The Axiomatic-Deductive Strategy of Knowledge Organization in Onto-based e-learning Systems for Chinese Image Medicine

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Abstract. The paper presents the axiomatic-deductive strategy of organizing knowledge in the e-learning course in Chinese Image Medicine, which satisfies the requirements for the semantic quality of an e-learning course. The tree-like structure of the axiomatic-deductive strategy of organization of the semantic space in the e-learning course for studying Chinese Image Medicine is proposed. The methods and tools of Chinese Image Medicine semantic space organization are determined. It is shown that the axiomatic-deductive strategy of organizing the semantic space in the e-learning course for Chinese Image Medicine is in the coherent sequential structuring of its meta-disciplinary logic-semantic core, its own abstract logical-semantic core, and the set of the partial logical-semantic areas of the semantic space of the e-learning course for Chinese Image Medicine, which are realized in machine-interpretive form as an ontology of Chinese Image Medicine. The structural components of the semantic space of the Chinese Image Medicine course are distinguished. The developed approach makes it possible to unify and standardize the representation technology of data and knowledge in the field of Chinese Image Medicine, to make knowledge specification by means of modern onto-based intellectualized e-learning systems, which makes it possible to use modern software tools for the collective development of e-learning courses for different directions of Integrative Medicine.

Keywords: E-learning Systems, Organizing of E-learning Course Knowledge, Axiomatic-Deductive Strategy, Integrative Medicine, Chinese Image Medicine.

1 Introduction

According to the strategy of the World Health Organization in the field of folk medicine [1], the development of a scientifically sound approach to the implementation of alternative and complementary medicine in the field of official medicine, both internationally and nationally, is an important strategic problem. Today, in most countries of the world, in particular, in the USA, China, Japan, South Korea, Russia, many countries of Europe and Brazil, there is a significant revival in the scientific study of non-conventional (alternative, complementary) methods of human health improvement and treatment, which contributes to the formation of such a promising direction of medicine as an Integrative (Integral, Holistic) Medicine [2, 3]. In China, Integrative Medicine combining the achievements of Western medicine and Traditional Chinese medicine (TCM). One of the important components of TCM is Chinese Image Medicine (CIM). The methods of CIM have a great interest for scientific research. In particular, research of CIM will enable the development of scientific theories, models, methods and informational-analytical tools within the framework of various sciences (medicine, biology, physics of complex systems, artificial intelligence, cognitive psychology, semiotics), which are based on the post-classical type of scientific rationality, the paradigm of rational holism and subjective ontologies.

Unlike TCM, which has a benefit of a number of large-scale clinical trials, theoretical scientific substantiation and a range of relevant information and analytical tools (ontologies, expert systems, grid-systems for TCM [4-10]), CIM has almost no similar research and relevant information and analytical tools. Given this state of affairs, a Program for the researches of Chinese Imaging Medicine for 2017-2023 (Program) was developed [11]. The Program is aimed at conducting comprehensive scientific researches of CIM in order to create a theoretical and experimental scientific basis for CIM, which will promote disclosure of the deep causes and mechanisms of human diseases and help to create effective methods for their prevention and treatment.

According to this Program, the creation of the integrated onto-based e-learning system for the CIM is the actual scientific and applied problem. Development of such e-learning system will considerably simplify, intensify and improve the quality and availability of educational process in CIM. Evidence-based standards of the CIM learning should be developed firstly for implementation of the e-learning information system. The standards include educational and professional program for a CIM therapist, educational qualification of a CIM therapist, curricula and steering documents in disciplines, lecture and practice-oriented learning materials, methods of testing and self-assessment testing of CIM specialists. General architecture of the e-learning information system for CIM therapists was developed in the paper [12].

In general, the quality of the e-learning course is determined (formed) by its two main components, in particular, the quality of the text (content) of the e-learning course and the quality of the development environment and the use of the e-learning course. In turn, the text quality of the e-learning course is determined by the quality of the syntactic and semantic components of the text (the syntactic quality of the e-learning course). The e-learning course semantic quality is the most important component of the general e-learning course quality and is primarily determined by its four components:

1) logicality of the e-learning course; 2) obviousness of the e-learning course; 3) coherence of the e-learning course; and 4) convenience of using the e-learning course. In the paper [13], one of the possible approaches to the organization of the e-learning course semantic space and text was proposed, based on the axiomatic-deductive strategy, which satisfies the requirements for the e-learning course semantic quality. The axiomatic-deductive strategy of organization of knowledge and educational content provides a clear, ordered and compact structure of knowledge organization about the e-learning course subject area. It gives it significant advantages over non-axiomatic strategies.

