
Comparative Analysis of Cartographic Education among Degree level Geography Student (A Case Study)

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Abstract:

The individual acquaintance derived from cartographic sketch or a free hand map refers as cartographic literacy. It is attained all the way through cartographic education only. As the location information, which has an important part of modern life is best related through sketches and maps. In other words cartographic education refers to the process of improving cartographic knowledge and understanding but it is a bitter fact that cartographic illiteracy is broadly prevalent among under degree students. Cartographic education is part and parcel of geography one of the well-liked and desired subjects at under-degree level. So the study of cartographic literacy at degree level student specifically among geography student to understand the pathetic picture of cartographic education is a need of the hour. Cartographic literacy and disparities in level of cartographic understanding and education is the new domain of geographic studies in post modern era. Cartographic literacy is also becoming more relevant for inclusive development of society and country. The present study is based on primary survey of 600 under degree geography students of various colleges out of four different Universities of India (Delhi University Delhi, Kurukshetra University Kurukshetra, Maharashtra Dayanand University Rohtak, Ch. Devlal University Sirsa) to determine the cartographic literacy level. The study area was selected by keeping in mind proximity, size and feasibility to carry out survey in the best possible way. Primary data was collected through systematic purposive random sampling technique with the help of a well designed questionnaire and requisite aid. For determining the cartographic literacy and education of under-degree level geographic students, Composite Index and Standard Deviation Technique has been used. To calculate the Composite Index principally 20 variables based on 4 indispensable categories such as location, Identification, Association and cartographic Technique were chosen to determine cartographic literacy. An endeavour has also been made to briefly compare the condition of cartographic literacy and suggests some measure of inclusive technique and methodology to improve cartographic literacy.

Introduction: Since the inception of humanity, sketches and their acquaintance are subject to use for copious purposes. The tale of sketches is not complete devoid of an allusion to nautical charts which were restricted to specific people for explicit purpose. In pre-historic period trails and cryptogram of the rocks as guide way may be taken as the foundation of modern cartography. In contemporary time technological changes has revolutionised the map/sketches acquaintance and their use. Cartographic knowledge has currently turned into incredibly virtual than real for effective use in solving complex natural resource planning problem. Cartography is defined as an art, science and technology of making maps, and is concerned with all stages of evaluation, compilation, design and drafting required to produce a new or revised map documents from all forms of basic data. The individual's knowledge of map as represented by a cartographic sketch may be referred to as cartographic literacy. To attain literacy in cartography, cartographic education is necessary, as the location information is best retained through sketches and maps. In any case, cartographic education needs to be given due emphasis at school level as well as under degree level. It has a vast field of map making beginning with outlining of the map, to placing of important information within the body of the map. Representation of physical attributes and thematic data through various techniques of points, line and areas are the various components of cartographic education. Though the formulation and implementation of well designed cartographic syllabi is an indicator of improvement process, but it is also a bitter fact that cartographic illiteracy is widening among under degree students. The primary focus of the syllabi is to improve cartographic literacy among students. But the situation has not improved up to the mark in quality parameters and the overall condition of cartographic illiteracy has relatively worsened among students.

Cartography education has been made the very essence of the part of the geography curricula starting right from the schools through colleges and the universities in the study area. At the school level, emphasis is more in learning the direction of the location of the earth's features/component on the maps. Till the secondary school stage, the concept of identification of map scales and features of map are introduced along with various elementary cartographic techniques. At higher secondary level students are taught to learn association of features with maps. Under graduate students are aimed to go stages further to acquaint with the cartographic application technique. They are trained in the selection and choice of scales, representation of relief features and landform types on maps and various analytical methods, topographical map interpretation, making of the weather maps, representation of statistical data through statistical methods and their application to cartographic representation. A basic component at this stage involves the education on various maps projections and their utility. Surveying is an integral part to gather land information and form an important part of cartographic education at the degree level. It has been pragmatic that at about the age of 10, child's cognitive growth progresses beyond the aptitude to comprehend maps that make use of pictographic depiction (Piaget.J. and B.Inhelder, 1967, p76). By the time the child reaches middle school he can represent environments with the use of symbols and map space prolifically (Cook 2005, p22). Therefore, students should be encouraged to use cartographic sketches/maps as part of their class work at an early stage. This may encourages them to recognise maps as instruments for expressing ideas and as a tool for learning and demonstrating knowledge.

Currently, cartography is in the state of rapid technological change which has completely

revolutionised map making and its use. Advancements in geo-spatial technologies and their widespread use have brought a major proliferation of information in digital form and with it major changes in cartographic techniques. The concept of thematic mapping has been shifting speedily from the conventional to the modern methods. The introduction of the computer assisted cartography has brought a new dimension in the map making process and efficient handling of large scale data sets together with better analysis and understanding of local and regional phenomena.

