

# Addressing Perception of Geoethics Through Geoscience Curriculum at IGNOU

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## ABSTRACT

Geoscience provides us with an overall understanding of earth's physical environment and its finites besides a perspective on why and how things happen around us. It also attempts to find solutions for global environmental problems in relation to place and time. Geoscientists can play an important role in addressing these global challenges and disseminating knowledge and awareness in the society. Although Geoscience is the basic element of all natural sciences, it is limited to a few chapters in the geography and environmental science books at school level in India. Hence, children remain unaware about the internal and external processes operating within and on the earth's surface and also the perception on geoethics as compared to their counter parts in the west. Unlike western world, our youth are perhaps less aware of implications of depleting and dwindling natural resources. Thus, it is a challenge for the educators to develop geoscience education programmes with a strong component and perspective on geoethics and sustainable development. The paper discusses the possible impact of geoscience education at IGNOU in developing graduates with an understanding and inclination on geoethics. Presently, in distance mode a wide range of programmes are being offered in subjects like environment, physics, chemistry, mathematics, biology except geology. Mega universities like IGNOU are at an advantageous position for offering geoscience education owing to its wide reach to cater to millions of learners. Keeping this in view School of Sciences at IGNOU is in the process of developing B.Sc. Courses in Geology after carrying out an extensive Need survey. The curriculum for bachelor degree programme, which includes the courses on physical and structural geology, petrology, mineralogy, environmental geology, hydrology, ore geology, remote sensing and GIS has been designed and developed with help of several eminent experts across India. The courses are expected to enhance understanding of the necessity to conserve our soil, mineral, water, fossil fuels and appreciate the concepts of geoethics and sustainable development.

**Keywords:** Geoscience education, geology, geoethics, sustainable development, ODL mode, IGNOU

Knowledge of geoscience is essential to understand the crucial global pressures in the coming century i.e. shortages of water and fossil fuels, coastal inundation, ecosystems breakdown, environmental degradation and global warming because geoscientists can play an important role in addressing these global challenges (SERC, 2016). The importance of geoscience education and literacy is rising rapidly because of the realization of the fact that how our wellbeing and survival is dependent on earth system and its resources.

With increasing population, the demand for natural resources is increasing day by day. Proper

management can ensure that the natural resources are used judiciously so that they fulfill the needs of present generation and also last for the generations to come. Thus, geoscience education is essential for the next generation to address important societal needs for sustainable use of natural resources, their development and management, natural hazards mitigation, environmental protection, and ecosystem restoration.

Geoscience education ensures that all inhabitants of the planet have knowledge of the natural processes that shape the physical environment, and is able to understand how actions of humans have an impact

on the Earth on local, regional, and global scales (Sharon *et al.*, 2012).

Geoethics aims to promote the sustainable use of natural resources in order to implement rigorous scientific studies so as to promote accurate information regarding natural hazards. This would also foster the social role of geosciences and help to guide policy makers towards a more sustainable development path and contribute to the development of more environment friendly technologies. This would bring awareness of the importance of the geological heritage and also contribute to the accuracy of the information conveyed by the geoscience museums which promotes links between the scientific community and society. Further will lead to create educational resources related to these principles (Vasconcelos, *et al.*, 2015). Furthermore, there is recognition of temporal relationship with natural resource identified through the concept of sustainable development wherein the ethical considerations suggest that man should utilize resource to meet not only today's need, but also the need of future generation. This requires solving issues involving need and ability, ethics and practicality in the ultimate protection and preservation of environment and growth (GSI, 2011). Thus, geoethics deals with ethical, social and cultural implications of geological research. It also reflects the opportunity for human being to become more conscious of the social role and responsibilities in conducting activities related to the environmental management and geo-resources exploitation. As reported in the 2009 Earth Science Literacy Principles Report (Earth Science Literacy Initiative, 2009), science educators are uniquely positioned to translate the big ideas of earth science into language and learning opportunities that can be understood by all students. According to this report, an earth-science-literate person understands the fundamental concepts of Earth's systems; knows how to find and assess scientifically credible information about Earth; communicates about earth science in a meaningful way; is able to make informed and responsible decisions regarding Earth and its resources; and recognizes that earth scientists use repeatable observations and testable ideas to understand and explain our planet (Dwight, 2010). Equally, geoscientists bring critical expertise to the goal of environmental sustainability, which aims to

ensure the continued existence of environmental resources, biodiversity and safe drinking water (Sharon *et al.*, 2012).