This work is devoted to the methods and tools of organizing the semantic space of CIM in the e-learning systems in accordance with the axiomatic-deductive strategy.

2 Main part

In Figure 1 the diagram that represents the structure of the semantic space of the CIM course for e-learning through the division of its logical-semantic core (LSC) is given. LSC is organized in accordance with the axiomatic-deductive strategy.

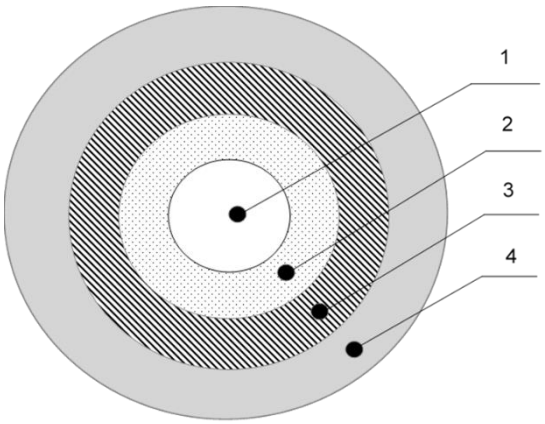

Fig. 1. Structural constituents of the semantic space of the e-learning CIM course: 1) meta-disciplinary LSC of the semantic space of the e-learning CIM course; 2) own abstract LSC of the semantic space of the e-learning CIM course; 3) a set of partial logical-semantic areas of the semantic space of the e-learning CIM course; and 4) the periphery of the semantic space of the e-learning CIM course.

The axiomatic-deductive strategy of organizing the semantic space of the e-learning CIM course is in the coherent sequential structuring of the meta-disciplinary LSC, its own abstract logic-semantic core, and the set of the partial logical-semantic areas of the semantic space of the e-learning course.

The structure of the CIM theory, which defines the general structure of the CIM ontology, is considered. It is proposed to divide the scientific theory of CIM into two

large parts: 1) General Scientific Theory of Integrative Medicine; and 2) Special Scientific Theory of Chinese Image Medicine. The special CIM theory is divided into five main sections: 1) the theory of reality and human, which correlates with meta-disciplinary LSC of the semantic space of the e-learning CIM course; 2) the theory of health and diseases, which correlates with own abstract LSC of the semantic space of the e-learning CIM course; 3) the theory and technology of diagnostics; 4) the theory and technology of therapy; and 5) the theory and technology of learning, the professional development of therapists. The last three sections of the CIM theory correlate with the different partial logical-semantic areas of the semantic space of e-learning CIM course.

Each stage of the organization of the LSC of the semantic space of the e-learning CIM course in accordance with the axiomatic-deductive strategy includes the following seven sub-stages:

1. Formation of the set of atomic (basic) concepts of the corresponding area (meta-disciplinary logic-semantic core, own abstract logic-semantic core or partial logic-semantic area) of the semantic space of the e-learning CIM course.

2. Generation from the atomic concepts of the set of derivative concepts of the corresponding area (meta-disciplinary logic-semantic core, own abstract logic-semantic core or partial logic-semantic area) of the semantic space of the e-learning CIM course, by applying logical operations (combining operations, intersections, additions, definition of concepts) to atomic concepts. Derivative and atomic concepts in their group form the terminological-conceptual apparatus of the corresponding field of the logical-semantic core of the semantic space of the e-learning CIM course, and the result of the combination of terminological-conceptual apparatuses of the meta-disciplinary logical-semantic core, its own abstract logic-semantic core, and the set of logical-semantic areas of the semantic space of the e-learning CIM course is the terminology-conceptual apparatus of the e-learning CIM course.

3. Formation of the set of relations between atomic and derivative concepts of CIM that fix the logical-semantic relations between them.

