Crowdsourcing Spatial Thinking Resources across Disciplines and Educational Contexts

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Abstract. GEOTHNK is an online repository and an authoring environment for the collection, creation, and sharing of educational resources and scenarios that treat spatial thinking from a wide range of perspectives – disciplines. The approach is based on crowdsourcing: (a) the collection of open resources and tools, and (b) the development of educational scenarios that enhance spatial thinking. The paper discusses the analysis of resources and the semantic organization of spatial knowledge within the GEOTHNK environment.

1 Introduction

Spatial thinking has been acknowledged as critical for increasing participation and success in STEM disciplines [1], but also highly relevant to social sciences and humanities [2]. Spatial thinking is defined as a constructive synthesis of three components [3]: (a) concepts of space, (b) tools of representation, and (c) processes of reasoning. For example, in order to identify areas vulnerable to flooding due to a sea level rise, learners should grasp spatial concepts such as location, distance / proximity, and elevation, use representation tools such as maps and terrain modeling, and be able to perform reasoning processes, such as combining maps and evaluating multiple criteria (e.g., the location of settlements) to make inferences about environmental consequences. However, research has shown that the components of spatial thinking are not treated equivalently in education; low-level spatial concepts are given priority relatively to higher-level spatial concepts and spatial representations, whereas higher-order cognitive skills are rarely promoted [4].

GEOTHNK [1] is an online repository and an authoring environment for the collection, creation, and sharing of educational resources and scenarios that focus on enhancing spatial thinking. Through its authoring environment and the semantic organization of spatial knowledge, GEOTHNK promotes this consideration of spatial thinking as a synthesis of spatial concepts, representation tools, and reasoning processes.

[1] http://portal.opendiscoveryspace.eu/community/geothink-community-400866

2 Organization of Spatial Knowledge within GEOTHNK

GEOTHNK is incorporated within Open Discovery Space (ODS)[2], a multilingual open learning platform for sharing eLearning resources; however, it has its own authoring environment, semantic structure, search mechanisms, and visualization tools. Beyond English, GEOTHNK is developed in five languages (Bulgarian, Dutch, German, Greek, and Romanian).

GEOTHNK is based on crowdsourcing educational resources and scenarios mainly from: teachers and teacher trainers, university students, science center educators, and adult learners. It may apply to different educational contexts (primary, secondary, and higher education), both in formal (school or university) and informal environments (science centers or independently on the web). The crowdsourcing approach is supported by organized implementation and validation activities such as Workshops, teachers training courses, competitions, and summer schools.

GEOTHNK includes two types of resources: educational objects and educational scenarios (or pathways). Educational objects are individual, and 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 and rely on the inquiry-based educational model. The authoring environment offers two templates for designing educational pathways: (a) a pre-structured template mainly for formal activities and (b) an open template mainly for informal activities. Educational scenarios are designed based on the definition of spatial thinking as a synthesis of spatial concepts, representation tools, and reasoning tools: users are able to enrich their scenarios with these components. For example, Fig. 1 shows the addition of concepts accuracy, map, and scale to an educational scenario.

GEOTHNK includes 342 concepts, defined by the consortium, both spatial (e.g., coordinates, altitude, and distance) and non-spatial (e.g., natural resources and alternative energy), concepts referring to tangible objects (e.g., city and canal) and concepts referring to abstract notions (e.g., form and connection). This set of concepts is developed based on a analysis of existing vocabularies, including TeachSpatial[3], the Schools Online Thesaurus (ScOT)[4], the Canadian National Standards for Geography[5], the Open Discovery Space[6] controlled vocabulary, and the Geography Dictionary & Glossary for students[7]. Each concept is described by three elements: (a) a term, (b) a definition, and (c) links to useful resources (Fig. 1). Concept terms and definitions, as well as their between relations are derived from WordNet [5].

The concepts and their between 802 taxonomic relations form a semantic network which supports an alternative, graph-based way of searching for educational resources (Fig.2). It is also an integral part of the development of educational scenarios since users are able to add concepts to their scenarios by selecting them from the semantic network.

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[2] http://opendiscoveryspace.eu
[3] http://teachspatial.org/
[4] http://scot.curriculum.edu.au/index.html
[5] http://www.cgeducation.ca/programs/geography-standards/default.asp
[6] http://www.opendiscoveryspace.eu/
[7] http://www.itseducation.asia/geography/

