

# Developing digital competence of the “Ukrainian electronic encyclopedia of education” users based on Semantic Wiki technologies: from online reference to analytical portal

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## Abstract

The digitalisation of education necessitates the development of advanced digital competencies among users of web-based knowledge platforms. This paper examines the evolution of the Ukrainian Electronic Encyclopedia of Education (UEEE) from an online reference resource to an analytic web portal with additional semantic functionality based on the MediaWiki platform. We explore how this transformation influences the requirements for role-specific digital competence of UEEE developers (authors, editors, moderators, and knowledge engineers). The study highlights the digital competence needed to operate effectively within the Semantic MediaWiki environment, including semantic markup, content structuring, multimedia integration, and semantic search skills. Particular attention is given to the competences of editors whose responsibilities directly impact content accuracy and system usability. We identify typical challenges based on an analysis of practical cases, user interactions, error patterns, and use them to propose a targeted competence development framework that includes regular training, collaborative support networks, role-based guidelines, and the potential use of AI-powered tools to support semantic editing, fact-checking, and academic integrity. The research underscores the need for methodological approaches tailored to the specific requirements of the Semantic Web technologies and advocates for further integrating ontological models to ensure consistent content formalisation.

## Keywords

digital competence, online encyclopedia, Semantic Wiki, analytical Web portal, ontological model

## 1. Introduction

The digitalisation of society significantly transforms the requirements for professional activity in the field of education. The development of digital competence, encompassing the ability to work with large volumes of information, critically evaluate sources, and effectively use digital platforms in professional interaction, has become particularly relevant.

The evolution of reference literature in the digital age is occurring through the transition from static online reference resources to interactive web-oriented systems with analytical functionality. Modern online encyclopedias not only record conceptual and terminological frameworks but also ensure their systematisation, updating, and unification in accordance with international standards. Today, web-oriented online encyclopedias are multifunctional tools that provide open access to scientific knowledge and support its analysis. They serve as powerful instruments for digitalising science and education, contributing to the development of terminological culture, particularly in pedagogy and psychology.

Open educational and scientific resources, particularly web-oriented automated information systems (WAIS) [1], can be used not only for knowledge accumulation but also as an environment for the

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development of cognitive, communicative, and research skills [2]. In this context, the *Ukrainian Electronic Encyclopedia of Education* (UEEE, <https://eduglos.iitta.gov.ua/>) is a modern, innovative platform that combines the functions of pedagogical knowledge systematisation, the maintenance of academic integrity and knowledge-oriented information processing based on semantic technologies. Through the integration of semantic technologies, users can perform deeper data analysis, discover meaningful relations between concepts in the pedagogic domain, and better understand the context of their descriptions.

UEEE also supports multimedia content with semantic metadata, visualisation tools for search results, links to external open resources, and the establishment of correspondences with pertinent terminological elements in encyclopedias in other natural languages. The further development of the encyclopedia envisions the incorporation of artificial intelligence (AI) elements (such as Large Language Models [3] both for semantic content structuring and for the creation of user-oriented consulting chatbots. Additional functionality, such as semantic integrity check services, improves the quality and transparency of the content. This semantic extension makes online encyclopedias valuable tools for education and scientific research.

The experience of the initial practical population of UEEE content demonstrates that all participants in encyclopedic content creation require not only basic digital literacy but also advanced digital competences, particularly in working with structured knowledge [4] and semantic markup that describes links between materials. This work necessitates specific personnel training approaches that combine methodological and technical awareness with analytical thinking. For example, the digital competences of UEEE editors should include the ability to work with semantic Wiki markup for the structured representation of encyclopedic knowledge and to process various multimedia formats used to illustrate articles.

Research in the field of digital humanities confirms that the successful use of semantic platforms requires a high level of knowledge interoperability, flexible thinking, and the ability to adapt content structures to the dynamic conditions of the digital environment [5]. This work necessitates specific personnel training approaches that combine methodological and technical awareness with analytical thinking. For example, the digital competences of UEEE editors should include the ability to work with semantic Wiki markup for the structured representation of encyclopedic knowledge and to process various multimedia formats used to illustrate articles.

Thus, the effectiveness of creating and applying the UEEE depends not only on improving WAIS interfaces and navigation capabilities but also on developing the digital competence of encyclopedia content editors. These competences should consider the specifics of using semantic Wiki technologies [6] and the particularities of the pedagogic domain, while ensuring academic quality, content integrity, and conceptual interconnection of materials.

## **2. Online encyclopedias: state of art and problems**

### **2.1. Technological foundations of UEEO: Web portals and their specifics**

Analysis of the prospects for the development and potential intellectualisation of WAIS shows the necessity of defining a specific subset of web resources that can be considered web portals and of identifying their common features and particular functions that distinguish them from other types of websites.

A *web portal* is a website organised as a multi-level integration of various resources and services, navigation tools, and information systems [7] which can be used as a network entry point to support the specific informational needs of individual users or user groups.

In this research, we define a web portal as a specially designed website that unifies the delivery of information from various sources on a single platform, assists with navigation and the personalisation of notifications, and offers advanced features such as task management, collaboration, business analytics, and more.

In our view, the main functions of a web portal are:

- *supporting of content updating* through a set of tools that enhance information search and improve content quality and integrity;
- *improving user interaction* by additional opportunities for communication between site owners, content developers, and users, thereby strengthening customer relations and offering high-quality, filtered information on a convenient and comprehensive platform;
- *ensuring domain orientation* by semantically linking the portal to a specific subject area to meet diverse user needs in searching for relevant information and services.

