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CLASSIFICATION OF DIFFERENT EDUCATION BOARDS IN INDIA USING FCA

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Abstract

Formal Concept Analysis (*FCA*) is an effective mathematical method employed for knowledge extraction from data in a structured manner. Based on the lattice theory, *FCA* discovers significant groupings of objects and their common attributes as formal concepts. India has acknowledged education as a tool for national growth and establishing a new social structure. The idea of curriculum gained popularity when education was established as a formal system of human society for learning, and it has continued to enjoy the considerable significance ever since. The different educational boards in India are *CBSE* (Central Board of Secondary Education), *ICSE* (Indian Certificate of Secondary Education), *NIOS* (National Institute of Open Schooling), State Board (*SB*), *IGCSE* (International General Certificate of Secondary Education), and *IB* (International Baccalaureate), and many more. Each board has a unique structure. The researchers have examined all six boards by considering the examination pattern and the analysis of the 10th standard subject. *FCA* was used to classify the 10th standard subjects and assessments in different school boards in India. The readers will clearly understand the information about different school boards, subjects, and assessments.

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Keywords and Phrases: *CBSE*, *ICSE*, *NIOS*, *SB*, *IGCSE*, *IB*, School boards, *FCA*.

1 Introduction

Formal Concept Analysis (*FCA*) is an effective tool for data analysis. The main objective of this study is to demonstrate the effectiveness of *FCA* in determining the underlying knowledge from real-life datasets. The basic details of *FCA* is available in [1, 5, 16] and a review of *FCA* is covered in many articles [10, 11, 12, 14]. An experiment was conducted on the dataset from different school boards in India. Data was collected from the Kaggle platform. And finally, the researchers will discuss the importance of schools and major school boards in India.

Education is the only important tool for changing the society. Schools are the places which not only serves to enhance one's learning but also, they contain the future of individuals and societies. Schools are essential for personal growth (educated, responsible, and successful citizens) and national development. Different educational boards follow different curricula across India and also it remains the same globally. Here, six major boards like *CBSE*, *ICSE*, *NIOS*, *SB*, *IGCSE* and *IB*. The importance of schools are academic learning and knowledge, character building and discipline, social development and communication skills, career preparation and future opportunities, personal growth and confidence, reducing social inequality, citizenship and social responsibility, health and well-being, and physical fitness. In this study, the researchers discuss a brief explanation about school board-based articles.

Aida Kairien discussed the understanding of the micropolitics in schools by *FCA*. Context were framed like school heads and the entire school community, the importance of leadership for teachers. The relationships between the attributes aids in the better understanding of a school's micropolitics which in turn, improve the community relationships for the implementation of the schools strategies [9]. Anirban Roy Chowdhury

et al. [2] analysed three English medium Indian school boards, *ICSE*, *CBSE*, and *NIOS* and discussed on the mode of exams they conduct and focuses mainly on the areas and topics. Usha *et al.* [15] analysed Indian school boards State, *CBSE*, and *ICSE*, which clearly shows inequality in terms of curriculum, examination, and fee structure of these three boards "Education brings Equality" and "One Nation and One Education System". Gharami *et al.* [6] analysed educational contents and the sope of language development in secondary level English under several school boards.

Marlies Honingh *et al.* [7] reviewed on school boards and educational quality and also identified which school boards contribute to education quality. Honingh *et al.* [8] discussed Dutch secondary school-based measurements of board characteristics, pupil achievements, and board behaviour. The study leaves gap to write more articles based on school boards depending on variables such as board behaviour and corporate governance. Dervarics *et al.* [3] mentioned and explained eight characteristics of effective school boards. According to the work and analysis of Sell *et al.* [13] the best way to manage a successful school district is to make sure that school boards create a vision for student learning and successfully convey that goal to the superintendent /cite13. Ford *et al.* [4] analysed school boards and their use of different models of governance. School board articles were discussed so far, and next we will discuss the outline of this paper. The author strategized to classify the different school boards in India. Understand the different subjects among the different board systems. The first section gives the information about *FCA*, the importance of school, and the different types of boards in India and reviewed many articles. In Section 2, the top six board-based subjects in India were collected. Classified the different boards and subjects by the use of *FCA* were discussed in section 3. Section 4 concludes the article.

