A comprehensive set of compatible semantic electronic textbooks and intelligent tutoring systems

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Semantic Electronic Textbook (SET)

SET is an electronic guide based on semantically structured education materials.

SETs are the next step of evolution of electronic education technologies due to their exceptional capabilities.

Electronic textbook	Semantic electronic textbook
• Database • Hypertext • Multimedia • Subject domain content structure visualization • Navigation is limited to a textbook structure • Solution examples are specifically prepared beforehand or are absent at all • Pattern-matching the answers • Traditional Help	• Semantics • Knowledge bases • Hypermedia semantic network • Subject domain semantic structure visualization • Semantic space navigation • Problem solver • Arbitrary answers and user error analysis • Interactive virtual laboratory • Intelligent Help

From traditional textbook to SET – transformation stages (1)

Stage 1. Specify a structure of a source material and its bibliographical attributes.

Stage 2. Decompose a text of a traditional textbook into basic semantic fragments and specify their order in the source text.

Stage 3. Determine a semantic typology of said fragments.

Stage 4. Extract keywords from these texts, generate corresponding sc-nodes and specify a connection between mentioned text fragments and corresponding sc-nodes.

Stage 5. Translate said text fragments of source education material to SC language. Establish a semantic equivalence between source text fragments and their formal representation in SC language

From traditional textbook to SET – transformation stages (2)

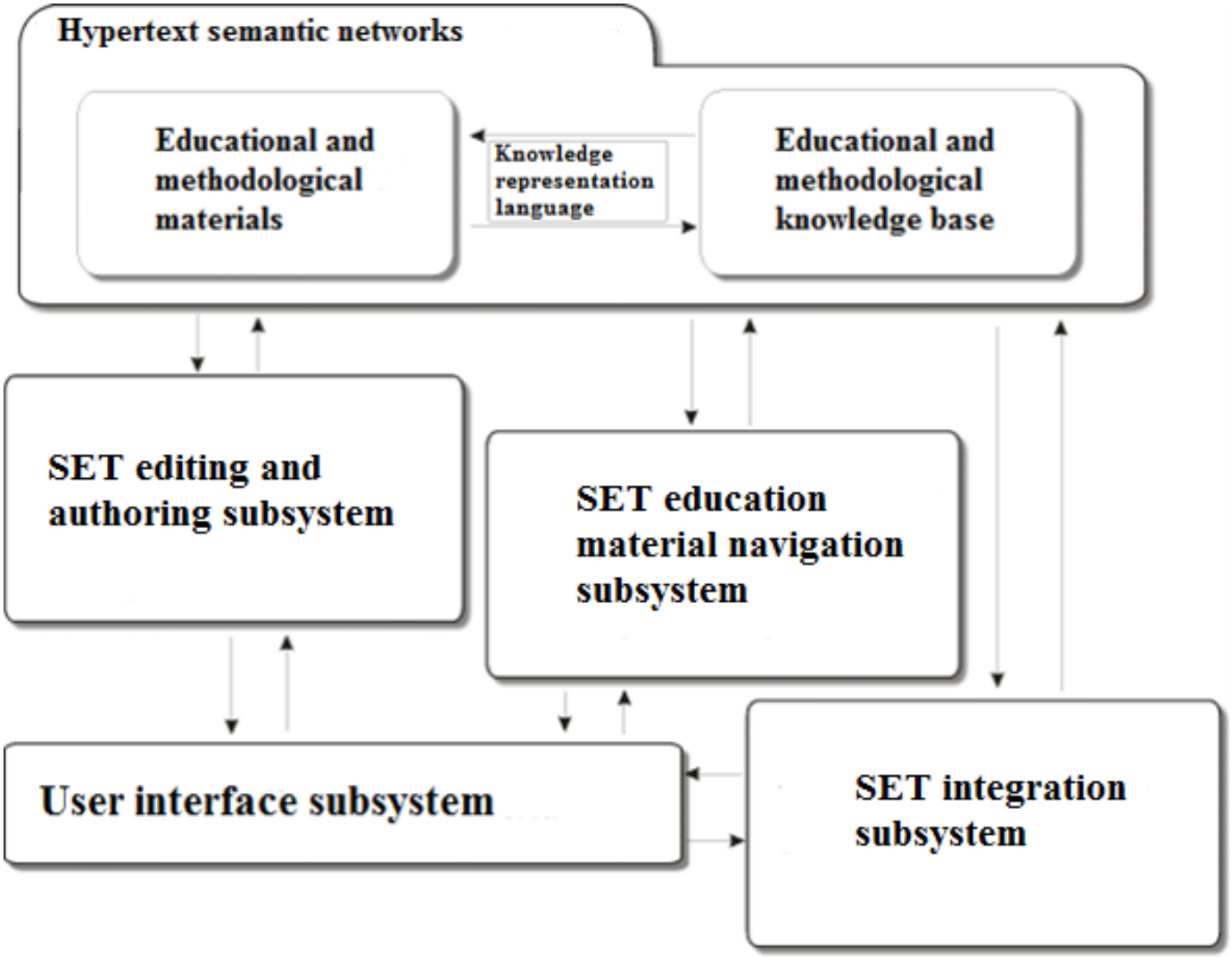
Stage 6. Provide definitions or explanations of aforementioned key terms (if they are not in the textbook) and key nodes introduced to specify a subject domain structure in Russian and SCL, while maintaining a semantic text equivalence between them. Besides, it is necessary to pick and formulate the basic definitions and comments, decipher a semantics and isolate groups of semantically bound elements for selected subject domain terms and relations.