The difference between web portals and other websites primarily focused on traffic growth lies in their aim to reduce traffic by providing more efficient and personalised analysis of content and user requests. Therefore, the programming languages and frameworks commonly used to develop web portals have specific characteristics and require significantly broader functionality. Additionally, their prevalence differs from that used for creating other types of websites.

From another perspective, web portals can be considered knowledge management systems that enable knowledge creation, sharing, and reuse.

We distinguish a subset of *information-analytical Web portals* (IAWPs) that provide a broader range of analytical services and automated knowledge acquisition services from data (for example, enriching the portal's ontological content models or improving the structure of semantic links). They support content processing at the knowledge level and involve data mining, machine learning, and logical reasoning elements. Such IAWPs require more complex content models for the integration, comparison, alignment, and visualisation of the information provided to users.

The main trends in developing IAWPs relate to their semanticisation and the potential for information reuse. These trends are directly connected to the Semantic Web project and extensively use the standards and knowledge representation languages developed within this initiative [8].

The development of web portals is progressing in the directions of personalisation, service improvement, intellectualisation, and user-centred design. In practice, these directions are often combined. **Personalisation** means that web portals increasingly adapt content and interfaces to individual user preferences to improve engagement and usability [9]. **Service Improvement** involves higher usability, interactivity, and integration of services aimed at meeting users' evolving expectations and supporting seamless digital experiences [10]. Intellectualisation is reflected in the increasing integration of Semantic Web technologies and intelligent systems to enable smarter, context-aware interactions [11]. User-centred design is realised through the creation of portals that are not only functional but also accessible, intuitive, and adaptive to diverse user groups [12, 10].

The development trends of IAWPs also relate to these four directions. However, they require greater attention to defining the set of services provided by the portal and additional requirements for content presentation that support the execution of these services.

To a large extent, the possibilities for portal semanticisation are determined by:

- the overall concept of portal development;
- its goals and purpose; the selected software;
- the model and structure of the portal's knowledge base;
- the expressive capabilities of the implemented search services;
- the tools and methods for portal content structuring;
- the possibilities for importing external knowledge bases.

However, it should be noted that a successful choice of content representation model, service set, and software implementation does not automatically guarantee the creation of a truly effective semantic portal. A web portal operates within an open and constantly changing information environment. Therefore, portal development requires continuously updating and integrating the knowledge models used on the portal and the content itself to ensure relevance and consistency.

The above analysis of web portal development directions demonstrates that the possibilities of portal development depends on the following prerequisites:

- the availability of open-source software that supports content scalability and offers sufficient expressiveness for representing complexly structured information;
- the use of a knowledge representation model that is compatible with knowledge management technologies in an open environment and supports both the import and export of knowledge from external information resources;
- the semantic structuring of content and the creation of metadata that describes this content;
- verifying content consistency and enabling its automated generation based on semantic markup;
- the availability of a consistent and expandable set of services for retrieval and navigation, as well as tools for content analysis and its automated generation in response to user queries.

One of the most promising directions in creating IAWPs that operate with open data is based on Wiki technologies and their semantic extensions. An example of this approach is the portal of the Great Ukrainian Encyclopedia (<https://vue.gov.ua>). At present, this portal meets many of the requirements aligned with modern trends in web portal development; however, it still requires further enhancement and continuous maintenance of both its structure and content to remain consistent with the dynamic changes in the open information environment and the evolution of the information resources that serve as its content sources.

Semantic extensions of Wiki technologies, such as the Semantic MediaWiki plug-in for MediaWiki, provide powerful tools for structuring content in accordance with Semantic Web standards. These tools enable collaborative editing of data and their metadescriptions, the creation of customisable sets of properties within metadata templates, and the dual-mode representation of such content in machine-processable and human-readable formats. This, in turn, allows for efficient data manipulation, automated management, comprehensive analysis, and streamlined publication.

The use of Wiki technology based on **MediaWiki technological platform** [13] and its semantic extension **Semantic MediaWiki** [14] has historically proven to be a powerful tool. It offers a large user community, open-source code, and transparent principles of development and maintenance. This technology is continuously evolving, supports compliance with the FAIR data principles [15], and provides sufficient functionality for working with the content of analytical web portals.

## 2.2. Digital competence of content creators and users

Currently, the issue of developing and enhancing the digital competence of users of web portals and digital educational resources is highly relevant and actively studied. However, the proportion of research specifically addressing electronic encyclopedic resources remains limited. Moreover, the primary target audience of such studies predominantly includes university students and/or faculty members. Common features across many studies include a focus on information and data literacy [16, 17, 18], digital content creation [16]. Safety [17], the development of multimedia and technological skills as components of digital competence [18, 19, 20], and a holistic understanding of functioning in a digital environment [21], which also encompasses the use of Web resources, including encyclopedic resources in particular.

Digital content creation skills, digital resource management, the necessity of continuous ICT learning, and the development of digital competence are essential for the effective use of Web platforms.

The rapid evolution of Web technologies, particularly tools for collaborative knowledge processing and semantic content management systems, has become a powerful catalyst for transformations in digital education and encyclopedic Web platforms. There is an increasing need to develop the ability to use digital services and resources and create knowledge, critically evaluate information flows, and maintain security and ethical standards within the digital environment. Systematically implementing the Digital Competence Framework for Citizens (DigComp 2.2) [22] is significant in this context.

International standards such as DigComp 2.2, UNESCO ICT CFT, ISTE Standards, ACM/IEEE Computing Curricula 2020 (CC2020), the European e-Competence Framework (e-CF), and the Skills Framework for the Information Age (SFLA) consider structured models for the development of digital skills, covering a wide range of abilities, including information literacy, communication, content creation, security and problem-solving, media literacy, and lifelong learning [23].