4. Formation of the set of mutually not interdependent and mutually not contradictory axioms - statements (to wit judgments), the truth of which is accepted without proof in the framework of this e-learning CIM course. Formally, axioms are functions (predicates) from basic and derivative concepts and clearly reflect (actualize, postulate) the logical-semantic relations between them.

5. Generation from the set of axiomatic statements of the set of derivatives of true statements (theorems) of the corresponding area (meta-disciplinary logic-semantic core, own abstract logic-semantic core or partial logic-semantic area) of the semantic space of the e-learning CIM course, by applying logical rules of derivation to axiomatic statements. The set of axiomatic and derivative statements form a set of true statements of the corresponding area (meta-disciplinary logic-semantic core, own abstract logic-semantic core or partial logic-semantic area) of the semantic space of the e-learning CIM course.

6. Formation of the set of taxonomies of the e-learning CIM course concepts, through the multiple use of operation of division of general concepts based on the predefined basis of division, providing automatic generation from more general (abstract) generic concepts of the discipline of its derivatives of species (partial) concepts of less level of abstraction and universality.

7. Formation of a set of true statements of a lower level of abstraction of e-learning CIM course as predicates given on the elements of taxonomy of concepts, which provide a strictly logical transition from more general (abstract) e-learning course statements to statements of a lower level of abstraction and universality.

The sequence of the first three sub-stages of the axiomatic-deductive strategy concerning the formation of the terminology-conceptual apparatus of the e-learning CIM course will be called the axiomatic-deductive sub-strategy of the organization of the terminology-conceptual apparatus of the e-learning CIM course (see Figure 2).

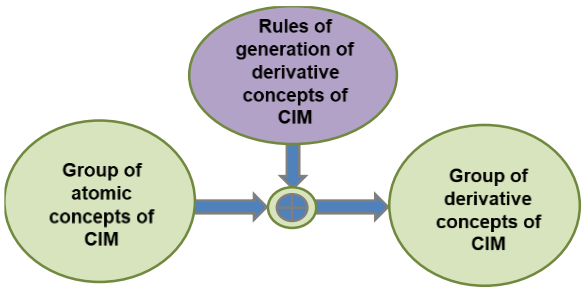

Fig. 2. Conditional scheme of axiomatic-deductive sub-strategy organization of the terminological-conceptual apparatus of the CIM.

The sequence of the following two sub-stages (fourth and fifth sub-stages) of the axiomatic-deductive strategy concerning the formation of a set of axiomatic and derivative statements of the e-learning CIM course will be called the axiomatic-deductive sub-strategy of the organization of the set of statements of the e-learning CIM course (see Figure 3).

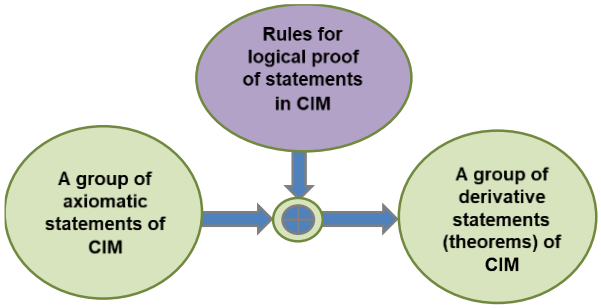

Fig. 3. Conditional scheme of axiomatic-deductive sub-strategy of organization of a group of truthful statements of the CIM.

An important sub-strategy of implementation of the axiomatic-deductive strategy of organizing the semantic space of the e-learning CIM course is the stage of formation of the set of taxonomies of the concepts of the e-learning CIM course and the stage of formation of the set of true statements of a lesser level of abstraction of e-learning CIM

course as predicates given on the elements of the taxonomy of concepts. These two sub-stages, in their totality, form a taxonomically-oriented sub-strategy of organization of the semantic space of the e-learning CIM course. Thus, taking into account abovementioned, the main components of the semantic space of the e-learning CIM course, the stages and sub-strategies of the axiomatic-deductive strategy, the axiomatic-deductive strategy of organizing the semantic space of the CIM course for e-learning can be presented as the tree structure, as shown in Figure 4.

