# Geospatial Information System in Education:
## A Critical Review

### Introduction

Geospatial Information System (GIS) is one of the most important contributions modern technologies. Geospatial perspective serves a prospective and powerful visual dimension to data through maps facilitating communication and discourse among different stakeholders. By locating data in the context of place, issues become more familiar and understandable to those who may not have experience in data analysis.GIS tools, in a plain description, enable to create thematic maps based on data stored in a spreadsheet or database. Data may be linked to a number of ways such as area e.g., country, line e.g., roads, rivers etc and point e.g., address; it may also be represented as charts and graphics. Functionally, GIS is a dynamic process allowing the data and map being automatically updated. It allows the user to visualise and analyse spatial information in novel ways that reveals previously hidden relationships patterns and trends. In the swiftly transforming modern technology, GIS is considered as the heart of all modern spatial decision making which may be a identifying a location, public service, planning or environmental planning. However, despite its potential important roles in the government, society and decision making, a negligible impact on education has been witnessed till date (Wiegand, 2001), though its application in schools and universities has already been witnessed a progressive development though in a low speed.

GIS were originally developed for scientific land management purposes in Canada during the 1960s during which Canada Geographic Information System was established for the collection and analysis of land use data and the production of statistics for land use management plan (Johnson and Pellikka, 2005). Since then, GIS has been typically used as a technologically advanced tool to provide potentially highly significance of the progress in presentation, preparation and flexibility to microplanning to justify the benefits (Hite, 2008).

GIS uses specialized software that integrates spatial data (e.g., geo-referenced coordinates such as latitude and longitude) and non-spatial data to produce geographic maps. Smith et al, (1987) opines that GIS is a database system in which the data are spatially indexed with a set of procedure in operation to answer queries about spatial entities in the database. Aronoff (1989) described GIS as a computer system capable of assembling, storing, manipulating and displaying geographically referenced data i.e. data identified according to their locations. According to the definition given by the Environmental Systems Research Institute (ESRI), California (1990), GIS is defined as an 'organized collection of computer hardware, software and personnel to efficiently capture, store, update, manipulate, analyse and display all forms of geographically referenced information'. According to Nyerges (1992), GIS is a system of hardware, software and procedure designed to support the capture, management, manipulation, analysis, modularity and display of spatially referenced data for solving complex planning and management problems, while Fischer and Nijkamp (1993) described GIS as 'a computer based information system which attempts to capture, store, manipulate and display spatially referenced data (in different points in time), for solving complex research, planning and management problem'. Burrough (1998) described GIS as 'a powerful set of tools for collecting, storing, retrieving, transforming and displaying spatial data from the real world for a particular set of purposes'.

 

It is also described as a decision support system that involves the integration of spatially referenced data in a problem solving environment. GIS mapping helps in visualising the results of field surveys providing vital information as well as facilitating in economising the financial and human resources. GIS is a user-friendly mapping method, which is a practical and useful technique in field researches and educational staff monitoring system to analyse the distribution of facilities in a geographically diverse area.

Education data may be perceived as geospatial as they contain information about schools and districts located within neighbourhoods, communities and different areas of metropolitan regions. 'Adding geospatial perspective to data involves identifying the physical location of "where" variables occur in geographic context. When data are associated with geographic coordinates for entities such as schools or census block groups, spatial perspective emerges from mapping the location and distance information. Today, geospatial perspective is most commonly created using a GIS to generate maps. GISs incorporate a variety of technologies and processes for collecting, analyzing, interpreting, communicating, and using geospatial data' (Elwood & Cope, 2009; Maantay & Ziegler, 2006; NRC, 2006).

GIS (i) may be regarded as the primary tool for generating maps and spatial analysis to define practical approaches or ways how GIS can be used by the educators and social scientists, (ii) can be considered for analyzing data in descriptive, quantitative and qualitative approaches, and (iii) may emphasise a mixed methods approach through public participation and discourse about social outcomes (important to the local communities and the public good), called "participatory GIS" (PGIS).

GIS and Education

GIS offers an influential decision-making tool in education sector across its administration, policy and instruction. For administrators, GIS can offer them an approach to visualize and manage the whole thing including monitoring campus safety, mapping campus buildings, cable and other infrastructure, routing school buses, planning of closing schools and opening new ones and in strategy of recruitment efforts. For policymakers in education, GIS provides them tools that can present patterns in educational achievement and the place for targeting of new programs. For instruction**,** GIS tools in the hands of students can facilitate them in knowing content in various disciplines such as geography, history, mathematics, language arts, environmental studies, chemistry, biology, civics, and more. GIS can be used as an inquiry-driven, problem-solving, standards-based set of tasks that incorporates fieldwork and provides career pathways that are increasingly in demand. It facilitates students to thinking critically, using real data and connecting to their own community in informal, primary, secondary, and university settings, which is in demand by the visual learners these days. GIS helps students to explore the relationships among many things such as people, climate, land use, vegetation, river systems, aquifers, landforms, soils, natural hazards and more.