Stage 7. Build a set-theoretical classification schema of the selected terms.

Stage 8. Indicate synonyms and homonyms of the selected terms.

Stage 9. Describe the most important correlations between said terms (except for the aforementioned set-theoretical classification).

SET Structure



Semantic electronic textbook can:

- understand the way problems were formulated, find their solution methods and solve problems, even if the methods required are not known at the moment;
- analyze arbitrary user responses for corresponding questions and user error semantics in solving corresponding problems;
- find semantic errors in information resources themselves (e.g., definition and statement correctness, term correctness, theorem proof correctness errors).

Advantages SETs get from transforming their content to a structured knowledge base

- Explicit representation of semantic structure of education material being studied, visualization of any level of said semantic structure in two and three dimensions, as well.
- Fairly complete knowledge of the subject domain at hand becomes available due to the fact that semantic structure of education material can be represented with any level of detail.

Advantages SETs get from having powerful information retrieval and problem solving tools

- Semantic space navigation within education material is enabled
- One can ask any questions and pose any problems to the system (within given subject domain)
- **The typology of questions and problems, that can be solved by SET, is virtually unlimited**
- Enables system-supervised training in problem-solving within a studied subject domain
- The system provokes the learner to develop both question- and problem-formulating skills

Main types of questions to the system:

- about connections between given entities;
- about differences and similarities of given entities;
- how has the system solved the problem;
- which method can be used to solve a given problem;
- which solution strategy can be used to solve a problem;
- if the given answer for the question is correct;
- if the given solution to the problem is correct.

SET user interface advantages

- UI unification: once a user has learnt how to use one system, he'll easy pick up another
- Enables system to understand user actions
- The main part of SET knowledge base, that describes semantics of the subject domain, is independent on the external languages (including natural ones).
- Enables implementation of natural language user interface.

