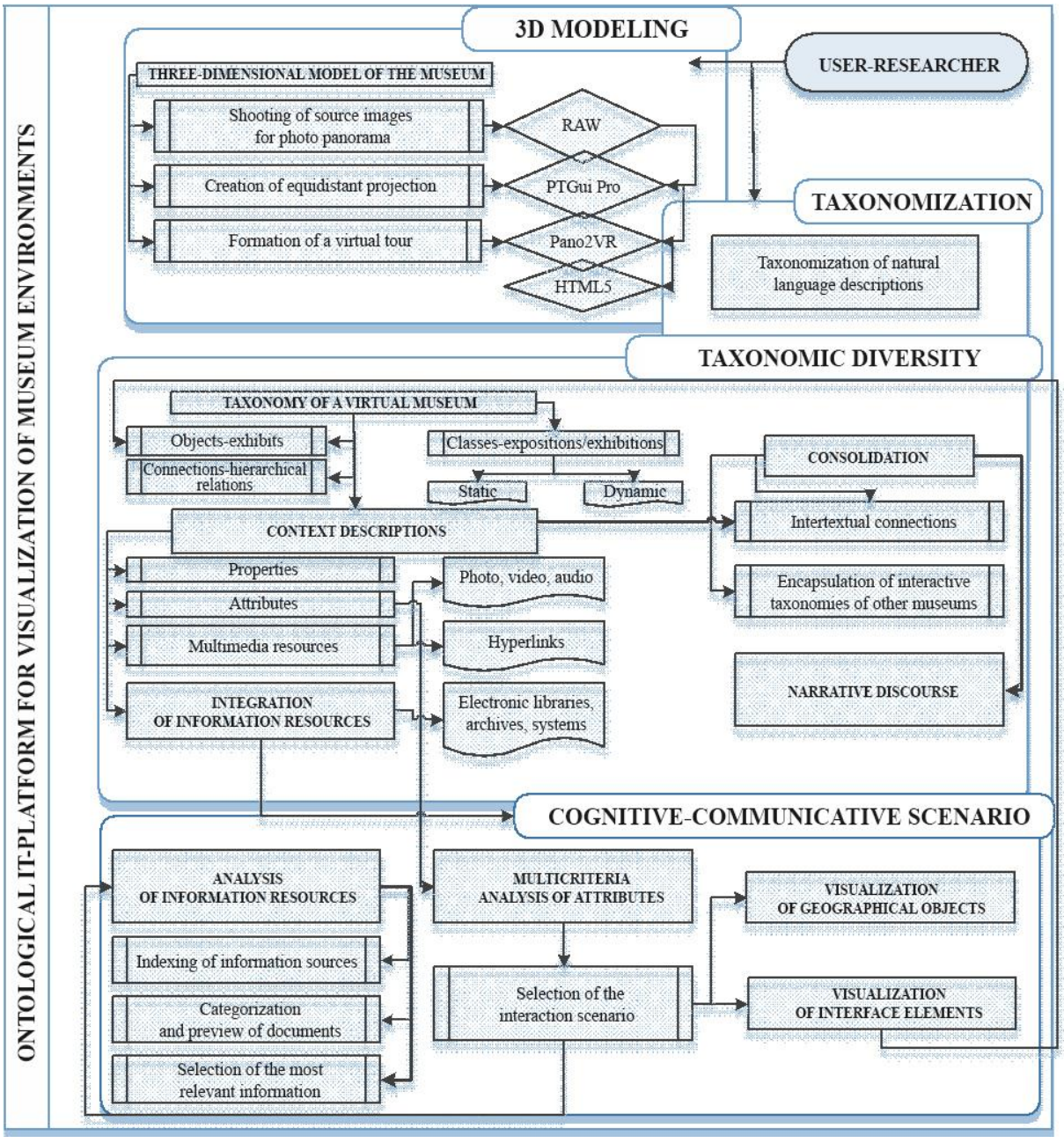

Fig. 3 The generalized scheme of the cognitive-communicative scenario of interaction with the consolidated DIHCPO

Conclusion

Improved model of ontological interface as a means of forming a cognitive-communicative scenario of interaction with consolidated digital images of historical and cultural heritage, which reflect digital narratives of descriptions of exhibits, which, unlike existing ones, provides a single system-organized information museum space.

A method of transdisciplinary consolidation of network information resources and knowledge systems of meaningful reflection of historical and cultural heritage in the environment of virtual museum expositions has been developed, which, in contrast to the existing ones, implements the process of forming a single systemologically organized museum space.

An ontological IT platform for transdisciplinary consolidation of 3D-panoramas with network information resources of the historical and cultural heritage content representation "Museum Portal" has been developed to support user interaction in the study of historical and cultural events, facts and phenomena in a single scientific and educational environment "Museum Planet", which, in contrast to the existing ones, implements automatic encapsulation of the latest digital museum images.

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Major Fields of Scientific Research: 3D Visualization Technologies, VR, DB Integration

MATURITY REQUIREMENTS MODEL FOR SOFTWARE REQUIREMENTS WITH THE IMPLEMENTATION OF ISO/IEC 25010 RECOMMENDATIONS

Vasyl Yatsyshyn, Oleksandr Kharchenko, Andriy Lutskiv

Abstract*: The article is devoted to the construction and formalization of the model of requirement maturity based on Requirements Maturity Model (RMM). The RMM model has been modified by implementing the recommendations of the ISO/IEC 25010 standard, which allows to reduce the threshold of transition of companies from a lower level of maturity to a higher level at the stage of requirements development and analysis, as well as to ensure efficiency of requirements management process. Formalized representation of the modified model of maturity in the form of terms of set theory allows to automate the processes of communication of quality requirements at the stages of software development, and the means of automating the collection of requirements - to increase the criterion of completeness of requirements.*

Key words: *model, maturity, quality, software, requirements*

Introduction

Modern software engineering technologies make it possible to implement systems with a high degree of functional integration, ease of use by end users, performance and reliability. Ensuring such properties of the software requires the introduction of both formal methods of displaying the objects of the subject environment, and technological and instrumental means of supporting life cycle processes. The final quality of the developed software product directly depends on the maturity of the software engineering processes used by a particular developer. Therefore, determining the level of maturity of processes and

product at the stages of the life cycle is an important and urgent task in the field of software engineering. Solving this problem involves substantiation or construction of models of maturity, in particular at the stage of definition and analysis of requirements, formalization of criteria for quality management and monitoring at the stages of the life cycle, creating procedures for their implementation in real projects.

Analysis of the current state of research

The maturity of software engineering processes is directly or indirectly studied by the scientific community of Ukraine [1-4] and foreign scientists [5-8]. As a result of such studies, models CMM [9], RMM [10], SMMM [11] and a number of others have been built, which determine the appropriate levels of process excellence and completeness of software development stages. These models allow to describe and evaluate a set of measures and resources of each stage of software implementation, to determine the level of maturity of the processes of a particular developer, which can be used by customers as a basis for decision-making when choosing a company.

One of the approaches that allows to significantly improve both the quality of software development processes and the quality of the final product is the implementation of the recommendations of the standards at the stages of the life cycle. In this context, it is advisable to apply the standards of the ISO / IEC 25000 series (ISO / IEC 25010, ISO / IEC 25030, etc.), but their effective implementation is hampered by factors such as imperfect formalized presentation of processes and quality assurance criteria, lack of strictly defined and standardized management procedures , monitoring and tracing requirements at the stages of the life cycle. As a result, it is almost impossible to achieve high maturity of process implementation and maturity of the software product itself. This study proposes the formalization of the requirements maturity model [10] with the integration of quality models of the standard [12], as well as a software module to collect software needs, which together will reduce the entry threshold for the development team and increase process maturity and performance at the analysis stage requirements.

Construction and formalization of the model of maturity of software requirements

The requirements maturity model (RMM) is given in [10] and consists of six levels, the structure and description of which are shown in Fig. 1.

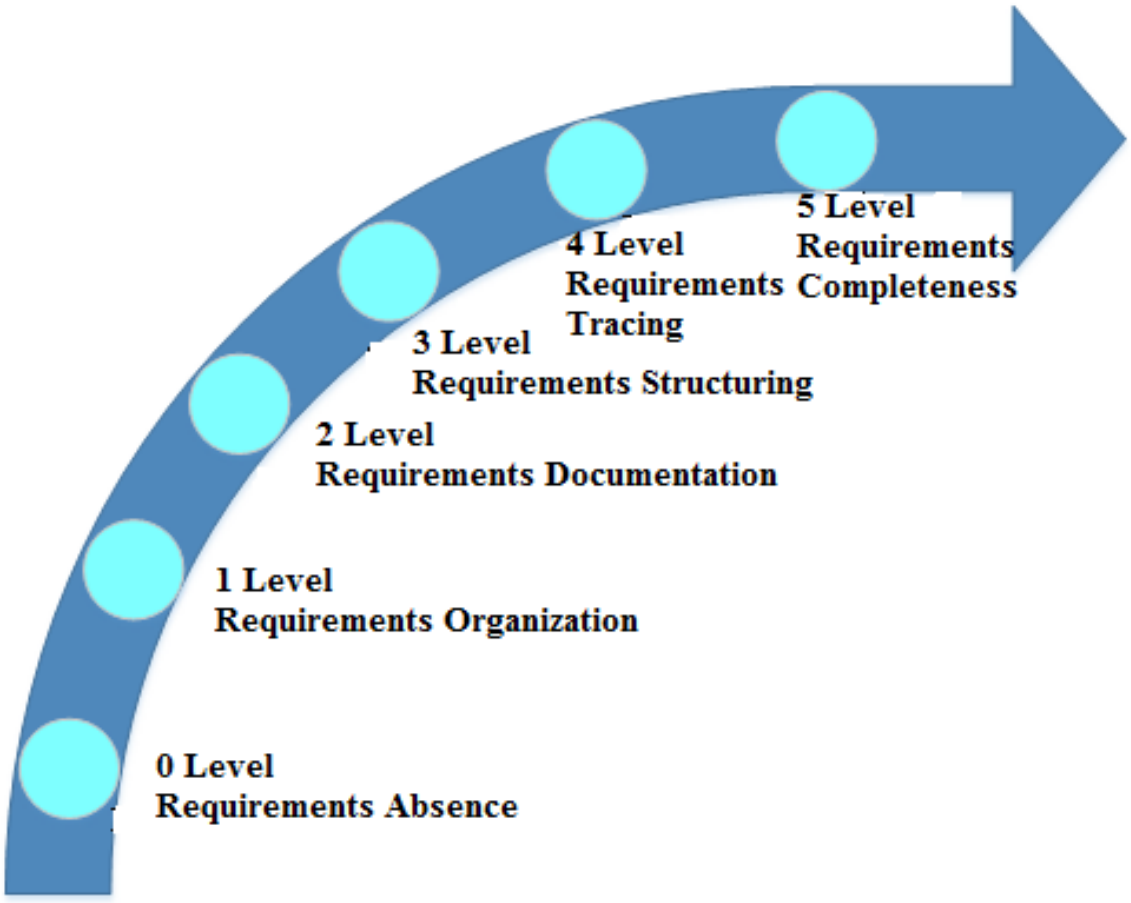

Fig.1. Requirements Maturity Model (RMM)

The software quality management process based on the RMM maturity model will allow developers to improve their process to meet the requirements step by step. At the same time, the improvement of the quality management process of requirements occurs at each subsequent step. In accordance with the concept

of continuous quality improvement, presented in Fig. 1, after the transition to the next stage, developers must put into practice all relevant to the process of action.

Having conducted a detailed description of each level of the maturity model (Requirements Maturity Model) and the corresponding processes, we formalize the presentation of the maturity model of software requirements in the implementation of software in terms of set theory. In the general case, the model of maturity can be represented as:

$$RMM = \{L_N, \{L_{N-1}\{L_{N-2}\{\dots\{L_0\}\dots\}\}\}\} \quad (1)$$

where *L* is a level of the requirements model maturity,

N is a number of levels of the maturity model.

According to the reasonable model, the number of maturity levels is 6.

L_0 is a zero level of requirements maturity, which implies their absence in terms of chaos and the presence of only part of the customer's needs. There are no software requirements at this level.