GIS is a tool that provides students a holistic computer and management skills such as computer, personal and organizational competencies. Due to the readily available information available these days, students can deal with uncertainty about data, understand its limitations related to error and omissions and manage it effectively (National Academies Press- US Department of Labor, 2010). GIS allows students to explore content knowledge and shows a way of thinking about the world (Bednarz, 2004; Kerski, 2008). These skills were identified as essential to the Senior Secondary (K-12) education by the National Academy of Sciences, USA (National Academy of Sciences, 2006). Geotechnology and with Bio- and Nano-technologies are the important skills in demand and for job markets for the current Century (Gewin, 2004).

In teaching and instruction, GIS can integrate with fieldworks to help students in understanding and appreciating our world (Louv, 2005). Students can collect information such as locations with GPS and attribute information about tree species, historical buildings, water quality, and other variables on a field trip or even on their own school or university campus. Based on the required and interested geographic queries, students can attain geographic resources and data collection and can analyze geographic data to discover relationships across time and space.

Investigations in Geography may be a heavy task requiring critical thinking while studying relationships among various variables e.g., the relationship between altitude, latitude, climate and cotton production so that, with prior knowledge on the requirements of cotton farming, it helps in decision making to find a suitable cotton growing area. Applications of GIS and its tools help students in their investigations, recommendations as well as in improving the living standard of people and the health of the planet. Their results after investigations may be presented using GIS platform and multimedia, which may spark additional questions for further research and inquiry. The perspective of geography is necessary for other disciplines too. GIS provides critical tools for studying different issues and for solving real problems on a daily basis e.g., when epidemiologist studying the spread of diseases, scientists studying climate change or businesspersons locating a new retail establishment, spatial analysis is a necessity.

As the living planet is changing constantly over the time as those caused by erupting volcanoes, meandering rivers, shifting plates, and human forces e.g., urbanization, there is a need to research and understand the underlying forces, their causes, measures and remedies and act on the required strategies and policy interventions. This throws the necessity of spatial thinking, inquiry and problem-based learning.  For all these, researchers, managers and students use GIS applications and tools to understand changing phenomena to learn thinking scientifically and analytically and make them become decision-makers for making a difference in the changing world. Thus, GIS is making a difference in the present education sector.

**GIS Approach in Education**

GIS in education may be described in three categories: (i) using GIS desktop software to manage data and generate maps, (ii) involving GIS Internet applications and (iii) dealing with GIS applications in the school curricula. GIS desktop software facilitates the user to control all the aspects of a GIS project including gathering and input of data, analyses of data and generation of spatial maps. This has the flexibility to learning the software and geographic concepts and to user's ability to acquire relevant data for the topic and format it for use in the GIS software.

GIS Internet website applications with the primary purpose of displaying data in a spatial format (Cartwright, 2008; Jones & Purves, 2008) are normally centred on a common theme such as census, education, health, or crime data. The GIS websites are specially designed to make the interface as user-friendly as possible so that users can generate maps easily by simply selecting variables from menus to display the map automatically to use for descriptive purposes only to visualize location and relationships between variables. This GIS website approach has the potential for reaching data visually and spatially to the greatest number of people.

 

GIS for school curricula has important implications as GIS has two important applications in the teaching–learning process. GIS can play a significant role in developing spatial thinking which, in turn, involves cognitive skills that can be taught and have broad ramifications across several subjects such as the maths, science, engineering, and technology (NRC, 2006; Sinton & Bednarz, 2007). Spatial reasoning skills are to be taught, applied and reinforced in the curriculum for which GIS has the power to develop spatial reasoning by requiring the learner to think using the concepts of place and space. In addition, geographic maps have been shown to increase the recall of related text material (Kulhavy et al., 1993). GIS provides a powerful platform for many types of learning (Kerski, 2008).

Below are some of the points how GIS can reinforce teaching and learning (NRC, 2006):

- GIS can facilitate the process of scientific problem formulation and solution demonstrating several principles of discovery-based, student-cantered inquiries.
- GIS can be helpful to solve a wide range of problems in real-world contexts by serving as a tool for both scientific research and problem solving, and thus creating a link between science and policy. In the school context, the link between science and policy may be demonstrated in GIS community projects.
- GIS can facilitate learning across the school subjects and enhance learning from interdisciplinary and multidisciplinary perspectives.
- GIS can offer a rich, generative, inviting and challenging problem-solving environment to empower students for addressing significant issues (with the same tools that professionals use to address issues in their work).
- GIS has the potentiality for accommodating and accessing the full range of learners, including the visually impaired, differently able students and those with difficulty of learning in traditional ways. It is also rigorous enough to challenge gifted students.
- GIS can be used effectively in diverse educational settings by infusing in the curriculum or using in traditional subject-based curricula of all grades. It also enables ranging modes of use such as the individual and stand-alone, collaborative and networked.