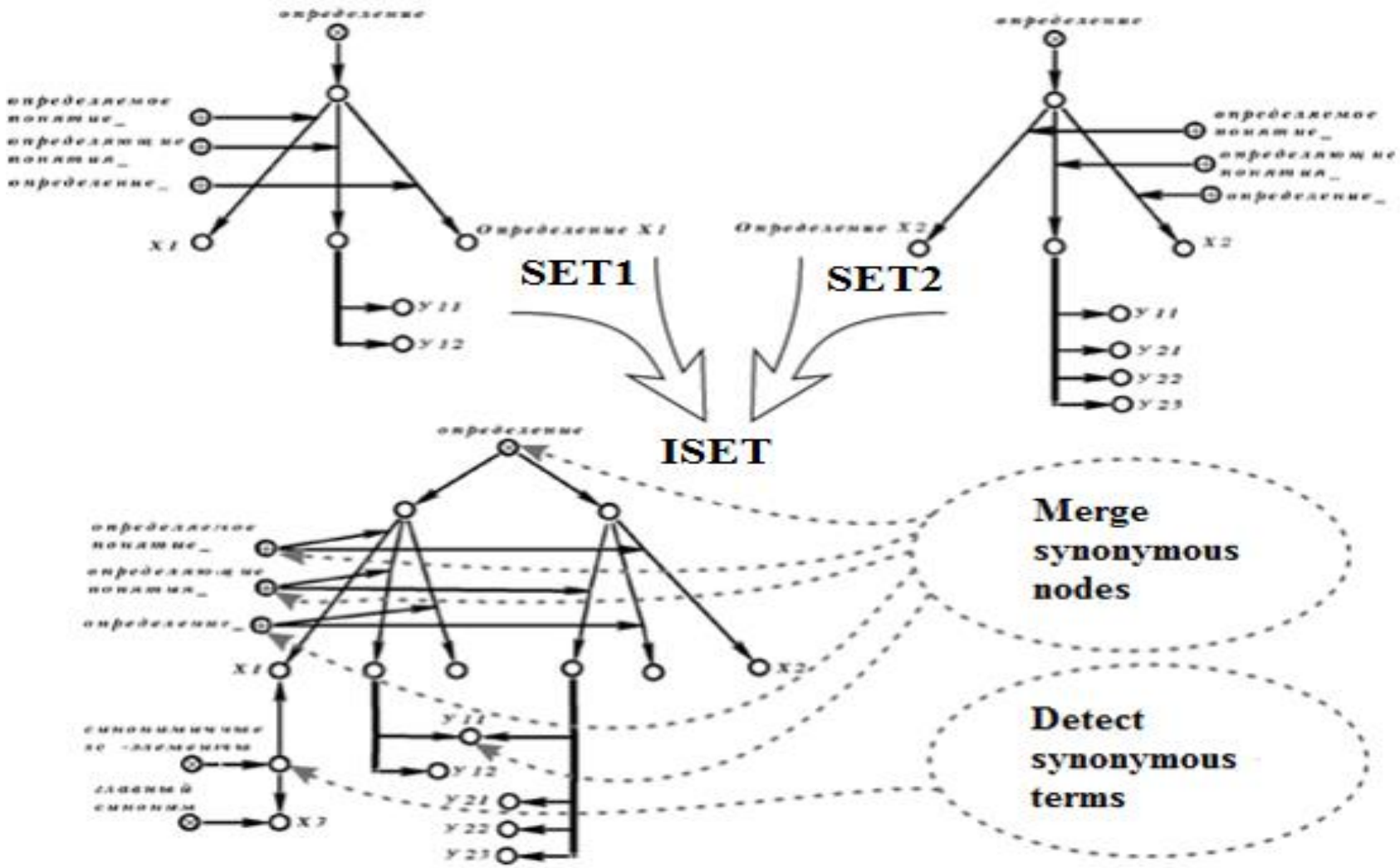
General user interaction advantages of the SET

- One is completely free to choose his/her own learning track.
- One is completely free to choose a problem to solve.
- Learning performance analysis is based on a semantic analysis of his/her interactions with the system.
- Intelligent help subsystem watches over and manages one's learning process.

Compatibility and integration advantages of SETs

- Easy integration of several separate complementary subject SETs into a single textbook.
- Explicit interdisciplinary connections allow learner to construct a comprehensive worldview for himself, since, as we all know, the world isn't divided into subjects

Semantic electronic textbooks integration



Primary subprojects, which are essentially the implementation stages of the complex innovative project being proposed (1)

Subproject 1. Develop initial versions of SETs in all **high school** subjects with knowledge base editing, verification, integration and navigation tools.

Subproject 2. Develop intelligent problem solvers for SETs in all **high school** subjects.

Subproject 3. Develop specialized user interface tools for SETs in all **high school** subjects (support tools for drawings, maps, virtual laboratories, etc.).

Primary subprojects, which are essentially the implementation stages of the complex innovative project being proposed (2)

Subproject 4. Based on developed SETs, develop intelligent tutoring systems that manage learning process based on individual learner traits.

Subproject 5. Develop an integrated tutoring system, which provides comprehensive **high-school** education.

Subproject 6. Build natural language user interface tools for the integrated intelligent tutoring system being developed.

Subproject 7. Develop a semantic associative computer (based on a non-Neumann architecture), oriented towards semantic network processing, which provides hardware support for the developed integrated tutoring system.

Groundwork

- Open Semantic Technology for Intelligent Systems (OSTIS) is being successfully developed (see http://ims.ostis.net)
- Several SET prototypes were developed:

Name	URL
Geometry SET prototype	http://geometry.giis.by
Numeric models SET prototype	http://algebra.giis.by
History SET prototype	http://history.giis.by
Geography SET prototype	http://185.24.221.90:8000

THANK YOU