



## ***INSTRUMENT-MAKING AND INFORMATION-MEASURING SYSTEMS***

## ***ПРИЛАДОБУДУВАННЯ ТА ІНФОРМАЦІЙНО-ВИМІРЮВАЛЬНІ СИСТЕМИ***

UDC 004.77

### **METHODOLOGY OF DEVELOPMENT AND ARCHITECTURE OF ONTOORIENTED SYSTEM OF ELECTRONIC LEARNING OF CHINESE IMAGE MEDICINE ON THE BASIS OF TRAINING MANAGEMENT SYSTEM**

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***Summary.** The work is devoted to solving the problem of the lack of a qualitative electronic training course on Chinese Image Medicine and analysis of the main tasks related to the sphere of knowledge management: content preparation, its adaptation and personalization, use in ontooriented E-learning. The key tasks that will decide on the creation of the system of electronic learning of Chinese Image Medicine are highlighted; the expediency of the use of ontology for systematization of the content of the system of electronic learning of CIM is substantiated and the ontological model of CIM is proposed; the stages of the development of the E-learning course CIM and the advantages of LMS are analyzed.*

***Key words:** ontology, ontological modeling, E-learning system, integrative informational and analytical environment, LMS.*

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**Statement of the problem.** In modern medical practice, there is an active penetration and synthesis of Western medicine and folk (traditional) medicine of the world, particularly, the methods of disease prevention and rehabilitation on the basis of Chinese image medicine (CIM) having an ancient origin and being a kind of traditional Chinese medicine, are becoming popular. In this context, as well as in accordance with the strategy of WHO [1] and the CIM research program [2], there is the need for an adequate scientific interpretation of the theory and practice of CIM, and the development of intellectualized information systems for professional activities, training CIM-specialists and carrying out comprehensive CIM scientific research as the promising component of so-called integrative medicine.

**Analisis of the available research results.** According to the program of CIM scientific research [2], the actual scientific and applied problem is the creation of the integrated ontooriented informational and analytical environment for scientific research, professional healing activities and electronic learning of CIM. The first steps in solving this task were carried out in [3], where general requirements were formulated and generalized architecture of the components of this environment was developed. The following components are defined: the information system of professional healing activity «Image-therapist», the knowledge base of

CIM, the expert system for the acceptance of diagnostic and therapeutic decisions, the information system of electronic learning CIM (SEL CIM), the information system of CIM scientific research. In [4], plurality of parts, sections, and conceptual projections of the conceptual model of Chinese image medicine were identified, which should be reflected in the knowledge base of the information-analytical environment of scientific research, professional healing and electronic learning of CIM. The development of modern information technology allows us to bring the educational process of CIM-specialists training on a new technological level. The papers [3-6] substantiated the importance and prospects of the creation of SEL CIM; it is suggested to develop SEL CIM with the use of domain ontology and using the modern educational management system (LMS – Learning Management System). LMS is required as a basis for the development, management and distribution of online training materials in the field of CIM and sharing them among the users. This approach is fully justified and is promising for CIM, as there are currently no effective ways to provide training material for relevant CIM audience. Since there are currently no research and design-technological decisions regarding the architecture and development stages of SEL CIM, this also defined the purpose of this article.

**The objective of the paper** is to develop the methodology for the creation and architecture of ontooriented SEL CIM with the use of modern learning management system (LMS).

**Statement of the task.** To achieve the set objective, it is necessary to isolate and analyze the stages of development of ontooriented educational systems; to explore the advantages of using ontologies for content preparation SEL CIM; to design the personalized prototype of SEL CIM using the modern educational management system.

