

## Incorporating Geo-Spatial Thinking in Elementry Educationm: Conceptualization And Domainwise Study.

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### Abstract

*Spatial thinking has occupied a distinct place in daily life of an individual. GIS (Geographic Information System) and GPS (Global Positioning System), these technologies have fulfilled the spatial needs of the people. Knowingly or unknowingly several tasks from the daily life of an individual are performed according to spatial thinking. But no formal academic background of spatial thinking is found for the curriculum. Implication and fostering of these spatial thinking abilities in the education proves to be necessary as pupils lack in figure ground perception, visualization and mental orientation of objects. Knowledge of scientific implications of Geospatial thinking in textbooks and curriculum can enhance the understanding of pupils. Eventually it will be visible in the high academic achievement of pupils.*

*Keywords: Spatial thinking, Geo-spatial abilities, domains, Subject matter and curriculum*

### Introduction

**N**ow a days Spatial thinking is getting growing concern in each and every spectrum of life. There wouldn't be any surprise if people are pampered by the use of GIS (Geographic Information System) and GPS (Global Positioning System). With these navigation technologies spatial thinking has occupied a distinct place in daily life. With the help of t this navigation and positioning technologies pare more fascinated to know about their places of interests, modes of travels, transportation facilities to reach there, atmosphere of the place, restaurants, shopping malls, multiplexes nearby are always high on the minds of the people. These technologies have fulfilled the spatial needs of the people. Spatial thinking is inherent ability of living entity on the Earth. Even birds fly at several miles and at the sunset they return to their own nests with the help of GPS system which is in built in their minds. Forecasting weather, cycle of rain and process of precipitation are related with the positioning and visual orientations of objects that is happening in the space. Knowingly or unknowingly several tasks from the daily life of an individual are performed according to spatial thinking.

Spatial thinking is a fundamental competency for the understanding of geography. Geography is integrated in Maharashtra state curriculum as an independent subject. Kothari commission in 1966 recommended geography as a mandatory part of social sciences studies. Basically, in India curriculums are framed on the basis of subjects. After the modifications in the curriculum of 1986, Regional and Economic geography was included in school geography but no major shift has been found from the perspectives of goals, objectives and the subject of geography. When the national curriculum again modified in 1999, it brought major changes such as 1) introduction of environmental studies at elementary level.2) integrated economic and regional geography based on Indian context and local aspects of geography are taken into considerations. 3) GIS system, Remote sensing, Computer Mapping were also included as the inclusion of technical geography. But somewhere there is need to concentrate on the framing of curriculum from the point of view of abilities and competencies. As spatial thinking plays an important role in the perception of geographical concepts. The subject like geography is fundamentally based on spatial abilities. But do not have academic background of spatial thinking. The need of the hour is to map the curriculum, subject

matter and outline the framework of geography from the point of view of spatial thinking. Implication and fostering of these spatial thinking abilities in the education proves to be necessary as pupils lack in figure ground perception, visualization and mental orientation of objects. Knowledge of scientific implications of Geospatial thinking in textbooks and curriculum can enhance the understanding of pupils. Eventually it will be visible in the high academic achievement of pupils.

Present paper briefly reviews the researches from the point of view of incorporating geo-spatial thinking in elementary education: conceptualization and domain wise study based on spatial thinking with the help of following mentioned points.

- 1) Literature related to spatial thinking: concepts.
- 2) Literature related to spatial thinking: domains, perspectives and levels.

**1) Literature related to spatial thinking: concepts**

Spatial thinking catches considerable attention not only in Geography but in other disciplines also. The increasing importance of spatial thinking triggered the increasing researches in the field of Geo-spatial Thinking. Here are some notable research studies focusing on the conceptual framework of spatial thinking.

**1.1) NRC (National Research Council) (2006): -**

NRC published the research report “Learning to Think Spatially” and this paper got the immense importance in the learning of spatial thinking. NRC stated that the Spatial Thinker is the first requirement for spatial thinking spatial thinker who can think and understand the major three components of spatial thinking. These three major components are as below.

- 1.The nature of space
- 2.The methods used to represent spatial information
- 3.The process of spatial reasoning

NRC in 2006 defined spatial thinking in the words such as “Spatial thinking is a constructive amalgam of three elements: concepts of space, tools of representation and processes of reasoning.”

NRC claimed that the spatial thinking means thinking about the space. In the thoughts of spatial thinking size, shape, location, direction and visual

orientations these spatial concepts are considered. It has also stated that the spatial thinking is beyond spatial visualization and spatial orientation.