These points clearly describe the benefit of teaching GIS in schools as a means of developing problem solving skills related to complex issues in real-world contexts. Using GIS for problem solving and research requires information to be synthesized into a comprehensible visual format that can be readily used to generate discourse on important school district, community and real-world issues related to school education and public good. Students who can solve problems by integrating multiple sources of data into a visual presentation with GIS mapping learn a valuable way of describing their learning outcomes and engaging in community discourse and policy analysis, which in essence are the skills needed for the development of, and engagement in, a GIS in Education mission.

#### GIS and School Mapping

School mapping involves physical location analysis of schools which requires knowledge of the settlements and population of the area. Based on the location and attributes of roads, houses, and other infrastructures as layers, accessibility analysis is made, which along with spatial analysis, helps in easy decision making (Hite, 2008). The application of GIS in school mapping is a term used in educational planning and management, which covers a wide range of educational planning and management concerns related to resource allocation, efficient delivery of services and improvement in efficient learning. Mapping is a tool commonly used to reveal the relationships between the distribution of schools and the distribution of school age population to be served by them in a given area. GIS database provides a comprehensive framework and organization of spatial as well as nonspatial data, which has become a focused tool to help planning and decision making. Mapping of schools along with the information on administrative boundary and the biophysical layers such as major road network and major settlements provides the ground reality in terms of geographic coverage.

GIS is based on the philosophy that location is important because variables and their relationships can vary by place and the space between them. Based on the Tobler's First Law of Geography which states, 'everything is related to everything else, but near things are more related than distant things' (Tobler, 1979), Aliyu et. al., 2013 opines that spatial distribution could indicate patterns of underlying process and incidents exposed to the impact of similar process tend to follow similar locating pattern. Thus, study on spatial cluster may possibly unveil information of the underlying geographical process that generates the spatial pattern, which in turn may help in knowing the underlying geographical process as well as its relation to the investigating phenomenon. The advancement in the field of geographical information systems (GIS) had contributed greatly to a number of studies dealing with measures of spatial access to educational facilities and resources. A number of studies have demonstrated mapping the distribution of facilities and analyzing their distribution to show whether they are clustered, dispersed or randomly distributed as well as to make out the facilities serving the people of the area. The use of GIS in analysing the distribution of facilities is becoming common these days. In fact, many studies have shown that GIS can be used in analysing a facility distribution; e.g., Ahmed et al (2013) finds in a study in Kano Metropolis that the distribution of Police Stations are in random, while Kibon and Ahmed (2013) also illustrates that the distributions of health facilities are in clustered.

In many developing nations, GIS and school mapping technique are commonly used to create the necessary conditions to accomplish the universal primary and secondary education (UPE and USE) as well as the escalating access to educational services for socially disadvantaged people (Hite 2008). According to O.O. Olubadewo et al (2013) while studying GIS as Decision Support System in Fagge, Kano State, Nigeria, the end product of the GIS provides the user with a map of specific region with focus on the schools locations and all related information to assist the decision-makers in either expanding current school or suggesting sites for new schools as well as those for student and resources location/allocation. The study also highlights need for the use of GIS in the educational sector for planning (O. O. Olubadewo, 2013).

In the United States, GIS proves to be useful in a school district comprehensive planning and management tool. SchoolSite Online in the United States, developed using the latest Geographic Information System (GIS) technology, is a unique web site and internet-based application committed for the demographic information and mapping needs of K-12 school districts. It provides secure Web access to maps of school district including streets, attendance boundaries, student locations, aerial photography and many other layers of information. These various types of data combined with the SchoolSite tools gives each District unique access to demographic reports and maps for planning. With SchoolSite Online helps users to:

 

- Create and print maps at any scale of the District including streets and a variety of other layers
- Generate and maintain school attendance boundary maps
- Upload student data files for address-matching creating computer "pin-maps" of student locations
- Visualize patterns on a map and color-code the student population based upon userdefined database queries
- Perform attendance boundary planning scenarios with the SchoolSite Online redistricting tools.
- Access community demographic reports for any area within a school district which include current year estimates and five year forecasts of population by age, socioeconomic and housing data.

