The Impact of the Spatial Design on the Learning Process and the Students' Socialisation: A Study on Secondary Schools Within the UK

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The Impact of the Spatial Design on the Learning Process and the Students' Socialisation: A Study on Secondary Schools Within the UK

By

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I, Ahmed Fouad, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Date

Abstract

The last century has witnessed an evolution in the human's understanding of learning from being a spoon-feeding process towards a process based on the ability of the human mind to receive information, construct the knowledge and then understand according to the learner's perceptions (Brown, 2004). However, the human's understanding of the spatial relation between the learning process and the physical environment of its occurrence is somehow lagging in terms of scientific research that can explain their relationship. This research attempts to focus on school learning, while aiming to understand the spatial impact of the building on the students' learning process. In fact, the academic life of the students inside the school premises is hardly studied without considering their social behavioural patterns. Both aspects are somehow tangled especially when learning is perceived as a social process (Sailer, 2015). Consequently, the research is expanded to include the spatial dimension of both the learning and socialisation of the students. Nine secondary schools in the UK are presented as a comparative case study based on quantitative analysis of the school buildings. Syntactic analysis is the key criterion of evaluation, supported by studying the organisation of various spatial components (circulation, social and learning spaces). The research highlights the important role of the spatial design and configurations, yet space is not the only player in the equation. Both the spatial parameters of the building in addition to other non-spatial parameters (school management, quality of teaching and the students' level of deprivation) inter-relate to impact the students' social and academic life inside the school. The research unveils the spatial potential within each school building that contributes to the students' learning and socialisation, hence the spatial configurational analysis should take part of the original school design process to set the foundation for students' social activity and mixing patterns. Nevertheless, space should be designed to accommodate various formats of learning or at least afford the school learning process.

Keywords: Students - Learning - Socialisation - Space - Configurations - Organisation

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1. Introduction

Studying educational systems, processes of learning and quality of teaching inside the school buildings is long researched with many theories and finding. One of the related fields of studies, which needs further exploration according to Kerstin Sailer (2015), is the spatial dimension of learning; as in the relation between learning and the physical environment. The complexity of understanding this relationship is due to the difficulty of evaluating or quantifying the output of the learning process and students' comprehension. Alongside the learning taking place inside the school building, students also formulate social relations and socialisation patterns which cannot be ignored while studying the school building. Aiming for a better understanding of the school physical environment, this dissertation attempts to investigate the impact of the spatial design and configuration on the learning process as well as the students' social life within the school building. In order to figure out the relationship between space, learning and socialisation, this research took the form of a comparative study of nine secondary schools in the UK. Quantitative analyses of the nine plans were performed and compared to each other. Analysis is meant to provide the data that is utilised to evaluate the school buildings and help understand the potential of space to afford the learning process and facilitate the students' socialisation patterns.

2. Literature Review

To understand the role of the school physical environment in the students' academic and social life, this research focuses on two main aspects. The first one is the spatial potential of the school building to induce the students' socialisation and interaction patterns. The second is to find out how the spatial parameters might affect the processes of learning taking place within the school building. This literature review attempts to highlight the sources, studies and theories that tackle these two topics to give a firm theoretical background about students' social behaviours and the processes of learning both in relation to the school building. Although learning and social behaviours appear to be two different topics, going deeper in studies will reveal how tangled and inter-dependent they are especially when perceived spatially.

This literature review is structure as follows:

2.1 What makes the spatial design of schools important to study

The concept of relating the school physical environment (spatial design and configuration) to the students' social life within the school premises has long been marginalised as a research topic. In the UK, parents are more interested in the test-score performance of the schools (Gibbons & Silva, 2010). Other school aspects of interest to the parents include accessibility of the school from home, peer group, friendliness of staff and support for those of lower abilities (Allen, Burgess & McKenna, 2014). In addition to the parents, authorities tend to overlook the spatial design of schools. This is shown in the school reports obtained from the Office for Standards in Education, Children's Services and Skills (OFSTED) where most of the data gathered and evaluations are concerned with the school management, the quality of teaching and the personal development, behaviour and welfare of the students (Ofsted Report, 2015).

2.2 Schools as ordinary building spaces affecting the social behaviour.

According to Bill Hillier (1996), the generic function of every building is not the purpose or the service it is providing to its users, but to generate, accommodate and facilitate movement. This movement will then lead to co-presence patterns that in return triggers socialisation and interaction among the users. So, within a building, the spatial configuration on its own without any social rules is the key factor controlling the everyday social life and encounters. Consequently, the building spaces being integrated or segregated, deeply embedded or shallow will impact the social behaviour of the users. Moreover, the spatial organisation of the building influences the movement patterns. A short model with a weak generative programme triggers uncontrolled movement and encounters which evolve morphogenically. On the contrary, a long model with a strong restrictive programme limits the users' interactions in space. Thus, buildings are according to Bill Hillier's description, "information-rich probabilistic space machines, able to absorb as well as generate social information through their configuration" (Hillier, 1996, P.305). In simple words, space produces and impacts the social behaviours not in a deterministic way, but rather by making certain behaviours more likely to occur than others.

2.3 The relation between learning, socialising and space.

Having the school discussed as ordinary building spaces, one should continue to understand what learning is, how it can be affected by space and how it links to human behaviours. The definition of learning in the dictionary as mentioned by Sailer (2015, P.2) is "an activity or process of gaining knowledge or skill by studying, practicing, being taught or experiencing something". Christopher Day discusses Jean Piaget's ideas on learning as being an interweaving network of relations. He continues by clarifying that "perception, action, interaction with others and reflection develop, modify and consolidate it" (Day, 2007, P.4). George Brown also adds the idea of learning as being a

"modification of behaviour brought about by experience" (Brown, 2004, P.6). Thus, if learning is about knowledge that triggers a change in someone's behaviour, then the social behaviours are no longer a secondary factor in the background of the process, but actually a dominant factor that shapes the outcome of learning. In fact, learning is considered a social process (Sailer, 2015). Moreover, since Bill Hiller (1996) has declared the strong relation between the spatial configuration and its impact on the users' social behaviours (which was discussed in the previous paragraph), then schools as buildings, i.e. their spatial organisation and design relate to the social behaviours of the students which eventually affects the learning process.

2.4 Processes of learning and how learning was conceptualised over time.

After discussing how space could impact the learning process, it appears important to research the processes of learning, their classifications and development over time and observe what has changed in the society's perception of learning. A very important concept about education and learning was proposed by the sociologist Basil Bernstein. He identified the curriculum content of learning as being weakly or strongly classified which is the degree of boundaries between the material being taught and how they inter-relate. As for the method of learning, Bernstein describes it either as being weakly framed with much freedom for the learner or oppositely being strongly framed with a high degree of control by the teacher over what is taught. Within these two components, school education can be sub-categorised according to whether they are course or subject based (Bernstein, 1973). Bernstein acknowledges Durkheim for setting the basis of his concepts through his social theory of organic and mechanical solidarity. For Bernstein, strong framing and classification of learning is identical to Durkheim's "ritual order" which resembles the mechanical solidarity, while weak framing and classification is similar to the flexible division of labour which matches an organic solidarity (Durkheim, 1893).