To meet the needs of the customer or users of the computer system at this level, it is proposed to automate the collection process by connecting data sources such as Skype, E-mail, and other documents that describe the need to implement software. This will allow storing in a single database information about the needs of users in the software and thus allow you to quickly move to the second level of the model of maturity requirements.

Formally, the first level of the model of maturity of requirements can be represented as:

$$L_1 = \{Doc_i, ExpMark_i, \{L_0\}\}, i = 1..T \quad (2)$$

where *Doc* is a set of documents describing the software requirements,

ExpMark is the expert scores of documents,

T is a number of documents describing the requirements at the first level of the maturity model.

Software needs, in general and according to [13], can be represented as:

$$R_c = \{P_i, C_{ik}\}\ i = 1..I, K = 1..M_i \quad (2)$$

where P_i are user needs;

C_{ik} are constraints of needs;

I is a number of customer needs;

K is a number of constraints of needs.

The second level of the software requirements maturity model of computer systems is focused on refining software requirements by applying different methods and creating an appropriate database of requirements. It can be formally represented as follows:

$$L_2 = \left\{R_i^c, MClar_{ij}, RClass_{ik}, RVer_{im}, \{L_1\{L_0\}\}\right\} \quad (3)$$

where R_i^c are customer requirements for software, *i=1..B, B* is a number of requirements at the second level of the maturity model;

$MClar_{ij}$ are methods of clarification of requirements (brainstorming, questionnaires, clarifications, collective inspection, etc.), *j=1..S, S* is a number of methods for clarifying the requirements;

$RClass_{ik}$ are classes to which the requirements belong R_i, *k=1..K*, *K* is a number of classes of software requirements;

$RVer_{im}$ are versions of the software requirements to control changes to it, *m=1..M*, *M* is a number of versions of the requirement.

To classify the requirements, it is proposed to use two classes: functional and non-functional requirements:

$$RClass = \{Func, NonFunc\} \quad (3)$$

where *Func* is a class of functional requirements that can be represented in the form of templates;

NonFunc is a class of non-functional software requirements at the second level of the maturity model.

The third level of the model of maturity of software requirements can be represented as a set, the elements of which are:

- attributes of requirements;
- requirements templates;
- requirements models;
- checklists;
- recommendations.

Formally, the third level of the maturity model can be represented as follows:

$$L_3 = \left\{R_i^{use}, Pattern_{ij}, RModel_{ik}, RList_{im},, Recom_{im}\{L_2\{L_1\{L_0\}\}\}\right\} \quad (4)$$

where R_i^{use} are customer requirements in the form of a quality model in use, *i=1..G*, *G* is a number of quality requirements in use;

$Pattern_{ij}$ are patterns for describing the software requirements for computer systems, *j=1..Q*, *Q* is a number of patterns;

$RModel_{ik}$ are models for requirements describing, *k=1..P, P* is a number of requirements models;

$RList_{im}$ are checklists to check the requirements, *m=1..M, M* is a number of checklists;

$Recom_{im}$ are recommendations for improving the requirements, *h* is a number of recommendations.

Requirements model R^{use} of the business system user is proposed in [13]. It looks like:

$$R^{use} = \{H_i^u, A_{ik}^u, C_{ik}^u, M_{ik}^u\}, i \in N_u^k, K = 1..S_i \quad (5)$$

Representation of quality requirements in use in the form of model (5) ensures their formalization in standardized, unified terms. This, in turn, allows to adequately and fully reflect the needs of business system users, to avoid vague

interpretations and "substitution of concepts", as well as greatly simplify the development of automation tools focused on supporting the technological processes of the early stages of LF. Based on the model (5), it is convenient to present the user requirements for the aircraft and then effectively manage the quality requirements, to ensure their variability, because they are structured.

At the fourth level of the maturity model, hierarchies of requirements are built, dependencies are established between them, standard solutions are determined, and so on.

For the formal presentation of the fourth level of the maturity model, it is proposed to use the external quality model of the ISO / IEC 9126 standard.

Formally, the fourth level of the maturity model of requirements is presented as follows

$$L_4 = \{R_i^{ext}, \{L_3\{L_2\{L_1\{L_0\}\}\}\}\} \quad (6)$$

R_i^{ext} are requirements in the form of a model of external quality in [13] are presented as follows:

$$R^{ext} = \{H_i^x, S_i^x, A_{ik}^x, C_{ik}^x, M_{ik}^x\}, i \in N_x \ , K = 1..F_i^x \quad (7)$$

Formalized presentation of external quality requirements allows to unambiguously and fully reflect the quality requirements in use, which meet the needs of the user and the customer of the aircraft. In addition, the formalization of requirements at the stage of their development ensures the accuracy and

simplicity of further development of the project, in particular, it concerns the selection and construction of the future architecture of the aircraft. Therefore, the implementation of the proposed formalization of the model of external quality of the aircraft is quite relevant because it simplifies and automates this process, as well as scientifically justify the feasibility and practicality of the application of standards [13].

The fifth level of the requirements maturity model is characterized by the processes of tracing requirements for design and testing components, prioritizing requirements, quantifying labor cost requirements, and implementing requirements management tools and integrating with computer systems software development tools. Formally, the fifth level of the maturity model can be represented:

$$L_5 = \left\{R_i^{in}, \{L_4\{L_3\{L_2\{L_1\{L_0\}\}\}\}\}\right\} \quad (8)$$

Internal quality requirements R_i^{in} are used to determine the properties of intermediate states of the product. You can use static and dynamic models, technical documentation and code. Internal quality requirements can be used to determine the strategy for further development and can serve as criteria for evaluating and verifying the development process.

Formalized presentation of internal quality requirements R^{in} according to [13] has the form:

$$R^{in} = \left\{H_i^x, S_i^x, A_{ik}^y, C_{ik}^y, M_{ik}^y\right\}, i \in N_x \ , K = 1..F_i^y \quad (9)$$

Graphically, the model of maturity of requirements with the appropriate levels and processes is shown in Fig. 2.

Thus, a model of software requirements maturity is formalized, which will allow more effective implementation of requirements management and ensure their quality at a low entry threshold for the development team and the organization as a whole

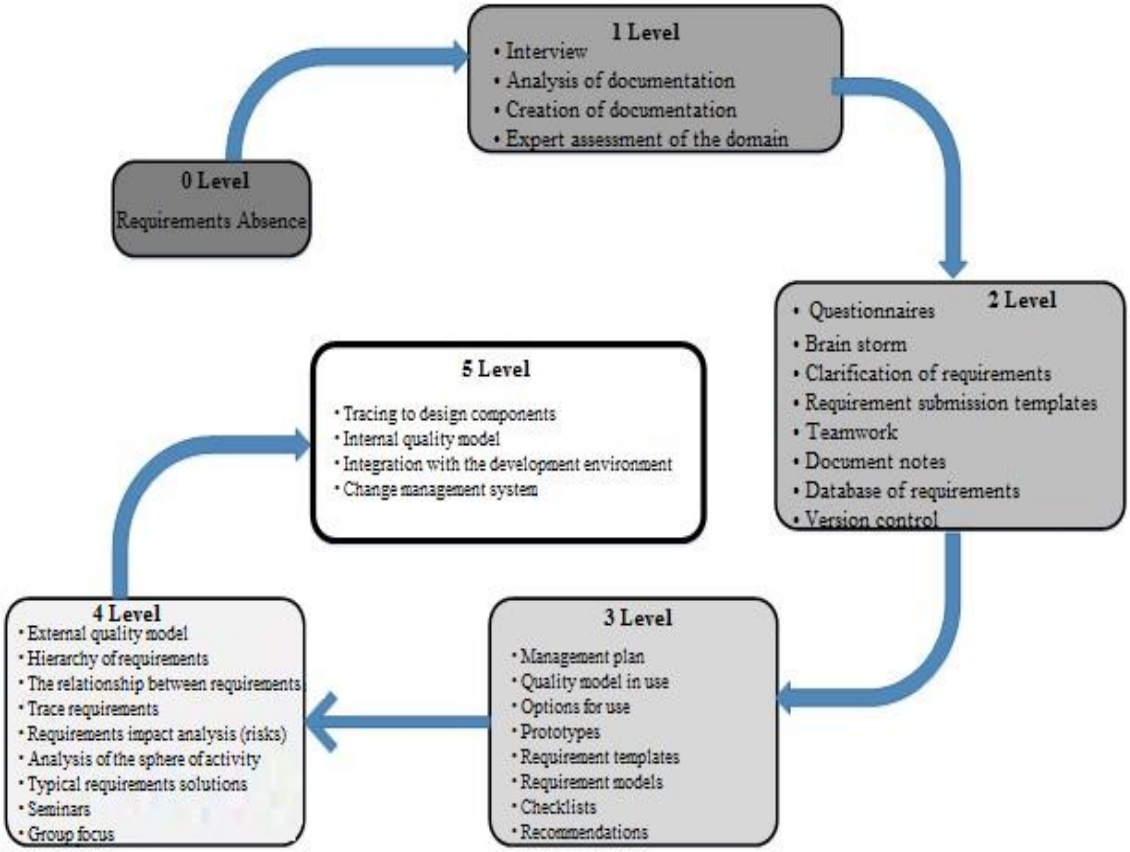

Fig. 2. RMM maturity model with implemented quality models of ISO / IEC 25010 standard

Automation of the process of requirements gathering at the second level of the maturity model

The most time-consuming process at the stage of determining and analyzing the requirements is their collection and structuring, which corresponds to the second level of the maturity model. Automation of this process is proposed to be implemented by creating and implementing an additional module to the quality management system [14].

The module for collecting software requirements and further integration with a sound CASE tool has been proposed to be developed on the basis of the Onlizer platform [16].

In order to start working with the Onlizer platform, it is needed to register on the website http://portal.onlizer.com/, and then log into personal account using the login form. If the authorization is successful, the main page of the system will be opened (Fig. 3), where it is possible to see the existing Applications, as well as the Workflows of this Application and their status.

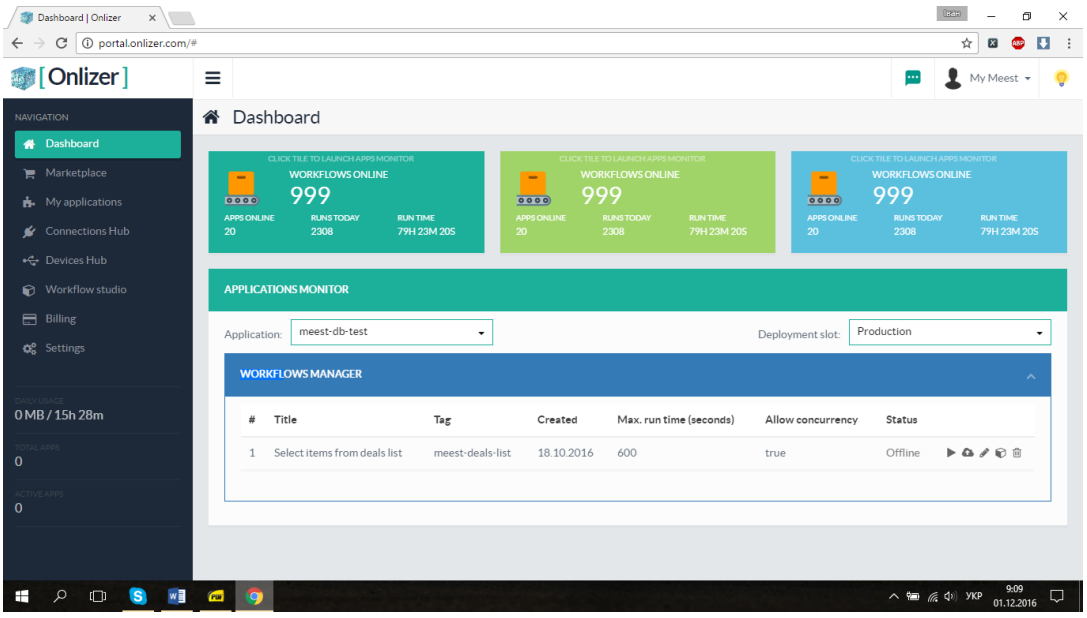

Fig. 3. Home page of the Onlizer system

Consider working with the Onlizer system on the example of a workflow that will collect requests from different messengers (Fig. 4).