**The results of the investigations.** Online learning is becoming more and more popular because of its flexibility, accessibility, interactivity and extensibility. The European Commission defines E-learning as «the use of new multimedia and Internet technologies to improve the quality of learning through improved access to resources and services, as well as remote knowledge exchange and collaboration.» The main tasks to be solved by creating SEL CIM can be specified as follows:

- expansion of the information base in the sphere of CIM through the reverse conversion of documents (transfer to electronic form), with the current classification and ranking of audio, video and other multimedia information;
- providing users with analytical tool for effective academic and research work;
- development of flexible commercial policy in planning of the work with these information resources;
- providing multilingual support;
- search and retrieval of information by semantic or indirect features;
- consolidation and integration of all information CIM-community is interested and which really exists and to which access is possible (intranets and the Internet);
- creation of a single information space to provide effective educational, scientific, methodological and analytical work of all groups of users, dissemination of information search results (knowledge exchange) between users;
- automatic distribution of unstructured information on hierarchical ontologies and taxonomies developed in advance on the basis of the acquired knowledge and life experience;
- realization of all the advantages of e-learning: freedom and flexibility (the opportunity to learn from different places and at any convenient time), individuality (independent choice of learning time, choice of sections for review, creation of own training schedule), access to materials for people with disabilities, training of larger number of people of different age groups, the simple formation of virtual communities.

As a key stage in the design and implementation of the scientific and conceptual basis of integrating medicine, and particularly, in the formation of the scientific paradigm of CIM, we consider the construction of its ontology apparatus. In general, computer ontologies de facto became a privileged means both for the presentation of poorly formalized medical knowledge and the basis of modern technologies for the development of educational systems. The development of the qualitative CIM ontology will form the basis for supporting both of these aspects as well as for developing scientific theory with the properties of integrity (completeness), the absence of logical contradictions, scientific interoperability, clarity and uniqueness of its elements and structure. Also, such ontology has a significant potential in developing e-learning systems with reusable components.

Taking into account CIM complexity its «knowledge» should be carried out systematically, from the perspective of the regularities of system integrity and the interaction of its constituent parts. The system knowledge in this subject area derives from the multilevel hierarchical organization, where all concepts, processes, and phenomena can be regarded as a set of smaller subsets (signs, details), and alternatively, any notion can be regarded as elements of higher classes of generalizations. After the knowledge is extracted from the experts, the interpretational (conceptual) model of CIM will be constructed on their basis. This model will build the basis for the formation of electronic learning system content, as well as CIM ontology.

Let us characterize the sectional structure of the general CIM theory, which we obtain from the conceptual CIM model. The section «Theory and technology of learning, development of the COM-specialist» will be used as content of the e-learning system (Table 1) [6].

**Table 1**

The structure of the theory of CIM

SECTIONS OF THEORY	DESCRIPTION OF SECTION CONTENT
Basic CIM theory	Describes the basic concepts and ideas of CIM and serves as practical-philosophical foundation for the rest of CIM sections
The theory of health and diseases in COM	Describes basic concepts of health and diseases in CIM; diagnostic standards of health and diseases for their evaluation by various methods of CIM diagnosis; classification and definition of diseases types in CIM
The theory and technology of diagnostics in CIM	Describes and formalizes theoretical foundations, methods and means of obtaining diagnostic medical information by CIM methods, as well as methods for its interpretation.
Theory and technology of therapy in CIM	Describes and formalizes theoretical foundations, methods and means of conducting therapeutic procedures in CIM, as well as their interrelations with the corresponding diagnostic information.
The theory and technology of CIM-specialist training and development	Describes educational theoretically and practically oriented content, as well as technologies for its implementation into the educational process for the training and improvement of CIM-specialists qualification

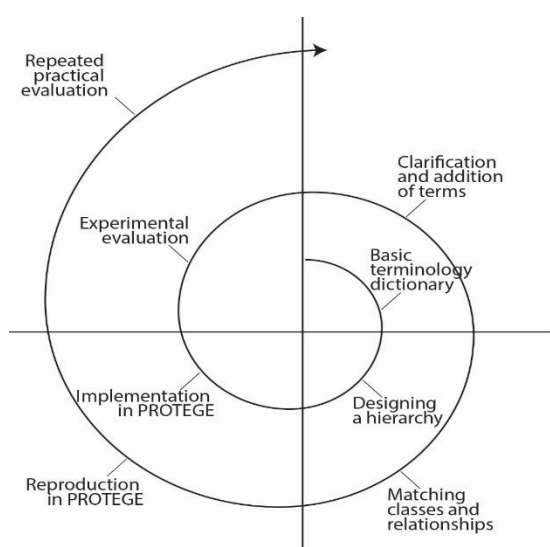
In order to allow the constructed ontology to perform further automated processing of the semantics isolated informational units, the basic concepts of the subject area should be