In addition, the society's understanding of the learning process across time is evolving. Kerstin Sailer (2015) summarises George Brown's description of learning in the nineteenth century as a spoon-feeding process mainly concerned with injecting the learners with knowledge and information. In the twentieth century, this process was denied by Vygotsky (1930) who argued in his paper 'The Socialist Alteration of Man' that the learners' ingestion or comprehension of knowledge provided by the teacher is mainly dependent on their mental development. Furthermore, in his book 'Mind and Society' Vygotsky believes that the environment, physical and social, will impact the learning process. He gives the example of kids' education and states that it is wrong to assume that children's source of knowledge will be provided only inside kindergartens (Vygotsky, 1978). To complement this idea, David Jonassen adopts constructivist conceptions of learning which declares that education cannot be transmitted. However, "knowledge is individually constructed and socially co-constructed by learners based on their interpretations of experiences in the world" (Jonassen, 1999, P.217). With the rise of the learner as the key player in the process of learning, Bernstein (1973) explains that education will evolve from the strongly framed systems into weaker boundaries. Sailer (2015) further explains the learning process as the teacher becomes an enabler whose role is just to set the environment where the learners acquire the knowledge themselves. She describes this development in the learning process as a "shift towards a learner-centred view rather than a teacher-centred view" (Sailer, 2015, P.2). Since learning is dependent on the physical environment and activities as the context of learning, the space and its organisation will play an important role in the learning process.

2.5 Spatial design of schools and its impact on students' socialisation

While the physical environment appears as a key contributor, still the impact of space and its configuration on the learning process and the social behaviour inside a school is under investigation and needs further research (Sailer, 2015). Among the available

research, there are some quantitative studies that used Space Syntax. Firstly, Pasalar (2003) has used syntactic analysis to compare four secondary schools in the United States. Results indicate that higher rates of social interactions among the users take place when the spatial layout provides high accessibility, shorter and intelligible pathways. Moreover, high levels of visibility and permeability within a school layout increase socialisation and friendship among students of different grades. Pasalar continues her research about school designs, which reveals that "Creating smaller schools is assumed to reduce the isolation that often causes the alienation and violence among students, they also increase social interaction and learning abilities of students" (Pasalar, 2007, P.51). A different research with more syntactic measures is performed by Kishimoto and Taguchi on Japanese elementary schools (2014). They found out that students' activity patterns correlate with the spatial Integration of the school spaces. Spaces that are shallower to reach (low step-depth value) have higher movement, distribution and encounters of the students for all the school grades. However, teachers seem not to favour highly integrated overall building spaces because of their limited flexibility.

Furthermore, another research about the spatial design of school buildings is based on observations and comparisons. Studying students in grade six and seven in an American school, Indira Dutt (2012) investigated the significance of visual connectivity within the school building and the indoor/outdoor relation using site observations, questionnaire and exercises to the students. The findings revealed that "students felt a sense of freedom, moments of joy, social cohesiveness, and aesthetic pleasure in relation to indoor/outdoor interfaces and the natural places of their school site" (Dutt, 2012, P.216). An older yet interesting quantitative studies is Hinchliffe's (1973) research on movement problems in a comprehensive school with a large number of students. He produces a model based on the coordinates of different entrances to school spaces, together with the journeys taken by the users (students and staff) to find out the time and distances of journeys, as well as places of congestion. The findings show that altering the school timetable to correspond to the building movement capacities and

the optimum routes would slightly decrease the congestion and save time. Hinchliffe proposed that school buildings could be designed from the very beginning in correspondence to the proposed schedule of the school. Regardless of the results of this particular school as a case study, a by-product of this research is that it unleashes the potential of designing a spatial configuration (or even adapting an existing building) to produce a desired level of social interaction and users' encounters. In other words, for a student, the probability of meeting another student either from the same or different grade or meeting a staff member in a certain place within a certain environment is not a coincidence, but is actually being considered in the initial plan. Since space has proven itself to matter in the students' social life at schools, it should be configured in a way that matches the school organisation and mission of nourishing the students' social life.

2.6 Can space afford learning processes?

In addition to contributing to students' social interaction, it can be argued that spaces also impact processes of learning. In a study of synchronising a spatial design configuration with the school learning process for the benefit of the learner, Tse et al. (2015) work on a long-term project where 'the strategic educational vision' adopted by a particular school is to be embedded in its final spatial design. The important question is: how can the school spaces afford the learning processes and how can this be evaluated? Firstly, it is crucial to understand the meaning of affordance and how it applies to architectural spaces. According to James Gibson (1979), affordance is defined as all the possible actions that might occur on an object or an environment, so in return, this object (or environment) affords this action. For example, a chair affords sitting. Within an architecture context (specifically the school building spaces), affordance of the learning process is simply the level by which space is flexible to accommodate the format of learning taking place and not to obstruct or defer the students' ingestion of knowledge. To investigate this relation between space and learning, Barrett et al.

(2013) performed a research on 153 classrooms in 27 different British schools with a total of 3766 students to investigate the impact of classroom design on pupils' learning. In summary, the study monitors the performance of the students in different classroom designs. It clearly declares the strong correlation between the built environment and learning potential. It concludes that "key design parameters explain 16% of the variation in pupils' academic progress achieved. These are Light, Temperature, Air Quality, Ownership, Flexibility, Complexity and Colour" (Barrett et al., 2013, P.118). Although this research is not directly linked to the concept of affordance, two of the variables listed above (flexibility and complexity) are design-related and can be further linked to the spatial configuration of the learning spaces which in return affects whether space can or cannot afford the learning process. In summary, the spatial configuration of a whole school building is linked to the design and configurations of the individual elements (learning spaces) which itself determines the degree of affordance of the learning process. This is following Hillier's theory of space as never existing on its own, but it is always part of a 'strongly relation system' where the whole impacts the element and vice-versa (Hillier, 1996).

2.7 Spatial design of schools and its impact on the learning process

The concept of space affording and influencing the learning process at various degrees brings in the picture the idea of adapting space to fit different learning formats. To put this simple, space cannot be treated as a rigid entity hosting the learning process, but it should respond to afford different learning formats. Sailer has explained this concept in her analysis of the fictional Hogwarts School of Witchcraft and Wizardry where "teaching styles vary and the spatial design of the school supports this well with different classroom layouts…by far the highest proportion of peer learning took place in the common rooms, dormitories and courtyards." (Sailer, 2015, P.8). Following the same line of thought, peer learning, which is one format involving less boundaries and authority from the teacher, seems to fit in highly integrated functional areas. On the

contrary, ‘traditional instructional model’ of teaching take place inside classrooms, which are deeper than most of the other school spaces, except the teachers’ studies and the library. She describes the classrooms as “strictly closed towards the corridor with no visibility relationships, thus assigning the teacher exclusive control over the class” (Sailer, 2015, P.13). Besides the normal classroom, Sailer clarifies that learning should be perceived from a wider perspective as a social process occurring not only inside the classroom but most importantly in public spaces, corridors, atria, and outdoor spaces.