Need & Justification: Presently cartographic studies are becoming more relevant for inclusive development of society and country. Cartographers have always kept predominant idea of map preparation that these maps would be in enormous use to the social scientists and general mass in day to day use. They try to popularise cartographic knowledge through non-formal education system and general awareness programme. Moreover, cartography has evolved an important component in the discipline of Information technology. Contemporary cartographic literacy has evolved as an important part and parcel of modern way of life. It is useful for scientist, administrator, planners, demographers, agriculture experts and researchers. There is an imperative call also to study cartographic awareness level and find out the practicable elucidation to improve the same. Thus, the present study has been selected to understand the cartographic literacy level among under degree students. The study area includes various colleges affiliated to four different universities (D.U.Delhi, M.D.U.Rohtak, K.U.Kurukshetra C.D.L.U.Sirsa)

Objective: The study was undertaken with following objectives:

1. To assess the cartographic literacy level among the under graduate students.
2. To determine and examine the component of cartographic literacy.
3. To compare the cartographic literacy level among the under-graduate students of different universities.
4. To suggest inclusive measures of improving cartographic knowledge through the various teaching aids.

Methodology: To examine and gauge the level of cartographic literacy, survey research is preferred, since published data pertaining to cartographic literacy is not available at micro as well as macro level. As, the main problem of field survey is to obtain representative data points, hence, systematic purposive random sampling technique has been adopted to acquire the relevant data through a well designed questionnaire and requisite aids. The present study is based on primary survey of 600 under degree geography students of various colleges affiliated under four different Universities (Delhi University, Delhi; Kurukshetra University, Kurukshetra; Maharashi Dayanand University, Rohtak and Ch.Devi Lal University, Sirsa). For determining the cartographic literacy among under-degree level geographic students, Composite Index and Standard Deviation Technique have been used. To calculate the Composite Index principally 20 variables based on 4 indispensable categories such as location, identification, association and cartographic application technique were chosen to determine cartographic literacy. Statistically each variable was powered with X_1, X_2 etc. Reasonable weightage was assigned to each variable. The selected variable was further clubbed under four indispensable categories of cartographic

learning process. Composite score of all the categories were taken as X_G value and mean value was calculated. After that Standard Deviation value was calculated. (Singh, R.L. & Singh, R. P.B.(1979,P39) Further an endeavour has been made to establish connection between indispensable categories of cartographic learning process to comprehend cartographic literacy at school level and cartographic education at under degree level. The cartographic literacy under deviation was grouped and finally comparative analysis was done to show level of cartographic literacy in under degree students. The paper also attempts to briefly compare the condition of cartographic literacy among different universities and suggests some measure of inclusive technique and methodology to improve cartographic literacy of degree level geography students.

Parameter and level of Cartographic literacy: To determine the cartographic literacy level among under degree geography student's justified quantitative analysis of data has been done and categorised under four cartographic literacy levels. The under degree geography students of Delhi University Delhi enjoys elevated level of cartographic literacy and followed by medium level by Kurukshetra University Kurukshetra, and low level by Maharishi Dayanand University and Ch.Devi Lal University Sirsa. It is also revealed that the percentage of students that endeavoured to draw that location, identification, association and application components were 49.8%, 50.8%, 29.8% and 29.4% respectively. It is sad to note that 3.21 percent students were unable to identify or locate a single parameter. (Appendix-1)

1. Location variable (X_{G1}): Cartographic education has been the very essence of the part of the geography curricula starting right from the schools through colleges and the universities. At the school level, stress is more towards the location of the earth features on the maps. Location is considered as a parameter of measurement of fanaticism of cartographic knowledge. Regarding this parameter it is seen that 49.8 percent of students were able to answer the entire four indicators pertaining to selected parameter. 25.5 percent student answered three indicators, and 14.5 percent student answered only two indicators. But it is surprising that 8.3 percent student answered only one indicator of pertaining parameters whereas, 1.87 percent student failed to answer even a single indicator. Cartographic literacy is not only important for the subject but also ensuring requisite for modern life. The majority of sample respondents had poor knowledge of location variable. Location variable responsiveness is most unpleasant in descending order from D.U.Delhi to K.U.Kurukshetra, M.D.U.Rohtak & C.D.L.U.Sirsa.