(Source: http://schoolsiteonline.com/)

**Web Based School GIS Application in India**

Web Based School GIS application is an initiative of the Department of School Education and Literacy, Ministry of Human Resources Department, Government of India for seamless visualization of school locations across the country. Using this application, geographic location of schools collected by the various School Education Departments of the states are brought together and mapped on the GIS Platform constructed by the National Informatics Centre (NIC), where these school locations are also interlinked with the school report cards based on U-DISE database, developed and hosted by the National University of Educational Planning and Administration. In the application, base map services like street maps and high resolution satellite images are available for better understanding of the topography/ terrain of the location. This web service application comprises of administrative boundaries up to village level and location information up to habitation level along with basic GIS functionalities and measurement tools, which will help to improve the quality of planning and better utilization of resources available under the Sarva Shiksha Abhiyan (SSA) and Rashtriya Madhyamik Shiksha Abhiyan (RMSA) (http://schoolgis.nic.in).

GIS in Classroom

Based on the findings of research, the prospective roles of GIS in the area of teaching-learning of geography are considered as diverse and varied. In the classroom teaching-learning of GIS, process of critical thinking is a key element for an effective use of GIS. Since this process helps students in developing the skills to analyse, synthesise and evaluate, this also enhances them skills of logical, mathematical, linguistic, spatial and inter-personal intelligence. In classroom, GIS can provide the students methods to investigate alternative answer to specific problems and situations resulting in reflective challenge for students while searching for a satisfactory answer to the queries. This technology makes both the students and teachers active learners simultaneously and more concerned towards society, thus resulting in the mutual benefit among the students, teachers and society.

## GIS as a Technique of Data Description

Education data comprise different types of variables on students, teachers, schools, districts, neighbourhoods and communities. There are various statistical techniques to identify patterns, relationships and differences in data that typically result in a single numerical value to "describe" the data in single, global measures. Data are generally represented in a summarised form and described across groups by means of statistics such as means and standard deviations to give global scores for the group "average" and how much they "vary" from the mean. The whole distribution can also be represented through a frequency distribution or a histogram. Such descriptive statistics summarise a visually complex table of numbers to a readily comprehensible one (Lund, 2007).

Creation of maps with GIS gives additional meaning to the data through geospatial perspective, while non-spatial variables (e.g., test scores) can be related with a location and placed in the context of their occurrence (i.e., a school building). This spatial framework provided by the map shows where variable values are in relationship to each other in the meaningful context of neighbourhoods and communities (Lund & Sinton, 2007). Here, the abstract values become comprehensible because their relationships become visible due to the real-world geospatial representation in maps where all data values are used to create a geospatial display instead of portraying a distribution of data with one global value (i.e., mean) (Mark & William, 2012).

There is an extensive power of GIS as tool to transform data into maps. Using GIS, the process of data description through geospatial visualization can be achieved by showing one variable on a map or through combining multiple variables into layers that sum up complex relationships. The base map/background can be a variable layer, e.g., polygons for school district boundaries that are filled in with colours related variable values, e.g., percentage of students with 80% or above percentage attendance. The background map can also be a digital satellite image of the area with school district boundary lines superimposed as the top layer or a layer of census block groups (Mark & William, 2012).

GIS desktop software provides different tools with which the user may create maps using various options to display the location, quantity, density and spatial relationships among variables. The user has also many options while selecting map characteristics (symbology, colors themes, patterns, and interval sizes) (Kimerling, Buckley, Muehrcke, & Muehrcke, 2009; Mitchell, 1999). GIS makes mapping and creating geospatial perspective a dynamic process by allowing rapid changes and multiple views of the data. Descriptive maps can provide keen insights into the data even without sophisticated analyses. Relationships become visible that may lead to hypothesis testing and problem solving.

## GIS and Quantitative Analysis

The process of associating data with location and generating maps provides the visual framework for seeing relationships among variables because of their physical proximity. These visual relationships, which become apparent when shown on maps, provide an aid to understanding the data and for generating hypotheses. However, the descriptive nature of visual inspection with maps does have limitations in defining more complex and less obvious relationships.

If schools are mapped for an area showing the percentage of students who scored proficient or advanced on a yearly test, a pattern of clustering or dispersion may be observed visually on the map. But, if a pattern of clusters is not visible clearly, or if an observed cluster is not likely because of chance, then there are spatial statistics that compare the observed locations of schools with a hypothetical random spatial distribution. To the extent that the observed distribution of schools differs from a random distribution, there may be significant clustering of schools that have high or low percentages of students scoring proficient or advanced (Mark & William, 2012). Mitchell (2005) provides a comprehensible introduction to spatial statistics such as the mean center and variance of geographical entities (or features; e.g., schools).