presented in the format accessible for automated processing in the form of classes hierarchy and relations between them transforming into learning objects in SEL CIM. These relationships structure the conceptual basis of CIM domain allowing them to interact with topics and educational objects. Such ontology will formalize the conceptual model and automatically carry out semantic operations, since the concepts and axioms that describe them have rigid invariance. Rules, statements, metadata for educational objects and the creation of simple justification mechanisms are provided in the OWL language.

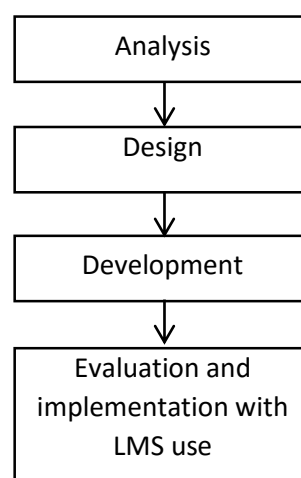
Formation of ontology as a system of knowledge oriented to support the educational process, it is reasonable to begin with the construction of thesaurus – an ordered set of basic terms, CIM concepts which will be the basic terminology dictionary, and its characteristic semantic relationships between concepts, and then follow the iterative process presented in Fig. 1.

Sections of the developed CIM ontology are presented in papers [4 – 6]. The developed ontological approach is a powerful simulator: ontology uses metadata for course curriculum to create the semantic network and the network of educational objects. The content of the ontologically managed e-learning platform is used to develop educational material for specific learning purposes, target groups and specific contexts and areas of knowledge on the one hand, and on the other hand, it is possible to use only a few specific elements of the educational object in a particular training project, to reuse the same training project in different contexts with different learning objects; and adapt the content of the same learning object to the particular user.

For the training course instructor the computer ontology will facilitate the process of developing this course, the listener will improve the perception of the material and the relationship of subject knowledge. At present, the electronic textbook has evolved as an appropriate e-learning interface with tools and services available through the platform and external connections. This gives him the opportunity to distribute on mobile devices (M-learning) and personal digital assistants (PDAs). Although at present there are some problems that require solutions (for example, the inconvenience of reading from the screen, limiting licensing), significant advantages (such as flexibility, accessibility, interactivity and extensibility) contribute to the rapid spread of e-learning.



**Figure 1.** Iterative process of developing an ontological model of COM



**Figure 2.** Stages of the development of the electronic course

The process of developing CIM e-learning course should be carried out according to the traditional algorithm presented in Fig. 2.

*Analysis.* This is the first stage of development, in which you should analyze the training content, training goals, target audience profile and interface analysis and form the CIM domain ontology, described above. On the basis of content analysis, the educational strategy is formed determining the best way to present information.

*Designing.* This stage can be divided into several steps. First, you need to capture the requirements and design tasks of the training management team. Here the educational and multimedia elements that should be included in the training course are determined. The next step is to develop the prototype – the full-featured version of the course that contains the main demonstration windows and shows how this course looks and functions in terms of graphical user interface assessment and user interaction. For the prototype, about 10% of the entire course is enough, it enables to save financial and time costs, improve the quality of the system being developed by making the necessary changes at the initial stages of development, rather than in full scale development. Another step to be taken at this stage is to focus on the effective strategy for developing the learning process, to determine the format of media content, to check the compatibility of the course with the distance learning standards. This step will ensure compatibility of components and the possibility of their multiple use.

*Development.* At this stage, the content sequence, page layouts, graphical user interface, interactive features should be provided and multimedia elements should be included in the course. Now there are a number of tools for fast creation of tutorials with built-in interaction and templates. This allows you to focus on consistent and comprehensive coverage of the material, which is the indisputable advantage for the complex CIM sphere.