In the end, this literature review has managed to portray a summary of the relationship between learning, socialising and space. As much as space, its design and configuration play an important role in the students’ learning and socialising patterns inside the school building, it still needs a lot of further studies to understand how these parameters relate to each other. And that is what this research would attempt to investigate.

3. Methodology

3.1 Case Study Introduction

This research takes the form of a comparative study of 9 secondary schools in the UK. All the schools are designed by Feilden Clegg Bradley Studios. The following table shows a brief about each of the nine schools:

	A	B	C	D	E	F	G	H	I
Simplified outline									
Number of Floors Excluding Mechanical/Electrical floors/rooftops	2	3	2	3	4	3	1	4	4
Total Area (sq.m)	10889	15214	8085	17094	15039	10063	5712	14077	15310
Location	Easton area, Bristol	Harold Hill, Greater London	Hastings, East Sussex	Marton, Blackpool, Lancashire	Ilford, London	City of West-minster, Greater London	Mansfield, Nottinghamshire	Liverpool Road, London	Greenford, Ealing
Total Number of Students	833	796	812	1097	630	1192	916	1163	375

Table 1: Information of the Nine Schools

3.2 The Research Questions

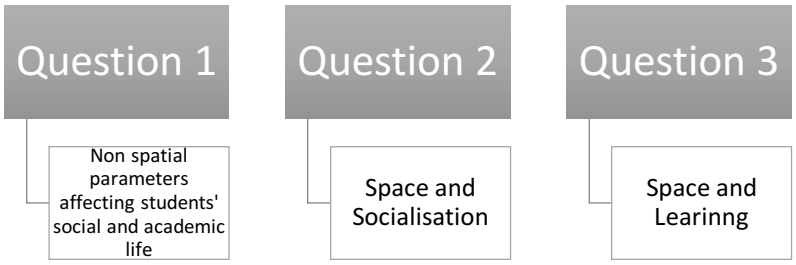


Figure 1: Content of the Research Questions

The research questions (*figure 1*) will define the scope of research, formulate the procedure of the analysis and define how the data will be presented and compared. Before studying space, the first inquiry explores the non-spatial parameters that impact the students' social and academic life inside the school premises. The question is what

are these parameters, how can we measure and compare them? The second question is related to space and socialisation. It is: what potential does the spatial organisation of the whole building (especially the social and gathering spaces inside the school) hold that enables the building to facilitate or prohibit students' socialisation patterns? If movement and encounters are the generic function of every building (Hillier 1996), then what are the design elements that make one school building differ from another in terms of the potential to generate movement? What does the configurational analysis of the nine schools uncover about these buildings elements? The third question is concerned with the learning process inside the school. It is: can the spatial organisation of the learning spaces in the school building afford the learning process taking place? In other words, how can the spatial organisation contribute to the process of learning?

3.3 Evaluating the Learning Process and the Building Potential for Socialisation

As much as it is difficult to evaluate the students' learning and ingestion of knowledge, it is important to have comparable data that can give an idea about the learning process taking place in each of the nine schools. One method of evaluation (which is adopted in this research) is through studying and comparing the students' attainment grades over recent years. Still, it is important to admit that these data cannot draw the full image of the education taking place inside the school. As for the students' social life, it is a complicated issue to evaluate without site observations (which existed in the original study plan but were not conducted due to ethical constraints). However, studying the school building through quantitative syntactic and non-syntactic measures can help in understanding the potential of space to generate socialisation patterns. What is actually taking place might differ, yet the spatial element always has an impact which is worth studying. To this point, there are three parameters in the equation:

space, the learning process and students' socialisation within the school building (*Figure 2*).

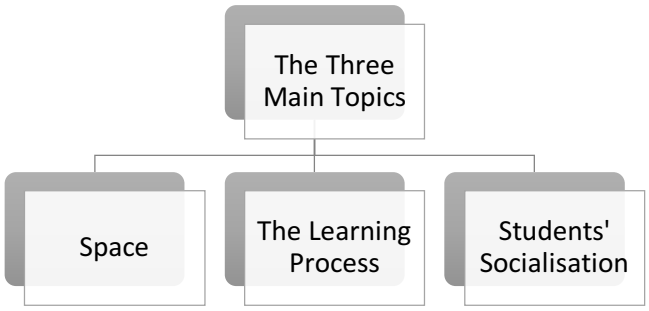


Figure 2: The Intended Scope of Research

Moreover, there are other factors (other than space; its design and organisation) that are known to impact the learning process and the students' social life inside the school building. These non-spatial factors include the students' social background and level of deprivation, the quality of teaching offered by the school to the students and finally the school management (*figure 3*). In order to create the whole image of the school life, these factors are included in the study and thus adding to it a new dimension, turning the research from a mere spatial investigation to an overall study of secondary schools with more focus on space, its design and configuration.

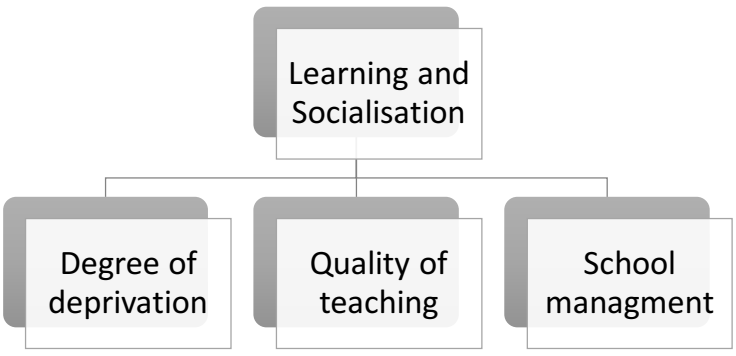


Figure 3: The Non-Spatial Parameters

3.4 Social, Educational, Organisational and Spatial Metrics

3.4.1 The Non-Spatial Parameters: How to Define and Measure

Information concerning the three non-spatial parameters is obtained from the governmental census data sets as well as the governmental online Ofsted reports that provide evaluations of the schools in the UK. Firstly, the students' social background and deprivation level is measured using the census data about the percentage of pupils eligible for free school meals (FSM) and the percentage of students with English not as a first language. The higher these two values are, the more the deprived percentage of students in each school. Combining both percentages into a scoring system out of four (to match the scales of other data sets) yields a value for the level of deprivation of the students within each school (see appendix for calculations).