2. Identification Variable (X_{G2}): In the high schools the concepts of map scales has been introduced along with various elementary cartographic techniques. Hence, students are trained to recognize various cartographic components. Cartographic literacy survey conducted is based on the numerous indicators pertaining to parameter of indication to comprehend the level of cartographic wakefulness. In the study area 50.8 percent students were able to identify the entire indicator pertaining selected parameter of identification, 33.6 percent students effectively answered 3 indicators of pertaining parameters, and 9.1 percent students could answer only two indicators. It is noteworthy that 5.7 percent answered only one indicator while 0.8 percent failed to answer even a single indicator. The identification variable receptiveness is unlikeable among these universities.

3. Association Variable (X_{G3}): At senior secondary level students are skilled to bracket together various geographical phenomena, features with different locations. On the subject of this parameter of cartographic echelon quantification, it was observed that 29.8 percent students answered the entire indicator, 30.9 percent students answered 3 indicators of various selected parameters, 19.7 percent answered two indicators and 12.8 percent only one indicator of various parameters. It is relatable to mention here those 6.77 percent students were cartographically illiterate which have failed to mark even a single indicator. The majority of sample respondents had poor knowledge of association variable. Association variable receptiveness is on the whole unpleasant from D.U.Delhi to K.U.Kurukshetra, M.D.U.Rohtak & C.D.L.U.Sirsa.

4. Cartographic Application Variable (X_{G4}): The under graduate cartography course in Indian universities go stages further to acquaint the students with the art numerous cartographic application. At this point the student are trained in the selection and choice of scales, representation of relief features and landform types on maps and various analytical methods, topographical map interpretation, study of weather maps, representation of statistical data through statistical methods and their application to cartographic representation. A new vital component at this stage involves the education on various maps projections and their utility. Surveying form another integral part of cartographic education at under degree level. In the present study cartographic application part replicates a tragic picture of cartographic literacy among under degree geography students. Cartographic application component is basic requirement at under degree level course. The sample survey reveals that 29.4 percent of students selected as respondent had perfect knowledge/awareness of cartographic application and 32.7 percent reflected partly wakefulness about cartographic application by answering 3 out of 4 indicators. The cartographic literacy regarding cartographic application was not up to mark among under degree geography student as 22.8 percent answered 2 indicators, 11.7 percent only one indicator and 3.4 percent student failed to answer even a single indicator. The condition of D.U.Delhi was better in comparison to other selected Universities.

Table-1
Composite Score of Cartographic Literacy

S.N.	Universities	X _{G1}	X _{G2}	X _{G3}	X _{G4}	X _G	d	d ²
1	D.U.,Delhi	3.25	3.35	2.82	2.91	12.33	0.598	0.358
2	M.D,U.,Rohtak	3.10	3.26	2.55	2.67	11.58	-0.152	0.023
3	K.U.Kurukshetra	3.16	3.28	2.66	2.77	11.87	0.138	0.019
4	C.D.L.U.,Sirsa	3.0	3.19	2.52	2.44	11.15	-0.582	0.339
						ΣX _G = 46.93		Σ d ² = 0.739
$\bar{X} = \sum X_G / N$		$d = X_G - \bar{X}_G$		$d^2 = (X_G - \bar{X}_G)$		$\sigma = \sqrt{\sum d^2 / N}$		
X _G = 11.732		σ = 0.445						

Source: Based on appendix-1

Table-2

Levels of Cartographic Literacy among Degree Students

S.N.	Level of Cartographic Literacy	Statistical Values	Composite Score	Name of University
1	Good	To + 2	12.178-12.622	D.U., Delhi
2	Medium	To +	11.732- 12.177	K.U., Kurukshetra
3	Poor	To -	11.287-11.731	M.D,U, Rohtak
4	Very Poor	To - 2	10.842 -11.286	C.D.L.U., Sirsa

From the analysis it is evident that the students display a low level of cartographic literacy. It has also been observed that there exists affirmative connection between school level location knowledge preservation, identification element withholding, association proficiency and cartographic application part at under degree level. In other words under degree student poor performance of cartographic knowledge depends upon the cartographic syllabi and knowledge at primary, secondary and higher secondary system. It is advocated in numerous researches that cartographic infrastructure needs continuous expansion and improvement to achieve justified cartographic knowledge. This comparison of the cartographic level of literacy among different universities also portrays a pathetic picture.(Table-1&2). On the basis of calculated composite scores the quantitative processing is fully justified and four level of cartographic literacy have emerged. The under- degree students of Delhi University Delhi enjoys high level of Cartographic literacy and followed by medium level by Kururukshestra University Kurukshetra , and low level by Maharishi Dayanand University, Rohtak and Ch. Devilal University Sirsa. Thus to improve cartographic literacy we have to understand the significance of cartography knowledge in social life as well as at school level. It is very important to alleviate cartographic illiteracy for inclusive development of the society.