*Evaluation and implementation.* At this stage, the quality of the developed course is tested to ensure correct functionality and content. Also the course may be translated into one or more languages at this stage if necessary. The course is then hosted on LMS for feedback and quality updates. The target audience is given a link, user information and passwords for access to the course.

In general, the distance learning process is performed according to the following pattern: the course attendant receives access to the training material, processes it, carries out tests, the server processes responses, generates reports with success analysis. LMS provides the following advantages:

- provides centralized and automated management of the learning process;
- provides unrestricted access to the course materials, including the audience in different time zones: as shown by analysis of the potential target audience, such requirement is in demand;
- provides operative tracking, progress and listeners results at all checkpoints; in the opposite case, the feedback availability allows the mentor to rationalize the educational behavior of the inexperienced listener;
- reduces the cost of training;
- дозволяє allows immediately to modify content of online courses practically in real time, providing speed and convenience of formation and delivery of information; as well as scalability (the ability of the system to expand and increase the amount of information processed);
- provides the opportunity to enrich the curriculum with the experience of interpersonal interaction through links to social networks or thematic forums;
- mobility support and compliance with all existing standards.

As the result, following the principles presented at each stage, as well as using the LMS Learning Management System, which is the foundation for building the entire e-learning

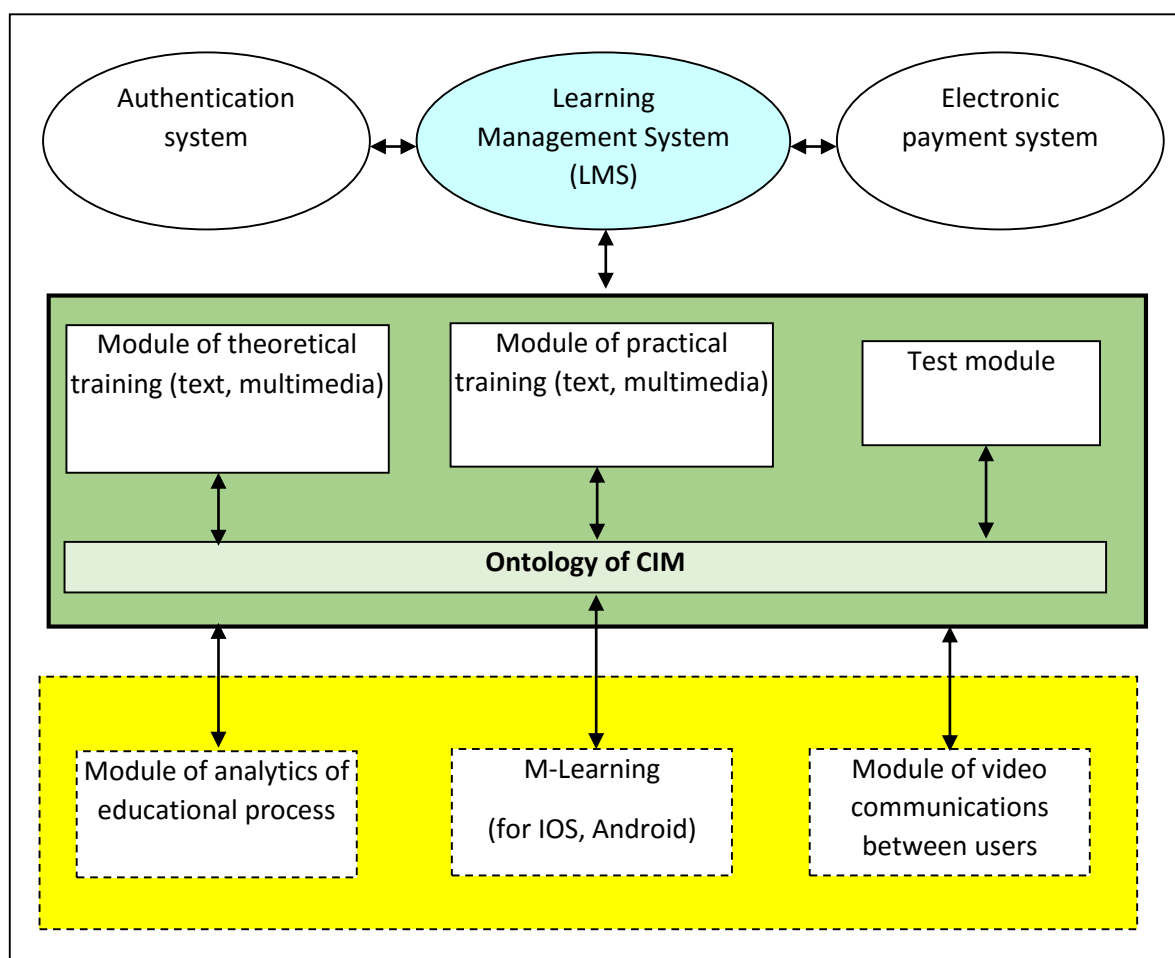
process, the prototype of Zhong Yuan Qigong Electronic Course (one of the components of non-traditional Chinese medicine) was developed.