Most publications refer to research and EU policy when describing the definition of digital competence. In the European Key Competence Framework, digital competence is defined as one of the key competences for lifelong learning, involving the confident and critical use of information technologies for work, leisure, and communication [24].

A review of recent publications demonstrates a growing focus on the challenges of measuring digital competence. It emphasises the critical importance of developing digital competence among learners and educators and enhancing the digital literacy of users of electronic resources [25, 26].

Based on the authors' experience of working with information-analytical systems built on the MediaWiki engine and its Semantic MediaWiki (SMW) extension, it has been observed that their users – including readers, editors, administrators, and expert reviewers – are engaged in a wide range of digital practices that correlate with the components of the DigComp framework. For instance, readers demonstrate competences 1.1 (browsing, searching, and filtering data, information, and digital content) and 1.2 (evaluating data, information, and digital content) as they interact with large-scale, categorised, and semantically annotated knowledge bases. Editors and content authors engage in the collaborative development of articles, which aligns with competences 3.1–3.3 (creating, re-elaborating digital content, and ensuring copyright compliance) and 2.4 (collaborating through digital technologies). Meanwhile, Web portal administrators, responsible for knowledge structuring, ontology maintenance, and categorisation schemes, acquire competences at levels 5.1 (solving technical problems), 5.3 (creatively using digital technologies), and 1.3 (managing data, information, and digital content).

MediaWiki and SMW provide a digital interaction infrastructure with open data in the context of civic engagement. As a platform that combines semantic structuring with openness to collaborative editing, it creates an environment for the integrated development of competence in civic participation through digital technologies (2.3 engaging citizenship through digital technologies), including interaction with open data and participation in professional discourse.

The involvement of reviewers and experts who conduct independent verification of materials contributes to developing skills in evaluating digital content (1.2) and supports maintaining ethical standards of interaction (2.5 Netiquette).

## Problem definition

We analyse the evolution of encyclopedic resources in the context of digital transformation to identify the most important directions for expanding the components of digital competence. This study demonstrates that the effective use of the functional capabilities of an online encyclopedia requires the competent application of semantic technologies by all participants involved in developing the *Ukrainian Electronic Encyclopedia of Education* (UEEE). However, the current level of digital competence among editors and moderators proves insufficient for creating and developing such a knowledge-intensive product. Therefore, it is necessary to specify more precisely the functional capabilities associated with the user roles in the UEEE and determine the most effective sequence of actions for developing the corresponding components of competence. This differentiation aims to identify existing gaps and determine priority areas for training. In this context, the interaction between editors, moderators, and knowledge engineers of the UEEE serves as an important data source.

The study was conducted on a relatively small sample of respondents, as its goal was to identify significant problems and generalised trends that could enable further scaling in user engagement. The choice of the UEEE as the object of the study is explained by the fact that the creation and processing of resources on this analytical portal, with its complex structure and heterogeneous content, requires collaborative and coordinated interaction among participants who are experts in various fields. In addition, the emphasis on using modern semantic technologies in its development necessitates continuous learning and professional development for all project participants.

**The purpose of the study** is to determine the current state of digital competences of all participants in the UEEE development, their differentiation according to roles in content processing (e.g., editors, authors, moderators, knowledge engineer) identification of key problems and selection of the most effective ways to improve competence, taking into account promising directions in the development of

the encyclopedic resource.

### 3. Main results of research

#### 3.1. Portal “The Ukrainian Electronic Encyclopedia of Education” specifics

The UEEE portal is an IAWP developed to support, integrate, and advance the conceptual and terminological framework of pedagogy and psychology. It offers extended tools for structuring, navigation, and search based on the semantic markup of natural language and multimedia content.

Main differences of UEEE from traditional printed publications:

- articles are not rigidly limited in volume;
- articles they can include the multimedia content (photo galleries, illustrations, videos, etc.);
- articles contain semantically defined links to external resources and other UEEE articles;
- articles metadata can be used for complex user requests;
- content is integrated with social media platforms, news feeds, and other digital resources.

#### 3.2. UEEE structure and key components

The structural elements represented on the main page of UEEE (figure 1) include:

- Information about the project and its objectives;
- Search tools;
- Alphabetical index of articles;
- Main thematic sections of the articles;
- Media file collection;
- Information about the encyclopedia’s authors;
- Contacts and feedback details.

Additionally, users can access sample articles from different categories, integrator pages, information about UEEE partners, and policies regarding the use of its content.

#### 3.3. User roles in the UEEE

The UEEE portal is developed based on the MediaWiki software that provides predefined user groups such as unauthenticated, authenticated, and automatically confirmed users and bots, administrators, bureaucrats, suppressors, and interface administrators. However, this role hierarchy does not fully meet the editorial process logic designed for UEEE.

User roles are determined by their objectives and their specific functions within the encyclopedia to achieve these objectives. From the perspective of knowledge management, these roles define access rights – both reading and editing – for various types of complex informational objects that constitute the encyclopedic content, which is structured based on semantic wiki technology. The main user roles in the UEEE include: readers, authors, editors, moderators, knowledge base engineers, programmers, and website administrators.