2 Data Description

The *CBSE*, *ICSE*, *NIOS*, *SB*, *IGCSE*, and *IB* are the most reputable boards where students can establish a basis for the future. Each of these boards, however, has different courses, evaluations, curricula, material, costs, goals, and methods for instructing students [2]. This paper particularly deals with only the subject and assessment in the 10th standard in different boards with the use of *FCA*. The following Table 2.1 contains the six school boards, subjects, sub-subjects and assessments.

Table 2.1: 10th standard subjects and assessments in *CBSE* board schools in India

Board	Subject	Subject (detailed)
1. <i>CBSE</i>	First Language	English
	Second Language	Hindi / Sanskrit / French
	Mathematics	Standard & Basic
	Science	IS Integrated Sciences (Physics, Chemistry, Biology)
	Social Science	History, Civics, Geography, Economics
	Optional Subject	Computer Science (CS), Artificial Intelligence (AI), Home Science (HS), Arts, Information Science (IS)
	Vocational Subjects	Information Technology (IT), AI, Coding
	Assessment Pattern	Year-end board exams
2. <i>ICSE</i>	First Language	English
	Second Language	Hindi / Sanskrit / French
	Mathematics	Maths
	Science	SS-Separable Subjects (Physics, Chemistry, Biology)
	Social Science	History, Civics, Geography
	Optional Subject	Computer Application (CA), Arts, Deama, Physical Education (PE), HS
	Vocational Subjects	Commercial Studies, Environmental Science (ES)
	Assessment Pattern	Internal and board exams
3. <i>NIOS</i>	First Language	English/Hindi
	Second Language	Hindi, Urdu, Sanskrit, etc.
	Mathematics	Maths
	Science	Science & Technology (ST)
	Social Science	Social Science
	Optional Subject	Data Entry, HS, Vocational Courses (VC)

therefore more specific. The concept 3 is more general concept than all other concepts, which means that this concept has less objects with more attributes and thus it is a more general concept. The concept 25 contains more objects and less attribute. Next, showed the extent and intent of the concepts in Figure 2.1.

Table 2.2: Concepts with their Intents and Extents for concept lattices from Figure 2.1

Concept	Extent	Intent
1	{ }	{Regional Language, English, Hindi, Sanskrit, French, Urdu, Spanish, German, Other, General Maths, Standard & Basic, Core/Extended, IS, SS, ST, IS or SS, History, Civics, Geography, Economics, General Social Science, GP, Individual Societies, CS, CA, AI, HS, Arts, IT, Drama, PE, Data Entry, VC, ES1, BS, Economics, PHE, Design, IS, AI, Coding, Commercial Studies, ES, HS, BS, SPVC, ICT, Business, TT, DT, Annual, Internal, Open School, Flexible, Cambridge, Project Based}
2	{SB}	{Regional Language, English, Hindi, General Maths, IS or SS, History, Civics, Geography, CS, ES1, SPVC, Annual}
3	{CBSE}	{English, Hindi, Sanskrit, French, Standard & Basic, IS, History, Civics, Geography, Economics, CS, AI, HS, Arts, IS, IT, AI, Coding, Annual}
4	{ ICSE }	{English, Hindi, Sanskrit, French, General, Maths, SS, History, Civics, Geography, CA, AI, HS, Drama, PE, Commercial Studies, ES, Annual, Internal}
5	{IGCSE}	{English, French, Spanish, German, Other, Core/Extended, SS, GP, Arts, Drama, BS, Economics, ICT, Business, TT}
6	{NIOS}	{English, Hindi, Sanskrit, Urdu, Other, General Maths, ST, General Social Science, HS, Data Entry, VC, HS, BS, Open School, Flexible}
7	{IB}	{English, French, Spanish, Other, General Maths, IS, individual Societies, Arts, PHE, Design, DT, Project Based}
8	{SB, CBSE}	{English, Hindi, History, Civics, Geography, CS, Annual}
9	{SB, ICSE }	{English, Hindi, General Maths, History, Civics, Geography, Annual}
10	{ ICSE , CBSE }	{English, Hindi, Sanskrit, French, History, Civics, Geography, AI, HS, Annual}
11	{ ICSE , IGCSE }	{English, French, SS, Drama}
12	{ ICSE , NIOS }	{English, Hindi, Sanskrit, General Maths, HS}
13	{ ICSE , IB }	{English, French, General Maths}
14	{CBSE, IB}	{English, French, IS, Arts}
15	{IGCSE, IB}	{English, French, Sanskrit, Other, Arts}
16	{NIOS, IB}	{English, Other, General Maths}
17	{SB, CBSE, ICSE }	{English, Hindi, History, Civics, Geography, Annual}
18	{CBSE, ICSE , NIOS}	{English, Hindi, Sanskrit, HS }
19	{SB, ICSE , NIOS}	{English, Hindi, General Maths}
20	{CBSE, IGCSE, IB}	{English, French, Arts}
21	{IGCSE, NIOS, IB}	{English, Other}
22	{SB, CBSE, ICSE, NIOS}	{English, Hindi}
23	{CBSE, ICSE , IGCSE, IB}	{English, French}
24	{SB, ICSE , NIOS, IB}	{English, General Maths}
25	{SB, CBSE, ICSE, IGCSE, NIOS, IB}	{English}