There is another category of spatial statistics that attempts to identify the overall global pattern of how the features themselves (e.g., location of schools) are distributed across a geographic area. For instance, 'the "nearest neighbour index" calculates the average distance between feature locations. The "observed" mean distance is divided by the "expected" mean distance to produce the nearest neighbourhood index. The index can be tested statistically to determine whether the pattern of feature locations represents a significant overall clustered, dispersed, or random pattern. Tate (2008) applied the nearest neighbourhood index to determine whether biotechnology companies in the St. Louis, Missouri, metropolitan area were clustered; he found that these organizations were indeed located in close proximity and the clustering pattern was estimated to be non-random. The clustering of the biotechnology industry across the region demonstrated the importance of geography as a factor in matters of access to quality educational resources, employment options, housing, transportation, and other social infrastructure' (see also Gordon, 2008).

While global patterns for feature locations can be found, patterns of clustering or dispersion can be calculated for feature values such as the school student–teacher ratio. Clustering of feature values tends to occur because entities such as the schools nearer to each other are more alike than those farther apart. If student–teacher ratios are more alike in schools with close nearness, then the overall pattern for these ratios will prove to be in cluster. As an illustration, schools in richer districts might tend to exhibit lower student–teacher ratios than schools in poorer districts. A spatial statistical test such as Moran's I test for global clustering is a true test for spatial autocorrelation (Anselin, 2005; Fortin & Dale, 2009; Jacquez, 2008; Mitchell, 2005). The presence of spatial autocorrelation (i.e., data are correlated because of spatial proximity) may indicate that the data points are not independent, a necessary assumption for many traditional statistical tests (Charlton, 2008; Fortin & Dale, 2009; Fotheringham, Brunsdon, & Charlton, 2002).

Besides finding global patterns of clustering for locations and their values, local patterns of clustering can also be identified (Anselin, 1995, 2005; Jacquez, 2008; Mitchell, 2005), which attempt to describe variation by determining if a feature (e.g., school) is surrounded by features with similar high or low values. When there is a significant local clustering, high values are surrounded by high values and low values are surrounded by low values. If the data are geographically clustered, It is likely that they exhibit spatial autocorrelation which indicates the presence of spatial dependence. 'Traditional regression models assume that the data for the outcome variables are uncorrelated, and so using these methods with spatially dependent data leads to the violation of this assumption. Several methods have been developed to account for spatial dependence leading to correlated outcome data. The first approach uses spatial regression models that attempt to account for spatial dependence by taking into account the correlation among data that are in close proximity' (Anselin, 2009; Ward & Gleditsch, 2008). 'Spatial regression models can use a spatially lagged dependent variable as a covariate when it is assumed that the dependent y values directly influence each other. If it is assumed that there are unidentified variables in the local context that account for the correlation among the dependent y values, then the spatial error model is used. This model postulates that the spatial components of the errors are correlated for clustered observations' (Ward & Gleditsch, 2008).

The second approach of geographically weighted regression (GWR) weights a data point according to its proximity to a specific location by a spatial kerning process. The weighting of data points is not constant across observations but varies by location across a region. Data points closer to the specific location are weighted more heavily than farther points. GWR reveals better geographically clustered data as a continuous spatial process whose variation can be represented on a map (Fischer & Getis, 2010; Fotheringham, 2009; Fotheringham et al., 2002). GWR shows that variable relationships may differ by location as well as it recognizes spatial dependence in clustered data. For instance, 'highachieving school districts have clusters of high performing schools and low-achieving districts have clusters of low-performing schools. These clusters of high- and low-performing schools indicate spatial dependence for schools within districts resulting in correlation among school performance based on location. It is possible that variable relationships such as time spent on homework with academic performance are not the same across districts' (Mark & William, 2012). Such a variation in relations by location is referred to as "spatial heterogeneity" or "nonstationarity," and GWR is able to incorporate these local spatial relationships in the analysis approach (Fotheringham, 2009; Fotheringham et al., 2002). Allowing variable relationships to change by location is similar to the concept of accounting for different levels or contexts in multilevel modelling. However, multilevel modelling deals with discrete units whereas many phenomena are spatially continuous and do not start and stop at artificial boundary lines. GWR allows relationships to change in a gradual and continuous manner across geographic space (Mark & William, 2012).