### **Importance of Geoscience and Geoscience Education**

What is Earth Science or Geoscience? The study of Earth Science provides the foundation for an understanding of the Earth, its processes, its resources, and its environment. Earth Science is the study of our planet in its entirety, how its lithosphere, atmosphere, hydrosphere, and biosphere work together as systems and how they affect each other and us. Earth Science integrates the basic sciences like biology, chemistry, physics, and mathematics to an understanding of the Earth around us. Earth and Space Science is a laboratory and activity oriented course, which lends itself well to helping students to develop knowledge and abilities about inquiry and the nature of science (Smith, 2004). Geoscience/Geology is a field within the Earth Science that specifically studies rocks, their composition, and the processes that lead to the rocks and landforms on Earth.

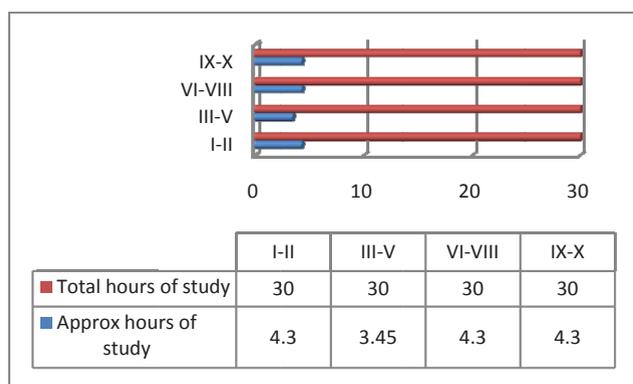
People are now increasingly getting more aware of the effects of climate change, sea-level rise, natural hazards and depleting water table. However, it is felt that citizens having some educational background in geoscience are better equipped to make informed decisions about key environmental issues. Hence geoscience education is essential to address important societal needs for natural resource development and management, natural hazards mitigation, environmental protection, and ecosystem restoration (GSA, 2016). It is also important in related fields like civil and environmental engineering, environmental studies, agricultural sciences, atmospheric and ocean sciences, life sciences, etc. We need access to clean water, air, environment and energy resources for our sustenance but either our resources are getting depleted or polluted and all these worries highlight the importance of geoscience literacy/ education.

### **Geoscience Education - Indian Scenario**

Although Geoscience is the basic element of all natural sciences, it is limited to a few chapters in the geography and environmental science books at school level. Thus, children remain unaware

about geoscience as a discipline and about the internal and external processes operating within and on the earth's surface as compared to their counterparts in the west. At school level, the students should be provided an integrated approach regarding educating them about our earth and its surroundings. However, at present except geoscience all other science subjects like physics, chemistry, mathematics and biology are taught at primary and secondary levels. Geoscience/geology is not receiving the required status as compared to the other science subjects taught at school level.

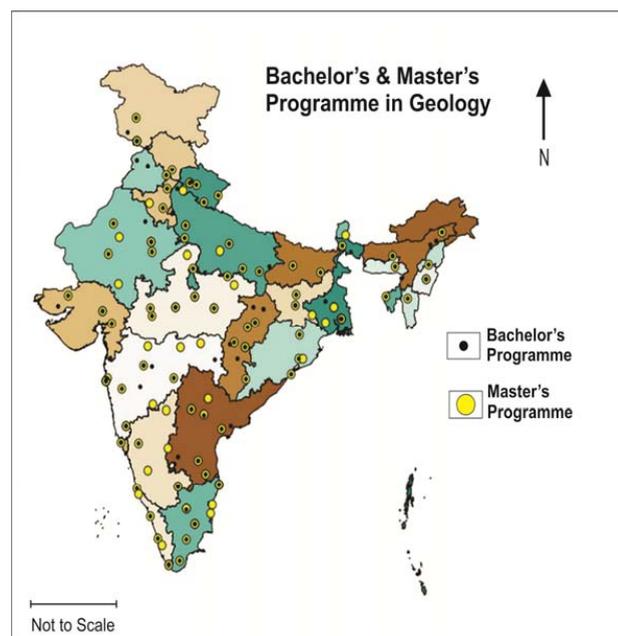
Central Board of Secondary Education (CBSE) syllabus was reviewed for primary, middle and secondary level. At present it is observed that except geology/geoscience all other science subjects like physics, chemistry, mathematics and biology are taught at primary, middle and secondary levels. However, some chapters/lessons of earth science are included under the broad heading of Environmental/ Social Sciences syllabus. Besides, it is observed that out of total 30 hours of study only 4.3 hours of study is dedicated to Environmental Education/Social science subject (Fig. 1). Geology is not receiving the required status as compared to the other science subjects taught at school level.