Suggestions for Improvement of Cartographic Literacy: Locations should be described in context of environments, episodes and interactivity to make sure that the significance of a particular location ought to be known. Students should be encouraged to draw sketch maps on board as an example of how maps communicate their ideas. Simplify frames of reference by reducing the continents to simple geometric shapes and relate locations of places to particular should be encouraged. Geo-mnemonics may be used, wherever rote learning is inevitable or unavoidable. The mnemonics could be made up and used as a class exercise. The students should be habituated to use simple atlases.They should be skilled to look to the general framework first, rather than allow in them to become lost in the details of the map. The students should be asked to construct the maps to ease the cartographic sketching through puzzle, tearing and physically drawing the maps. Students may be asked to simply cut up outline maps and to put pieces of the puzzle map into an outline border as a jigsaw puzzle. If, at the beginning of the activity, the students require help, then the teacher may refer them to a finished map. Students may be asked to tear a piece of paper and develop the shape of the required area/place .The teacher may begin the exercise by providing a model for students to follow. The students may be asked to physically draw the mental maps of any given area/place and to compare their

products to the mercantile maps to judge the accuracy. The drawing may be corrected and used for future review. Further the students can be trained in mapping through computers. Computer aided cartography can be introduced at school level as well as during higher education which has advantages of accuracy in mapping, consistency in output, easy scale changing, error reduction and labour saving in map production.

Conclusion: The study highlights that low level cartographic literacy exists among the under degree geography students. The techniques discussed above help students to develop their geographic support. The future teachers need to develop their mental maps of the world. This can be accomplished through formal and informal geographic learning. As the location information, which has an important part of modern life is best related through sketches and maps. This skill has to be enhanced and its widespread use should be encouraged among all levels of students. Strategies must be used that focus on the retention of location information at school level as a way to improve an individuals' mental map of the world. Presently cartographic literacy has become utmost condition for social scientists, administrators, planners, demographers, agricultural experts and researchers. So, there is a need of holistic approach to understand the above mentioned issues at grass root level.

References

1. Awasthi,B.L.(1969),Ancient Indian Cartography, in Dr. Satkari Mookerji, Felicitation Volume, *Chowkhamba Sanskrit Studies*, vol. 69 , 275-78.
2. Cook,J.L. & ook,G. (2005) *Child Development: Principles & Perspectives*, Allyn & Bacon 75 Arlington St., Suite 300 Boston, MA 02116, 5-22.
3. Deshpande,C.D.(1953)A Note on Maratha Cartography, *Indian Archives* 7 ,87-94.
4. Taylor, D.R.F. (1994), Perspectives on visualization and modern cartography. In A.M. MacEachern, D.R.F. Taylor (eds), *Visualization in Modern Cartography*, Oxford, UK: Pergamum: 333-342.
5. Habib,I.(1977) Cartography in Mughal India, *Indian Archives* 28 , 88-105.
6. Dykes,J. (1995). Cartographic Visualization for Spatial Analysis, Barcelona: Proceedings *17th International Cartographic Conference*: 1365-1370.
7. Wood,M. (1994). Visualization in a historical context. In A.M. MacEachern, D.R.F. Taylor (eds) *Visualization in Modern Cartography*, Oxford, UK: Pergamon: 13-26.
8. Tripathi,M.P.(1963) Development of Geographic Knowledge in Ancient India, *Journal of the Oriental Institute* (Baroda) vol. 12, 390-424.
9. Raza,M.& Ahmad,A. (1972) ,Historical Geography: A Trend Report, in *A Survey of Research in Geography*, Popular Prakashan, Bombay , 147-169,
10. Fisher,P.& Dykes, J. &Wood ,J.(1993). Map design and visualization. *The Cartographic Journal* 30 (2):136-142.
11. Piaget, J. & Inhelder, B. (1967) *A Child's Conception of Space*,(F. J. Langdon & J. L. Lunzer, Trans.). New York: Norton (Original work published 1948)
12. Singh, R.L. & Singh, R. P.B. (1979): "Spatial Planning in Indian Perspective", *N.G.S.I. Research Bulletin*.P39.

13. Singh,R.L., Singh, L. R. & Dube, B. (1966),The Ancient Indian Contribution to Cartography, *National Geographical Journal of India*, Vol.12, 24-37.