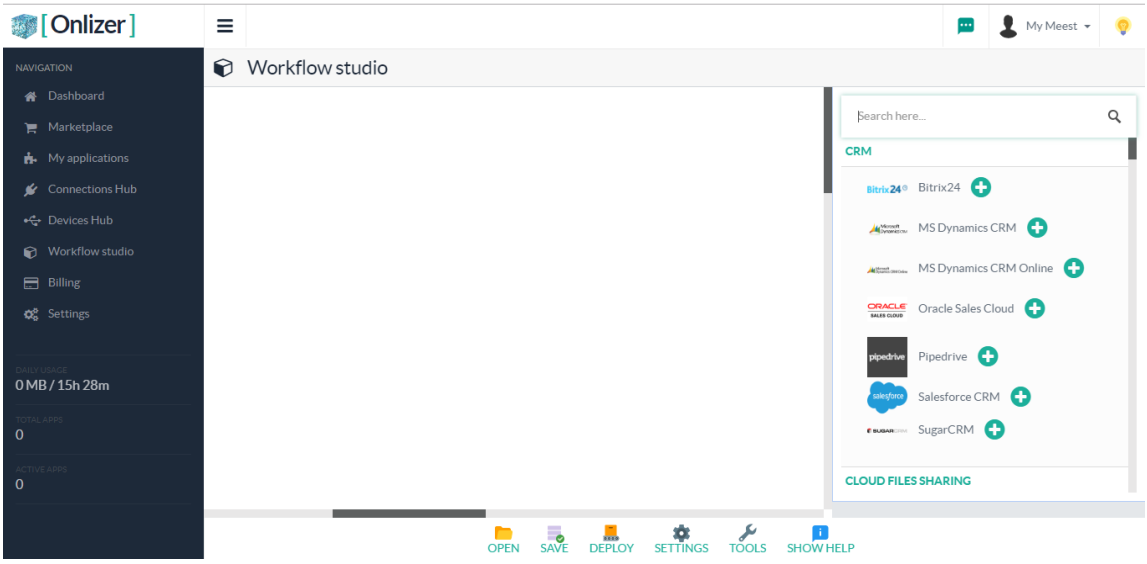

Fig. 4. Appearance of Workflow studio

To start, it is needed to create an application and workflow in the Workflow studio. Then on the right panel you need to select the connectors: HTTP Endpoint, Skype, Viber, Telegram and Slack, as well as the connector for storing information (user needs) in the MS SQL Server database.

The next step is to move the connectors to the work area, where they are configured (Fig. 5).

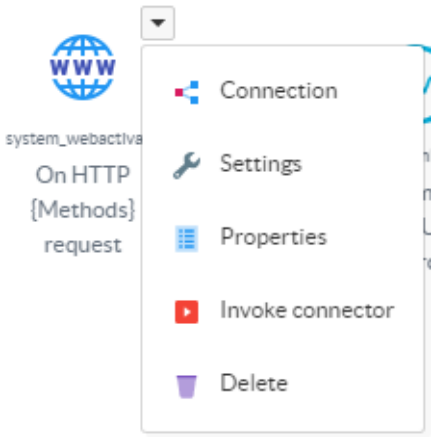

Fig. 5. Context menu of the connector

By adjusting the parameters of the connectors and the connections between them, it is obtained a workflow (Fig. 6), which provides a collection of requirements from certain potential sources of information.

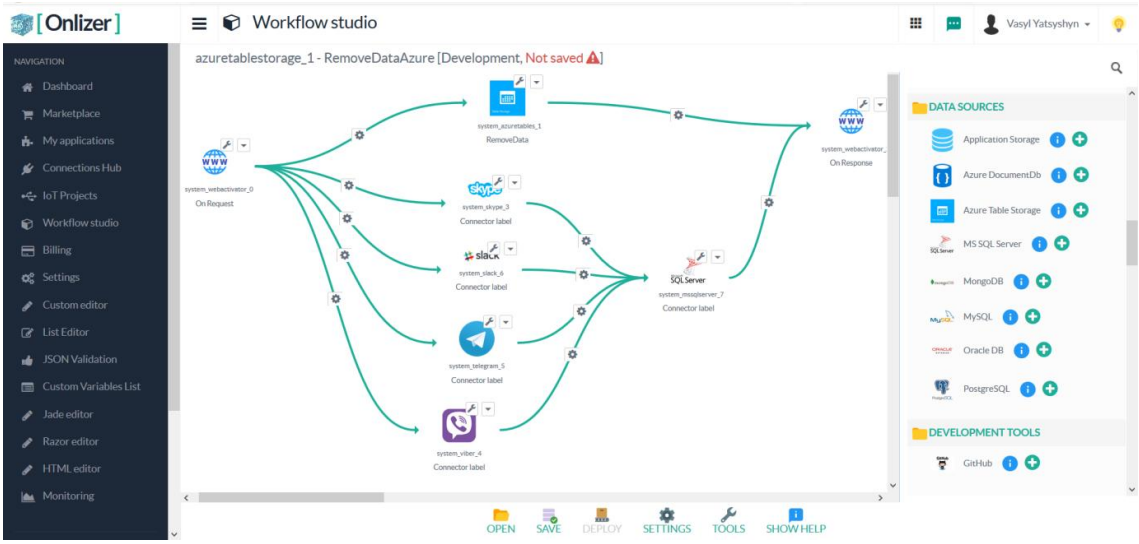

Fig. 6. Workflow to collect customer needs

When all the components are configured it is needed to click Save to save the workflow. To start the saved workflow is possible by clicking the Start button in the application settings window.

As a result, to obtain records in the database about the needs of a particular stakeholder in software, in the form of a field structure of the corresponding table. The fields of the table are:

- record identifier;
- type of means of communication;
- communication time;
- contact person from the customer;
- contact person from the developer;
- message content (or file link);
- recording time.

In this case, the integration of the developed requirements collection module and CASE requirements management tool based on the quality model is carried out through shared access to the database needs.

The architecture of the software requirements maturity support tool will look as shown in Figure. 7.

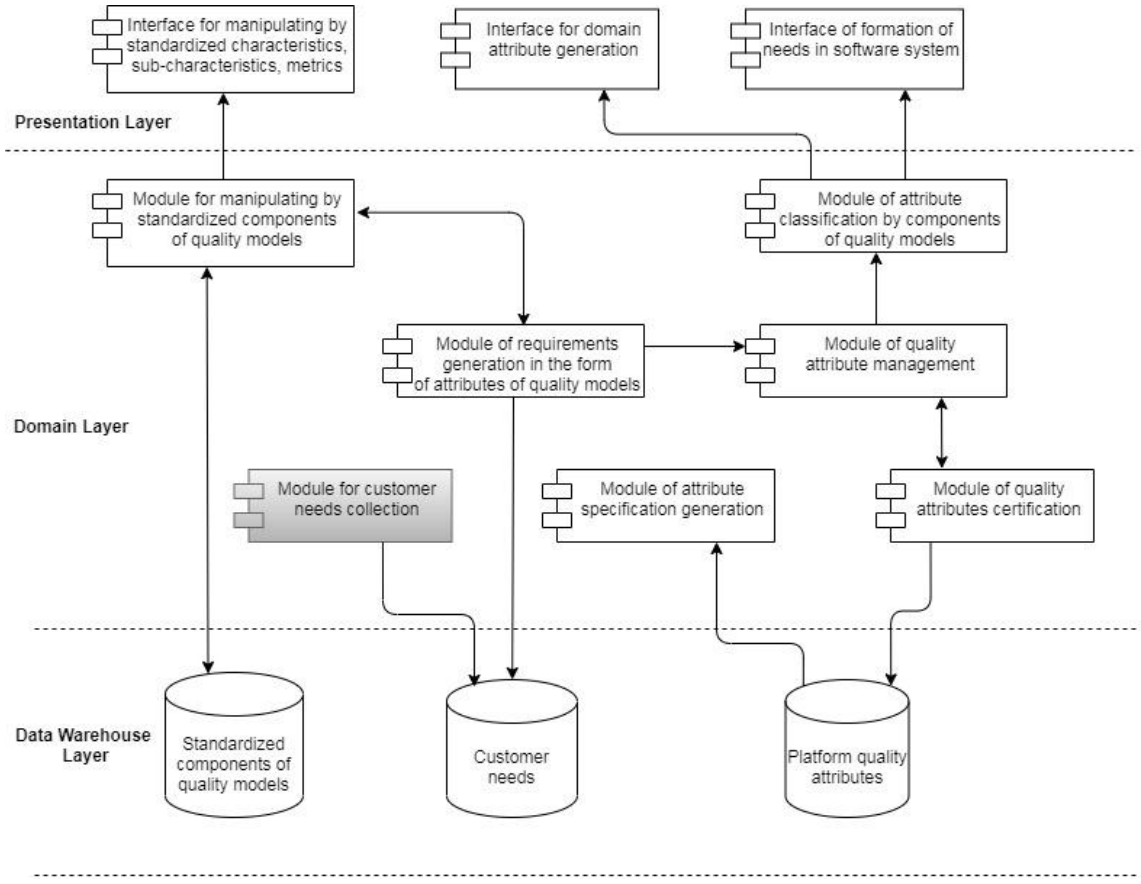

Fig. 7. The architecture of the means of supporting the second level of the maturity model

The developed module for collecting customer needs from additional sources such as Skype, Viber, Slack, Telegram makes it possible to supplement the customer's needs in software and in the computer system as a whole. This module provides greater completeness of the requirements for the software to be implemented.

The integration of the developed module into the CASE tool for management and requirements development based on quality models is carried out on the basis of communication with the customer needs database located in the data warehouse layer. This module is completely isolated from the CASE tool and works as a service that can be run on schedule when establishing communication between the development team and the system customer. Payment for the use of the module is made only for the real time of its use.

Conclusions

The article substantiates and formalizes the requirements maturity model RMM (Requirements maturity model) with implemented quality models of ISO / IEC 25010, which allows to reduce the transition threshold of companies in the presence of chaos in the requirements for higher levels of maturity model and thus increase the efficiency of requirements management. .

Formalized representation of the modified maturity model allows to automate the processes of communication of quality requirements at the stages of software development, which ensures the maturity of this process.

The Onlizer platform has created a module for collecting requirements from messengers, which are used in the interaction of members of the development team and customer representatives, which is also an element of increasing the maturity of processes at the second level of the RMM model. The developed module is at the same time a means of automation, which allows to increase the quality criterion of requirements for their completeness, and thus improve the quality of the final product.

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Major Fields of Scientific Research: Software Engineering

PROBLEMS OF DEVELOPMENT OF SCIENTIFIC AND METHODICAL COMPETENCE OF TEACHERS IN THE SYSTEM OF METHODICAL WORK OF PRIMARY SCHOOL

Olga Zolochevska

Abstract: *The article analyzes the problems of development of scientific and methodical competence of teachers of educational institutions of the first degree in the system of in-school methodical work.*

It is established that the reform of general secondary education has led to significant changes in the management of educational institutions, in particular to highlight the problem of managing the development of scientific and methodical competence of teachers of educational institutions of the first degree as a priority.

A definitive analysis of the category "development" and a holistic analysis of philosophical, psychological, pedagogical, scientific and methodical literature and regulatory framework to identify, critically comprehend and generalize the views of scientists and management at various levels on the essence of the process of managing the development of scientific methodical competence of teachers of educational institutions of the first degree in the system of intra school methodical work.

A theoretical analysis of the problem of managing the development of scientific and methodical competence of teachers of educational institutions of the first degree and directions in solving the problems of developing scientific and methodical competence of teachers in the system of intra school methodical work are formulated.

Keywords: *competence, development, scientific and methodical competence, primary school teachers, New Ukrainian School, teachers of the first-grade educational institution, intra school methodical work.*

ACM Classification Keywords: scientific and methodical competence

Introduction

Socio-economic and scientific-technical changes affect the introduction of new directions in educational policy and make new demands on the organization of conditions for the formation of theoretical approaches and the introduction into educational practice of models and programs of teacher training. The effectiveness of educational institutions of the first degree is determined and depends on the level of professional competence of teachers, in particular on the development of such a component as scientific and methodical competence.