The knowledge graph (figure 2) illustrates the relationships between the core interaction elements within UEEE. It is generated by the authors of this study using [aigraphmaker.net](https://aigraphmaker.net), incorporating artificial intelligence elements and external knowledge bases. The knowledge graph reflects traditional conceptions of user roles in an online encyclopedia. However, it should be noted that within the UEEE, these roles exhibit significant distinctions determined by the following factors:

- the specifics of the portal content and the requirements of its sources (the list of encyclopedia articles is pre-approved, and authorized representatives of these organizations must provide information regarding organizations and their employees);



**Figure 1:** The main page of the UEEE (fragment).

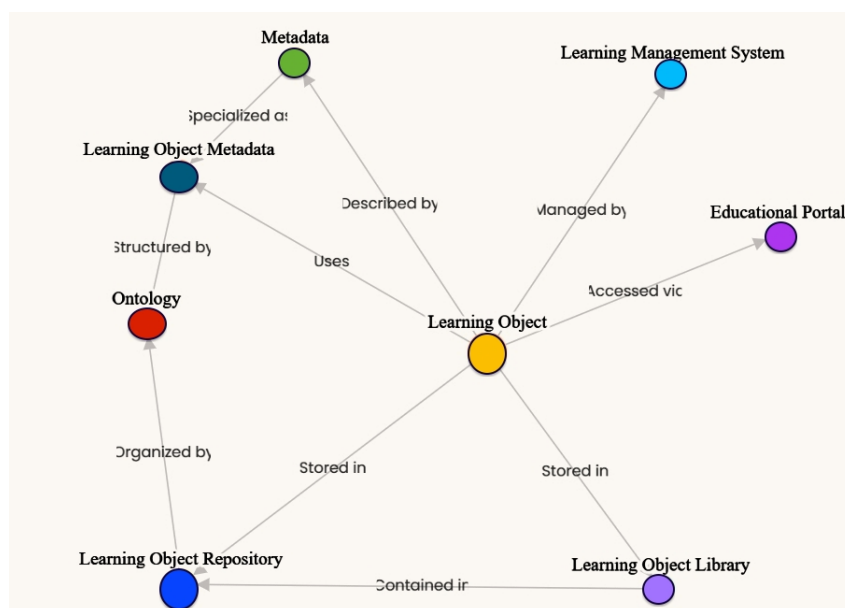
- the capabilities and expressive tools of wiki technology and its semantic extensions that define types of tasks performed by content developers;
- the AIWP content development process is significantly more complex than that of a traditional online reference resource, as it includes stages of developing, refining, and implementing a knowledge base and semantic content structuring tools;
- the collaborative activities of editors have to be centrally administered (coordinated) to prevent duplication in the creation of encyclopedia articles;
- the digital competence of certain participants of the content generation process (particularly editors) can be insufficient for accurately representing the semantic components of articles (this task necessitates both moderator oversight and additional training);
- the need for feedback between content authors (who do not directly interact with the portal), editors (who edit this content into the portal), and knowledge base developers.

The permissible actions for the primary user roles, as shown in the table, are denoted as follows: R – reading, W – editing, and yes/no – available/unavailable functionality, and define the digital competences required by different types of users. This study focuses on the digital competences of editors responsible for uploading and managing content on the wiki-based platform integrated with Semantic Wiki technologies. This focus is justified because this user category performs the most significant volume of content-related operations. Therefore, potential errors on their part could significantly affect the overall quality of the information resource.

According to table 1, we can identify the specific digital competences required for users in each role.

### 3.4. Digital competence of UEEE users

At the stage of testing the experimental prototype of the UEEE, we urgently need to define more clearly the tasks of project participants related to the development and maintenance of its reliable functioning according to their respective roles.



**Figure 2:** Knowledge graph representing user interaction with UEEE content according to their roles.

**Table 1**

User permissions within the UEEE according to their roles.

| Objects, functionality                 | Reader | Author | Editor | Moderator | Knowledge engineer | Site administrator | Programmer |
|----------------------------------------|--------|--------|--------|-----------|--------------------|--------------------|------------|
| Main page                              | R      | R      | R      | W         | W                  | W                  | W          |
| Encyclopedia articles                  | R      | R      | W      | W         | W                  | W                  | R          |
| Wiki template pages                    | no     | no     | R      | R         | W                  | R                  | R          |
| Category pages                         | R      | R      | R      | W         | W                  | W                  | R          |
| Semantic property pages                | no     | no     | R      | R         | W                  | R                  | R          |
| Graphical objects                      | R      | R      | W      | W         | W                  | W                  | W          |
| Integrator pages                       | R      | R      | R      | R         | W                  | R                  | R          |
| Creation of encyclopedia article pages | no     | no     | no     | yes       | yes                | yes                | no         |
| Creation of Wiki template pages        | no     | no     | no     | no        | yes                | no                 | no         |
| Creation of category pages             | no     | no     | no     | yes       | yes                | yes                | no         |
| Creation of semantic properties        | no     | no     | no     | no        | yes                | no                 | no         |
| Semantic search                        | yes    | yes    | yes    | yes       | yes                | yes                | yes        |
| Site sonfiguration                     | no     | no     | no     | no        | no                 | yes                | yes        |

Based on this, it is necessary to identify the specific components of *digital competence* (DC) required to perform these tasks successfully. In the further DC description, we use the terminology based on the specific features of the Semantic MediaWiki environment and the particular characteristics of UEEE content.

The analysis of individual roles aims to single out precisely those functions that relate to their specific responsibilities. It should be noted that the same person can combine several roles: for example, prepare an article for the UEEEO as an author, publish it as an editor, and then check the correctness of its presentation as a moderator.

The “**Author**” role does not require user authorisation within the wiki resource, as authors are responsible for developing and submitting a draft version of an encyclopedic article and accompanying multimedia materials. The publication process is managed by editors, designated representatives of the institutions affiliated with the National Academy of Educational Sciences of Ukraine and higher

education institutions with an educational focus. Although researchers can propose their materials for editorial consideration using the designated feedback form, the moderator's responsibility is the selection of authors and approval of submitted materials. The key components of author DC are: possessing subject-specific knowledge relevant to the prepared article; the ability to effectively use open information resources for content development, including scientometric databases to identify up-to-date, highly cited references; skills in finding open data resources to support their arguments; proficiency in using automated translation tools and plagiarism detection systems, especially considering the risks of unethical use of Generative AI. The DC availability enables authors to offer higher-quality and more relevant content. Therefore, the development of the UEEE provides consultations and reference materials aimed at enhancing the authors' digital competence in these areas.