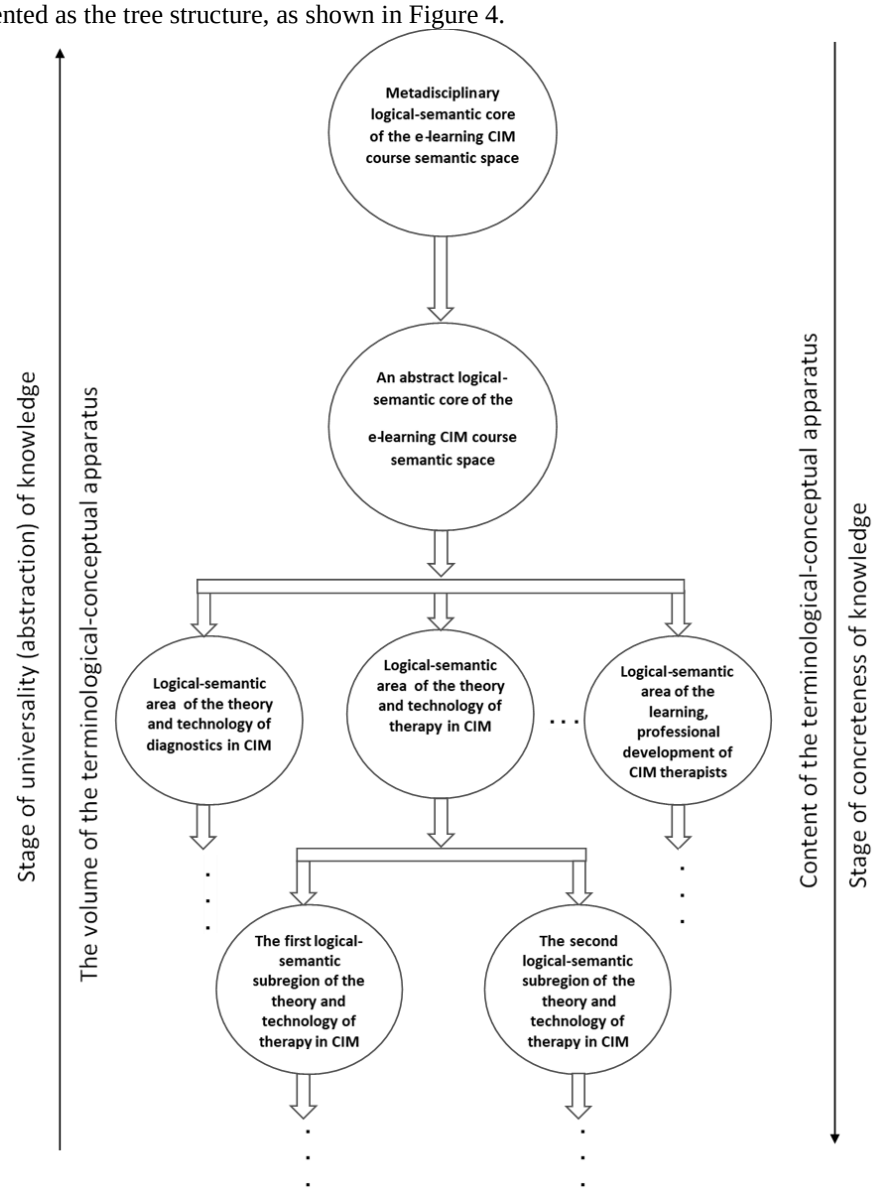

Fig. 4. The tree structure of the axiomatic-deductive strategy of organizing the e-learning CIM course semantic space.

The structure of knowledge organization in CIM is its conceptual model. This conceptual model is implemented in the machine-interpretive form as the CIM ontology. The OWL language was chosen for development and specification analysis of the conceptual model description of CIM [14]. A fragment of the ontology of the CIM diagnostic methods developed in the Protégé environment is presented in Figure 5 (in the form of a hierarchy) and in Figure 6 (in the form of an ontograph). OWL's ontology description language is used.