The quality of education being offered to the students is defined according to three criteria. Firstly, the score given within the governmental Ofsted report of each school (out of four: 1=outstanding 2= good 3=needs improvement 4= inadequate). Secondly, the pupil-teacher ratio for every school, which is a value provided within the census data. It is argued that the lower the ratio, the better the quality of education provided by each school. The UK government has actually set a maximum ratio for secondary education classes of GCSE which is 18. Thirdly, the ratio of teaching assistants to teachers. Lowering this ratio reflects a higher quality of education since there are more experienced teachers in relation to the teaching assistants. Combining the three values yields a score for the quality of teaching. Finally, school management is being evaluated through the grade obtained from the Ofsted report. Figure 4 shows a summary about the parameters and the criteria of evaluation for each.

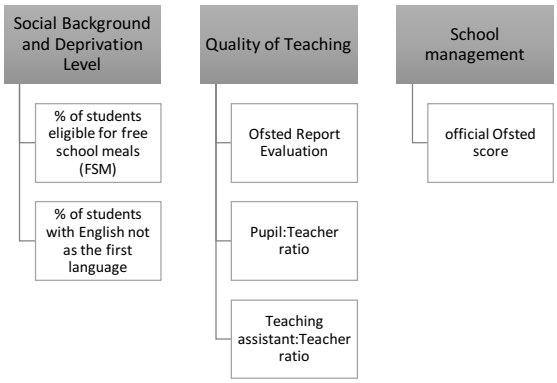


Figure 4: The Non-spatial Parameters Breakdown

3.4.2 The Spatial Parameters: Components and Configurations

The spatial parameters within a school building (and almost every other building) cannot be evaluated separately. According to Hillier (1996), the spatial properties are mainly defined through the configuration of the elements. This sort of configurational analysis will be the primary reference for comparisons and conclusions for the nine school buildings. The study also includes comparative quantitative data of the spatial components of the school buildings, because they explain the differences between one design and another in terms of spatial organisation, which indicates the possible points of strengths or weaknesses in the design of each school. The most important spatial components being studied are the entrance location, school circulation, the socialising spaces and the learning spaces.

In order to evaluate the school building configuration, Visual Mean Depth (abbreviated as VMD through out this research) will be the main syntactic measure. It is convenient to utilise as it measures the mean global number of visual turns to reach one specific point from every other point, and thus its values are comparable between different schools. An additional complementary measure used is the Visual Step Depth (VSD) from the entrance, which shows how deep or shallow certain areas of the plan are from the entrance. The syntactic measures are exported into Geographical Information System software (QGIS) where various queries can be applied to the data sets as well as relating the results to the spatial composition of the nine school buildings (which

space/room has what values for the VMD and VSD). GIS software is also used in applying mathematical function and operator to the data set to get comparable properties of the analysis (Average, Minimum, Maximum, Standard deviation, Frequencies of certain values, upper and lower percentiles).

3.5 Combining, Comparing and Correlating the results

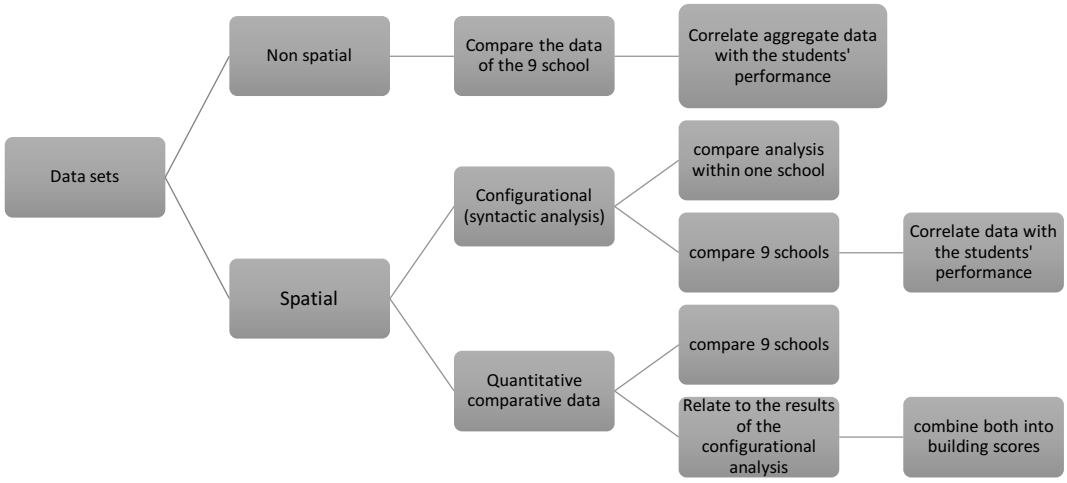


Figure 5: Data sets Division and relations

The previous two sections have discussed two sets of data within this research. The first one is the non-spatial data (being defined by parameters that affect the students school life) and the second set is the spatial data including the configurational analysis (from syntactic analysis) and the quantitative spatial components (as in the school building components). Within the first set, all the data of the nine schools are being compared against each other. After that, all the parameters are aggregated to be correlated against the performance of the students. As for the second set of data, the VMD of the nine schools is compared against each other. Discussing each building on its own will highlight the unique features within every school. The syntactic and comparative quantitative data is then combined within a scoring system. The resulting score will be correlated with the students' performance. Finally, correlations from both sets (spatial and non spatial) are being discussed and explained to be presented in the findings summary (*figure 5*).

4 Quantitative Analysis of the Nine Schools

4.1 The Non-Spatial Parameters

4.1.1 The Parameters and their Evaluation

This chapter will introduce the non spatial parameters, which affect the learning process and the socialisation patterns of the students inside the school building. All the parameters are measured in percentages but converted into a scale out of 4 to match the Ofsted data scale (see the appendix sheets for full details of the calculations and formulas). The first parameter is the level of deprivation among the students. Figure 6 and 7 show the percentages of students eligible for free school meals (FSM) and the percentage of students with English not as a first language. Both values are combined in the scoring system (*Figure 8*). School F has the highest level of deprivation among students followed by school A. School D is the least deprived followed by C. Schools H, B, I and G are considered within the middle range.