In addition, the development of the UEEE requires adherence to a standardised and consistent approach to content presentation. Therefore, authors should refer to previously published articles. Specifically, they need the ability to review existing UEEE articles and access information regarding the structure of articles of specific types (currently, UEEE includes such categories of articles as historical and contemporary personalities, organisations, documents, etc. accompanied by examples and structural templates).

The **"Reader"** role allows registered and unregistered users to view content and propose new terms or suggest corrections to existing ones. DC required for readers is limited to navigating wiki pages, following hyperlinks and category links, performing searches by page titles, keywords, and alphabetical indexes. To enable effective feedback from readers to the UEEE, users must possess the digital competence necessary to use email or other communication channels supported by the UEEE.

The **"Editor"** role involves submitting, editing, and updating article content (text and multimedia), as well as coordinating the tasks performed by authors and reviewers. The core components of editors' DC include: basic knowledge of wiki markup; familiarity with semantic wiki markup; proficiency in using UEEE-specific wiki templates; the ability to review existing UEEE articles (as examples) in editing mode; the ability to upload multimedia objects to the UEEE storage and to correctly integrate multimedia of various types into article pages (using both templates and appropriate markup); the ability to properly apply semantic properties to structure article content. Additionally, editors have to be familiar with the specific UEEE requirements: selecting the appropriate article templates, using the correct tags for semantic markup, and providing authors with clear explanations regarding comments and suggestions related to content (for instance, it is recommended that references to open-access information resources supplement articles published on the portal).

The **"Moderator"** role is associated with the organisation and management of publishing high-quality content. This DC includes searching for article authors, coordinating editors and authors' work, publishing current article versions, updating informational content when necessary, managing content requests, and performing portal analytics. Moderators are expected to possess basic knowledge of semantic wiki markup at a more advanced level than editors. Their DC should also include: proficiency in using UEEE wiki templates; the ability to work with articles in editing mode; the ability to create and manage semantic properties; the ability to review and understand the structure of templates; the ability to upload multimedia objects to the UEEE storage; the ability to embed multimedia objects of various types into articles (using both templates and wiki markup); the ability to correctly apply semantic properties to structure article content.

The **"Knowledge Base Engineer"** role requires DC to manage distributed knowledge and its collaborative use. This specialist is responsible for organising the portal's knowledge base (KB) and updating its structure. The core components of the digital competence required for a KB engineer include: advanced knowledge of wiki markup; proficiency in creating and applying semantic properties within wiki markup; the ability to develop and edit wiki templates for standard UEEE article types (for example, UEEE currently uses templates designed explicitly for article categories such as "Organization", "Personality", "Reference Entry", etc.); the ability to construct semantic requests; the ability to work with articles in editing mode; the ability to upload multimedia objects to the UEEE storage; the ability to embed multimedia objects of various types into articles; the ability to accurately apply semantic properties for the proper structuring of article content.

DC requirements for users depend on the specific role they perform. For the roles of **Editor**, **Moderator**, and **Knowledge Base Engineer**, these requirements are similar in nature but necessitate different practical skills. A single individual can perform multiple roles depending on the situation.

The core components of DC for the “**Web site Administrator**” role include: the ability to manage user access rights; the ability to differentiate and assign various levels of user access, organise user accounts, and delete them if necessary; the ability to create and delete wiki pages, as well as add UEEE structural elements to these pages; the ability to install and manage wiki plugins (widgets) for presenting multimedia objects, facilitating search functions, and enabling information visualisation, among other features.

Users performing the “**Programmer**” role are responsible for server administration, MediaWiki installation, portal design, the development of additional functional modules, and the installation, updating, and removal of plugins. The core DC components for this role include: server administration skills; the ability to install MediaWiki and additional plugins; proficiency in updating system versions and creating backups of both the encyclopedia’s structure and content; the ability to develop and implement additional features and modules for the portal as requested by moderators.

## 4. Discussion

### 4.1. Development of editors’ digital competence: challenges and paths for improvement

Identifying strategies for DC improvement of UEEE editors requires, in particular, the development of practical skills for the effective and appropriate use of digital tools in preparing and enriching AIWP content.

While deploying the UEEE AIWP, we identified specific skill and knowledge development needs of editors related to content publication. We establish the main factors that influence these needs:

- the team of editors and moderators is changed over time, and new participants often lack the necessary knowledge and skills, or their experience is not aligned with the specific features of UEEE (for example, individuals familiar with traditional wiki markup tend to use it instead of semantic markup, and this approach causes content processing errors);
- the range of participant functions is expanded in the process of UEEE portal development (for example, with the use of additional types of articles and additional semantic properties), and this function complication requires additional training;
- increasing complexity in the structure of the UEEE can lead to variability in understanding the meaning and purpose of content elements. Therefore, it becomes necessary to document the KB structure and the formal semantic descriptions of its components (for instance, editors mix the templates for "reference entry" and "definition");
- the expansion of content is associated with greater diversity in article types that causes the need to develop new templates, provide examples of their use, and offer training in their practical application;
- gradually, editors and authors need to gain a more comprehensive understanding of semantic Wikis’ expressive capabilities to formulate new requests to the KB engineer concerning acceptable semantic property values, data representation formats, permissible and impermissible configurations, exceptional cases, etc.