**GIS Education in India**

GIS education has been introduced in India about fifteen years back from now. Discussions among the academics regarding the format and curriculum of GIS teaching has been on since its first inception in the universities and it has evolved and come out with full vigour and implementation possibilities. GIS was first introduced in school curriculum of higher secondary level in the year 2000. Since then, GIS in India has acquired a wider coverage in school education. For the schools, (both the government and private) under or affiliated to the CBSE and following the CBSE syllabus follow NCERT Geography syllabus and the textbooks for teachers, GIS and remote sensing has been introduced in the syllabus to develop the understanding of the subjects among the students and teachers. It has been observed that some states and union territories of the country such as Uttarakhand, Himachal Pradesh, Kerala, Haryana, Delhi, Chandigarh, Assam, Arunachal Pradesh, Sikkim, Bihar, Jharkhand, Goa and Jammu &Kashmir have adopted GIS and remote sensing in the
Geography curriculum at the level of higher secondary school, while GIS is yet to be introduced in the school curriculum of Uttar Pradesh, Karnataka and West Bengal. However, despite its inclusion in the Geography curriculum since more than a decade, GIS and remote sensing in school may still be regarded as at a beginning in the country.

One of the main reasons for the above result may be assigned to the lack of trained teachers in the subject. Though GIS and remote sensing have been introduced in some of the universities in the country, still the subjects have not been widely introduced in all universities and colleges across the country. Moreover, a link between secondary education and higher education must be established for a wide spread and its continuity in the system.

 

**Issues on GIS in India**

There are some important issues concerned with the academics of GIS in India. Since GIS is purely related to a multidisciplinary technology encompassing all the spatial sciences and technologies such as the remote sensing and GPS, it is obvious that GIS developers and users comprises people from diverse backgrounds. Another issue related to GIS is on its naming as GIS, GIS technology, Geoinformatics, GI-Science or Spatial Technology, which has led to confusion that a well defined format for GIS education in India could not be developed even after a long time period of its introduction in the country (Arun, 2010).

There has not been any GIS accredited organization or well-defined procedures for GIS teaching at national level in India. It is the high time for the country to design a national level GIS education policy and a well defined accreditation and certificate procedures, which is very important for the academic and research sector. Though GIS is found active sometimes in private sectors, they are wholly concerned with digitization and spatial database generation works mostly for commercial purposes resulting in producing mainly the GIS technicians and not the GI Scientists (Arun, 2010). So, there is an urgent need for a formal and well-defined GIS education in the country to develop and produce knowledge, scientists and researchers instead of only GIS skilled labour.

Need for a Practical Approach

Geography has become an important aspect of 'high-tech microcomputers, digitisers, scanners, databases, statistics, graphics, colour printers and plotters. Rapid development in the field of GIS and remote sensing during the last few recent decades has contributed immensely in Geography by bringing it to the forefront of both public and commercial attention. (David R. Green, 2001). So, for India, there is a call for wiping out the notion of geography as a non-utility subject in the society by indifferent attitude of school administrations and negligence towards geography, lack of skilled teachers and poor infrastructure facilities.

All the academic and training institutions should come together to move forward in the field of Geography research and education. Like in some countries, there must be an organisation of academics from universities, colleges, teacher education departments, school teachers and NGOs who are essentially working in the area of geography education to involve themselves in the relevant fruitful activities and bring innovations and changes related to the subject in the country.

Though professional training of teachers has been considered fundamental for a qualitative improvement of education for many years (Kothari Commission, 1964-66), only a very few concrete steps has been able to take up in the last three decades (NFG- Teacher Education, NCF-2005). In this respect, NCERT, with the help of EDUSAT, could take up steps towards imparting in-service education to teachers in all subject areas through the face to face mode and distance education mode. So, education system in India should take a concern of this point immediately and act on quickly to meet the needs of the current scenario.

Most of the teachers and instructors in the Indian schools are still digitally and computer illiterate without the working knowledge of computer including many of the geography teachers, the reason being GIS a new subject in the universities, colleges and institutions in the country and hence this branch of subject has not been exposed to these teachers so far. This, along with the ignorance and reluctance towards such modern technology, has developed a barrier between the teachers and teaching and learning Geography in the classroom.

**REFRENCES**


1. Ahmed, M. N., Muhammad, M. U., Mohammed, & Idris, Y. (2013). A Gis-Based Analysis of Police Stations Distributions in Kano Metropolis. IOSR Journal of Computer Engineering (IOSR-JCE), 8(4), 72-78. ISSN: 2278-0661, ISBN: 2278-8727
2. Aliyu, A., Shahidah, M. A. & Aliyu, R. M. (2013). Mapping and Spatial Distribution of Post PrimarySchools in Yola North Local Government Area of Adamawa State, Nigeria. International Journal of Science and Technology, 2(5), May, 2013.
3. Anselin, L. (1995). Local indicators of spatial association—LISA. Geographical Analysis, 27(2), 93–115.
4. Anselin, L. (2005). Spatial statistical modeling in a GIS environment. In D. J. Maguire, M. Batty, & M. F. Goodchild (Eds.), GIS, spatial analysis, and modeling (pp. 93–111). Redlands, CA: ESRI Press.
5. Anselin, L. (2009). Spatial regression. In A. S. Fotheringham & P. A. Rogerson (Eds.), The Sage handbook of spatial analysis (pp. 255–276). Thousand Oaks, CA: Sage.
6. Aronoff, S. (1989). Geographic Information Systems: A management perspective. Ottawa: WDL publication.
7. Arun K Saraf, 2010. GIS Education in India Issues and Challenges. Geospatial World. https://www.geospatialworld.net/article/gis-education-in-india-issues-and-challenges/ 8.