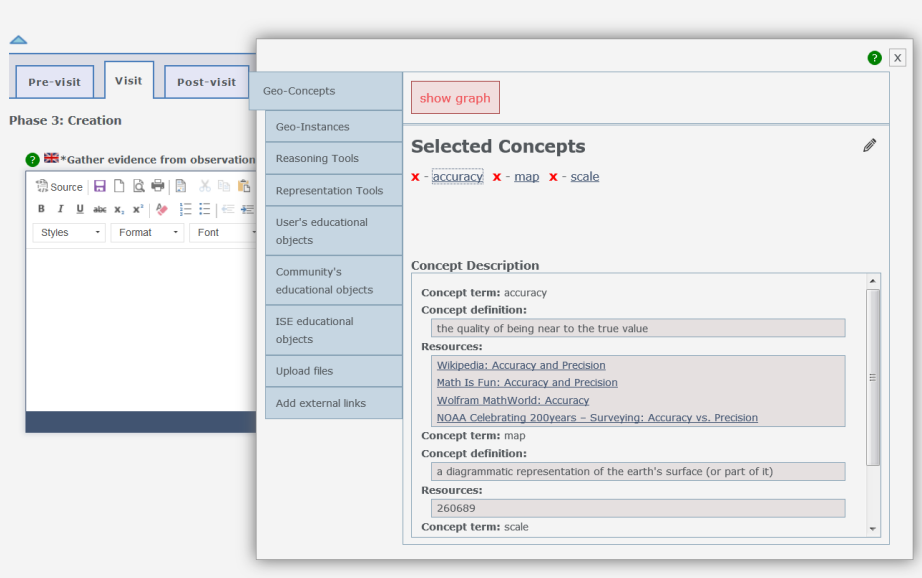

Figure 1. Attaching concepts, representation tools, reasoning tools, and other resources to educational scenarios.

GEOTHNK provides also links to various categories of online representation tools: (a) maps, map viewers, and map making, (b) country maps, (c) atlases, (d) historical maps, (e) virtual globes, (f) satellite and areal imagery, (g) data visualizations, and (h) models. A reasoning tool may be 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. Reasoning tools, due to being scenario-specific, are added by users.

Users contribute to the repository in different ways: they are able to create new educational objects or scenarios, reuse educational scenarios developed by other users, tag educational resources, and create new reasoning tools. The aim is to underpin the collection and creation of educational resources relative to spatial thinking from different perspectives - disciplines. For example, some educational scenarios that relate to the concept scale are:

- Distances and scales
- Earthquake – A natural phenomenon
- Geographic coordinates and maps
- Geographical orientation for 6th grade
- Logarithms in science
- Maps and Diagrams
- Moon travelers
- Night Sky
- Perceptual image of an urban environment
- Spatiotemporal evolution of the Aegean Archipelago

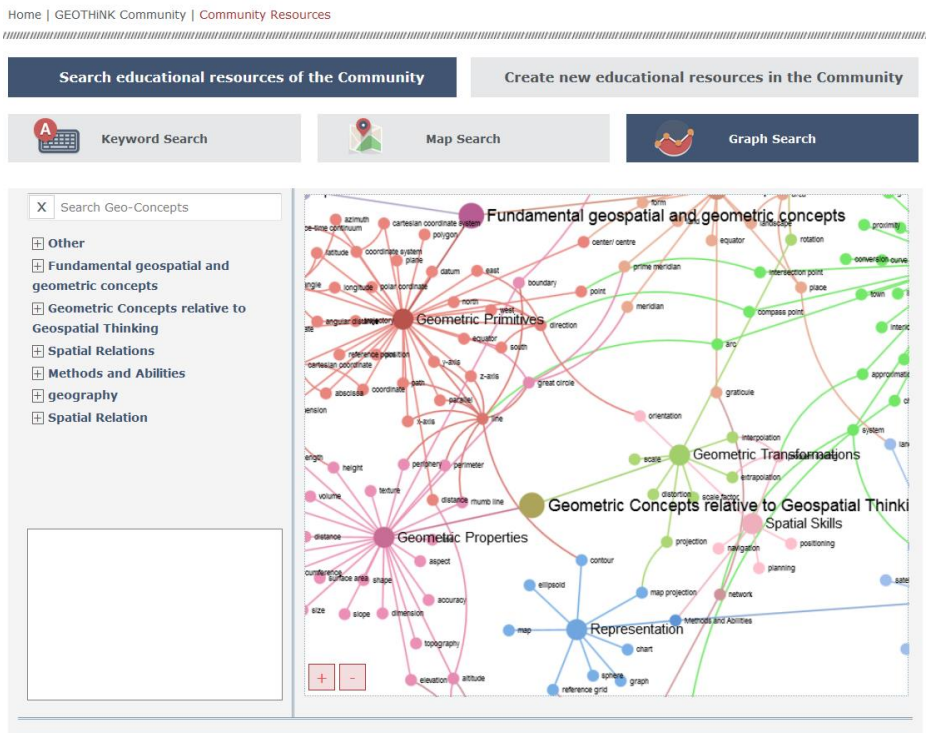

Figure 2: Graph-based search of GEOTHNK resources.

3 Conclusions

An underlying assumption of the project is that the geospatial domain is inherently transdisciplinary. This assumption was overly verified by the variety of educational scenarios related to diverse subjects such as Geography, Mathematics, History, and English teaching. Another assumption that remains to be verified in future steps is whether the enrichment of educational scenarios with spatial concepts, representation tools, and reasoning tools may indeed enhance the spatial thinking skills of learners.

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