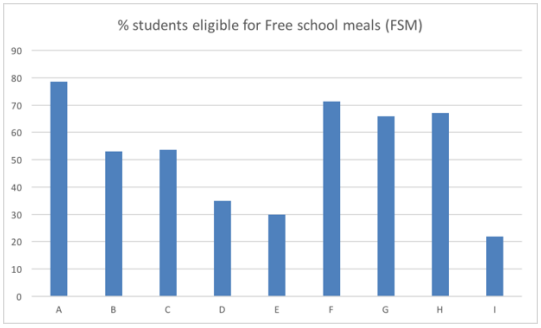


Figure 6: Percentage of Students Eligible for FSM

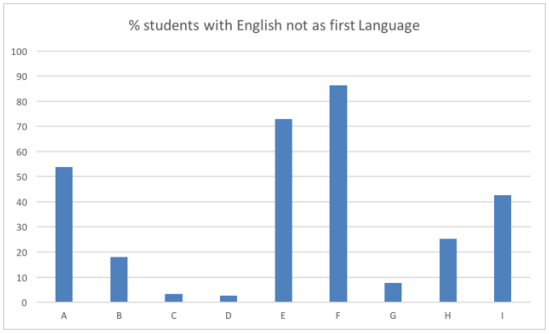


Figure 7: Percentage of Students with English not their First Language

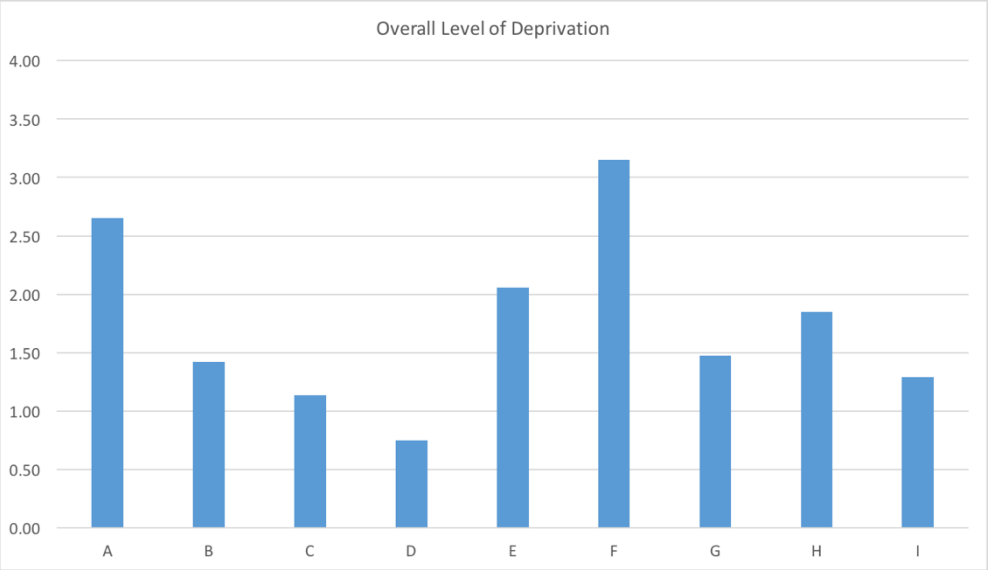


Figure 8: The Overall level of Students' Deprivation in each school

The second parameter is the quality of teaching. Figure 9 shows the evaluation from the Ofsted report concerning the quality of teaching. Further data about pupil: teacher ratio and teaching assistants: teachers ratio are shown in Figure 10 and Figure 11. The final score after compiling all the data for each school is shown in Figure 12.

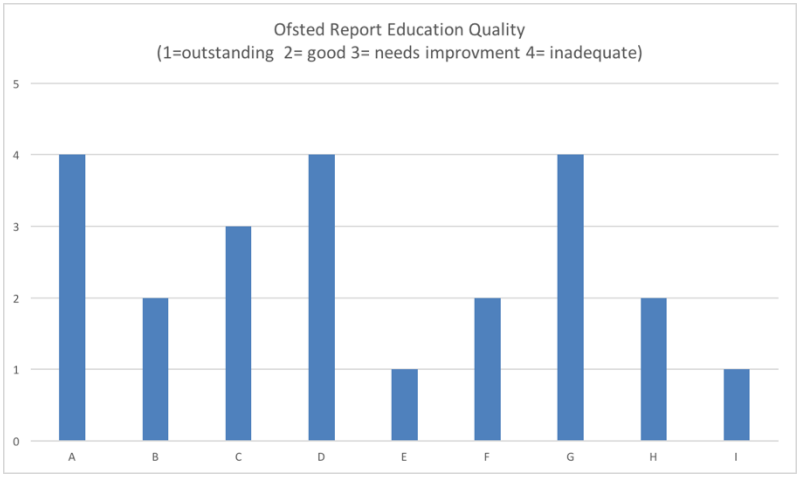


Figure 9: Ofsted Report Quality of Teaching Score

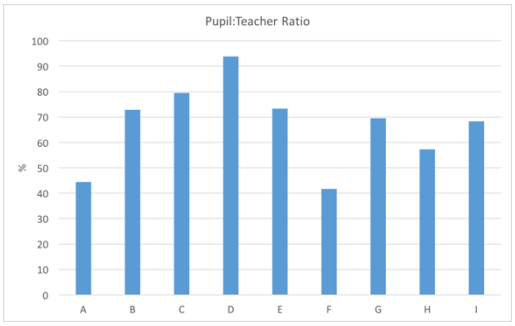


Figure 10: Pupil: Teacher Ratio(the lower the better)

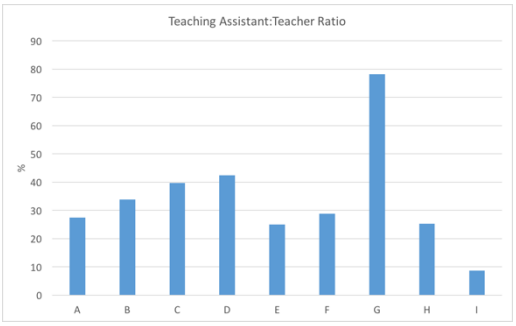


Figure 11: Teaching Assistant: Teacher Ratio (the lower the better)

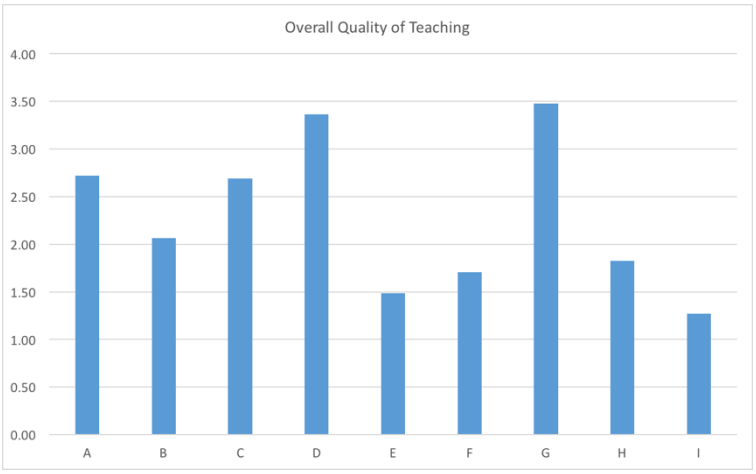


Figure 12: The Overall Quality of Teaching in Each School (the lower the better)

The third parameter is the school management which is evaluated through the Ofsted report data shown in Figure 13.