Bednarz, S. 2004. GIS: A tool to support geography and environmental education? GeoJournal 60(2): 191-199.

9. Bednarz, S. and G. Ludwig.1997. Ten things higher education needs to know about GIS in primary and secondary education Transaction in GIS. 2(2); p.123-133.
10. Birtain, M. Clarke, G. Clarke, M., and Wilson, A., 1996. Intelligent GIS: Location Decision and Strategic Planning . Cambridge, Geoinformation International
11. Burrough, P. A. (1998). Principles of Geographic Information System. New York: Oxford.
12. Cartwright, W. E. (2008). Mapping in a digital age. In J. P. Wilson & A. S. Fotheringham (Eds.), The handbook of geographic information science (pp. 199–221). Malden, MA: Blackwell.
13. Cartwright, W. E. (2008). Mapping in a digital age. In J. P. Wilson & A. S. Fotheringham (Eds.), The handbook of geographic information science (pp. 199–221). Malden, MA: Blackwell.
14. Charlton, M. E. (2008). Quantitative methods and geographic information systems. In J. P. Wilson & A. S. Fotheringham (Eds.), The handbook of geographic information science (pp. 377–394). Malden, MA: Blackwell.


 

15. Cook, W.J.Collins, S., Flynn, M.K. Guttman, M., Cohen, W., and Budiansky, S., 1994. 25 breakthroughs that are changing the way we live and work, U.S. News and world Report, 2 May, p. 46-60

16. David R. Green – GIS in school education in GIS: A Sourcebook for Schools Edited by David R. Green , 2001, Taylor &Francis, London.

17. Education Technology , Position paper , National Focus Group, NCF-2005, NCERT
18. Elwood, S., & Cope, M. (2009). Qualitative GIS: Forging mixed methods through representations, analytical innovations, and conceptual engagements. In M. Cope & S. Elwood (Eds.), Qualitative GIS: A mixed methods approach (pp. 1–12). Thousand Oaks, CA: Sage.

19. Elwood, S., & Cope, M. (2009). Qualitative GIS: Forging mixed methods through representations, analytical innovations, and conceptual engagements. In M. Cope & S. Elwood (Eds.), Qualitative GIS: A mixed methods approach (pp. 1–12). Thousand Oaks, CA: Sage.

20. ESRI (1990). ARC News Vol. 23, September (Environmental Systems Research Institute, Inc., Redlands, CA, www.esri.com)

21. Fischer, M. M. & P. Nijkamp. (1993). Design and use of geographic information systems and spatial models. In Geographic Information Systems, Spatial Modelling and Policy Evaluation, ed Manfred M. Fischer and Peter Nijkamp. New York: SpringerVerlag.

22. Fischer, M. M., & Getis, A. (Eds.). (2010). Handbook of applied spatial analysis: Software tools, methods and applications (1st ed.). Heidelberg, Germany: Springer.

23. Fortin, M. J., & Dale, M. R. T. (2009). Spatial autocorrelation. In A. S. Fotheringham & P. A. Rogerson (Eds.), The Sage handbook of spatial analysis (pp. 89–104). Thousand Oaks, CA: Sage.

24. Fotheringham, A. S. (2009). Geographically weighted regression. In A. S. Fotheringham & P. A. Rogerson (Eds.), The Sage handbook of spatial analysis (243–254). Thousand Oaks, CA: Sage.

25. Fotheringham, A. S., Brunsdon, C., & Charlton, M. (2002). Geographically weighted regression: The analysis of spatially varying relationships. Chichester, England: John Wiley.

26. Fotheringham, A. S., Brunsdon, C., & Charlton, M. (2002). Geographically weighted regression: The analysis of spatially varying relationships. Chichester, England: John Wiley.

27. Gewin, V. 2004. Mapping opportunities. Nature 427: 376-377. 22 January.

28. Gordon, C. (2008). Mapping decline: St. Louis and the fate of the American city. Philadelphia: University of Pennsylvania Press.