All six school boards are at the same bottom level and are therefore considered equally important concerning concept 1. It is evident from the concept lattice diagram in Figure 2.1 that the attributes and objects associated with each concept can be viewed simultaneously within the hierarchical structure.

2.1 Language

Table 2.3: Language-based formal context

	Regional Language	English	Hindi	Sanskrit	French	Urdu	Spanish	German	Other
<i>CBSE</i>		X	X	X	X				
<i>ICSE</i>		X	X	X	X				
<i>NIOS</i>		X	X	X		X			X
<i>SB</i>	X	X	X						
<i>IGCSE</i>		X			X		X	X	X
<i>IB</i>		X			X		X		X

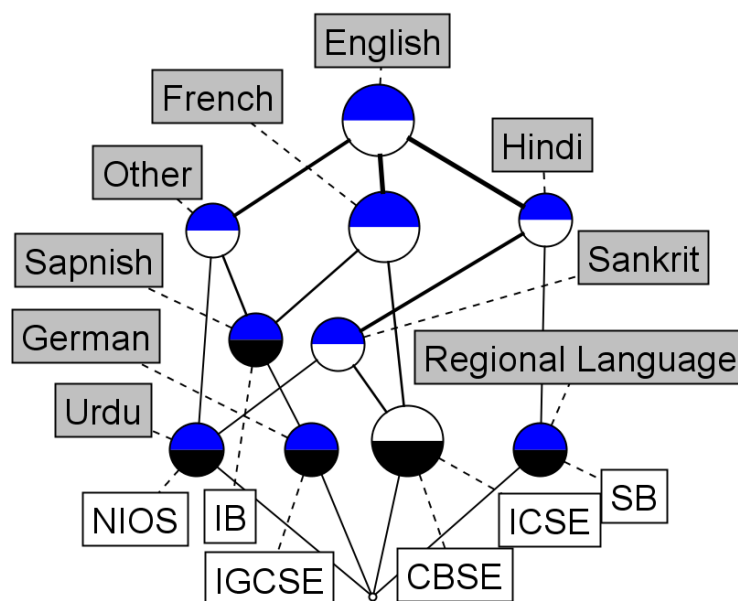


Figure 2.2: Language-based concept lattice from Table 2.3

From the concept lattice, Figure 2.2 contained 11 concepts whose intents and extents were also clearly mentioned. The numbering of concepts in the concept lattice starts from the bottom to the top and moves from right to left. Every 10th standard students study English as one of the subjects, and it is mandatory for all the boards. *CBSE* and *ICSE* boards both depend on the same language. The *IGCSE* board stands as a super-concept of the *IB*board; *IB* remains a sub-concept of *IGCSE*. The *NIOS* and *SB* boards contain Urdu and the regional language, respectively.