Cognitive psychologists studied spatial thinking in broad manner. They propounded two broad dimensions of spatial thinking abilities. Those two dimensions are:

- 1) Spatial visualization
- 2) Spatial orientation

Spatial visualization is the ability of representation and operations of mental stimuli. Spatial orientation is the ability of comprehension of the various dimensions of pictures from different perspectives. Adding to this some geographic researcher stated that one more dimension is important in spatial thinking i.e., the understanding of spatial thinking.

**1.2)Golledge and Stimson (1997): -**

Golledge and Stimson ranked first among those researchers who proposed the definitions of spatial thinking abilities. They defined spatial thinking abilities as.

“Spatial relations include abilities to recognize spatial distributions and spatial patterns to connect locations, to associate and correlate spatially distributed phenomena, to comprehend and use spatial hierarchies, to rationalize, to orient to real-world frames of reference, to imagine maps from verbal descriptions, to sketch maps, to compare maps, and to overlay and dissolve maps.”

With the above cited comprehensive definitions of spatial thinking Golledge and Stimson agree with the report and stated that spatial thinking skill comprises of three important dimensions as

- a) Spatial visualization
- b) Spatial orientation
- c) Spatial relations

Golledge and Stimson contributed by giving a comprehensive and detailed definition of spatial thinking. They assert that these three dimensions are important in the understanding of spatial thinking.

**1.3) Gatrell (1991) :-**

Gatrell firstly talks about space and defines it as “Space is a set of objects linked by specific relation.”

He considers space as a set of objects and all the objects in the space are linked with each other with the similarly related properties and they are

characterized accordingly. Further Gatrell claimed two typologies of spaces based on two major factors ; distance and relation. The two typologies can be cited as

- a) Metric spaces
- b) Non-Metric spaces

Metric spaces are those spaces in which distance can be calculated with the help of Euclidean and Manhattan distance. Relative relation can be found in this type of spaces. Non-metric spaces cannot be calculated by using algorithmic functions. But in individuals’ daily life the relative relations are found regarding non-metric spaces such as ‘far’, ‘close’ etc.

Spatial abilities are closely related with process of civilization and the specific understanding of the surrounding objects and phenomena. Spatial thinking abilities of an individual develops when he get more enriched spatial experiences.

**1.4) Grossner (2012): -**

Grossner proposed that the maps and graphs visualize and fill the gaps between the reality of entity and spatial concepts in the minds of an individual. With the help of advanced technology individuals can sort out their problems. Furthermore, the researcher classifies this representation into two categories. The classification of spatial thinking by Grossner is as below.

- a) Internal representation
- b) External representation

Internal representation includes cognitive spatial abilities for instance rotation of objects and cross section visualization. On the other hand, external representation can be presented in the form of scaling, computations etc.

Researchers such as Montello (1995), Newcombe (2010) , Wegner (1912) have also contributed a lot for the understanding spatial thinking.

**2) Literature related to spatial thinking: domains, perspectives and levels.**

Spatial thinking abilities can be developed by imparting training to the mind. Suitable environment is more significant to foster spatial thinking. Parents, teachers and students should work hard to acquire mastery over spatial thinking abilities. Here are some notable researchers who have tried ascertain some

domains, levels, perspectives and dimensions of spatial thinking abilities.

**2.1) Gersmehl and Gersmehl (2006,2007)**

The researcher vividly elaborated the 13 types of spatial thinking competencies as stated below.

**SPATIAL THINKING COMPETENCIES BY GERSMHL and GERSMHL COMPETENCIES**

- 1.Describing a location
- 2.Comprehending conditions
- 3.Knowing spatial connections
- 4.Comparing between places
- 5.Guessing a zone of influence
- 6.Guessing a zone of influence
- 7.Reasoning based on a spatial analog
- 8.Assessing a spatial association
- 9.Making a spatial hierarchy
- 10.Depicting a spatial transition
- 11.Noticing spatial patterns
- 12.Designing and using a spatial model
- 13.Mapping a spatial exception

The above cited set of spatial objects can help in the understanding of spatial thinking abilities. From the point of view of Gersmehl location is a complicated term and students need higher order cognitive process to understand it. In spite of location, direction, distance these spatial abilities should be invoked firstly and then location should be explored. All the competencies proposed by Gersmehl are linked with each other.