Three important principles were also taken into account, which are essential for the entire CIM e-course:

1). Principle of adult education: adults learn in a different way than children. Mentors of the course should encourage rather than teach because adults are autonomous and self-regulated, limited in time through various internal and external factors, and at the same time focused and problem oriented, although they have different learning styles.

2). Learning style: Someone is more likely to perceive textual information, others are multimedia or practicing. In e-learning it is necessary to achieve a balance of presentation of heterogeneous data by carefully integrating text, audio and graphics.

3). Principles of design training are used to facilitate adult learning. Depending on the audience profile and the content of the course, different educational design models are used, among which the most popular is the ADDIE model. ADDIE is a traditional model, which includes analysis, design, development, implementation and evaluation corresponding to the chosen method of developing CIM course.



**Figure 3.** The Architecture of the E-learning System CIM

The electronic training system of Zhong Yuan Qigong has been implemented through three main modules: theoretical block module, practical block module, testing module. The architecture of the e-learning system is presented in Fig. 3 and is implemented as web-based client-server technology data transmission system. Fig. 4 shows the views of the implemented prototype of e-learning system using the modern educational management system.

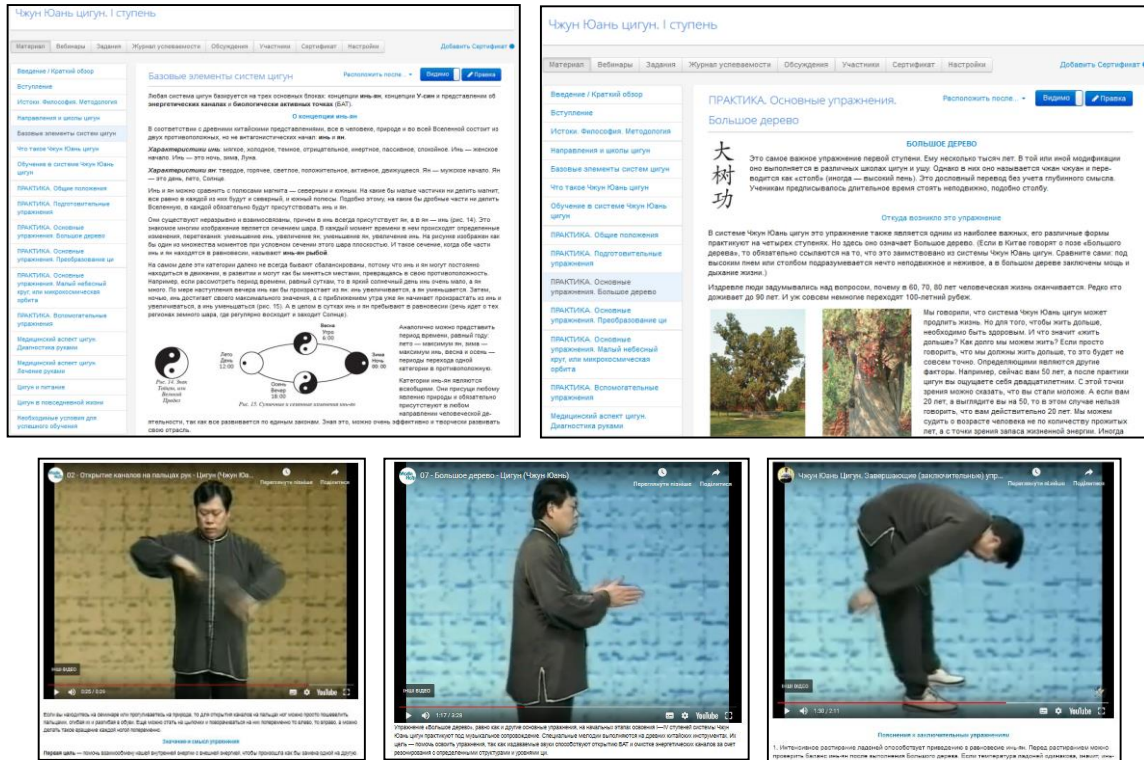


Figure 4. Zhong Yuan Qigong Electronic Learning Window View

**Conclusions.** The methodology of development and architecture of CIM electronic learning system with the use of learning management system is offered; quality ontological management of its content is implemented in this paper. Ontorotation of such a system solves the problem of the clarity of the conceptualization of this domain. The developed e-learning platform will allow the reuse of the same curriculum in different learning contexts, and thus lower cost, improve quality and increase adaptability.

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## МЕТОДОЛОГІЯ РОЗРОБЛЕННЯ ТА АРХІТЕКТУРА ОНТООРІЄНТОВАНОЇ СИСТЕМИ ЕЛЕКТРОННОГО НАВЧАННЯ КИТАЙСЬКОЇ ОБРАЗНОЇ МЕДИЦИНИ НА БАЗІ СИСТЕМИ УПРАВЛІННЯ НАВЧАННЯМ