2.2 Mathematics

Table 2.4: Maths-based formal context

	General Maths	Standard & Basic	Core/Extended
<i>CBSE</i>		X	
<i>ICSE</i>	X		
<i>NIOS</i>	X		
<i>SB</i>	X		
<i>IGCSE</i>			X
<i>IB</i>	X		

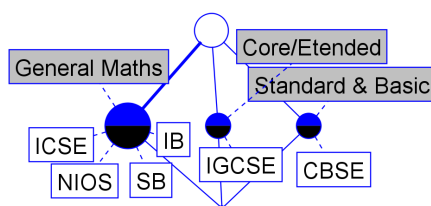


Figure 2.3: Maths-based concept lattice from Table 2.4

By considering the Figure 2.3, which contains 5 concepts: mathematics remains a compulsory subject for all the boards, with only small changes in the frame of syllabus setting. The *SB*, *NIOS*, *ICSE*, and *IB* boards follow the same math, but *IGCSE* and *CBSE* follow a different math. The subject-wise classification of 10th standard students makes it clear that maths is an essential subject and cannot be avoided.

2.3 Science

Table 2.5: Science-based formal context

	IS	SS	ST	IS or SS
<i>CBSE</i>	X			
<i>ICSE</i>		X		
<i>NIOS</i>			X	
<i>SB</i>				X
<i>IGCSE</i>		X		
<i>IB</i>	X			

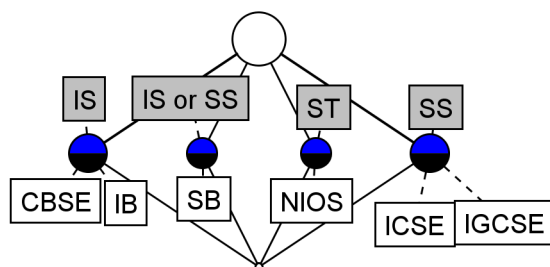


Figure 2.4: Science-based concept lattice from Table 2.5

Figure 2.4 contains 6 concepts; *IGCSE* stands as the super concept of *ICSE*. The *CBSE* and *IB* boards follow the same science syllabus. *NIOS* remains different from the other five boards of schools. Anirban Roy Chowdhury *et al.* analysed science and maths subjects in different school boards detailed in [8].

2.4 Social science

Table 2.6: Social science-based formal context

	History	Civics	Geography	Economics	General Social Science	GP	Individual Societies
<i>CBSE</i>	X	X	X	X			
<i>ICSE</i>	X	X	X				
<i>NIOS</i>					X		
<i>SB</i>	X	X	X				
<i>IGCSE</i>						X	
<i>IB</i>							X

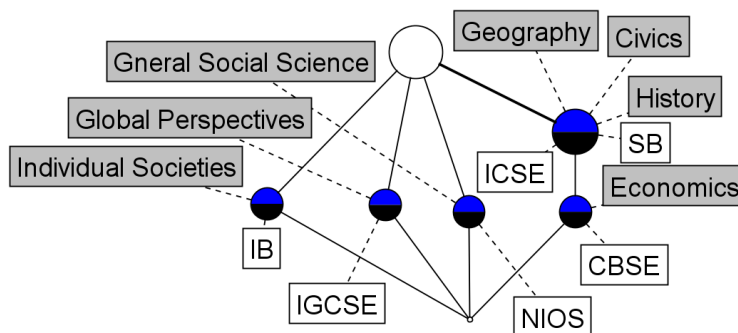


Figure 2.5: Social science-based concept lattice from Table 2.6

The researchers discussed the social science subject-based classification in Figure 2.5, which contains 7 concepts; it remained clear in the understanding of the subject. *CBSE* remained as a super concept of *SB*, and economics was the one extra part added to the *CBSE* syllabus. The other three boards have different styles of social studies that were followed.