**Fig. 1:** Approximate hours of Environmental Education/ Social Science Subjects taught in CBSE Syllabus (Source: Primary, Middle and Secondary - CBSE-I Portal)

Gogoi *et al.* (2016), surveyed the conventional institutes/universities offering Bachelors and Masters programmes in Geology and reported that Bachelors and Masters programmes are being offered at 147 and 135 institutes/universities, respectively. Both Bachelors and Masters level programmes were reported to being offered at 75 institutes/universities across India in conventional mode (Fig. 2). Only one university, i.e. B.R. Ambedkar Open University,

Hyderabad offers geology in ODL mode. It was also reported by them that most number of bachelors programmes in Geology are being offered in the state of Maharashtra followed by North Eastern states, Chhattisgarh, West Bengal, Uttar Pradesh and Rajasthan states whereas most number of Masters level programmes in Geology are being offered in Maharashtra followed by Tamil Nadu, Madhya Pradesh, Uttar Pradesh and Rajasthan (Fig. 3). The reason behind this could be the rich mineral resources qualified human resources, job availability in government and private organizations directly or indirectly related to geosciences.

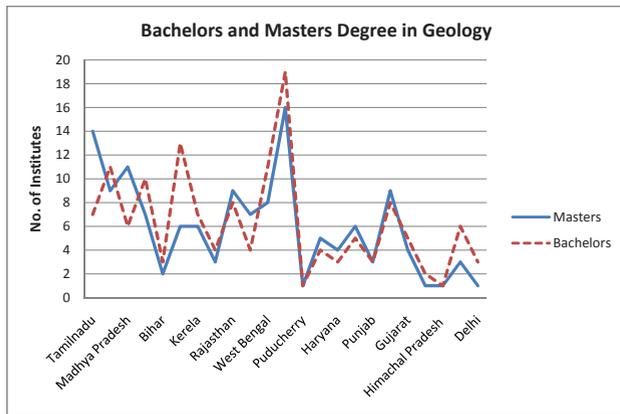


**Fig. 2:** Spatial distribution of institutes/universities offering Bachelors and Masters Level programmes in Geology in India

### Geoscience Education in ODL mode: IGNOU Experience

Presently, a wide range of programmes are being offered in ODL mode in subjects like environment, physics, chemistry, mathematics, biology except geology. The second University to offer geology related programmes in ODL mode is the Indira Gandhi National Open University, which is currently offering doctoral programme in Geology since 2012 and the post graduate certificate programme in geoinformatics since 2014. Mega universities like IGNOU are at an advantageous position for offering geoscience education owing to its wide reach and flexibility to cater to millions of learners. Keeping this in view School of Sciences at IGNOU is in the

process of developing Bachelor's degree (B.Sc.) courses in Geology.



**Fig. 3:** State wise distribution of institutions offering Bachelors and Masters Degree in Geology

Before planning for developing the courses, an extensive survey was carried out by preparing a questionnaire and sending the same to different institutes/universities as well as several government and private organisations operating in geology and related fields and employing students from geology background. In comparison to a University department where faculty strength is limited, the ODL system has an advantage that several number of experts/educators can be involved in development of self learning materials and this bachelors degree programme has also benefitted from it since a large number of experts/educators were involved from curriculum design to self learning material development.

### Relevance of Geoscience Education in Geoethics

Geology is a fascinating subject which observes the pulse of the Earth. It studies the Earth as a whole, its origin, structure, composition and history (including life) and the nature of processes which have given rise to its present form. Geology is an outdoor/field science with its own approach and standpoint. Study of environment includes understanding of (i) physical conditions and (ii) social and cultural conditions. Physical conditions constitute mostly the abiotic characteristics of the environment such as the earth material, minerals, soils, water, landforms, air that together affect growth and development of man. The social and cultural conditions include environmental parameters such as the ethics,

economics, etc. which affect the behavior and performance of individuals or a community (GSI, 2011).

The curriculum for bachelor degree programme, which includes the courses on physical and structural geology, petrology, mineralogy, environmental geology, hydrology, ore geology, remote sensing and GIS has been designed and developed with help of several eminent experts drawn from both academia and industry across India. The following core courses are included in the bachelor's degree programme which is expected to enhance understanding of the necessity to conserve our soil, mineral, water, fossil fuels and appreciate the concepts of geoethics and sustainable development.

**Physical Geology:** Physical aspects, the internal and external agencies and processes that shape the Earth are dealt in physical geology. It includes *Structural Geology* which is the study of structures observed in the rocks. *Geotectonics* concerns with the movements of the Earth's crust and the shape, structure, and arrangement of the rock masses resulting from deformation caused by movements. *Geomorphology or Physiography* deals with the study of the surface features of the Earth which are produced as a result of various external agencies operating on the Earth's surface. Geomorphology, along with information on soil, water and vegetation has become one of the important contributions in planning for various developmental and changing activities. *Geoenvironmental* studies emphasize on the future prediction and calculation of geosystem response to various types of active interactions of environment with the surroundings. It is the relations between man and his geologic, geomorphic, physical, cultural and social environments. Environmental geology is essentially the geology of interactions amongst various geofactors.