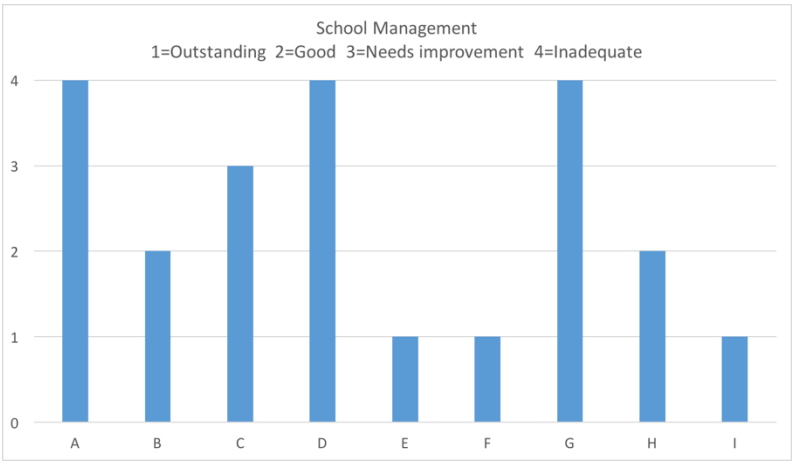


Figure 13: School management Score

4.1.2 The Parameters' Combinations and Correlations Against Students' Performance

Plotting the aggregate of the education quality and the level of deprivation gives an idea about the students' circumstances, taking into consideration both internal and external factors of the school. Figure 14 and 15 illustrate both parameters combined in a bar chart and diamond graph. The bigger the Polygon of the diamond, the worse the situation is.

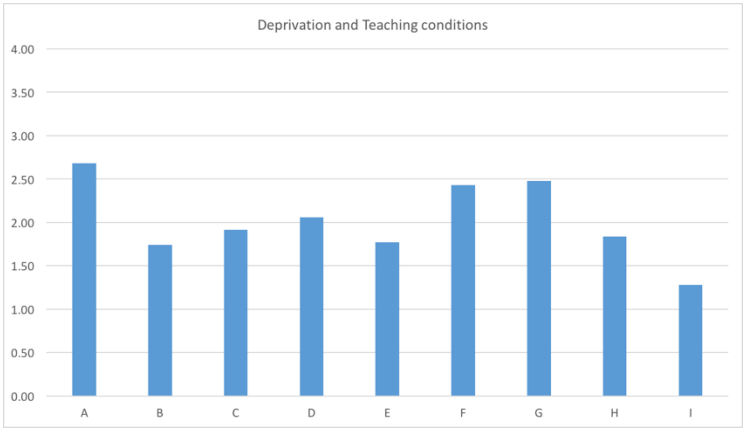


Figure 14: Combined Score of Deprivation and Teaching Quality

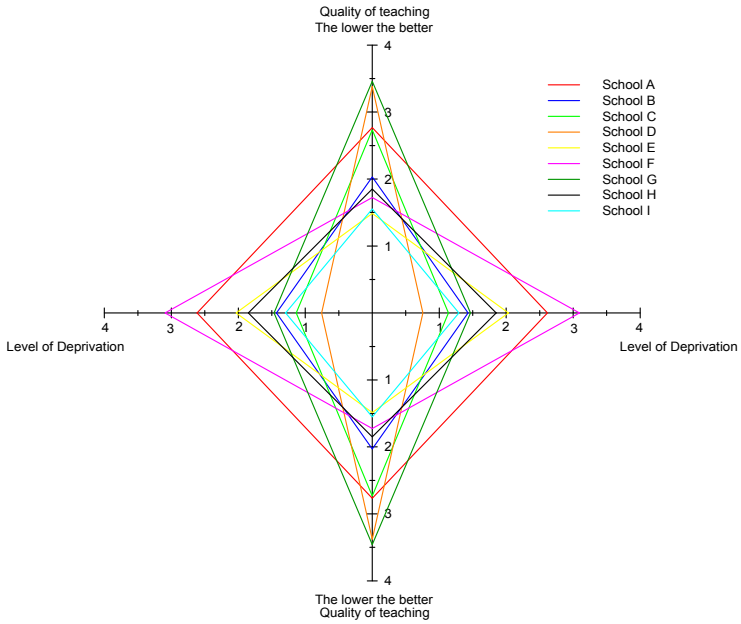


Figure 15:Deprivation vs Quality of Teaching Diamond Graph

Adding the school management as a third parameter (*Figure 16 and 17*) yields a combination of the non spatial parameters that affects the main aspects of this research; students' learning and socialising.