14. WWW.eurekaencyclopedia.com/index.php/Category:Maps

Appendix-1

Selected Parameters for Analysis of Cartographic Education Level among Degree Students and their X & X_G Values

Variables	Quality Parameter	Indicator	Study area																
			Delhi University (150)			M.D.U.Rothak (150)			K.U.Kurukshetra (150)			C.D.L.U.Sirsa (150)			Total (600)				
			No.	%of	X Value	No.	%of	X Value	No.	%of	X Value	No.	%of	X Value	No.	%of	X Value		
A	B	C	D	D-i	D-ii	D-iii	R-i	R-ii	R-iii	K-i	K-ii	K-iii	S-i	S-ii	S-iii	T-i	T-ii	T-iii	
Location																			
X ₁	Continents	S. America,	4	91	60.7	2.4	81	54.0	2.1	87	58.0	2.32	76	50.7	2.0	335	55.	2.23	
		Africa,				3		6							3		8		
		Australia, &	3	38	25.3	0.7	33	22.0	0.6	30	20.0	0.6	30	20.0	0.6	131	23.	0.70	
		Asia				6		6									5		
			2	13	8.7	0.1	17	11.3	0.2	19	12.7	0.25	22	14.7	0.2	71	11.	0.24	
X ₂	Oceans	Arctic,	4	83	55.3	2.2	72	48.0	1.9	76	50.7	2.03	66	44.0	1.7	297	49.	1.98	
		Pacific,				1		2						6		5			
		Atlantic,&	3	38	25.3	0.7	40	26.7	0.8	43	28.7	0.86	38	25.3	0.7	159	26.	0.79	
		Indian				6								6		5			
			2	16	10.7	.21	21	14.0	0.2	18	12.0	0.24	25	16.7	0.3	80	13.	0.27	
X ₃	Imagery lines	Tropic of	4	75	50	2.0	66	44.0	1.7	71	47.3	1.89	61	40.7	1.6	273	45.	1.82	
		Capricorn,				0		6						3		5			
		Tropic of Cancer,	3	43	28.7	0.8	44	29.3	0.8	39	26.0	0.78	37		0.7	163	27.	0.81	
		Prime Meridian,&				6		8					24.7	4		2			
Equator		2	18	12	0.2	23	15.3	0.3	24	16.0	0.32	29	19.3	0.3	94	15.	0.31		
		1	09	0.6	0.1	14	9.3	0.0	13	8.7	0.09	17	11.3	0.1	53	8.8	0.09		

								9						1				
			0	05	3.33	00	03	2.0	00	03	2.0	00	06	4.0	00	17	2.8	00
X ₄	State	Telangana,	4	79	52.7	8.4	73	48.7	1.9	74	49.3	1.97	70	46.7	1.8	296	49.	1.97
		Jharkhand,				3			5						7		3	
		Chhattisgarh&	3	46	30.7	0.9	43	28.7	0.8	45	30.0	0.9	41	27.3	0.8	175	29.	0.87
		Madhya Pradesh				2			6						2		2	
			2	20	13.3	0.2	27	18.0	0.3	25	16.7	0.33	28	18.7	0.3	100	16.	0.33
					7			6						7		7		
			1	05	3.3	0.0	06	4.0	0.0	06	4.0	0.04	09	6.0	0.0	26	4.3	0.04
														6				
			0	00	00	00	01	0.7	00	00	00	00	02	1.3	00	03	0.0	00
																	5	
X ₅	Physical feature	Thar Desert ,	4	74	49.3	1.9	72	48.0	1.9	72	48.0	1.92	75	50.0	2.0	293	48.	1.95
		Vindhyanchal				7			2								8	
		Mountains,	3	40	26.7	0.8	32	21.3	0.6	34	22.7	0.68	32	21.3	0.6	138	23.	0.69
		Rajmahal Hills &							4						4		0	
		Karakoram Range	2	20	13.3	0.2	25	16.7	0.3	23	15.3	0.31	21	14.0	0.2	89	14.	0.30
					7			3						8		8		
			1	16	10.7	0.1	18	12.0	0.1	19	12.7	0.13	17	11.3	0.1	70	11.	0.12
														1		7		
			0	00	00	00	03	2.0	00	02	1.33	00	05	3.3	00	10	1.6	00
																	7	
X ₆	Group-1 Cartographic Location		4	40	53.6	2.1	36	48.5	1.9	38	50.7	2.03	34	46.4	1.8	149	49.	1.99
						4	4		4	0			8		6	4	8	
			3	20	27.3	0.8	19	25.6	0.7	19	25.5	0.76	17	23.7	0.7	766	25.	0.77
						2	2		7	1			8		1		5	
			2	87	11.6	0.2	11	15.1	0.3	10	14.5	0.29	12	16.7	0.3	434	14.	0.29
				3	3		0	9			5		3		5			
			1	48	6.4	0.0	66	8.8	0.0	61	8.13	0.08	75	10.0	0.1	250	8.3	0.08
														0				
			0	08	1.1	00	15	2.0	00	09	1.2	00	24	3.2	00	56	1.8	00
																	7	
Identification																		
X ₆	Continents	Europe,	4	93	62	2.4	85	56.7	2.2	87	58.0	2.32	82	54.7	2.1	347	57.	2.31
		Africa,				8			7						9		3	
		South America ,	3	50	33.3	1.0	56	37.3	1.1	60	40.0	1.20	62	41.3	1.2	228	39.	1.19
		Australia							2						4		7	
			2	07	4.7	0.0	09	6.0	0.1	03	2.0	0.04	06	4.0	0.0	25	4.2	0.08
					9			2						8				
			1	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
			0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
X ₇	Sea	Red Sea	4	59	39.3	1.5	50	33.3	1.3	47	31.3	1.25	39	26.0	1.0	195	32.	1.30
		Great Lakes				7			3						4		5	