The problem of development of scientific and methodical competence of teachers of educational institutions of the first degree has found its expression in laws and regulations, which indicates the need to solve it in the context of reforming general secondary education. The functional goal of the State National Program "Education" ("Ukraine of the XXI Century" 1993) is to reproduce the intellectual, spiritual, cultural potential of people, bringing domestic science, technology and culture to the world level and identify ways to reform it.

Optimization of intra school methodical work in the educational institution of the first degree is a necessary condition for managing the development of scientific and methodical competence of teachers of educational institutions of the first degree, as primary school teachers master the components of scientific and methodical competence at all stages of professional development.

Analysis of recent publications.

An important aspect of studying the development of scientific and methodical competence teachers in primary education is the analysis of constant changes in secondary education in Ukraine, accompanied by the development of new laws and regulations, state standards, curricula, programs, textbooks and manuals. In particular, in 2012, new State Standards for Primary General

Education, curricula, textbooks and manuals for primary school students were introduced; In 2016, a new primary school reform was launched, aimed at creating comfortable psychological and pedagogical conditions for students' education.

The problem of development of scientific and methodical competence of teachers of educational institutions of the first degree found its expression in legislative and normative acts, which testifies to the need to solve it in the context of the reform of general secondary education. The functional purpose of the State National Program "Education" ("Ukraine of the XXI century") (1993) is to reproduce the intellectual, spiritual, cultural potential of people, bringing domestic science, technology and culture to the world level and identifying ways to reform it.

The Law of Ukraine "On Complete General Secondary Education" (2020) states that a teacher must constantly improve his/hers professional level in the system of postgraduate education. Requirements for teachers necessary for Ukrainian society are set out in the Law of Ukraine "On Complete Secondary Education": a teacher is a person with high cultural and moral qualities, who has appropriate pedagogical education, appropriate level of professional training, pedagogical activity, ensures efficiency and quality. jobs whose physical and mental condition allows them to perform professional duties in general secondary education institutions. "

The urgency of the problem of development of teachers of scientific and methodical competence of educational institutions of the first degree is enhanced by the order of the Ministry of Education and Science of Ukraine "On approval of qualification characteristics of professions (positions) of pedagogical and scientific-pedagogical employees of educational institutions". This order sets out the requirements for the cognitive component of scientific and methodical competence of teachers of educational institutions of the first

degree, in particular, such as: teaching subjects; the content of school primary education ".

The document outlines the requirements for the content and procedural components of scientific and methodical competence of teachers of educational institutions of the first degree:

1) "the teacher carries out training and education of pupils, promotes formation of the general culture of the person, socialization; plans educational material on the Ukrainian language, reading, mathematics and other general subjects which are taught";

2) "uses various forms, methods, techniques and teaching aids; ensures the implementation of educational programs; students master the requirements of the State Standard of Primary General Education in full";

3) "makes proposals to improve the educational process";

4) supports academic discipline, attendance, respect for the dignity, rights and freedoms of students in accordance with the Law "On Education" and the Convention "On the Rights of the Child";

5) "participates in the activities of methodical associations and other forms of methodical work."

The "Guidelines for the teaching of subjects in secondary schools" found its expression changes in updating the content of primary education; preparation and conduct of lessons as the main form of organization of educational activities in the classroom; expanding the range of organizational forms, teaching methods and methods of educational interaction.

The Concept of the New Ukrainian School (2016) states: "The content of education and its methodology should be closer to practice." This argument highlights the problem of managing the development of scientific and methodical competence of teachers of first-level educational institutions, as they must "not just conduct a lesson - 45 minutes, but implement it with students." In the context of the reform of general secondary education, this requirement requires the heads of educational institutions of the first degree to optimize the activities of in-school methodical work with teachers on the basics of education and training, teaching methods, professional use of innovative forms, methods, teaching aids. student activities.

The concept of the new Ukrainian school emphasizes the importance of scientific and methodical competence and its functionality: "A successful teacher and specialist - will solve many questions about the quality of teaching, communication with children and school administration ... - a person who loves his/her subject, which is taught by a professional".

As teachers are given the freedom to choose curricula, textbooks, methods, strategies, methods and teaching aids, primary school leaders are working to update the forms of intra school methodical work in order to develop their scientific and methodical competence. That is why the focus group of school principals, who participated in the discussion and development of the Concept of the new Ukrainian school, said: "Children today want modern teachers, children today want creativity, children today want teachers who understand them first."

In this regard, the implementation of the provisions of the Concept of the new Ukrainian school should be carried out taking into account:

• Convention for the Protection of Human Rights and Fundamental Freedoms (European Convention on Human Rights, 1950);

• Council of Europe Recommendation № R (83) 13 “On the role of secondary schools in preparing young people for life” (1980);

• Resolution № 1 "On new challenges for teachers and their training" (Resolution on new challenges for teachers and their education (№ 1), 1987);

• Recommendation 1123 “On Practical Education Assistance in Central and Eastern Europe” (1990).

These documents are the basis for the organization of effective management of the process of development of scientific and methodical competence of teachers of educational institutions of the first degree.

Various aspects of problems of pedagogical education that have a direct impact on the development of scientific and methodical competence of teachers have been studied by such Ukrainian scientists as: N. Bibik, O. Bida, M. Vashulenko, L. Volyk, L. Zimakova, O. Kilichenko, L Koval, N. Kozakova, N. Kolesnyk, Kolomiets, Y. Korotkova, A. Kramarenko, S. Martynenko, M. Parfenov, S. Parshuk, N. Pakhalchuk, D. Pashchenko, L. Petrichenko, O. Savchenko and others.

Analysis of philosophical, sociological, psychological-pedagogical and scientific-methodical literature showed that, despite the large number of scientific papers and the proper development of various aspects of the problem, scientists have not found any work that would be the result of studying the problem of development scientific and methodical competence of teachers in the system of methodical work of educational institutions of the first degree.

Theoretical analysis of the problem of managing the development of scientific and methodical competence of teachers of educational institutions of the first degree gives grounds to assert that the activity of teachers has always been the subject of research by scientists and practitioners. The results of research on its

various aspects organically complemented the theory of education management, the theory of education and training and methods of teaching subjects. However, the problem of managing the development of scientific and methodical competence of teachers of educational institutions of the first degree remained out of the attention of researchers and did not become the subject of a separate systematic study.

In light of the above, the purpose of the article is to highlight the problems of managing the development of scientific and methodical competence of primary school teachers in the system of intra school methodical work and to formulate directions for their solution.

Problem statement

The problem of development of scientific and methodical competence of teachers of educational institutions of the first degree is a complex, multicomponent process. For its effective implementation it is necessary to clearly understand the essence of the category "development". The introduction of the concept of "development" in scientific circulation in the second half of the twentieth century was accompanied by the search for resources for its development in human nature and the improvement of its inherent qualities. Scientific research of this period considers the problems of socialization of all spheres of public life - politics, economics, legal system, culture, science and education. In particular, in the system of general primary education, the concept of "development" defined the essence of the requirements for the organization and course of the educational process in educational institutions of the first degree and its scientific and methodical support.

Algorithm

The concept of "development" in the philosophical dictionary is seen as a smooth transition from the old state of the subject to a new, higher, perfect, which is manifested in quantitative, qualitative and structural changes under the influence of internal and external factors.

In a general sense, development is interpreted as progressive changes that occur in psychological processes, first in thinking, and then - memory, attention, perception, emotions. The quality of education, which is determined and depends on the professional competence of the teacher, the scientists consider in the developmental dimension. It is natural that the professional competence of primary school teachers should be considered in terms of development, because since the 90s of the twentieth century, they are in constant search due to changes in the relationship between pedagogy and practice and a number of reforms.

"Development" in the philosophical aspect is an irreversible directed, natural change of material objects, as a result of which a new qualitative state of the object arises; the process of personality formation under the influence of external and internal, controlled and uncontrolled social and natural factors; purposeful accumulation of information with its further ordering, structuring. The driving force of development is the purposeful struggle of opposites - the positive and negative sides of the process.

We will consider the development of scientific and methodical competence of primary school teachers on the one hand as the acquisition, acquisition of new knowledge, skills and experience, and on the other hand - the restructuring, change of already formed ideas about the educational process in primary school.

In the context of the above, it should be noted that scientific and practical problems associated with the development of scientific and methodical competence of primary school teachers in the system of in-school methodical work have been, are and remain the object of study of scientists and practitioners.

It is quite natural that the reform of general secondary education has led to significant changes in the management of educational institutions, in particular to highlight the problem of managing the development of scientific and methodical competence of primary school teachers from all available resources as a priority. This fact determines the need for professional adaptation of management at all levels of school management to new managerial realities and challenges, complementing the theory of sectoral knowledge management, obtained as a result of studying the stated problem.

Based on the analysis of various scientific sources and practical experience, it was found that increasing attention to the problem of managing the development of scientific and methodical competence of teachers in the system of intra school scientific and methodical work is due to radical changes in primary school. Their main reasons are the overload of students with subjects and educational material, the inability of students to apply the acquired knowledge in life.

The palette of views on the essence of the process of managing the development of scientific and methodical competence of teachers of educational institutions of the first degree can be traced in the works of scientists devoted to the scientific description of these changes (O. Savchenko, V. Kurilo, V. Lozova, O. Marinovska, etc.). In particular, Academician O. Savchenko in the article "Quality of primary education: the essence and factors

of influence" describes the most significant changes: the world of childhood has changed because other children come to school (more aware, relaxed, but often unwilling to learn and communicate with peers, with impaired attention , health, etc.), which are much more difficult to teach and educate than previous generations.

According to researchers, the severity of the problem of managing the development of scientific and methodical competence of teachers of educational institutions of the first degree necessitates the search for innovative pedagogical technologies, the functional purpose of which is to master the positive social experience of primary school students.

Analysis of plans and programs of methodical work of primary school allowed to conclude that in the system of intra school work on the researched problem subjects of management do not pay enough attention to self-education of teachers of educational institutions of I degree and individual work to define the professional needs and interests; development of the theory of education and training in the context of the reform of general secondary education; study of the essence and significance of pedagogical research in the activity of teachers of educational institutions of the first degree, methods of pedagogical research and specifics of their use.

Conversations with primary school teachers have shown that teachers often equate the concept of "scientific and methodical competence" with "teaching methods"; superficially understand the place and essence of scientific and methodical competence in professional activities; identify such empirical methods as observation, conversation and testing, with methods of teaching students; only occasionally use in practice the results of modern research and development.

In light of the above, we assume that the effectiveness of managing the development of teachers of scientific and methodical competence world institutions of the first degree in the system of intra-school methodical work will contribute to innovative forms, methods and tools of teaching. In particular, it is about the use of methods of problem presentation of lecture material, discussions, research projects, pair and group forms of work, meetings with scientists, solving pedagogical problems aimed at successful implementation of priority provisions of the New Ukrainian School, use of project and game learning technologies. which will promote the activation of cognitive interest of teachers of educational institutions of the first degree to the development of scientific and methodical competence.

While in practice the traditional approach of subjects of management concerning application of forms, methods and means of training in the system of intra school methodical work in the course of carrying out lectures, seminars, meetings of school methodical associations, etc. prevails. The style of their implementation is reproductive in nature, and therefore does not contribute to the optimization of management of the development of scientific and methodological competence of teachers of educational institutions of the first degree in the system of intra-school methodical work. Therefore, today primary school teachers do not have a positive motivation to perform various types of research tasks that contribute to the development of scientific and methodical competence.

Scientific and methodical competence of teachers of educational institutions of the first degree, in addition to its functional purpose, is designed to ensure the development of their propensity for research, creative solutions to educational problems, skills to work with different sources of information to expand scientific and pedagogical and methodical horizons.

Thus, characterizing the state of research of the problem of development of Scientific-Methodical Competence of teachers of educational institutions of the first degree, it is possible to allocate its following signs:

- currently, there are differences between the theoretical development of the structure of scientific and methodical competence of teachers of educational institutions of the first degree and the inclusion of its components in practical programs and models of teacher training;
- the main emphasis is on the development of professional knowledge, skills and abilities, individual personal components, ie includes a limited set of components that are expected to be influenced;
- theoretical development of goals, objectives, principles, models of organization of the process of development of scientific and methodical competence of teachers of educational institutions of the first degree does not take into account the peculiarities of teacher training at different stages of his professional activity development, offers a set of tools and methods etc);
- the system of advanced training courses at the city and regional level is focused on theoretical and practical training of teachers, development of certain qualities, but does not take into account the peculiarities of professional scientific and methodical activities in a particular school, teacher adaptation problems, its integration into the school system.