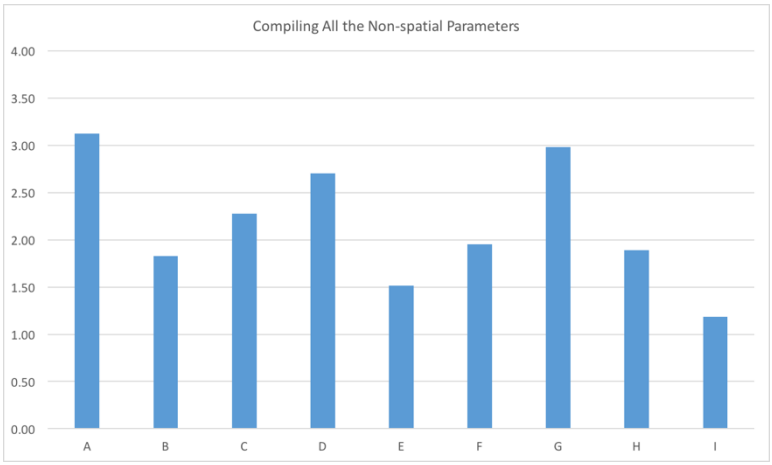


Figure 16: The Three Non-Spatial Parameters Combined

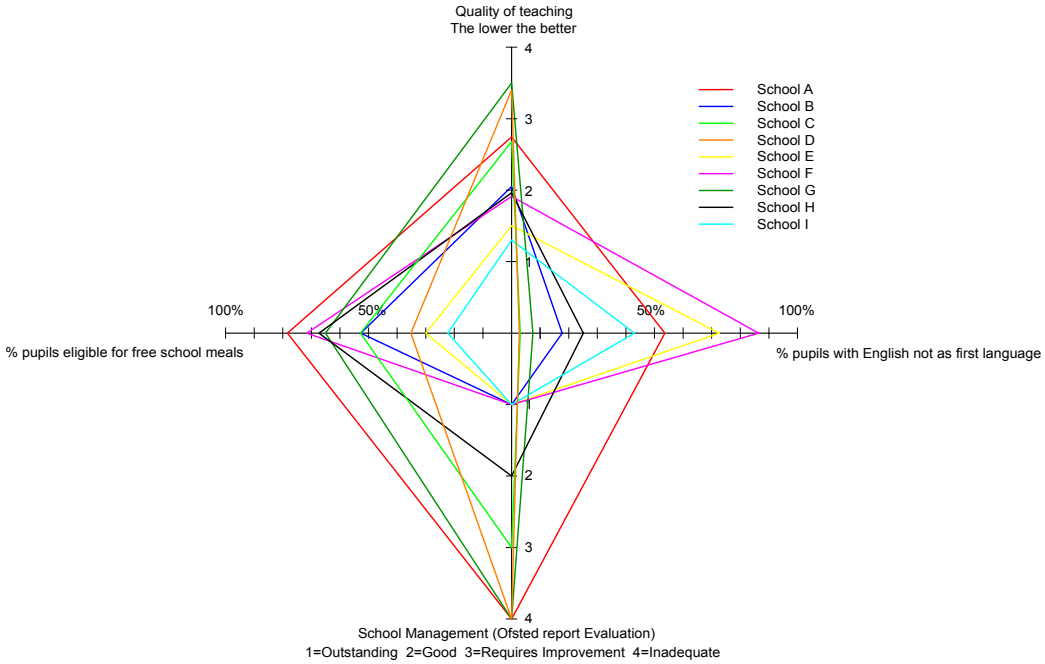


Figure 17: Overall Non-Spatial School Performance

All the non spatial parameters (being presented in a single scoring system) can be plotted against the students' performance. The overall level of performance by the students (*figure 20*) is obtained from the average attainment grades in the last four

years (2012-2015) (*figure 18*) and the evaluation obtained from the Ofsted report (*figure 19*).

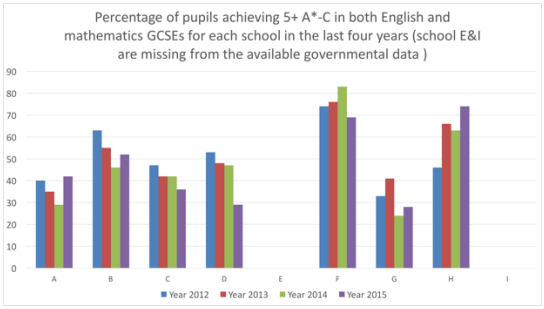


Figure 18: Students' GCSE Scores 2012-2015

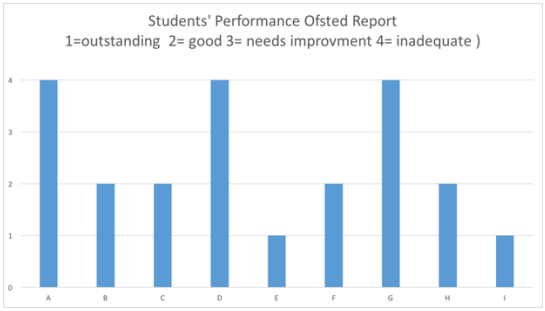


Figure 19: Ofsted Evaluation: Students' Performance

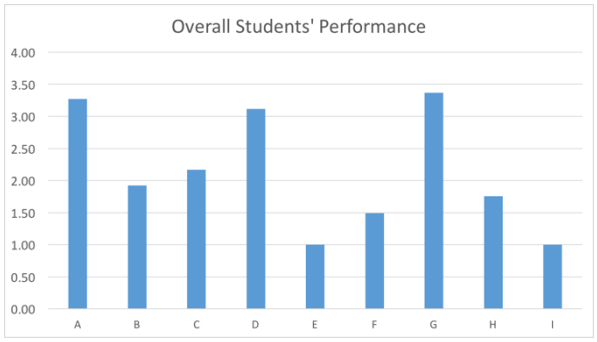


Figure 20: Overall Students' Performance

The resulting chart (*figure 21*) shows the relationship between the non-spatial parameters and the students' performance. Calculating the P-value and the R2 for the data (*table 2*) shows a significant correlation (P-value<0.05) which is very strong (R2=0.94). This proves how these parameters impact the learning process. In spite of this correlation, the spatial dimension of the analysis remains crucial because the students' lives inside the school building cannot be diluted into attainment grades only. The spatial structure helps in understanding the full image of the students' learning and socialisation.

Corr Non-spatial and students' perfromance	R Square	P value
	0.9423	1.3747E-05

Table 2: P-value and R2 for the Correlation (Performance Against Non-spatial Parameters)

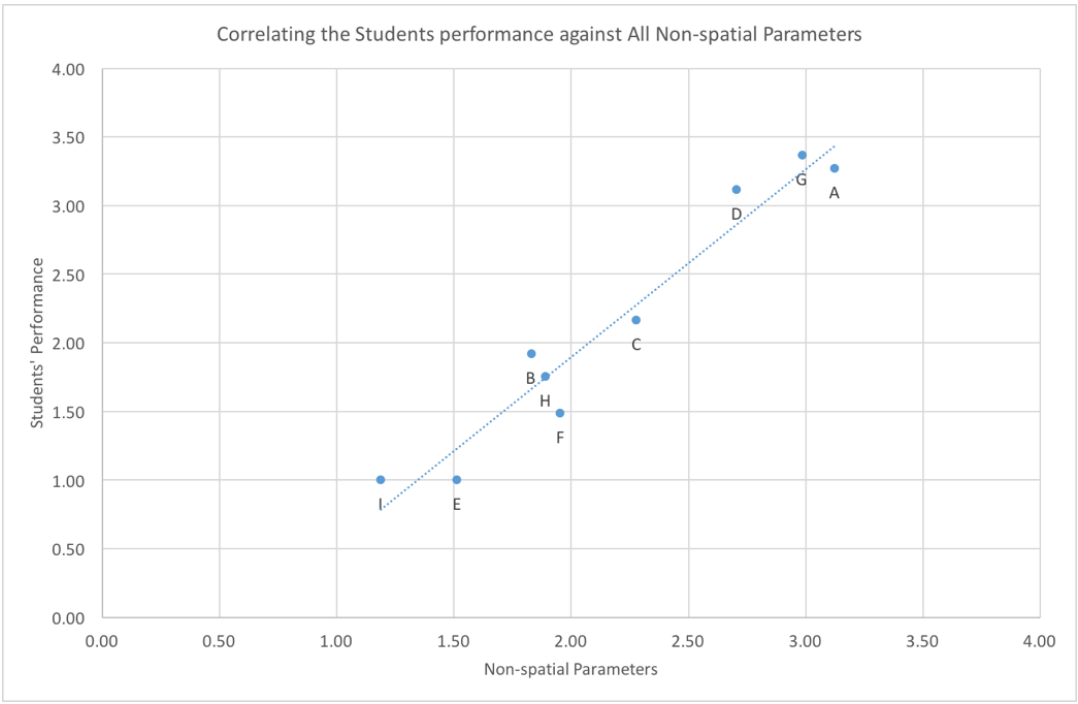


Figure 21: Correlating the Non-Spatial Parameters and the Students Performance

4.1.3 Summary of the Observations and the Performance of Every School.

According to results shown before, school F has the highest level of students' deprivation. School A comes second and school D has the least. In terms of the education quality, school A is the lowest quality while School I is the best. School E, F and I have the best management, while A, D and G have the lowest score of management. Combining some of the above data yields more conclusions. School A followed by G are worst in the aggregate of the three parameters, while school I is the best. School G has the least students' achievements while school I and E have the highest. Table 3 and 4 show a summary of these findings.