		Caspian Sea	3	57	38.0	1.1	52	34.7	1.0	58	38.7	1.16	53	35.3	1.0	220	36.	1.10	
		Black Sea				4			4					6			7		
			2	26	17.3	0.3	35	23.3	0.4	31	20.7	0.41	39	26.0	0.5	131	21.	0.44	
						5			7					2			8		
			1	07	4.7	0.0	10	6.7	0.0	11	7.3	0.07	13	8.7	0.0	41	6.8	0.07	
						5			7					9					
			0	01	0.7	0.0	03	2.0	0.0	03	2.0	0.0	06	4.0	0.0	13	2.2	0.0	
X ₈	Country	Bengala Desh	4	98	65.3	2.6	89	59.3	2.3	91	60.7	2.43	88	58.7	2.3	366	61.	2.44	
		Bhutan				1			7					5			0		
		Pakistan	3	52	34.6	1.0	61	40.7	1.2	58	38.7	1.16	60	40.0	1.2	231	38.	1.15	
		Sri Lanka			7	4			2								5		
				2	00	00	0.0	00	00	0.0	01	0.7	0.01	02	1.3	0.0	03	0.5	0.01
															3				
			1	00	00	0.0	00	00	0.0	00	00	0.0	00	00	0.0	00	0.0	0.0	
			0	00	00	0.0	00	00	0.0	00	00	0.0	00	00	0.0	00	0.0	0.0	
X ₉	State	West Bengal	4	10	68.7	2.7	90	60.0	2.4	89	59.3	2.37	86	57.3	2.2	368	61.	2.45	
		Gujarat		3		5			0					9			3		
		Assam	3	45	30.0	0.9	56	37.3	1.1	57	38.0	1.14	60	40.0	1.2	218	36.	1.09	
		Himachal Pradesh				0			2						0			3	
				2	02	1.3	0.0	04	2.7	0.0	04	2.7	0.05	03	2.0	0.0	13	2.2	0.04
							3		5						4				
			1	00	00	0.0	00	00	0.0	00	00	0.0	01	0.7	0.0	01	0.2	0.01	
														1					
			0	00	00	0.0	00	00	0.0	00	00	0.0	00	00	0.0	00	0.0	0.0	
X ₁₀	Physical features	Focus, Epicentre,	4	65	43.3	1.7	60	40.0	1.6	64	42.7	1.71	59	39.3	1.5	248	41.	1.65	
		Ox bow lake, Barchans				3			0					8			3		
			3	29	19.3	0.5	30	20.0	0.6	25	28.4	0.85	26	17.3	0.5	110	18.	0.55	
						8			0					2			3		
				2	29	19.3	0.3	27	18.0	0.3	24	16.0	0.32	21	14.0	0.2	101	16.	0.34
						9		6					8			8			
			1	27	18.0	0.1	30	20.0	0.2	34	22.7	0.23	38	25.3	0.2	129	21.	0.21	
						8		0					5			5			
			0	00	00	0.0	03	2.0	0.0	03	2.0	0.0	06	4.0	0.0	12	2.0	0.0	
X _{G2}	Group-2 Cartographic Identification		4	41	55.7	2.2	37	49.9	1.9	37	50.4	2.02	35	47.2	1.8	152	50.	2.03	
						1	4		9	8			4		9	4	8		
				3	23	31.1	0.9	25	34.0	1.0	25	34.4	1.03	26	34.8	1.0	100	33.	1.01
						3	5		2	8			1		4	7	6		
				2	64	8.5	0.1	75	10.0	0.2	63	8.4	0.17	71	9.47	0.1	273	9.1	0.18
						7		0					9						
			1	34	4.5	0.0	40	5.3	0.0	45	6.0	0.06	52	6.93	0.0	171	5.7	0.06	
						4		5					7						
			0	01	0.1	0.0	06	0.8	0.0	06	0.8	0.0	12	1.6	0.0	25	0.8	0.0	
Association																			