In our opinion, the solution of these components of the problem of development of scientific and methodical competence of teachers of educational institutions of the first degree requires the creation of such a model of management of scientific and methodical competence of teachers of educational institutions of the first degree, which would focus on developing all components and

formations that determine the social and professional requirements for teachers, features of pedagogical activities in a particular secondary school.

The existing system of intra school methodical work is not flexible and mobile enough, is not able to respond quickly to the needs and requests of society, and does not take into account the peculiarities of the development of scientific and methodical competence of teachers at different stages of teaching.

Conclusion

The urgency of the researched problem is caused by increase of attention of subjects of management of various levels to pedagogical activity of teachers of educational institutions of the first degree, its complication in the context of reform of general secondary education. These are logical requirements for:

1) scientific and methodical competence of teachers within the educational process, which should be a practice-oriented methodical knowledge of general principles and methods of pedagogical activity (competence, as an interdependent teacher and interdependent concepts, are an integral characteristic of the teacher's personality these concepts are united by pedagogical activity); knowledge of the specifics of pedagogical tools (methods, techniques, technologies), which must have teachers of educational institutions of the first degree; knowledge of the skilled use of methods and forms of pedagogical activity as reliable and effective ways to obtain the planned result; empirical knowledge of educational management;

2) the process of realization of scientific and methodical competence by teachers of educational institutions of the first degree in the educational process and its comprehension.

The development of scientific and methodical competence of teachers of educational institutions of the first degree is provided, first of all, by effective, purposeful organization of intra school methodical work. The methodical service of first-level educational institutions should create conditions for primary school teachers not only to implement ready-made curricula, but also to take an active part in their development and experimental testing and to use innovative authorial approaches when designing lessons.

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PROBLEMS OF MANAGING THE DEVELOPMENT OF THE DIGITAL COMPETENCE OF HEADS OF GENERAL SECONDARY EDUCATION INSTITUTIONS OF UKRAINE

Garret Bodome

Abstract*: The article analyzes the problems of development of digital competence of heads of general secondary education institutions of Ukraine.*

It has been established that serious changes have taken place in modern education and the role of the head of a general secondary education institution has changed significantly, the degree of his freedom and, at the same time, the level of responsibility has increased.

Therefore, now one of the urgent problems is the problem of preparing the heads of general secondary education institutions for the use of Internet services in management activities, the formation of their readiness to study and use modern Internet technologies, to the formation of digital competencies.

A definitive analysis of the categories "management", "development" is carried out and a holistic analysis of the philosophical, psychological, pedagogical, scientific and methodological literature and regulatory framework is made in order to determine, critically reflect and generalize the views of scientists and management subjects of various levels on the essence of the development management process digital competence of heads of institutions of general secondary education of Ukraine.

Keywords*: ICT, management, development, digital competence, heads of general secondary education institutions, digital technologies.*

ACM Classification Keywords*: digital competence*

Introduction

The modern system of general secondary education in Ukraine has undergone serious changes. Institutions of general secondary education have received a new state order; they must become more independent in the development of educational programs, in the choice of forms and methods of organizing the educational process, and in spending money. In this regard, the role of the head of a general secondary education institution changes significantly, the degree of his freedom and, at the same time, the level of responsibility increases. This can be traced in modern regulations and the concept of the New Ukrainian School (hereinafter - NUS).

It is proposed to take into account that the rapid spread of "digital" technologies makes digital skills (competencies) of the citizens key among other skills. The Digital Agenda offers a comprehensive list of digital competencies that a modern manager should possess, including the head of a general education institution.

Given the fact that the goal of introducing IT technologies into the school management process is to improve the quality and efficiency of management decisions and the transition to paperless technology, the problem of managing the development of digital competencies for school leaders is gaining a nationwide scale.

This goal can only be achieved if schools are properly equipped with computers and free access to electronic resources. Thus, the managerial activity of a modern school leader is becoming more and more intellectual and scientific.

Problem statement

Today, heads of institutions of general secondary education must use IT technologies in the preparation of reports, the formation of databases of students and pedagogical workers, in office work, work with regulatory

documents, the organization of educational and methodological work and contractual activities.

Based on the generalization of scientific knowledge and world experience in managing the development of digital competencies at the level of general education secondary educational institutions, the process of organizing the technological process is considered as a factor in improving the management digital activity of educational leaders. Technologization is primarily due to the fact that today huge masses of people are involved in the education process, who in a limited time must receive a fairly large amount of theoretical and practical knowledge, various kinds of information. On the other hand, school principals objectively face the need to repeatedly interact with teachers, parents, and students within the framework of typological situations using repetitive operations, actions and procedures in a certain sequence (algorithm).

The development of learning technologies that provide conditions for the full development of the individual at different levels of the lifelong education system is possible only through updating the pedagogical foundations of the educational process, all its elements, which ultimately leads to the formation of various professional competencies of education managers. In the light of the study, the technologization of managing the development of digital competence of heads of general secondary education institutions is designed to ensure the integrity of this development by organizing a continuous learning process.

The possibility of innovation and technologization, and then digital transformation of the process of professional self-improvement of school principals in the direction of enriching digital competencies, can be provided by various groups of modern pedagogical technologies:

firstly, information and communication technologies (ICT) for universal purposes, such as office programs, graphic editors, Internet browsers, telecommunication tools, augmented reality, and the like;

secondly, pedagogical technologies (learning technologies), including those involving the use of ICT or based on their use;

third, specialized digital educational technologies (edtech), such as virtual mentors; simulators; educational game quests in augmented reality; game environments and sensorium; Smart tutorials - smart sandbox, smart board, and the like;

fourthly, production technologies (digital, material and social, or humanitarian), ensuring the enrichment of professional digital knowledge, skills and abilities of school principals.

A detailed analysis of scientific, vocabulary, encyclopedic literature made it possible to summarize that the basis of the category "management of the development of digital competence of heads of general secondary education institutions" is the terms "management", "development", "development management". "Digital Competence" (head of the SEO). Thus, we believe that the management of the development of the studied phenomenon among school principals is a continuous sequential influence on the part of the subjects of management, as a result of which the formation, change, systematization, regulation of the declared integral quality of the leader's personality occurs and is reflected in his (her) attitude to the use of ICT in professional activity. , in his (her) behavior in the context of digitalization of the educational process.

Since 2013, European scientific communities and practitioners have developed and presented in 2016 - 2017 European Digital Competence Framework for Citizens (DigComp). This conceptual reference model is structured in 5 dimensions that define the following areas: information and data skills, communication and collaboration, digital content creation, security. The designated model serves as the basis for organizing the process of developing the digital competence of teachers and heads of educational institutions. In the last 3-4 decades, the process of digital transformation has also been observed in the field of Ukrainian education.

Based on the generalization of scientific knowledge and world experience in managing the development of digital competencies at the level of educational institutions, the process of organizing technologies is considered as a factor in improving the management digital activities of educational leaders.

An analysis of scientific sources shows that researchers are studying the context, complexity and creativity of a competence-oriented professional postgraduate education [K. Oleinik], a conceptual and terminological excursion is carried out to concretize the essence of such concepts as “competence”, which have been used in pedagogy since the 1980s. [Kravchenko; Flint]) determines what is acceptable and what is problematic for higher education in Ukraine [Bugrov].

First of all, we note that competence-based education (CBE) was formed in the 60s and 70s in the United States. In the study of I. Zimnyaya, attention is drawn to the fact that the concept of “competence” was first used in 1965 by N. Chomsky (University of Massachusetts) in relation to the theory of language, transformational grammar in the understanding of the “system of generating processes”. The author draws attention to the fundamental difference between competence (as knowledge) and use (real application of this knowledge in specific situations), noting that in the idealized case, use is a direct reflection of competence. It is “use” that is an actual manifestation of competence as “secret”, potential, which is actually connected with thinking, with skills, that is, with the experience of the person himself [Zimnaya].

At the same time, in the work of Elliot, A. J., & Dweck, C. S. (2005). “*Competence and Motivation: Competence as the Core of Achievement Motivation.*” the category of competence is meaningfully filled with personal components, including motivation. Thus, in the 60s of the last century, a modern understanding of the differences between the concepts of “competence” and “competence” was laid, where the latter is interpreted as an intellectually and personally conditioned experience of a person's social and professional life based on knowledge.

The UNESCO materials outline a range of competencies that should already be considered as the desired outcome of education. The study by I. Zimnyaya notes that the international commission on education for the XXI century. formulated "four pillars" on which education is based: "learn to know, learn to do, learn to live together, learn to live", essentially defines the main global

competences. In the program of the Council of Europe (Bern, 1996), the question is raised that for educational reforms it is essential to define the key competencies that students are called upon to acquire both for higher education and for successful future work.

In the summary report, V. Hutmacher noted that the concept of competence, which is part of a number of concepts such as skills, competence, ability, skill, etc., still does not have a clear definition. Nevertheless, all researchers agree that the concept of "competence" is closer to the concept of "know how" than to the concept of "know what." Following N. Chomsky, V. Hutmakher emphasizes that “use is competence in action”, and gives the definition of five key competences adopted by the Council of Europe that “armed young Europeans should be”.

In the broad context of an understandable interpretation of competence, A. Khutorskoye uses the term "educational competencies", which are determined by the personality-activity approach to education, since they relate exclusively to the student's personality and turn out to be, and are also checked in the process of fulfilling a complex action. The author explains the understanding of the concepts of competence as follows. Competence (from Latin - competentia) means a range of issues in which a person is well aware, includes a set of interrelated personality traits (knowledge, abilities, skills, methods of action, experience, abilities) for effective activity in certain areas. A. Khutorskoye understands by competence a certain alienated, predetermined requirement for a person's educational training. And competence includes a person's personal attitude to the subject of activity; it is a personal quality (characteristic) that appeared in the learning process.

That is, competence is a specialist's possession of the relevant competence, encompasses his personal attitude towards it and the subject of activity [Khutorskoy, p. fourteen]. Drawing conclusions, we can assume that the digital competence of heads of secondary general education institutions consists of a set of competencies, reflected in the ability to:

1. information management, which covers knowledge, skills and abilities to search for the necessary data, analyze it and use it in accordance with the goals of the teacher's pedagogical activity;
2. collaboration, covering the knowledge, skills and abilities necessary for the participation of teachers in online communities and their interaction with other users on the Internet;
3. communication, which covers the knowledge, skills and abilities of teachers to communicate using online tools, taking into account confidentiality and security;
4. creation of content and knowledge, covering the knowledge, skills and abilities of a person for creative activity and the creation of new knowledge through the use of ICT and prior knowledge and content that are disseminated using Internet services;
5. ethics and responsibility, which covers the knowledge, skills and personality traits of a person for proper behavior on the Internet;
6. evaluation and Problem-solving, which is manifested in the appropriate selection of ICT self-assessment and assessment of knowledge, skills and abilities in various academic disciplines and for solving the problems of processing assessment results using ICT and providing appropriate advice; technical efficiency (or Technical Operation), covering the knowledge, skills and abilities of the individual necessary for the effective, safe and correct use of ICT in their professional and educational activities.

The development of learning technologies that provide conditions for the full development of the individual at different levels of the lifelong education system is possible only through updating the pedagogical foundations of the educational process, all its elements, which ultimately leads to the formation of various professional competencies of education managers. In the light of the study, the technologization of managing the development of digital competence

of heads of general secondary education institutions is designed to ensure the integrity of this development by organizing a continuous learning process.

Algorithm

The information society needs specialists with special qualifications; it needs managers - people who are able to independently design and manage structures, people who can learn, independently work with information - only they can count on success in the information society. That is why it is necessary to prepare all members of society for life and professional activity in a highly developed information and communication environment.

Now the information and communication environment is understood as a set of conditions that ensure the implementation of the user's activities with the information resource, as well as information interaction with other users using interactive means of information and communication technologies interacting with him as a subject of information communication and a person.