The analysis of the experience of UEEE editors and moderators in publishing encyclopedic articles reveals common mistakes and shortcomings, including:

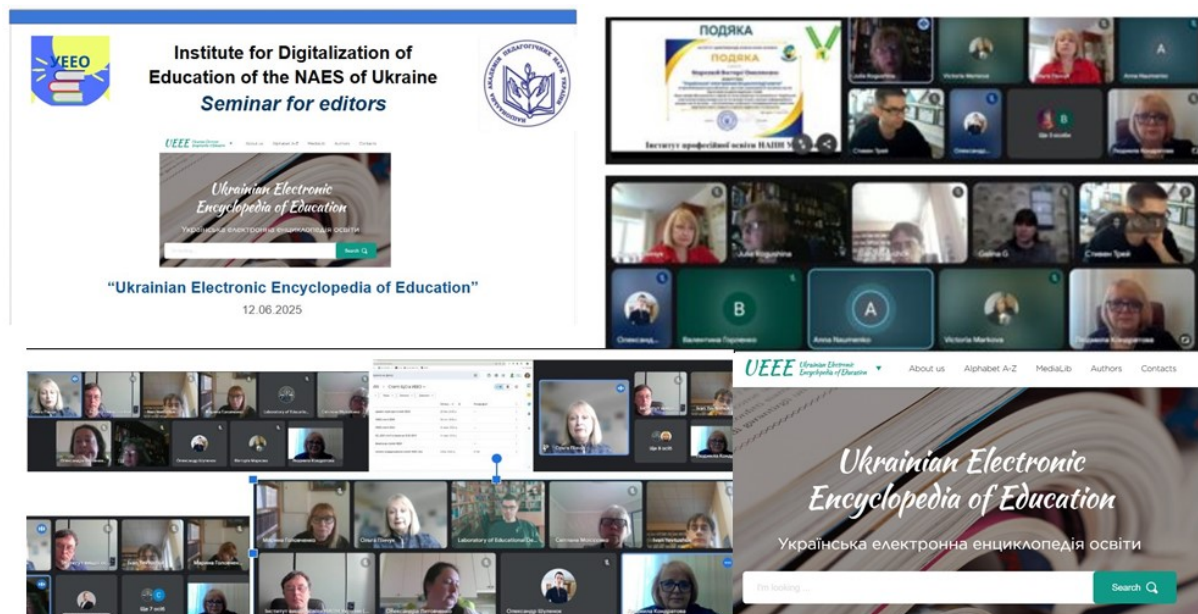
- incorrect structuring of article sections (for example, in reference-type articles, editors frequently make the typical mistake of providing an excessively detailed definition or misallocating content between the sections "historical background," "characteristics," and "classification");
- incorrect selection of the article category and use of irrelevant template;

- lack of semantic specification for internal and external hyperlinks in accordance with UEEE guidelines (use of hyperlinks instead of semantic properties);
- incorrect completion of semantic wiki templates for UEEE articles, such as using inappropriate delimiters or entering values of incorrect types;
- incorrect spelling of proper names in UEEE formats.

Other examples of mistakes are the use of low-quality images in articles, errors in formatting elements, incorrect information about authors and editors entered on the corresponding pages, and the incorrect selection of the article status. Additionally, some problems deal with the reference lists used by the articles (particularly concerning source relevance, completeness, and accessibility).

In response, we implemented the following activities and measures to develop the DC of UEEE editors:

- monthly training sessions for UEEE editors, conducted both in-person and online (figure 3);
- organisation of collaborative interaction and communication within the Telegram group "UEEE Editors" for prompt support, advice, and information sharing. The group includes specialised threads such as: article title requests, completed articles, articles under review, technical issues, the main group chat, and a consultation platform.
- individual consultations and practical demonstrations;
- practical workshops on article creation and multimedia content publication;
- preparation of a comprehensive manual available on the UEEE IAWP "Help" page;
- supplementing pages of categories and semantic templates with explanations regarding their appropriate use.



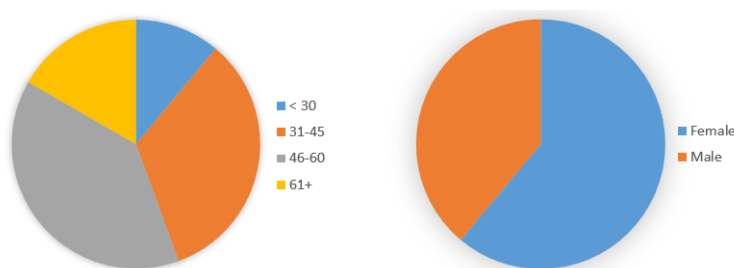
**Figure 3:** Conducting workshops for the UEEE editors.

These measures aim to correctly represent content elements, both textual and multimedia. The training facilitated the transition from visual text formatting to more complex tasks with the Wiki code editor and the use of semantic markup tags. The variety of training formats allows for consideration of individual differences in information perception by editors, as well as the diversity of their prior experience and initial levels of DC.