**2.2) JO and Bednarz (2009)**

JO and Bednarz proposed taxonomy of spatial thinking. This taxonomy is based on the three major elements. The elements of the taxonomy are a) concept of space b) tools of representation c) process of reasoning. The researchers have displayed these three major elements, sub-elements and some small factors of sub- elements in 3D cube. Each element represented in the cell denotes unique characteristic.

**Table 1.0 Components of spatial thinking under each element as below.**

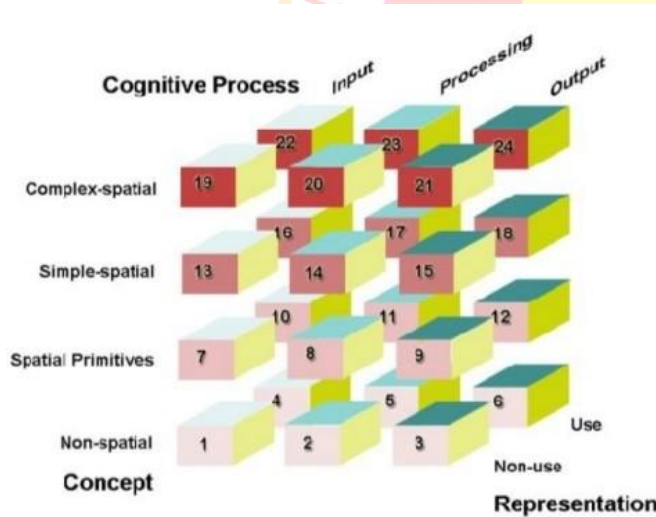
<b>Complex Spatial</b>	<b>Distribution, pattern, dispersion and clustering, density, diffusion, dominance, hierarchy and network, spatial association, overlays, layer, gradient, relief, scale, map projection, buffer.</b>
<b>Simple spatial</b>	<b>Distance, direction, connection and</b>

	linkage, movement, transition, boundary, region, shape, reference frame, arrangement, adjacency, enclosure
<b>Spatial Primitives</b>	Place-specific identity, location, magnitude.
<b>Input</b>	Name, define, list, identity, recognize, recite, recall, observe, describe, select, complete, count, match.
<b>Processing</b>	Explain, analyze, state casualty, compare, contrast, distinguish, classify, categorize, organize, summarize, infer, make analogies, make exemplify, experiment, sequence.
<b>Output</b>	Evaluate, judge, predict, forecast, hypothesize, speculate, plan, create, design, invent, imagine, generalize, build a model, apply a principle.
<b>Use</b>	Map, diagram, chart, graph, photo.

fundamental properties of space. All the objects in the space have a significant relation between them. This relation is calculated in dimensional and scalar properties. Drawing inferences of relations between the objects is also a major task.

**Table 1.1 Five-Levels of geospatial concepts (Golledge et al.,2008a)**

Concept and Level				
Primitive	Simple	Difficult	Complicated	Complex
Identity	Arrangement	Adjacency	Buffer	Area association
Location	Distribution	Angle	Connectivity	Interpretation
Magnitude	Line	Classification	Gradient	Map projection
Space-time	Shape	Coordinate	Profile	Subjective space
	Boundary	Grid pattern	Representation	Virtual reality
	Distance	Polygon	Scale	
	Reference Frame			
	Sequence			



**Figure 1.0 A taxonomy of spatial thinking**

From Jo,I. and S.Bednarz.2009 Evaluating Geography Textbook Questions from a spatial perspective: Using Concepts of Space, Tools of Representation, and Cognitive Processes to Evaluate Spatiality. Journal of Geography 108:4-13.

**2.3) Golledge (2008): -**

The researcher extensively elaborated the different levels of spatial thinking. They represent the set of spatial thinking which is hierarchical in order. Geo-spatial concepts help to decide the levels of spatial thinking. The primitive spatial thinking helps to understand the surroundings. People should learn scalar, dimensional properties because this is the

The above cited hierarchical domains of spatial thinking can most appropriately be used by a Geography teacher while teaching in the geography classroom. From primitive competencies to complex competencies spatial competencies require a special action plan and rich inputs to develop them. Golledge contributed by setting the hierarchical object set in spatial thinking.

**Conclusion: -**

The conceptual framework makes the thought process of a researcher crystal clear and adds the clarification in the comprehension. Several researchers tried their best to elaborate spatial thinking and various domains of it. Knowledge of various domains foster the application of a concept. The implication of a concept requires a practical and scientific base.

Thus, providing conceptual base and asserting various domains of spatial thinking can make it feasible for the implications of it in the spectrum of education.

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