2.5 Optional

Table 2.7: Optional subject-based formal context

	CS	CA	AI	HS	Arts	IS	Drama	PE	Data Entry	VC	ES1	BS	Econo	PHE	Design
<i>CBSE</i>	X		X	X	X	X									
<i>ICSE</i>		X	X	X			X	X							
<i>NIOS</i>									X	X					
<i>SB</i>	X											X			
<i>IGCSE</i>					X		X						X	X	
<i>IB</i>					X										X

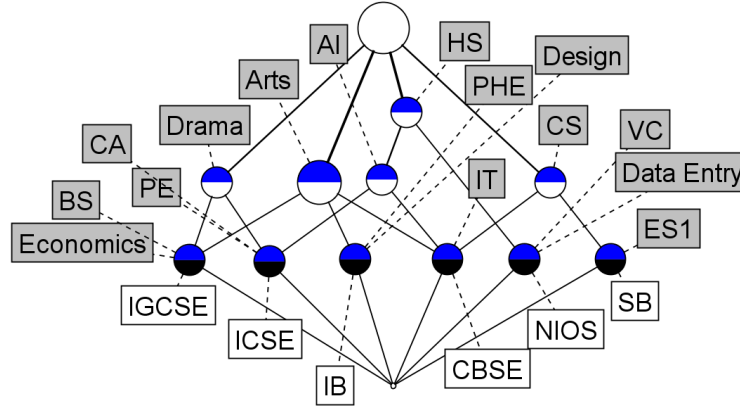


Figure 2.6: Optional subject-based concept lattice from Table 2.7

Figure 2.6 illustrated the optional subject-based classification, contains 13 concepts, and it remained feasible to understand the concepts. The optional subject is the only identified area of interest for a student in his(her) future to carry on and continue higher studies and it remained entirely different from the core papers. So, the students were interested, involved, learned quickly, and collaborated with the different class students, and they automatically improved their sociality and some other knowledge.

2.6 Vocational

Table 2.8: Vocational Subject-based formal context

	IT	AI	Coding	Commercial Studies	ES	HS	BS	SPVC	ICT	Business	TT	DT
<i>CBSE</i>	X	X	X									
<i>ICSE</i>				X	X							
<i>NIOS</i>						X	X					
<i>SB</i>								X				
<i>IGCSE</i>									X	X	X	
<i>IB</i>												X

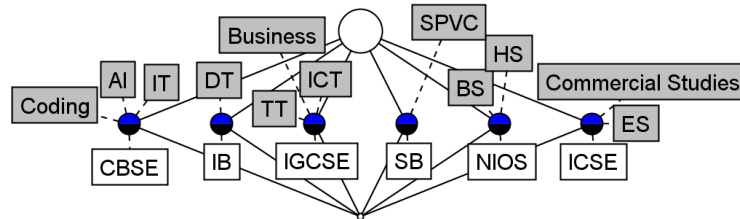


Figure 2.7: Vocational Subject-based concept lattice from Table 2.8

And finally, Figure 2.7 contained 8 concepts on the vocational-based subject. This also clearly showed the concepts and subjects of the different boards. This is also like an optional subject. All the school boards followed different vocational subjects, but the students had the freedom to select the subjects. Automatically, students got the knowledge from different areas and joined some other classes. This made them to enhance their learning and also they gained knowledge other than their academical.

2.7 Assessment

Table 2.9: Assessment-based formal context

	Annual	Internal	Open School	Flexible	Cambridge	Project based
<i>CBSE</i>	X					
<i>ICSE</i>	X	X				
<i>NIOS</i>			X	X		
<i>SB</i>	X					
<i>IGCSE</i>					X	
<i>IB</i>						X

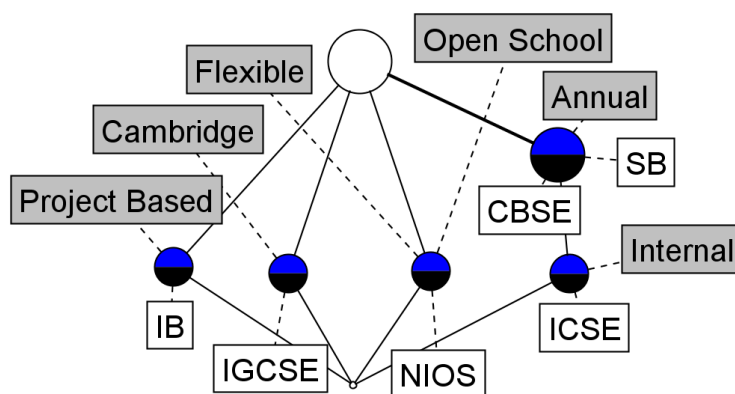


Figure 2.8: Assessment-based concept lattice from Table 2.9

The assessment has been made at this stage, which remained critical because the process ends with the success or output of the one year. Figure 2.8 contained 7 concepts; *ICSE* is the super concept of *CBSE* and *CB*. Cambridge-based assessment also had a year-end exam but written, oral, coursework, and practical. On conducting assesment twice a year, in June and November, results were issued in August and January (Grade A* to G). Mostly, the schools followed the year-end assessments, while a few boards followed in a different manner. Thus, the study suggest that people or student should be aware of the differences among the school board's subjects, assessments, fee structure, etc.