In such conditions, the heads of institutions of general secondary education, who have knowledge in the field of new educational technologies, need to constantly demonstrate their skills and have a professional environment for operational interaction. This requires a comprehensive solution to such issues as:

- continuous professional development of heads of general secondary education institutions in the use of digital technologies in daily and professional activities;
- software and hardware updating and maintenance of the functioning of equipment and information resources of schools, providing access to the Internet;
- information and methodical support of the professional activities of heads of institutions of general secondary education using ICT.

These tasks can be successfully solved within the framework of the system of methodical work of institutions of general secondary education, which can be defined as an integral set of measures, actions, resources, as well as management processes and actions that:

- aimed at assisting the heads of general secondary education institutions in identifying professional difficulties and identifying problems in the use of ICT tools and methods in the process of continuous professional pedagogical education with the aim of their own professional and personal development;
- contribute to the presentation of an educational request and the design on its basis of educational programs for advanced training in the field of effective use of ICT tools by managers in their professional activities;
- focused on systematic diagnostics of the state of digital competence formation for heads of general secondary education institutions, on advising them on the use of ICT tools and methods in professional activity, on the examination of the results and products of professional activity based on ICT;
- are developed in the course of joint activities by all subjects of the methodical service of institutions of general secondary education;
- use the potential of distance learning technologies, taking into account its specifics.

The exponential development of ICT in recent years requires a revision of the entire structure and content of the development of digital competence for heads of general secondary education institutions. ICT application training cannot simply follow the improvement of technology; in the current learning environment, it must be forward-looking. It is necessary that the specialist is ready to use those ICTs that will become widespread in the near future.

Today, it is in the field of education that network technologies, multimedia technologies, and distributed data processing technologies can be successfully applied. In addition, right now, due to the simplification of the user interface, it

has become possible for managers to learn such issues as the development of multimedia applications for educational purposes, information interactions in local and global networks.

It is obvious that the improvement of the development of digital competence of heads of general secondary education institutions should be focused on the advanced training of the director, who is able to ensure the progressive use of ICT in education. Based on the foregoing, it can be argued that outstripping the development of digital competence of heads of general secondary education institutions will allow achieving the following educational goals:

- stimulate the use of the capabilities of modern ICT tools to improve the effectiveness of training;
- to contribute to the formation of experience in the rational distribution of computer functions in the educational space;
- to determine the optimal ratio of new pedagogical technologies and traditional teaching methods;
- to promote the implementation in the educational process of a student-centered approach to learning;
- to stimulate the development and implementation of methods for conducting classes of any kind using all the capabilities of ICT.

The main methods of developing digital competence for heads of general secondary education institutions and their advantages.

Let us consider in detail the methods used in the development of digital competence of heads of general secondary education institutions.

Explanation story - a complex method that combines the presentation of educational material with detailed explanations, comparisons, justifications, conclusions and reliance on the professional experience of leaders. It is advisable to provide computer support for the lessons in demo mode.

Lecture - a methodologist for a relatively long time orally expounds a significant amount of educational material, using the techniques of enhancing the cognitive activity of heads of general secondary education institutions. The methodologist, as a rule, prepares in advance the corresponding computer presentation, which contains various information objects: photographs, diagrams, diagrams, video clips, animations. This allows not only to activate the attention of listeners, to lay out new material in a better quality, but also contributes to the immersion of school principals in the educational information and communication environment.

Conversation - using the questions posed, the methodologist encourages the heads of institutions of general secondary education to reason, analyze the facts and phenomena under study in a certain logical sequence and independently approach the corresponding theoretical conclusions and generalizations. When conducting a conversation, it is necessary to maintain a logical plan, questions and answers should reflect the sequence of the development of the topic.

Practical work with information sources (texts on paper, electronic publications for educational purposes, implementing the capabilities of multimedia technology, work in the Internet / Internet technologies, etc.) and with instrumental software (for example, for creating presentations).

The mastery of new knowledge is carried out independently by each head of a general secondary education institution by studying the material presented on paper or electronic media, and comprehending facts, examples, theoretical generalizations, while simultaneously with the assimilation of knowledge, school principals acquire the skills of information activity and information interaction, automation of educational methodical activities based on ICT tools.

Method of exercises, training (reproductive exercises) - the heads of institutions of general secondary education perform multiple actions, i.e. train (exercise) in the application of the learned material in practice and in this way deepen their knowledge, develop the appropriate skills.

Research laboratory work - heads of institutions of general secondary education under the guidance of a methodologist and, according to a pre-prepared plan, perform experiments or perform certain practical tasks aimed at developing thability to carry out:

- automation of computing and information retrieval activities;
- organization of management research using ICT tools, etc.

In the process of this activity, the heads of institutions of general secondary education master the technological methods of working with ICT tools and other technical means related to ICT tools.

Independent work - the activity of the heads of institutions of general secondary education, is carried out without the direct participation of the methodologist, but on his instructions at a time specially provided for this.

Creative exercises - heads of institutions of general secondary education use knowledge and skills in various combinations, independently find an original solution to the assigned tasks. It is the successful application of this method that allows us to say that in the course of coursework, school principals develop not only knowledge, skills and abilities, but also some competence in the area under study.

Thus, the proposed management methods for the development of digital competence of heads of institutions of general secondary education provide the following advantages:

- the combination of pedagogical (to transfer the minimum, but necessary amount of new knowledge and practical skills) and andragogical (to ensure the improvement of digital competence) teaching models ensures the effective implementation of the development of awareness of school principals in the field of means and methods of using ICT in professional activities;

- the development of professional educational activity allows planning effective professional development of school teachers in the field of formation and development of digital competence;
- person-centered learning stimulates the creation of conditions for the professional development of heads of institutions of general secondary education, its individual and collective - information activities based on ICT tools and methods;
- the continuity of the formation of digital competence through regular information and educational and methodical support during the development of digital competence of heads of general secondary education institutions creates conditions for qualitative changes in the professional activities of school principals through the use of new information resources and educational services.

We consider it expedient to carry out a detailed analysis of current trends in the development of digital competence of heads of general secondary education institutions as a requirement for the implementation of modern educational reforms in the context of international experience.

Currently, Ukraine is at the stage of gradual transition to the information stage of development associated with the active introduction of digital, information and communication technologies in all spheres of life, which requires constant updating of knowledge and skills necessary for successful mastery of these technologies. The use of information technology allows to realize the goals and objectives of ensuring the modern quality of education, directly related to the implementation of the competency approach.

The process of introduction of digital, information and communication technologies in the field of education determines new requirements for the training of heads of general secondary education institutions. The new generation of teachers must have integrated knowledge in the field of digital and information technologies, telecommunications, the ability to navigate freely in the global flow of information, competently find and process the necessary data and then make management decisions based on them.

However, despite the general acceleration of the process of informatization of education, now the heads of general secondary education note the lack of university training to solve professional problems related to the use of computers and lack of skills in creative use of digital technologies to solve non-standard management tasks. Nowadays, digital technologies create new opportunities for building the educational process and solving a wide range of educational problems, in particular those that have not yet been solved by means of traditional education, and fundamentally new ones. Example:

- the use of artificial intelligence is the basis for: services that provide the design of individual educational routes and the organization of training according to the individual curriculum of children with special educational needs; adaptive learning systems that automatically adjust to individual learning strategies and other features of a particular student; self-educational electronic courses;
- virtual reality technologies allow to design digital and screen (visual, including spatial) models of objects, providing: creation of motivating game and realistic entourage at stages of development, fixing and control of educational material; opportunities for studying invisible, micro- and macro-objects and virtual experimentation with them; formation of skills and competencies for work in dangerous industries, in extreme situations;
- the use of digital duplicate, digital footprint and Big Data technologies allows to create a system of personalization of monitoring of learning success and dynamics of student development;
- chat-bot technology is increasingly used to provide prompt meaningful feedback to students receiving secondary education in the process of distance learning;
- the use of augmented reality technologies ensures the implementation of a set of principles of digital didactics (practical orientation, interactivity, polymodality) in the process of forming professional skills and abilities in the real production process;

- technologies of electronic identification and authentication (face, voice recognition) can be used to verify the participants of the educational process during the demonstration exam online;
- blockchain technology is needed to build a single information educational environment in educational networks, to ensure the effective implementation of networked educational programs and projects;
- digital technologies for specialized educational purposes - edtech (educational technologies), usually use one or more of the above digital technologies.

Various information and digital innovations are being introduced into the organization and content of the educational process of general secondary education institutions. Modern digital educational resources are a means of learning and serve as a tool to improve its quality. For example, digital technologies have didactic (educationally significant) properties, including:

- freedom to search for information in the global information network;
- personality - the availability of unlimited opportunities to individualize the needs and characteristics of each student, including the choice of presentation of material, level of difficulty, pace of work, number of repetitions, the nature of training, play environment, etc.;
- interactivity - the ability to provide multi-subjectivity in the process of educational communication and learning interaction);
- multimedia (polymodality) - the ability to comprehensively use different channels of perception (auditory, visual, motor) in the learning process;
- hypertext - the freedom of movement in the text, a concise presentation of information, the modularity of the text and the need for its continuous reading, the reference nature of information, folding-unfolding information, the use of cross-references, etc.;
- sub-culturalism - the correspondence of the usual way of the world for the digital generation, "recognizability", - thanks to which students are immersed in a familiar digital environment. The change of teaching aids, as well as the change in any part of the educational environment, naturally leads to the restructuring of the whole system: significantly

changes the activities of the subjects of the educational process, as well as forms and methods of teaching, content of educational material.

Therefore, the activities of the head are complicated both in content and psychologically. After all, there are often situations that require quick and effective decision-making. In these conditions, the readiness of directors of general secondary education to work in new conditions is seen as the ability to work in difficult predictable conditions.

Note that the Concept of implementation of state policy in the field of general secondary education reform considers information and communication technologies (ICT) in the educational process as a "tool for ensuring the success" of the NUS. Renovation of the Ukrainian school requires the introduction of new educational technologies into the educational process. One of the ways to create such a school is to use ICT technologies in the educational process. According to modern researchers, the end-to-end use of ICT in the educational process and management of educational institutions and the education system should become a tool to ensure the success of the New School. Information and digital competence involves the confident and at the same time critical application of information and communication technologies by modern man of the XXI century in everyday life, in professional activities, public space and private communication. Along with this, the leading role in the implementation of the NUS Concept depends, in particular, on the effective use of modern information and digital technologies by the heads of general secondary education institutions. Therefore, at present, the system of advanced training of school principals is actively working to ensure the development of digital competence of heads of general secondary education institutions. However, scientific knowledge about the process of managing the development of this phenomenon is now somewhat fragmentary, which actualizes the feasibility of our scientific research.

It should be noted that etymologically the word "management" comes from the verb "manage", which means:

a) to direct the course, movement of someone or something (for example, to drive a ship, car);

b) to manage, direct the activities, actions of someone or something (for example, to manage the state, secondary school, to manage the educational process).

Therefore, management is a process of influence of the subject on the object in order to achieve a new qualitative state of the latter. The subject of management is the one who manages (the head of the secondary education institution). The object of management is the one who is managed (subordinate teachers, students). In pedagogical management, the influence on the object of management is carried out using a cohort of methods. The method is a certain, the most rational, pre-developed sequence of certain tasks, works, decisions. In the system of pedagogical management of advanced training of heads of general secondary education institutions, methods occupy a special position, as they are characterized by practical application. It is through methods that education managers influence managed objects to transform them from their original state to their desired state. Management methods are ways of carrying out management activity, which, on the one hand, is a process of realization of management functions, and on the other - influence on the personnel of the organization. By the nature of the action there are economic, organizational-administrative, socio-psychological and quantitative management methods.

Analyzing the concept of "management", we have identified its main characteristics: it is a process of purposeful change of state of another object; the process of streamlining, regulating the system in order to obtain the desired result; the creative principle of management is reduced to providing conditions for optimal functioning of the managed system. The phrase "development management" often appears in the system of professional development of pedagogical workers. Therefore, let us interpret the category of "development".

The category of development is one of the leading in modern scientific research. Note that the categories are the most capacious and general concepts about the essence and properties of science. Pedagogical categories

- the main pedagogical concepts that express scientific generalizations. The main pedagogical categories include upbringing, education, training. At the same time, domestic science often also operates with general scientific categories, such as "development" and "formation".

