The GEOTHNK Approach to Spatial Thinking

Marinos Kavouras, Margarita Kokla, Eleni Tomai*
National Technical University of Athens

http://www.geothnk.eu

GEOTHNK: Semantic pathways for building a spatially-thinking society

▸ Online repository and authoring environment for the collection, creation, and sharing of educational resources that cultivate spatial thinking skills through different disciplines and educational contexts.

▸ Supports:

  ▸ access to various resources and educational scenarios

  ▸ creation of new educational scenarios through an authoring environment

  ▸ semantic association and exploration of knowledge and resources

  ▸ geographic and semantic visualization of educational scenarios

Consortium

National Technical University of Athens

Address
Heroon Polytexneiou, 9,
15780, Zografou, Athens
GREECE

Contact Details
Prof. Marinos Kavouras
mkav@survey.ntua.gr

Ellinogermaniki Agogi

Address
Dimitriou Panagea Str.
GR 153 51 Pallini Attikis
GREECE

Contact Details
Dr. Angelos Lazoudis
angelos@ea.gr

INTRASOFT International S.A.

Address
S.A. 2b, rue Nicolas Bové L-1253
LUXEMBOURG

Contact Details
Irene MATZAKOU
irene.matzakou@intrasoft-intl.com

Association of Geographic Information Laboratories of Europe

Address
Heidelberglaan 2, 3584CS, Utrecht
NETHERLANDS

Contact Details
Prof. Michael Jackson
mike.jackson@nottingham.ac.uk

Casa Corpului Didactic Cluj

Address
str. Septimiu Albini nr. 91
ROMANIA

Contact Details
Ms. Dorina Kudor
dorinakudor@yahoo.com

Konstantin Preslavsky University of Shumen

Address
115, Universitetska St, 9700 Shumen
BULGARIA

Contact Details
Prof. Margarita Hristova-Plashilska
rector@shu-bg.net

Bundesministerium fuer Bildung und Frauen

Address
BMBF - Federal Ministry of Education and Women's
Affairs, Minoritenplatz 5, 1014 Vienna
AUSTRIA

Contact Details
Mr. Reinhold Hawle
reinhold.hawle@bmbf.gv.at

Stichting GeoFort

Address
Nieuwe Steeg 74,
4171KG Herwijnen
NETHERLANDS

Contact Details
Dr. Tabitha van den Ende
tabitha@geofort.nl

Target groups and educational contexts

▸ Target groups:
  ▸ Teachers
  ▸ University students
  ▸ Science center educators
  ▸ Adult learners
▸ Levels of education
  ▸ Schools (primary and secondary)
  ▸ Higher Education
  ▸ Adult education
▸ Educational environments
  ▸ Formal (school and university)
  ▸ Informal (science center / museum)
▸ Languages
  ▸ English
  ▸ Bulgarian
 ▸ Dutch
  ▸ German
  ▸ Greek
  ▸ Romanian

Resources

▸ Educational objects: individual, reusable digital units such as text, images, maps, websites, and interactive and multimedia materials.

▸ Educational scenarios: describe a whole lesson plan or any other formal or informal activity using the inquiry-based educational model

   ▸ pre-structured template mainly for formal activities
   ▸ open template mainly for informal activities

What is spatial thinking?

▸ not a single ability

▸ a **blending of knowledge and skills**

▸ supports people in identifying, interpreting, and visualising location, distance, relationships, movement, change, patterns, and trends through space.

▸ **can be cultivated** with substantial results

Importance of spatial thinking (Sinton et al., 2013)

- a **horizontal thread across the curriculum** (learning to understand and practice spatial thinking in all school subjects) and