29. Hite, J. S. (2008). School Mapping and GIS in Educational Micro-Planning. Working Document, International Institute for Education Planning (UNESCO).

30. Hite, J. S. (2008). School Mapping and GIS in Educational Micro-Planning. Working Document, International Institute for Education Planning (UNESCO).

31. Jacquez, G. M. (2008). Spatial cluster analysis. In J. P. Wilson & A. S. Fotheringham (Eds.), The handbook of geographic information science (pp. 395–416). Malden, MA: Blackwell. 32.

 

Kerski, J. 2008. The role of GIS in digital earth education. International Journal of Digital Earth. 1(1): 326-346.

33. Kibon, U. A. & Ahmed, M. (2013). Distribution of Primary Health Care Facilities in Kano Metropolis Using GIS (Geographic Information System). Research Journal of Environmental and Earth Sciences, 5(4), 167-176, Maxwell Scientific Organization.
34. Kimerling, A. J., Buckley, A. R., Muehrcke, P. C., & Muehrcke, J. O. (2009). Map use: Reading and analysis (6th ed.). Redlands, CA: ESRI Press.
35. Louv, R. 2005. Last Child In the Woods. Algonquin Books.
36. Lund, J. J. (2007). Mapping and quantitative reasoning. In D. S. Sinton & J. J. Lund (Eds.), Understanding place: GIS mapping across the curriculum (pp. 49–62). Redlands, CA: ESRI Press.
37. Lund, J. J., & Sinton, D. S. (2007). Critical and creative visual thinking. In D. S. Sinton & J. J. Lund (Eds.), Understanding place: GIS mapping across the curriculum (pp. 1–18). Redlands, CA: ESRI Press.
38. Maantay, J., & Ziegler, J. (2006). GIS for the urban environment. Thousand Oaks, CA: Sage.
39. Mark C. Hogrebe & William F. Tate IV (2012). Geospatial Perspective: Toward a Visual Political Literacy Project in Education, Health, and Human Services. In Review of Research in Education, Vol. 36, pp. 67-94
40. Mitchell, A. (1999). The ESRI guide to GIS analysis: Vol. 1. Geographic patterns & relationships. Redlands, CA: ESRI Press.
41. Mitchell, A. (2005). The ESRI guide to GIS analysis: Vol. 2. Spatial measurements & statistics. Redlands, CA: ESRI Press.
42. National Academies Press. US Department of Labor. 2010. Geospatial technology competency model. http://www.careeronestop.org/competencymodel/ pyramid.aspx?GEO=Y. 43. National Academy of Sciences. 2006. Learning to Think Spatially: GIS as a Decision-Support System in the K-12 Curriculum.
44. National Curriculum Framework for School Education- 2000, NCERT, New Delhi
45. National Research Council. (2006). Learning to think spatially: GIS as a support system in the K−12 curriculum. Washington, DC: National Academies Press.
46. Nyerges, T., Jankowski, P., L., Smith, A., Moore, T. J. & Horvath, E. (1997). Spatial Group Choice: a SDSS Tool for Collaborative spatial decision-Making, Geographical Information Science.
47. Pandey, Aparna, Role of GIS in School Geography, Journal of Indian Education, NCERT, November 2011.
48. Pavlovskaya, M. (2009). Non-quantitative GIS. In M. Cope & S. Elwood (Eds.), Qualitative GIS: A mixed methods approach (pp. 13–37). Thousand Oaks, CA: Sage.
49. Pellika & Johnson (2005). Interactive Geographic Information System (GIS) Application for European Upper Secondary Schools.

50. Pickles, J. (Ed.). (1995). Ground truth: The social implications of geographic information systems. New York, NY: Guilford Press.

51. Sinton, D. S., & Bednarz, S. W. (2007). About that G in GIS. In D. S. Sinton & J. J. Lund (Eds.), Understanding place: GIS mapping across the curriculum (pp. 19–34). Redlands, CA: ESRI Press.

52. Smith, T. R., Menon, S. & Starr, J. E. (1987). Requirement and Principles for the implementatioand construction of large scale geographic information system. International Journal of Geographic Information System.

53. Teacher Education, Position paper , National Focus Group, NCF-2005, NCERT

54. Tobler, W. (1979). 1979. Cellular geography. In Philosophy in geography, ed. S. Gale and G. Olsson, 379–86. Dortrecht: Riedel.

55. Ward, M. D., & Gleditsch, K. S. (2008). Spatial regression models. Thousand Oaks, CA: Sage.

56. Weiner, D., & Harris, T. M. (2008). Participatory geographic information systems. In J. P. Wilson & A. S. Fotheringham (Eds.), The handbook of geographic information science (pp. 466–480). Malden, MA: Blackwell.

 