Development is an objective process and the result of internal consistent quantitative and qualitative change of physical and spiritual forces of man (physical development, mental, social, spiritual). This change, which is the transition of quality from simple to more complex, from lower to higher; a process in which the gradual accumulation of quantitative changes leads to the onset of qualitative ones. Being a process of renewal, the birth of the new and the demise of the old, development is the opposite of the processes of regression, degradation. In classical psychological knowledge, development is a process of irreversible, directed and natural changes, which leads to the emergence of quantitative, qualitative and structural transformations of the human psyche and behavior. The main properties of development that distinguish it from all other changes are irreversibility, direction, regularity. However, the development process is not universal and not homogeneous. This means that in the course of development there are multidirectional processes: "the general line of progressive development is intertwined with changes that form the so-called" deaf "moves of evolution or even directed towards regression".

Today the idea of development is key in the ideology of the New Ukrainian school, the central problem in this ideology is the search for ways of development and self-development of educational systems. In our opinion, an important strategic line in the development of digital competence of school principals is the strategy of enriching the knowledge, skills, abilities of principals of general secondary education institutions to use digital technologies in the process of solving managerial tasks.

The Law of Ukraine “On Education” (2017) defines the range of competencies of the head of an educational institution. The principal is responsible to the state for the organization and quality of educational work with students, strengthening

their health and physical development, training of employees, the school's relationship with the family, as well as for the economic and financial condition of the school.

The head of an educational institution is a representative of the educational institution in relations with state bodies, local governments, legal entities and individuals and acts without a power of attorney within the powers provided by law and the constituent documents of the educational institution. The head of the educational institution within the powers granted to him/her:

- organizes the activities of the educational institution;
- decides on the financial and economic activities of the educational institution;
- appoints and dismisses employees, determines their functional responsibilities;
- provides organization of the educational process and control over the implementation of educational programs;
- ensures the functioning of the internal system of quality assurance of education;
- provides conditions for effective and open public control over the activities of the educational institution;
- promotes and creates conditions for the activities of self-governing bodies of educational institutions;
- exercises other powers provided by law and the constituent documents of the educational institution.

Given the outlined theses, we consider it appropriate to summarize that a modern leader must work ahead, not be afraid to implement modern information and digital innovations, both in their work and in the work of the educational organization. After all, the development of digital technologies and their large-scale implementation in all sectors of the economy form new requirements for the competencies of personnel employed in various sectors of the Ukrainian economy. Digital competencies are becoming a significant factor in the competitiveness of educational entities. This applies not only to production

structures that produce innovative products, but also to structures and educational structures involved in the formation of intellectual resources of society. Thus, in the system "education - science - production" digital competencies become a creative factor that, transforming into an intellectual resource, generates effective development of the system. In the context of digital transformation of the Ukrainian economy, the dominant element of the system "education - science - production" is general secondary education. This is due to the fact that education, promoting the development of human capital, provides the formation of models of competencies that reflect the requirements of the digital economy to the knowledge, skills and abilities of staff. Such models, covering the range of skills, abilities and knowledge, reflect the trends of the digital society, in particular, the need for lifelong learning.

In today's conditions, educational structures, including general secondary education, are a key part of preparing students for life in society of new digital technologies and their application in practice.

Therefore, schools today should primarily focus on solving problems of training, retraining and advanced training of directors of general secondary education in the field of:

- application of CICT and innovative pedagogical methods;
- development of curricula, programs and teaching materials of a new type that meet the requirements of the Global Knowledge Society;
- creation of professional networks and educational communities for consolidation of experience and pedagogical practices, as well as provision of appropriate organizational and preparatory measures to achieve accessibility of all school principals to modern methodological developments.

Confirmation of this opinion can be found in the Digital Agenda of Ukraine. This document states that the rapid spread of "digital" technologies makes digital skills (competencies) of citizens key among other skills. Thus, "digitalization" and cross-platform are currently the main trends in the general labor market. The implementation of such an approach requires a radical change in the whole

paradigm of postgraduate education, the development of innovative models of the educational process that integrates new educational technologies. First of all, it concerns integration into the process of professional development, including the development of digital competence of heads of general secondary education institutions, machine learning technologies, artificial intelligence, introduction of information-educational and digital environment.

The role of the modern school principal, the level of his training - in particular digital competence - is extremely important for the implementation of the values of the New Ukrainian School. That is why the current head of general secondary education must have innovative practices to guide teachers to implement such learning models as: adaptive learning, synchronous and asynchronous learning, blended learning, self-directed learning, distance learning, cloud and mobile learning, virtual classroom, inverted class, e-learning management system, learning process, course (CMS) management system, gamification, personalization, digital storytelling, etc.

Currently, it is not enough for the head of a general secondary education institution to be technologically literate and be able to pass on the accumulated knowledge to his subordinates. The modern head of the educational organization must be able to help the teaching staff to use digital technologies for successful cooperation, solving current educational problems, mastering new knowledge, skills and abilities, as the school principal is focused on developing a personality capable of owning, applying, analyzing, synthesizing information. to be a full-fledged employee and citizen.

It is worth noting that often the head of the educational organization does not even know what can be done or how to significantly save time through the use of modern digital educational resources. It should also be emphasized that the knowledge of the possibilities of using modern digital educational resources and the ability to work with them is not enough for their effective use in the educational process of general secondary education, as well as for the direct implementation of management functions. In order to solve this problem, it is necessary to timely develop the necessary methodological materials for the use

of modern digital educational resources and develop a system of measures in the system of advanced training aimed at developing digital competence of heads of general secondary education. Summarizing the scientific achievements of modern researchers, showed the fact that competence is reflected in the set of competencies. Therefore, within the study we will consider that the digital competence of the heads of secondary schools consists of a set of competencies that are reflected in the ability to:

- information management, which includes knowledge, skills and abilities to search for the necessary data, their analysis and use in accordance with the objectives of pedagogical activities of the teacher;
- collaboration, which encompasses the knowledge, skills, and abilities necessary for teachers to participate in online communities and interact with other users on the Internet;
- communication, which covers the knowledge, skills and abilities of managers to communicate using online tools, taking into account confidentiality and security;
- creation of content and knowledge, which includes knowledge, skills and abilities of the individual for creative activities and the creation of new knowledge through the use of ICT and previous knowledge and content disseminated through the Internet;
- evaluation and Problem-solving, which is manifested in the appropriate selection of ICT to solve the problems of processing the results of evaluation using ICT and provide appropriate advice;
- technical operation, which covers the ability to safely and correctly use ICT in their professional and educational activities.

Due to the fact that the purpose of implementing IT-technologies in the school management process is to improve the quality and efficiency of management decisions and the transition to paperless technology, the problem of managing the development of digital competence of school leaders is gaining national scale.

This goal, as P. Grabowski emphasizes, can be achieved only with the appropriate equipment of schools with computer equipment and free access to electronic resources. In a modern school, which monitors and diagnoses the educational achievements of students, implements personality-oriented and developmental learning, the flow of information received by participants in the educational process increases many times over. In this regard, the use of modern information technology is an integral part of the educational process and the most important area of implementation of the NUS Concept and the strategy of preparing students for life in the information society. Today, this process requires the head of the general secondary education institution and the administrative apparatus as a whole to be constantly involved in the process of learning and mastering new information technologies in order to increase the innovative potential of the educational institution.

The head of a general secondary education institution as a competent and effective manager of the education system, without a doubt, acts as a leader of the teaching staff of the educational organization, and therefore he must be a "carrier" of the changes he wants to see in others [Kravchenko G. Yu. competence of the head of the educational institution in the conditions of postgraduate pedagogical education]. This involves the constant professional development of leaders, the use of digital educational resources, which provides both monitoring of the current situation in educational activities, and the opportunity to experiment and develop new directions in the educational process.

The importance of ensuring the development of digital competence of modern heads of general secondary education institutions is noted by V. Lavruk, which points to the fact that the school principal in the education system is the most valuable human resource and capital, because it is from the quality of his work as a manager-professional, the presence of a creative approach to management primarily depends on improving the efficiency of a particular educational organization.

While information oversaturation and constant structural and systemic changes in the social sphere, the penetration of information and communication and digital technologies in all spheres of life significantly increase the importance of digital training of heads of educational organizations, including schools. The modern manager of the system of domestic general secondary education must be not only professionally competent, but also able to solve current educational problems through the use of digital technologies.

Thus, there is a need to review the existing system of professional development of teachers, in particular the heads of general secondary education. After all, today the development of digital competence as a component of professional competence is becoming an important goal of retraining the leaders of educational organizations in the digital economy. The process of professional growth and development of professional knowledge, skills, abilities of school principals is very complex and time-consuming, especially today, when the range of competencies that must be mastered by an effective manager has become so diverse and multifaceted. At the same time, in our country there is a lack of methodological support for the development of digital competence of heads of general secondary education institutions in educational institutions focused on additional vocational education and in their special training programs aimed at quality retraining of modern managers of the XXI century. The outlined theses aim to find ways to develop the digital competence of teachers in the experience of foreign countries.

Thus, in the countries of the European Union, where educational reforms are aimed at harmonizing curricula and standards to the requirements of the international community, a number of documents have been developed to adjust the system of training and retraining of teachers to current trends, encourage new digital tools and use them in everyday life, work.

Conclusion

Based on the analysis of the outlined concepts that form the basis of the category "management of the development of digital competence of heads of

secondary schools", we conclude that the management of the phenomenon under study by school principals is a continuous sequence of actions by management entities. there is a formation, change, streamlining, regulation of the announced integral quality of the leader's personality, which reflects his attitude to the use of information and communication and digital technologies in professional activities, his behavior in terms of digitalization of the educational process.

In summary, we note that the information society today makes special demands on school leaders, their professional competence, one of the most important components of which today is digital competence. Possession of digital competence in combination with the skilled use of modern means of information and communication technologies is the basis for the implementation of the tasks of NUS.

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REVIEW OF DRAWBACKS OF EXISTING TOOLS TRANSFORMING PLATFORM SPECIFIC MODELS TO CODE

Anton Shyrokykh

***Abstract**: AGILE as way of developing software have great support in development community. Using of software models as abstractions could increase software accuracy and documentation quality, but does not apply with AGILE principles, due to high effort. Model to code transformation via model driven development has a potential to resolve high effort problem and make modeling align better with AGILE principles.*

As reliability and flexibility of code generation tools is very important characteristics, paper is devoted to investigation of code generation approach that can be supported by most widespread used tools that allow to obtain code skeletons from UML class diagrams.

***Keywords**: Code generation, Model driven development, Class diagram, Object-Oriented Programming.*

Introduction

According to AGILE manifesto and principles, teams should at regular intervals reflects on how to become more effective, pay continuous attention to technical excellence and good design, deliver working software frequently and welcome changing requirements (Manifesto for Agile Software Development). Developing models as additional abstractions of software help teams communicate better, detect high level errors early and increase quality of software under development. But models as additional artifacts require additional efforts to produce, support and to keep them up to date. This makes this powerful tool

almost not applicable in conditions of AGILE software development process with often requirements changing. Also it is not compatible with principle "Working software over comprehensive documentation".

Model to code automatic or semi-automatic transformation process using model driven development approach helps to solve most of the defined problems. Model to code transformation helps to reduce development effort on coding, as most of the code is generated from the model, and also helps to support connection of models to code, making it simple to keep up to date. Model driven development makes model to code transformation compatible with AGILE manifesto and principles.

There exists several approaches to implement code generation in model driven development. Some of the approaches are: modeling with support of transformation language, direct model manipulation, intermediate representation approach. Different approaches allows to choose and balance some key attributes, as flexibility of code generation, effort to perform transformation, transformation accuracy etc. Each of approaches has representative technology, but the most widespread used tools use visual notation of the model and use direct model manipulation approach to perform transformation. In most cases transformation implementation is either hidden, or not extensible. As a result, produced code needs some effort comparing with manual coding or more accurate but more expensive transformation approaches, as using of transformation language.

Code generation is a key activity in Model-Driven Development approach. The aim of UML diagrams models not to be just models, but to become a code that corresponds to processes or software structure. Nowadays there are some

foundation in papers divided to investigation of analytical Model transformation aspects.