X ₁₁	Physical feature	Niagara Fall,	4	55	36.	1.47	48	32.	1.2	50	33.3	1.33	48	32.0	1.2	201	33.	1.34	
		Mt.Everest,			7			0	8						8			5	
		Grand Canyon,	3	45	30.	0.09	42	28.	0.8	46	30.7	0.92	49	32.7	0.9	182	30.	0.91	
		Mt.Kilimanjaro			0			0	4						8			3	
			2	32	21.	0.43	29	19.	0.3	25	16.7	0.33	24	16.0	0.3	110	18.	0.37	
			3			3	9						2			3			
			1	15	10.	0.10	21	14.	0.1	18	12.0	0.12	20	13.3	0.1	74	12.	0.12	
					0			0	4					3			3		
			0	03	2.0	00	10	6.7	00	11	7.3	00	09	6.0	00	33	5.5	00	
X ₁₂	Habitat	Bedouin	4	51	34.	1.36	39	26.	1.0	42	28.0	1.12	37	24.7	0,9	169	28.	1.13	
		Zulus			0			0	4						9			2	
		Eskimo	3	44	29.	0.88	31	20.	0.6	38	25.3	0.76	33	22.0	0.6	146	24.	0.73	
		Bushman			3			7	2						6			3	
			2	28	18.	0.37	37	24.	0.4	32	21.3	0.43	35	23.3	0.4	132	22.	0.44	
			7			7	9						7			0			
			1	18	12	0.12	26	17.	0.1	23	15.3	0.15	29	19.3	0.1	96	16.	0.16	
						3	7							9			0		
			0	09	6.0	00	17	11.	00	15	10.0	00	16	10.7	00	57	9.5	00	
							3												
X ₁₃	Physical feature	Trans-Siberian	4	45	30.	1.20	35	23.	0.9	37	24.7	0.99	31	20.7	0.8	148	24.	0.99	
		Railway Line			0			3	3						3			7	
		Hermitage	3	51	34.	1.02	56	37.	1.1	58	38.7	1.16	61	40.7	1.2	226	37.	1.13	
		Great Barrier			0			3	2						2			7	
		Reef	2	31	20.	0.41	27	18.	0.3	25	16.7	0.33	28	18.7	0.3	111	18,	0.37	
				67			0	6						7			5		
			1	12	8.0	0.08	14	9.3	0.0	14	9.3	0.09	11	7.3	0.0	51	8.5	0.08	
								9						7					
			0	11	7.3	00	18	12.	00	16	10.7	00	19	12.7	00	64	10.	00	
							0										7		
X ₁₄	Tribes	Gujar -	4	64	42.	1.71	47	31.	1.2	55	36.7	1.47	43	28.7	1.1	209	34.	1.39	
		Bakarwal,			7			3	5						5			8	
		Garo-khasi-Jyan	3	45	30.	0.9	51	34.	1.0	50	33.3	1.00	59	39.3	1.1	205	34.	1.02	
		tia,			0			0	2						8			2	
		Bhil, Jarwas	2	29	19.	0.39	29	19.	0.3	25	16.7	0.33	24	16.1	0.3	107	17.	0.36	
				3			3	9						2			8		
			1	09	6.0	0.06	18	12.	0.1	15	10.0	0.10	16	10.7	0.1	58	9.7	0.10	
							0	2						1					
			0	03	2.0	00	05	3.3	00	05	3.3	00	08	5.3	00	21	3.5	00	
X ₁₅	Plains	Sawanas	4	49	32.	1.31	40	26.	1.0	41	27.3	1.09	37	24.7	0.9	167	27.	1.11	
		Downs			7			7	7						9			8	
		Pampas	3	42	28.	0.84	45	30.	0.9	47	31.3	0.94	33	22.0	0.6	167	27.	0.83	
				0			0	0						6			8		
			2	34	22.	0.45	28	18.	0.3	31	20.7	0.41	39	26.0	0.5	132	22.	0.44	