**Mineralogy** deals with 'study of minerals' related to their formation, composition, characteristics, properties (physical and optical), classification, mode of occurrence and origin as well as their geographical distribution and utilisation. *Economic Mineralogy* deals with minerals of economic importance. It is the study of economically useful minerals and rocks of the Earth's crust like coal, petroleum and garnet, etc. *Crystallography* is a branch which deals with the study of crystals, its external forms and internal atomic structure.

**Petrology** deals with 'the study of rocks' including the origin, texture, structure, mineralogical composition, distribution, and history of rocks. *Igneous petrology* deals with the study of primary igneous rocks developed on consolidation of hot molten material. *Sedimentary petrology* includes study of sediments or sedimentary rocks formed on mechanical disintegration or chemical decomposition of pre-existing rocks. *Metamorphic petrology* is designed to study rocks formed when a pre-existing rock undergoes changes in response to increased pressure and/or temperature.

**Palaeontology** is the study of ancient remains of plants and animals that are found in the rocks of past geological periods. The life of the past ages is preserved in the rocks in form of fossils. It can be further divided into vertebrate palaeontology, invertebrate palaeontology, micropalaeontology, palaeobotany and palynology.

**Stratigraphy** is the study and arrangement of rocks of the Earth in *chronological order* is the subject matter of stratigraphy. This branch of geology deals with the study of stratified and other rocks as a record of geological history.

Apart from the core geology courses the syllabus also includes applied and allied branches which deal with the application part of the geology.

**Ore Geology** deals with the processes of ore formation; importance of metallic and non-metallic mineral deposits; mineral exploration techniques; and mineral economics. Knowledge of mineral resources and its uses is essential during the course of exploration. *Mining geology* deals with the study of application of geology to mining engineering to select suitable sites for quarrying and mining. *Engineering geology* deals with the geological studies related to problems that arise in civil engineering projects along with suitable treatments like construction of dams, tunnels, mountain roads, building stones and road materials.

*Hydrogeology* is related with ground water and is the field between Geology and Hydrology.

*Geoinformatics* develops and uses spatial data and information to address the problems including the ones related to mineral exploration, geomorphology, structural geology, land use planning, natural resources management, hazard assessment, disaster

management, *etc.* The theoretical knowledge and hands-on training in the basics of geoinformatics technologies will acquaint learners with use of the technology in analysing spatial data, and widen opportunities of learners for study and developing career in different sectors of employment involving the fields related to geoinformatics.

### **Nature of imparting Geoscience education through ODL at IGNOU**

The print medium or the self-instructional learning materials will be the primary component of a learner, which would be supplied to the learners for both theory and practical courses. In ODL mode, conduct of practicals and field work is still a major challenge. The challenge is far greater in terms of offering practical exposure to geoscience learner since the learners are at a distance. Electronic media, Radio, Audio and Video are the important component for teaching in distance education system. The challenges can be overcome by adopting judicious combination of contact classes for theory and practical and also the use of ICT and tools for e-content development, distribution, counselling for theory and practicals, *etc.* The number and nature of experiments have been designed in such a way that it meets the basic requirement for a geoscience learner to identify common rocks, minerals and ores, geomorphic features, and understanding of economic minerals, mineral resources and its uses. Besides it also aims at cultivating in them awareness and a sense of responsibility towards conservation of non-replenishable natural resources leading towards sustainable development. As is the current practice, the field study and laboratory classes will be conducted by using the infrastructural facilities available in the already existing institutions of Higher education.

### **CONCLUSIONS**

- ❑ Geoethics prepares geoscientists to be aware and receptive of their responsibility to the public and the environment. Geoscience educators must be sensible and conscious of their crucial role to play in the lessening of the impact and influence of georisks and in the protection of people from the effects of future disasters and spreading the awareness. Geoscience educators can sensitize the students and society for

judicial and sustainable utilization of natural resources.

- ❑ The level of awareness of Geoethics can be raised through inclusion of geoscience/geology curriculum in the Schools, Colleges and Universities so that children are attracted towards its adventurous nature, applications aspects, job opportunities and employment. Such education will help making youths more sensitive towards their physical environment, geohazards, energy and natural resource conservation, etc.
- ❑ School of Sciences at IGNOU is in the process of developing bachelor's degree courses in Geology which includes the courses on physical and structural geology, petrology, mineralogy, environmental geology, hydrology, ore geology, remote sensing and GIS. The curriculum is designed in such a way that it enhances the understanding on the significance of natural resources management and instill sense of geoethics.

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