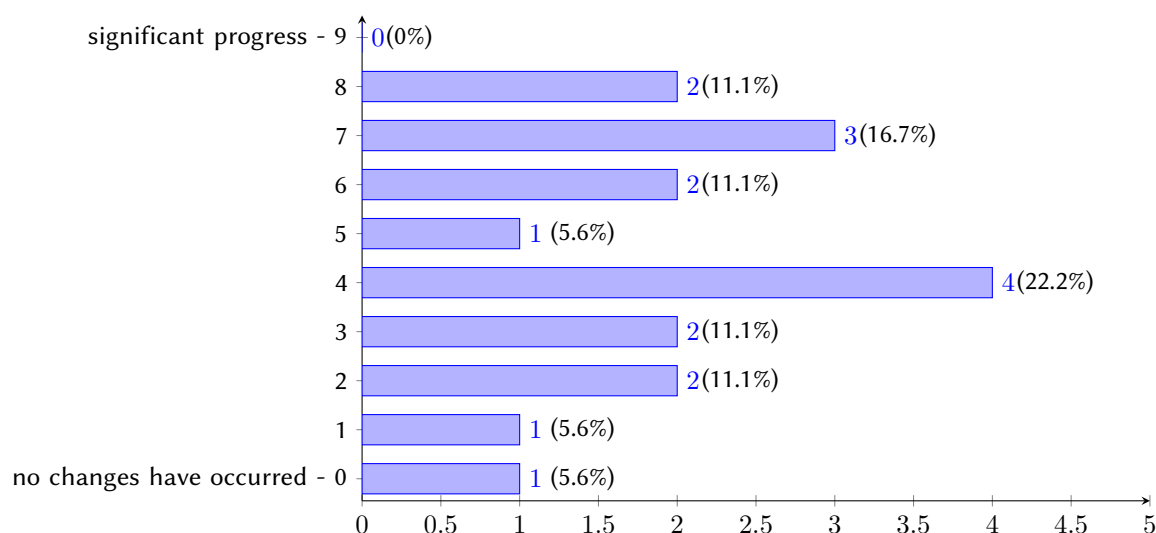
A survey was conducted among editors with diverse levels of digital competence, education, age, and professional experience. The survey participants were involved voluntarily and were duly informed

about the survey's purpose and objectives. The limited sample size is explained by the fact that only editors with confirmed practical experience in the UEEE content publishing are included in the study, which ensured a high level of relevance of the data obtained. The scientific novelty of the study lies in identifying priority directions for developing the digital competence of editors as a specific group of users within the UEEE ecosystem, as well as in revealing trends that had not previously been the subject of systematic analysis. The survey results provide a foundation for further scaling the existing experience and for developing methodological solutions capable of minimising risks during the expansion of the user base. Thus, even at the present stage, it is possible to outline problem areas and propose ways to overcome them that significantly contribute to developing a methodology for assessing digital competence in web-oriented encyclopedic systems.

61.1% of respondents are female and 38.9% are male. A considerable proportion of the respondents are over 46 years old, with 16.7% being over 60 years old. (figure 4). The editor evaluations of their current digital skills, their ability to work with articles, and their progress in digital competence are defined on a scale from 0 to 9 (where 9 indicates significant progress and 0 indicates no change) (figure 5).



**Figure 4:** Survey results of UEEE editors and moderators (information about editors and moderators).



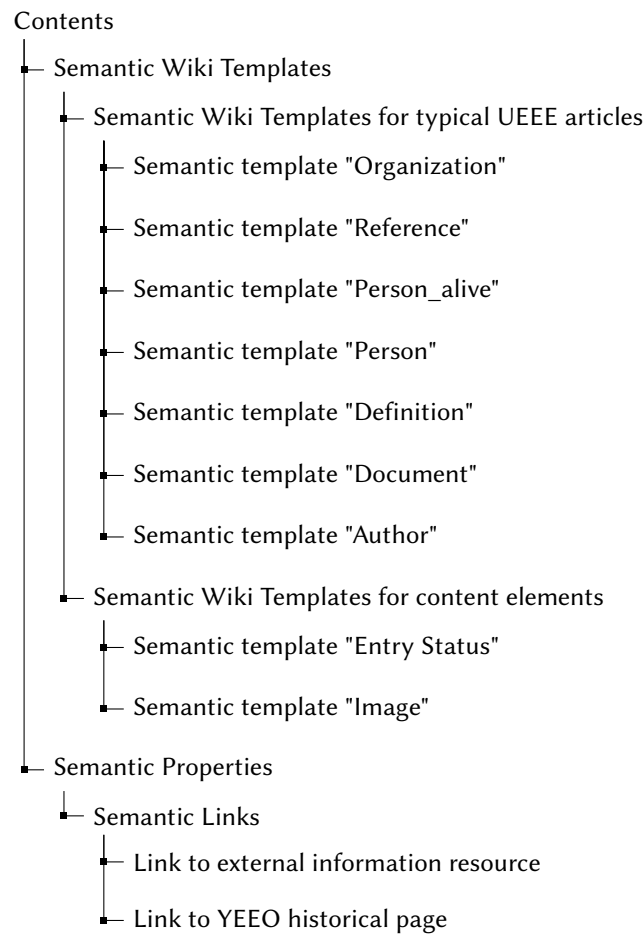
**Figure 5:** Survey results of UEEE editors and moderators on the development of DC (Rate the changes in your digital competence during the process of working with UEEE).

## 4.2. Use of Wiki templates for typical articles, samples, and WI page examples

An important tool in the Wiki environment is the ability to create templates for typical informational objects. In Semantic MediaWiki (SMW), the parameters of such templates are interpreted as semantic properties of the corresponding article, which can then be used for semantic search.

In developing the UEEE, various technological elements have been designed to support editors in their work. Semantic wiki templates and properties have been created to ensure standardised information

representation and to enhance search capabilities for data contained within article content (figure 6).



**Figure 6:** “Help” page structure in the Ukrainian Electronic Encyclopedia of Education.

The portal currently contains:

- semantic wiki templates for typical UEEE articles (templates for article types such as “Organization”, “Reference”, “Personality”, “Definition”, “Document”, “Author” etc.);
- semantic wiki templates for common content elements of articles (templates such as “Article Status”, “Image”, “Gallery”, “Semantic Link”, “External Resource” etc.).