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**Резюме.** Опіраючись на відомі результати досліджень і зважаючи на стан справ у сучасній медичній практиці та розвиток інтегративної медицини, проаналізовано необхідність створення системи електронного навчання для китайської образної медицини (СЕН КОМ). Виділено ключові задачі, які вирішить розроблення такої системи, що доводить актуальність задачі. Здійснено аналіз основних завдань, що відносяться до сфери управління знаннями: видобування знань від експертів КОМ, їх формалізація й трансформування в якісний контент, його адаптація та персоналізація, використання в е-навчанні. Виокремлено розділи загальної теорії КОМ та обґрунтовано доцільність застосування онтології для систематизації слабоструктурованих знань для них. Так як комп'ютерні онтології де факто стали привілейованим засобом як для представлення неоднозначних медичних знань, так і основою сучасних технологій розроблення навчальних систем, то запропоновано ітеративний процес розроблення онтологічної моделі КОМ, яка стане основою електронного навчального курсу КОМ. Проаналізовано етапи алгоритму розроблення електронного курсу на базі системи управління навчальною діяльністю із дотриманням суттєвих принципів навчання дорослих. Визначено переваги, які забезпечує LMS для слухачів курсу КОМ. Розроблено архітектуру онтоорієнтованої СЕН КОМ із використанням сучасної LMS, в якій виокремлено основні модулі та їх взаємодію. Дотримуючись визначених принципів та вимог, розроблено персоналізований прототип системи електронного навчання для однієї зі складових нетрадиційної китайської медицини (Чжун Юань цигун). Пропонований підхід може бути застосований і до інших складових знань нетрадиційної китайської медицини, які претендують на наукове визнання світовою спільнотою в складі інтегративної медицини та доступ до яких на даний час не є загальнодоступним.

**Ключові слова:** онтологія, онтологічне моделювання, система електронного навчання, інтегроване інформаційно-аналітичне середовище, LMS.

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