					7			7	7					2		0		
			1	21	14.0	0.14	29	19.3	0.19	24	16.0	0.16	32	21.3	0.21	106	17.7	0.18
			0	04	2.7	00	08	5.3	00	07	4.7	00	09	6.0	00	28	4.7	00
X _{G3}	Group-1 Cartographic Association		4	26	35.4	1.41	20	27.9	1.19	22	30.0	1.20	19	26.3	1.04	894	29.8	1.19
			3	22	30.7	0.91	22	30.5	0.90	23	31.9	0.96	23	31.3	0.94	926	30.9	0.93
			2	15	20.4	0.40	15	20.0	0.40	13	18.4	0.37	15	20.0	0.40	592	19.7	0.39
			1	75	10.0	0.10	10	14.8	0.14	94	12.5	0.13	10	14.4	0.14	385	12.8	0.13
			0	30	4.0	00	58	7.7	00	54	7.2	00	61	4.0	00	203	6.7	00
Mapping Technique																		
X ₁₆	River	Mississippi	4	52	34.7	1.39	42	28.0	1.12	44	29.3	1.17	39	26.0	1.04	17	29.7	1.18
		Huang-Ho-Yellow	3	47	31.3	0.94	49	32.7	0.98	44	29.3	0.88	38	25.3	0.76	17	29.8	0.89
		Amazon	2	36	24.0	0.48	31	20.7	0.41	31	20.7	0.41	32	21.3	0.43	13	21.0	0.43
		Nile	1	15	10.0	0.10	24	16.0	0.16	27	18.0	0.18	35	23.3	0.23	10	16.1	0.17
			0	00	00	00	04	2.7	00	04	2.7	00	06	4.0	00	14	2.3	00
X ₁₇	Mountains	Ural	4	50	33.3	1.33	34	22.7	0.91	41	27.3	1.09	37	24.7	0.99	16	27.2	1.08
		Andes	3	48	32.0	0.96	50	33.3	1.03	51	34.0	1.02	39	26.0	0.78	18	31.8	0.94
		Rocky	2	29	19.3	0.39	30	20.0	0.40	29	19.3	0.39	32	21.3	0.43	12	20.0	0.40
		Alps	1	20	13.3	0.13	21	14.0	0.14	20	13.3	0.13	29	19.3	0.19	90	15.0	0.15
			0	03	2.0	00	15	10.0	00	09	6.0	00	13	8.7	00	40	6.7	00
X ₁₈	Conventional Sign	Bridge	4	49	32.7	1.31	43	28.7	1.15	48	32.0	1.28	41	27.3	1.09	18	30.1	1.21
		Churgh	3	53	35.3	1.06	45	30.0	0.90	46	30.7	0.92	48	35.3	1.06	19	32.2	0.96
		Temple	2	30	20.0	0.40	35	23.3	0.47	37	24.7	0.49	35	23.3	0.47	13	22.7	0.46
		Fort	1	17	11.3	0.11	22	14.7	0.15	15	10.0	0.10	21	11.3	0.11	75	12.5	0.12

			0	01	0.7	00	05	3.3	00	04	2.67	00	05	3.33	00	15	2.5	00
X ₁₉	Rivers	Damodar	4	56	37.	1.49	47	31.	1.2	51	34.0	1.36	42	28.0	1.12	19	32.	1.31
		Mahanadi			3			3	5							6	7	
		Caveri	3	55	36,	1.10	56	37.	1.1	62	41.3	1.24	60	40.0	1.20	23	38.	1.16
		Ganga			7			3	2							3	8	
			2	35	23.	0.47	40	26.	0.5	35	23.3	0.47	43	28.7	0.57	15	25.	0.51
				3		7	3							3	5			
			1	04	2.7	0.03	07	4.7	0.0	02	1.3	0.01	05	3.3	0.03	18	3.0	0.03
								5										
			0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
X ₂₀	Highways	N.H.8	4	50	33.	1.33	41	27.	1.0	44	29.3	1.17	30	20.0	0.80	16	27.	1.10
		N.H.7			3			3	9							5	5	
		N.H.1	3	50	33.	1.0	48	32.	0.9	44	29.3	0.88	48	32.0	0.96	19	31.	0.95
		N.W.1			3			0	6							0	7	
			2	30	20	0.4	36	24,	0.4	37	24.7	0.49	41	27.3	0.55	14	24.	0.48
								0	8							4	0	
			1	17	11.	0.11	15	10.	0.1	17	11.3	0.11	19	12.7	0.13	68	11.	0.11
				3			0	0								3		
			0	03	2.0	00	10	6.7	00	08	5.3	00	12	8.0	00	33	5.5	00
X _{G4}	Group-4 Cartographic Application		4	25	34.	1.37	20	27.	1.1	22	30.4	1.22	18	25.2	1.01	88	29.	1.17
				7	3		7	6	0	8			9			1	4	
			3	25	33.	1.01	24	33.	0.9	24	32.9	0.99	23	31.1	0.93	98	32.	0.98
				3	7		8	1	9	7			3			1	7	
			2	16	21.	0.43	17	22.	0.4	16	22.5	0.45	18	24.4	0.49	68	22.	0.46
		0	3		2	9	6	9			3			4	8			
			1	73	9.7	0.10	89	11.	0.1	81	10.8	0.11	10	14.5	0.01	35	11.	0.12
						9	2				9				2	7		
			0	07	0.9	00	34	4.5	00	25	3.33	00	36	4.8	00	10	3.4	00
															2			

Source: Field Survey