3 Discussion

The overall classification of this particular work revealed the outline of different school boards, 10th standard subjects, and assessments covered. The selection of language mostly remained as the first option, which was either English or the mother tongue and in *SB* it remained as regional language. In India State Board has 10 divisions for the 10th standard students. The list of *SB* in India are Tamil Nadu State Board of School Examination(*TNBSE*), Maharashtra State Board of Secondary and Higher Secondary Education (*MSBSHSE*), Bihar School Examination Board (*BSEB*), Uttar Pradesh Madhyamik Shiksha Parishad (*UPMSP*), Board of Secondary Education, Rajasthan (*RBSE/BSER*), Gujarat Secondary and Higher Secondary Education Board (*GSEB*), Board of Secondary Education, Odisha (*BSE Odisha*), Karnataka Secondary Education Examination Board (*KSEEB*), West Bengal Board of Secondary Education (*WBBSE*), and Board of Secondary Education, Andhra Pradesh (*BSEAP*). Based on the above boards, the following language serves as their mother tongue, which is the first language; the second language remains also optional, but the first option is English or Hindi. As our national language is Hindi, they both stands above all the other regional languages in India for the communication purposes which made English or Hindi for being the compulsory language to learn.

Mathematics, science, and social science were the compulsory subjects for all the school boards in 10th standard, but the higher secondary schools were different in choosing the subjects. Optional and vocational subjects were rooted in extracurricular activities, making it essential for students to choose their higher secondary and college courses wisely, as these serve as the foundation for their future. Continuous engagement in academics occasionally made the students feel tedious, involving in these activities offered them a refreshing break, allowing students to return to their core subjects with ease and clarity, leading to a more stress-free learning experience. Optional and vocational activities were often hands-on, engaging both the mind and body, which benefits the overall health.

The key aspect of all school board *PT* periods was to enhance the students' holistic development. Particularly, *CBSE* school boards have *PT* periods on regular basis. These days, students participate in *PT* and engage in additional activities such as yoga, basic floor exercises, and track and field events. Nowadays, *PT* periods are made compulsory for all the schools and standards, but they lack necessary equipments and sufficient grounds for all the students. Scheduling physical training (*PT*) between 11 AM and 3 PM is not ideal for students' health, however, having *PT* for two to three hours per week is feasible. Ideally, sessions should be scheduled after 3 PM and when the climate is more suitable for outdoor activities and there is no time restriction or schedule for indoor games.

The researcher recommended that the government should look after the schools with no grounds and take necessary action to give the strict order to develop the ground. In the current scenario of stressful environment, students have heavy competition with other students, schools, parents, and teachers. Only these extra curricular activities can make them fit physically, mentally, and emotionally.

Parents and students, before entering the schools or selecting the schools, kindly refer to the full details of the schools, subjects, fees, etc., and then decide. Homes, schools, and the society are the three main factors where a student can learn, grow, and enhance themselves which helps them for their better future and also the countrys development.

FCA makes it feasible to analyse and understand the data clearly. Through the analysis of the review articles based on *FCA* has discussed clustering, attribute reduction, knowledge reduction, concept reduction, etc. Thus, it is evident that only this current study has analysed based on the data model.

4 Conclusion

In the current study, the different school boards in 10th standard and subjects in India were classified by the use of *FCA*. Thus, *FCA* serve as one of the best data analysis tools in scientific research. Which aids people to know more about the school boards and subjects without any further search outdoors. This research leaves a gap to collect and analyse 11th and 12th boards and subjects using *FCA* and different data analysis methods, such as *CART* and neural networks for its future endeavours (scope).

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