- a **vertical thread through the curriculum** (from kindergarten through college)
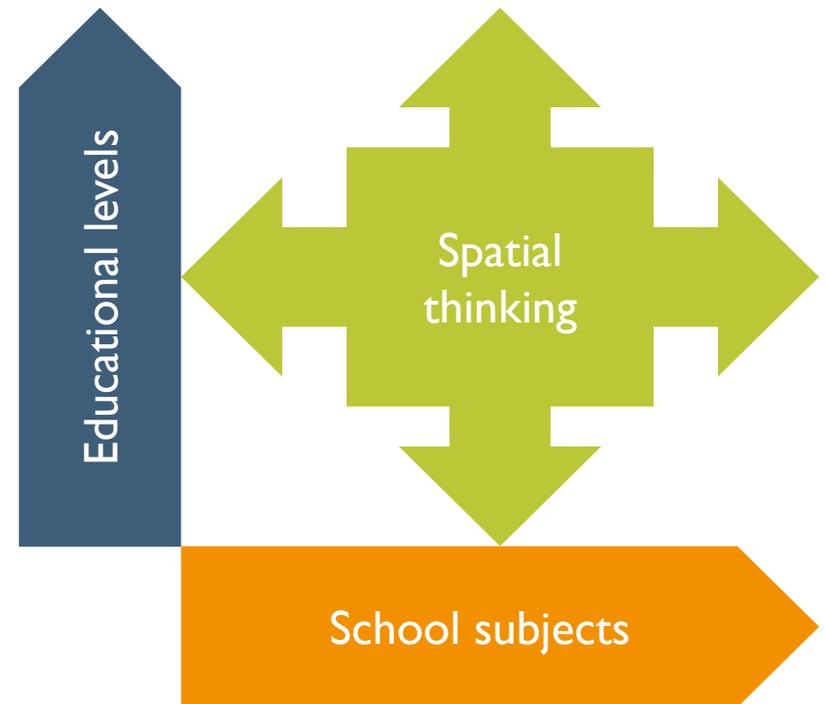
1ˢᵗ underlying idea regarding spatial thinking

Spatial thinking is a synthesis of 3 components: concepts, representation tools, and reasoning processes (National Research Council, 2006).

- **Implementation**: users are prompted to enrich their educational scenarios with concepts, representation tools, and reasoning tools

- **Objective**: cultivate all 3 components of spatial thinking

1. GEOTHNK concepts

- **342 concepts** defined by the consortium based on the analysis of:

  - TeachSpatial

  - Schools Online Thesaurus (ScOT)

  - Canadian National Standards for Geography

  - Geography and Mathematics Dictionary and Glossary for students (ITS Asia)

  - Open Discovery Space (ODS) Vocabulary

1. GEOTHNK concepts

▸ Each concept is described by:

  ▸ a term

  ▸ a definition (from WordNet)

  ▸ links to useful online resources (770 in total collected by the consortium)

2. Representation tools

‣ Links to 55 online representation tools (added by the consortium)

‣ Types:

  ‣ maps, map viewers, and map making,

  ‣ country maps,

  ‣ atlases,

  ‣ historical maps,

  ‣ virtual globes,

  ‣ satellite and areal imagery,

  ‣ data visualizations,

  ‣ models

‣ Example: Geogebra: Interactive 2D and 3D geometry models

3. Reasoning tools

‣ Any kind of tool (educational game, learning activity, interactive application, etc.) that may facilitate the understanding of a concept or scenario and prompt reasoning processes.

‣ Due to being scenario-specific, are added by users.

‣ Examples:

  ‣ Mercator puzzle

  ‣ Layers of the atmosphere virtual lab

  ‣ ArcGIS (Trial Edition)

  ‣ Geocaching: GPS-based hunt game

4. Instances – geographic representation of educational scenarios

▸ **Thousands of instances** linked to concepts are dynamically drawn from the GeoNames Geographical Database.

▸ Support:

  ▸ the visualization of educational scenarios in geographic space

  ▸ an additional search mechanism, i.e., the map-based search: the user interacts with the map to select geo-instances of interest

2nd underlying idea regarding spatial thinking

Spatial thinking is a multi-dimensional, transversal ability that cross-cuts several subjects and grade levels.

- **Implementation**: multidisciplinary organization and semantic association of knowledge
- **Objective**: cultivate spatial thinking through different subjects, at different stages of education.

Semantic network: semantic representation and association of educational scenarios

▸ **342 concepts and 802 taxonomic relations**

▸ Translated into **5 languages** with a semi-automatic approach employing BabelNet and manual translations

▸ Supports:

  ▸ efficient search and retrieval of educational material

  ▸ creation of educational scenarios

  ▸ semantic – visual representation of educational scenarios
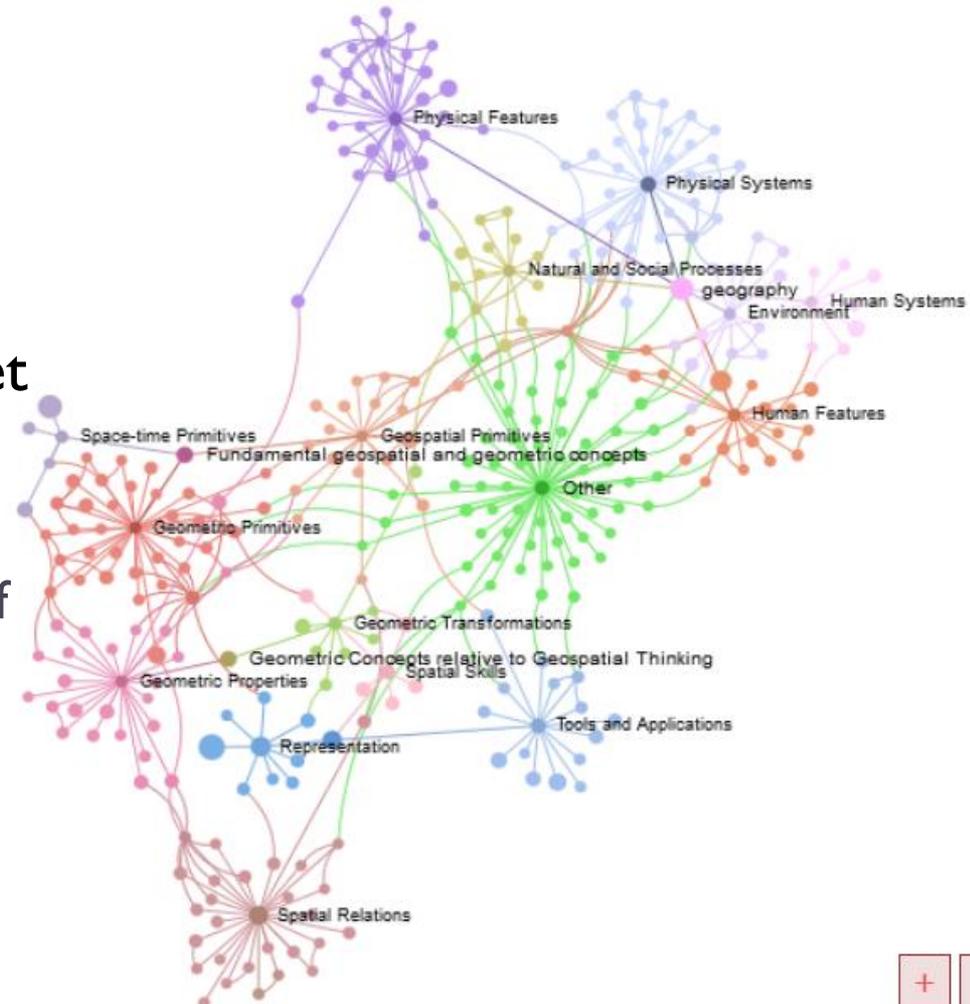
First World War: the conflict of ideologies
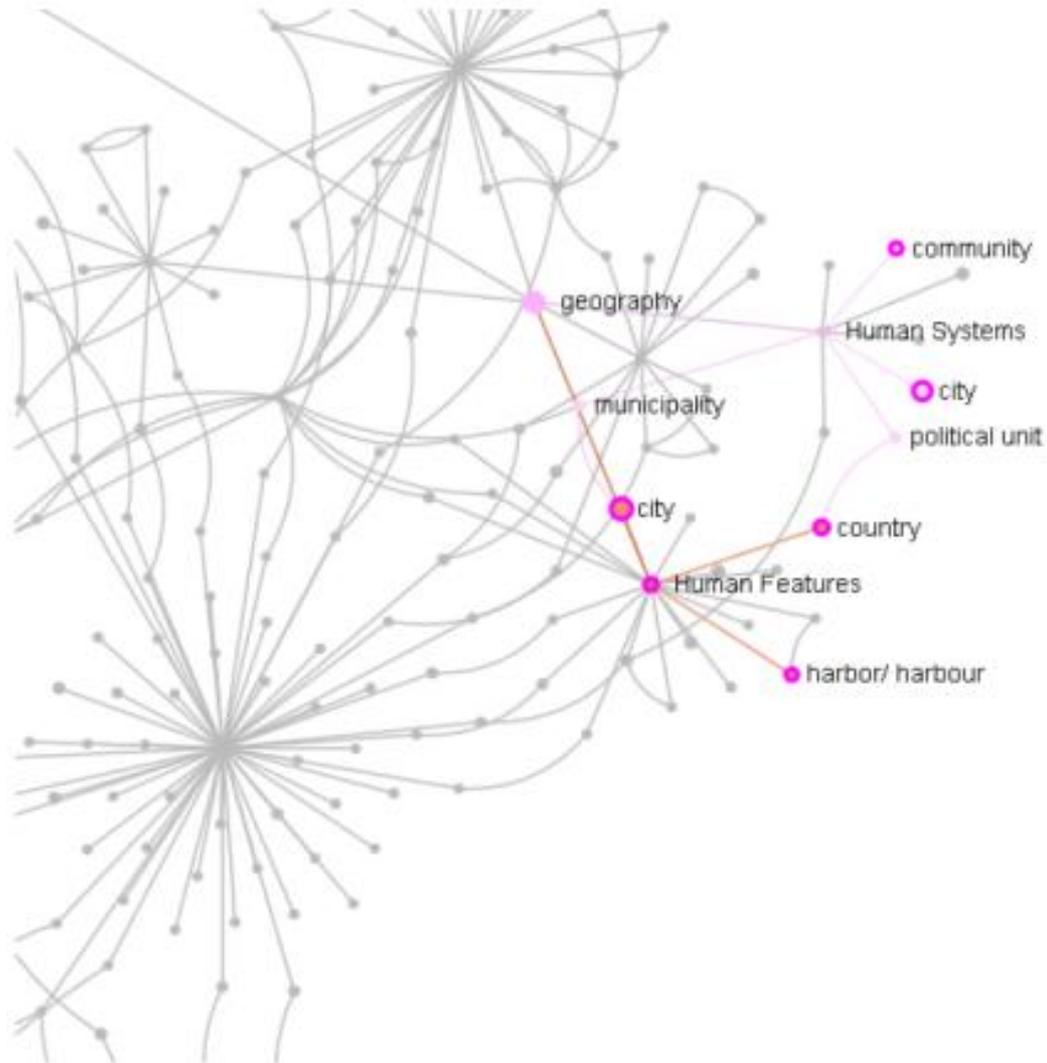
Crowdsourcing results