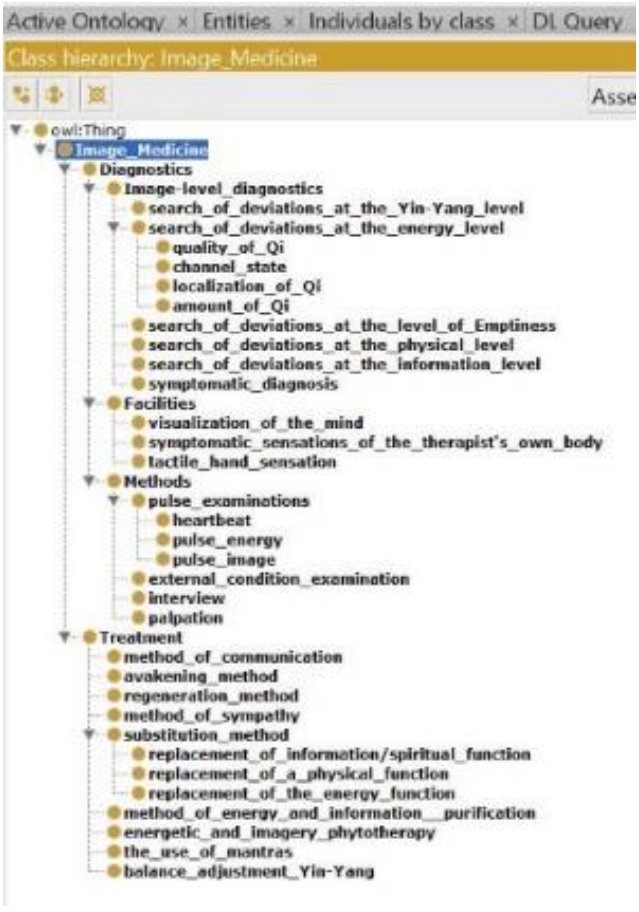

Fig. 5. A snippet of the CIM ontology.

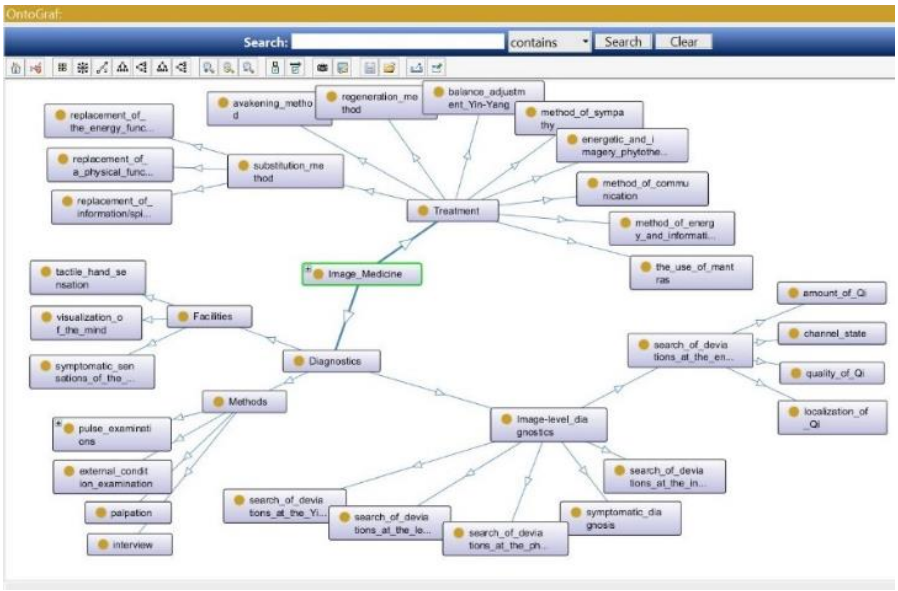

Fig. 6. A snippet of the CIM ontology.

3 Conclusions

The axiomatic-deductive strategy of knowledge organization of the CIM course for e-learning, which was developed in the paper, will make it possible to unify and standardize the technologies of presentation of information (data and knowledge) in the field of CIM, which will make it possible to overcome the problem of semantic heterogeneity of less structured and difficult formalized knowledge in the field of CIM. This strategy has the following positive properties:

1. Guarantees e-learning course semantic quality requirements.
2. Has a logical structure that is well formalized, which provides clear, ordered, compact structure of knowledge organization in the e-learning CIM course.
3. Enables an explicit knowledge specification by means of modern onto-based intellectualized e-learning systems, which makes it possible to use modern software tools for the collective development of e-learning CIM courses.
4. Well agrees with the mathematical apparatus of descriptive logic as the formalism of ontologies, which provides unification, standardization of the technology of presenting text and knowledge in the CIM.

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