These templates are intended to simplify content editing and enable editors not fully proficient in semantic wiki markup to take advantage of its functionalities.

SMW allows only the definition of value types (e.g., text or number) but does not formally describe their class at the semantic level (for example, whether a value represents an organisation name or a country). For example, articles from the category “Personality” have a semantic property “place of work” defined in SMW as a “text” type. However, this definition does not clarify what should be indicated as its value – the city, the country, or the name of the organisation where the person works. Editors find it challenging to understand the relation between the parameters of such templates and their permissible values.

Therefore, employing more advanced tools for knowledge formalisation, namely ontologies, is advisable. Ontologies allow for the explicit specification of the classes to which the values of semantic properties for different object types should belong [27]. The application of ontological analysis requires a higher level of digital competence (DC) from all participants involved in content creation. For editors and moderators, this involves interpreting and applying the graphical representation of the UEEE ontological model (figure 7). For the Knowledge Base (KB) engineer, it requires proficiency in creating

and extending the UEEE ontology (figure 8), generating visual representations of relevant ontology fragments, constructing SPARQL queries to this ontology [28], and importing knowledge from external ontologies.

**Figure 7:** Visual representation of the UEEE content ontological model in Protege (fragment).

**Figure 8:** Ontological model of UEEE content (fragment).

and moderators who have already acquired skills in working with SMW currently lack the knowledge and abilities necessary to apply ontological analysis. This lack complicates understanding the potential of tools for structured knowledge representation and semantic linking of information. Therefore, it is advisable to conduct additional targeted training emphasising the practical processing of real cases, which will gradually foster a practical understanding of the ontological approach for knowledge representation and facilitate mastering the principles of working within a semantic environment.

Improving editors' and moderators' DC enables more effective use and replenishment of domain knowledge formalised within this ontological model. Such formalisation is expected to ensure more standardised content representation and to prevent several common errors and misunderstandings of instructions in the publication of articles.

## **5. Conclusions and prospects for further research**

The analysis of the interrelation between user roles, their DC, and the functional capabilities of the UEEE platform demonstrates that, despite the availability of basic instructional materials and training activities, complex tasks such as content updating, categorisation, and expert verification remain challenging for editors, moderators, and authors. This problem highlights the need to shift from universal solutions to personalised approaches that consider the user's existing level of digital literacy, cognitive styles, and professional context.

Currently, the development of high-quality online encyclopedias has to be based on the extensive expertise of subject specialists who provide accurate and up-to-date content and the most pertinent information technologies that ensure the accessibility and comprehensibility of the represented information while enabling its practical use. However, it is essential to recognise that the achieved results also depend on the necessary digital competencies of all participants involved in creating and using the encyclopedia – specifically, their ability to correctly apply information technologies and effectively use relevant additional analytical tools and information sources.

This study aims to identify the specific skills and knowledge required by different categories of UEEE users and developers, assess the current level of their digital competencies, and determine appropriate measures of competence development. The conducted analysis demonstrates that the availability of detailed guidelines provided on the UEEE platform and the regular organisation of training sessions do not fully address the complex information needs of user groups with such roles in UEEE development as editors, authors, and moderators.

Despite the technological potential of the selected platform for the construction of the analytical Web portal, we detect a persistent gap between the level of UEEE development tools and the readiness of a broad user base to their effective practical application. This gap highlights the need to develop an integrated methodology for advancing DC that should encompass not only technical skills related to working with MediaWiki and Semantic MediaWiki but also form critical thinking, information literacy, and the ability to navigate ontological knowledge structures.

Thus, the UEEE's development prospects as an analytical Web portal are linked to innovations in information and communication technologies and a deeper understanding of users' digital needs and cognitive behaviour within the dynamic environment of open education.

In the future, we also consider the potential use of specialised AI instruments based on large language models that, after targeted training in a dialogical mode, can provide editors and moderators with interactive consultations about semantic markup and structuring of articles, help in analysing content integrity and text quality, ensure academic integrity and prevent plagiarism, and support elements of fact-checking. These elements of UEEE development and their use by editors are at the stage of accumulating typical user requests and selecting response formats most comprehensible to various user groups.

## Author contributions

Conceptualization, Olha P. Pinchuk and Julia V. Rogushina; methodology, Julia V. Rogushina; software, Julia V. Rogushina; formal analysis, Olha P. Pinchuk; investigation, Liudmyla G. Kondratova; data curation, Liudmyla G. Kondratova; writing – original draft preparation, Olha P. Pinchuk and Julia V. Rogushina; writing – review and editing, Olha P. Pinchuk and Liudmyla G. Kondratova; visualization, Julia V. Rogushina and Liudmyla G. Kondratova; supervision, Olha P. Pinchuk; project administration, Liudmyla G. Kondratova. All authors have read and agreed to the published version of the manuscript.

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## Data availability statement

The data supporting the findings of this study are partially available within the article. The study involved human participants who completed an anonymous survey and were aware that the results would inform the refinement of educational content. To preserve participant confidentiality, the full raw dataset is not publicly available, but anonymised selected, processed data relevant to the objectives of this research can be made available upon reasonable request from the corresponding author.

## Conflicts of interest

The authors declare no conflict of interest.

## Declaration on Generative AI

In the preparation of this paper, the authors used Generative AI tools, specifically <https://copilot.microsoft.com>, to support grammar correction and  $\LaTeX$  formatting. The tools were employed solely to improve language clarity and document presentation. All intellectual content was conceived, written, and verified by the authors. The authors have thoroughly reviewed all AI-assisted outputs and accept full responsibility for the final content of the manuscript.

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