▸ Users contribute to the repository by:

  ▸ creating new educational objects or scenarios,

  ▸ reusing educational scenarios developed by other users,

  ▸ tagging educational resources, and

  ▸ creating new reasoning tools.

▸ 656 registered members

▸ 413 featured resources (143 educational objects and 270 educational scenarios)

▸ 68 reasoning tools

▸ >4000 tags added on resources

GEOTHNK resources and education levels

Education level	Resources
Primary Education	116
Secondary Education	291
Higher Education	69

Primary Education

- [Make your own Globe](#)
- [Make your own Compass](#)
- [Deep Inside The Earth](#)
- [Teaching directions -3rd and 4th grade](#)
- [Giving directions: How can I get to…. Map orientation for 5th grade](#)
- [Mathematical orientation for 5 grade](#)
- [Open Streetmaps: Missing Maps](#)
- [World Market Routes game](#)
- [Me and my family](#)
- [Pyramids](#)

Secondary Education

‣ Touch the Sun

‣ The planet's atmosphere

‣ Milky Way - the backbone of night

‣ Navigation then and now

‣ Distances and scales

‣ From counting pebbles to the GPS

‣ Towns and villages in Bulgaria - 10 grade

‣ Map Projections

‣ Eratosthenes' measurement of the Earth's Circumference

‣ Volcanoes and Plate tectonics

‣ Google Earth the Metropolitan cities

‣ Regular Pyramid

Higher Education

- [Representation of data using cartograms](#)
- [Perceptual image of an urban environment](#)
- [Visualization and Representation of multidimensional data in two-dimensional space](#)
- [Winery Sitting](#)
- [Hydrological Data Analysis of Thrace's Water Department](#)
- [Mapping roads and buildings from satellite data, through the procedures of unsupervised and supervised classification](#)
- [Online Analysis of Earth Observation data for Agricultural Applications](#)
- [Optical Instruments](#)

GEOTHNK resources and curriculum subjects

Curriculum subjects	Resources
Science	221
Geography and Earth Science	197
Environmental Education	41
Physics	13
Astronomy	9
Mathematics	52
ICT	32
English teaching	27
History	25

A closer look on Geography and Earth Science: …and on Mathematics:

GIS: 19	Graphical display of data: 10
Cartography: 9	Geometry: 34
Maps & plans: 21	Transformation: 7
Spatial Transformations: 6	

20 Most used concepts

Concept	Occurrences
map	109
location	90
geography	85
city	75
Representation	70
Spatial Relations	59
area	54
distance	52
Methods and Abilities	51
island	48
Fundamental geospatial and geometric concepts	44
geographic information systems	42
Geometric Concepts relative to Geospatial Thinking	42
city	39
scale	38
Spatial Relation	38
time	37
Physical Systems	36
mapping	35
Tools and Applications	35