Review of Papers

Model-to model generative approaches work with graph representation of models. In order to obtain resulting models For example, in the paper (Eickhoff C at. el.,2019) it is proposed to use reachability graph computation for Eclipse Model frameworks (EMF). Such models are based on model transformations provided as simple Java lambdas. Thus, it is possible to test and check model and controller synthesis on EMF model using model transformations. Proposed tool enables sharing of common sub-models between multiple states thus providing a memory efficient encoding of large reachability graphs. Model attributes can be modified. It is model to model transformation tool based on graphs. Using java.lang.reflect authors could achieve this reflective access for general Java objects can be archived.

Other direction of software development artifacts producing are related to web development sphere.

Paper (Laaz, N. at. el, 2019) presents an approach based on MDA for the user interfaces development of SWAs. A Meta Model for Html5 is defined. Then the transformation engine that allows the automatic generation of the output models is developed. These models represent an input to a Model to Text generator that give an almost complete web pages ready to be deployed, focusing on the graphical aspect of the application on one hand, and the annotations and the user event handling on the other. The main contribution in the proposed approach is the generation of ontologies, as well as annotated web pages from one IFML diagram, besides the abstraction of technical details. By using this models driven method, the user interfaces of semantic web applications can be

easily generated without having to know all the technical specification of the execution platform.

Fundamentals of Model transformation approaches used in AGILE approach are investigated in paper (Chebanyuk & Markov, 2016). Authors consider Model-Driven Engineering promises and analyze research state of art of different Model transformation activities.

Tasks, needed to be automated, for increasing effectiveness of different software development operations are summarized in paper (Shane Sendall and Wojtek Kozaczynski). Authors formulate requirements from software model transformation language, which supports model-driven software development are formulated. This paper makes strong contribution to systematic review of model transformation requirements and also to classification of architectural approaches to transformations.

In order to answer to automatic code producing challenge many commercial and noncommercial tools support such function as codegeneration. From the other hand, one can prove, that namely such Model-Driven Development foundations are popular and used often, which can be implemented by many developers to fell concepts of Code Generation.

Investigation of Codegeration Features of tools

Most widespread used tools use visual notation of the model and use direct model manipulation approach to perform transformation. Visual notation in most cases corresponds to UML Class diagram, which is considered to be a standard notation.

The general drawback of that approach, that transformation implementation is either hidden, or not extensible. As a result, produced code needs some effort comparing with manual coding or more accurate but more expensive transformation approaches, as using of transformation language. In addition each particular tool can have own drawbacks and limitations.

Several widespread used codegeneration tools from software models were chosen to investigate their codegeneration drawbacks.

Visual Studio Class Designer

Class Designer is a part of Microsoft Visual Studio IDE. Source code of IDE Class Designer is not public and does not support extensions.

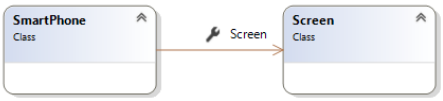
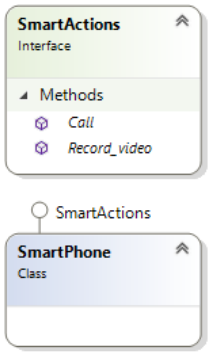
Class Designer has the next features:

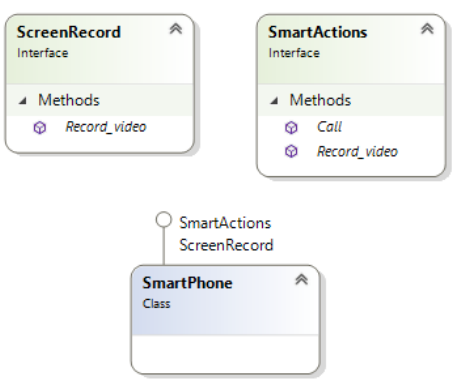
1 Design: Edit your project's code by editing the class diagram. Add new elements and delete unwanted ones. Your changes are reflected in code.

2 Visualize: Understand your project's structure by viewing the classes in your project on a diagram. Customize your diagram so that you can focus on the project details that you care about the most. Save your diagram to use later for demonstration or documentation.

3 Refactor: Override methods, rename identifiers, refactor parameters, and implement interfaces and abstract classes (Microsoft, 2019).

Table 1. Visual studio drawbacks

Bug code	Drawing or explanation	Textual description
VS-B1		There are two classes on class diagram and inside of one class declare a property named as other class is declared. You obtain an error message from Visual Studio environment that this data type already is used. But, according to design rule it is expected the generation of composition relationship between two classes. You cannot do it, because Visual Studio Environment do not contain composition relation.
VS-B2		You have an interface and a class. You design inheritance relationship between interface and class inside of the code generated class it is expected to see interface methods with public modifier ready for overloading. Really such a situation is not happened. Only inheritance is appeared.

Bug code	Drawing or explanation	Textual description
VS-B3		Then it is advisable when several interfaces have method with the same signature and when they are inherited by the same class to point explicit inheritance starting from the name of the interface.
VS-B4	Designer can add to class diagram as many components (classes and interfaces) as he considers that it is needed.	There is no mechanism of verification class diagram to correspondence of cognitive design principles

Eclipse codegeneration tool

The EMF project is a modeling framework and code generation facility for building tools and other applications based on a structured data model. From a model specification described in XMI, EMF provides tools and runtime support to produce a set of Java classes for the model, along with a set of adapter classes that enable viewing and command-based editing of the model, and a basic editor (Eclipse, 2018).

The core EMF framework includes a meta model (Ecore) for describing models and runtime support for the models including change notification, persistence support with default XMI serialization, and a very efficient reflective API for manipulating EMF objects generically.

Three levels of code generation are supported:

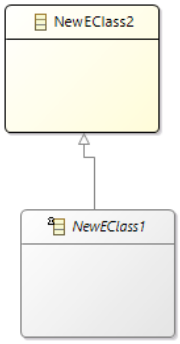
Model - provides Java interfaces and implementation classes for all the classes in the model, plus a factory and package (meta data) implementation class.

Adapters - generates implementation classes (called ItemProviders) that adapt the model classes for editing and display.

Editor - produces a properly structured editor that conforms to the recommended style for Eclipse EMF model editors and serves as a starting point from which to start customizing.

All generators support regeneration of code while preserving user modifications. The generators can be invoked either through the GUI or headless from a command line.

Table 2. Eclipse drawbacks

Bug code	Drawing or explanation	Textual description
E-B1	Repeats VS-B2 behavior	
E-B2	Repeats VS-B3 behavior	
E-B3	Repeats VS-B4 behavior	
E-B4		Generated code shows that interface (namely abstract class) inherits NewClass2

NClass

NClass is a free open source tool to create UML class diagrams with C# and Java language support. The user interface is designed to be simple and user-friendly for easy and fast development. Initially the project was developed by Balasz Tihanyi on sourceforge.

Existing features:

4 C# and Java support with many language specific elements;

5 Simple and easy to use user interface;

6 Inline class editors with syntactic parsers for easy and fast editing;

7 Source code generation;

8 Reverse engineering from .NET assemblies;

9 Printing / saving to image;

Table 3. NClass drawbacks

Bug code	Drawing or explanation	Textual description
NC-B1	Repeats VS-B1 behavior	
NC-B2	Feature is absent	Design limitation – to establish a generalization relation between interface and a class
NC-B3	Repeats E-B4 behavior	

Codegeneration efforts overview

Despite all reviewed drawbacks of chosen approach, codegeneration saves much effort in programming. But auto generated code is not ready for use and needs to be completed manually. Significant effort could be taken to perform correspondence of code structures with complex relations between classes, for example to design patterns.

Consider class diagram of design pattern “Proxy” and estimate efforts needed to be taken while completing codegeneration results.

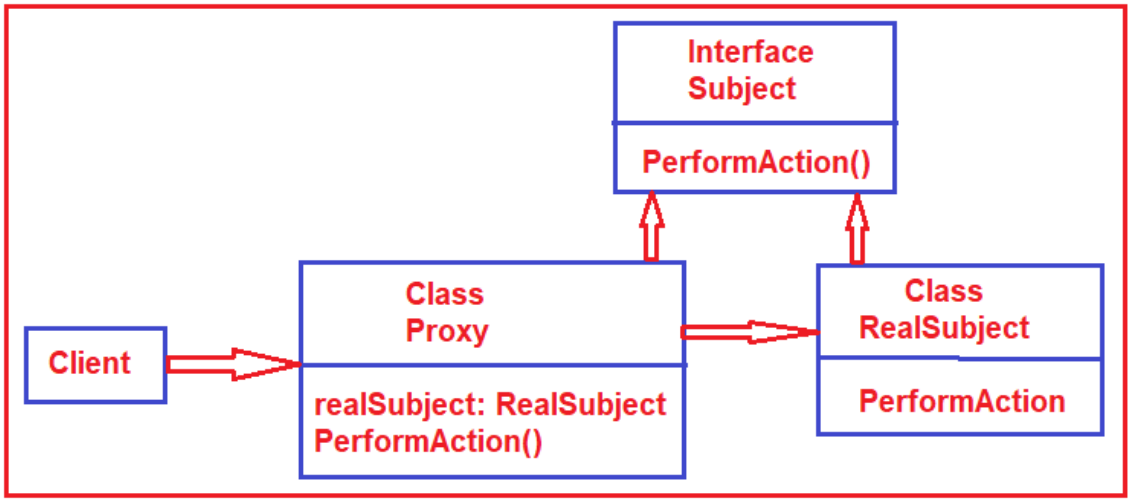


Figure 1. Class diagram of design pattern “Proxy”

Figure is taken from https://dotnettutorials.net/lesson/proxy-design-pattern/

Two variants of code, namely code generated by Visual Studio automatically and code designed by software developer are given in the table 4.

Table 4. Differences between generated code and such a one that is designed by developer

Code skeleton created by developer Code is taken from https://dotnettutorials.net/lesson/proxy-design-pattern/	Code skeleton, created by visual studio codegeneration tool

`public class Employee`
`{ }`
 	
`public interface ISharedFolder`
`{`
`void PerformRWOperations();`
`}`
 	
`public class SharedFolder : ISharedFolder`
`{`
`public void PerformRWOperations()`
`{`
`……..`
`}`
`}`
 	
`class SharedFolderProxy : ISharedFolder`
	`public interface Subject`
	`{`
	`void PerformOperation();`
	`}`
	
	`public class Proxy : Subject`
	`{`
	`public RealSubject RealSubject`
	`{`
	`get => default(RealSubject);`
	`set`
	`{`
	`}`
	`}`
	`}`
	
	`public class RealSubject : Subject`
	`{`

```
    {
        private ISharedFolder folder;
        private Employee employee;

 public void PerformRWOperations()
        {
           …
      folder = new SharedFolder();
folder.PerformRWOperations();
            …
         }
    }
}
```

```
    }
```

As result of automatic code generation, interface and classes were created. Work items to complete manually includes:

1. create private RealSubject field in Proxy class and complete implementation of getter and setter
2. define PerformOperation method from Subject interface in RealSubject class and complete implementation
3. define PerformOperation method from Subject interface in Proxy class and complete implementation with private RealSubject instance call
4. complete PerformOperation method in Proxy class with additional Proxy logic

Conclusion

Paper proposes investigation of codegeneration tools. Ideas of investigation is the next: in AGILE approach codegeneration – is operation that must reduce of developer effort. Different software development tools are better to use in different stack of technologies. Number of efforts, spent to refine obtained skeleton of code, influences to general codegeneration time. Practically, all codegeneration tools require additional efforts after codegeneration. These efforts are spent to perform a correspondence of code structure with compex relations between classes, for example to design patterns.

Further research

Such an investigation becomes a start point to perform further investigations, that consists from the next steps:

Grounding of analytical approach or fundamentals to describe transformation rules (model to code transformation) removing limitation of existing codegeneration techniques

Representation of architectural schemas of transformation tool

Analyzing bug tables (table 1-3) representing a set of transformation rules in terms of chosen analytical approach

Designing an architectural solution of newly designed transformation tool

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Major Fields of Scientific Research: Model-Driven Development, Distributed long-living transactions

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