Multidisciplinarity

Night Sky

Moon travelers

Touch the Sun

Logarithms in science

Maps and Diagrams

Scale

Earthquakes : The example of the 1953 earthquake

Vocational pathways and more... in my city

Perceptual image of an urban environment

Spatiotemporal evolution of the Aegean Archipelago

Design your own town

Geographical orientation for 6th grade
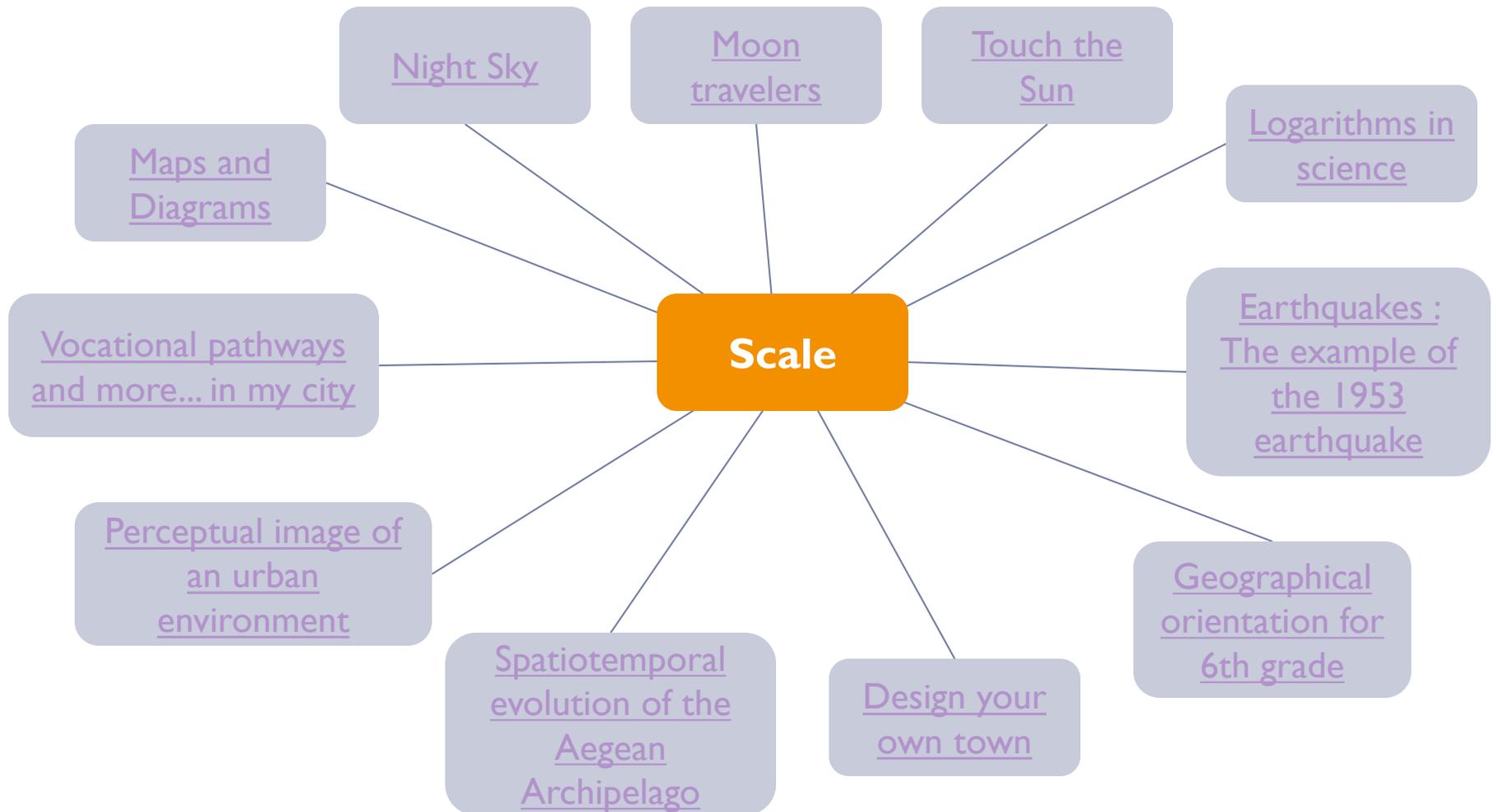
Conclusions

▸ Implementation activities are necessary to train users to the GEOTHNK approach

▸ Target groups have a wide, multidisciplinary conception of spatial thinking; cross-cuts different subjects and levels of education

▸ Spatial concepts also relate to the international trend and discussion about crosscutting concepts in education

▸ Future steps

  ▸ trace spatial thinking across the curriculum

  ▸ address the learners – may and how the GEOTHNK approach enhance the spatial thinking skills of learners?

  ▸ showcase how crosscutting concepts such as scale, pattern, and system may be explicated using real-case examples from the spatial or geospatial domain

http://www.geothnk.eu

http://portal.opendiscoveryspace.eu/community/geothink-community-400866