	level of Deprivation	Quality of Teaching	School Management	All Non Spatial Parameters	students performance
A	2.65	2.72	4	**3.34**	**3.27**
B	1.42	2.07	2	**1.87**	**1.92**
C	1.14	2.69	3	**2.46**	**2.17**
D	0.75	3.36	4	**3.03**	**3.12**
E	2.06	1.48	1	**1.38**	**0.96**
F	3.15	1.71	1	**1.71**	**1.49**
G	1.48	3.48	4	**3.24**	**3.37**
H	1.85	1.82	2	**1.92**	**1.76**
I	1.29	1.27	1	**1.14**	**0.92**
Best	D	E & I	E, F, I	I	I
Worst	F	G	A, D, G	A	G

Table 3: Summary of the Non-spatial Parameters (the Lower the Better)

Ranking (1=most appealing)	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
Level of Students' Deprivation									
	D	C	I	B	G	H	E	A	F
Quality of Education									
	I	E	B	H	F	C	D	G	A
School Management									
	I	E	F	H	B	C	A	D	G
Overall Non-spatial Parameters									
	I	E	F	B	H	C	D	G	A
Students' Performance									
	I	E	F	H	B	C	D	A	G

Table 4: Ranking the Non-spatial Parameters

4.2 The Spatial Analysis

4.2.1 Building Spatial Configurational Study of Each School: Syntactic Analysis

4.2.1.1 The Procedure of Analysis: Setting up the Measures and the Applied Thresholds

For the nine schools, the same procedure of analysis is being used. The first step is obtaining the results for the Visual Mean Depth (VMD) of the school floor plans (*figure 22*). Then, the data is processed in QGIS to add thresholds (filters) to the VMD to find out which areas are less than 3 turns and which are more than 4 turns (closest value to the average) (*figures 23 and 24*). The second syntactic measure is the Visual Step Depth from the entrance (VSD) plus its threshold of spaces less than three turns from the entrance (*figure 25 and 26*). QGIS is also used to calculate the average, standard deviation, minimum and maximum values in addition to the lower and upper 2.2% percentile of the results which will provide further understanding (*figures 27, 28, 29, 30 and 31 respectively*).

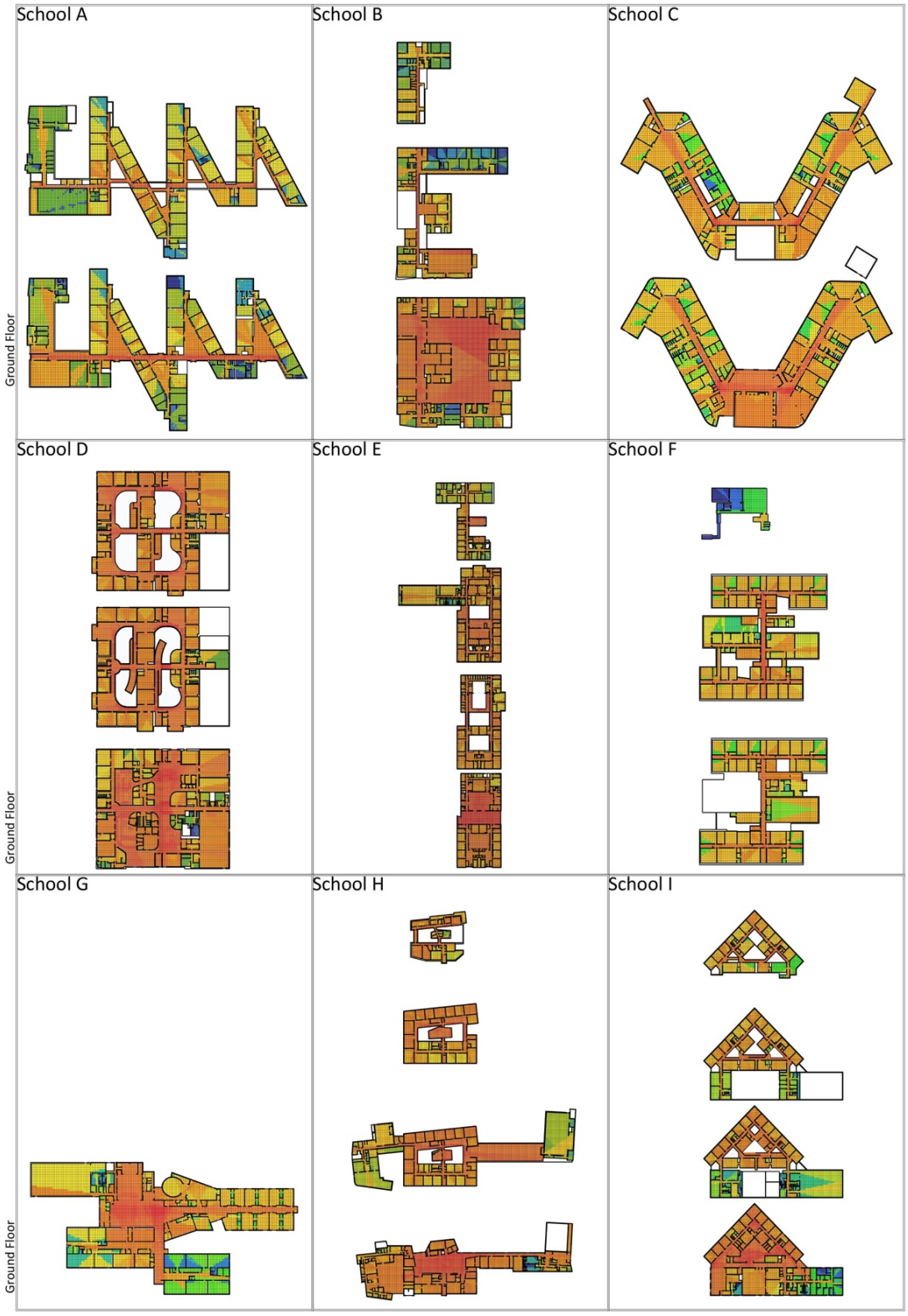


Figure 22: Visual Mean Depth of the Nine Schools

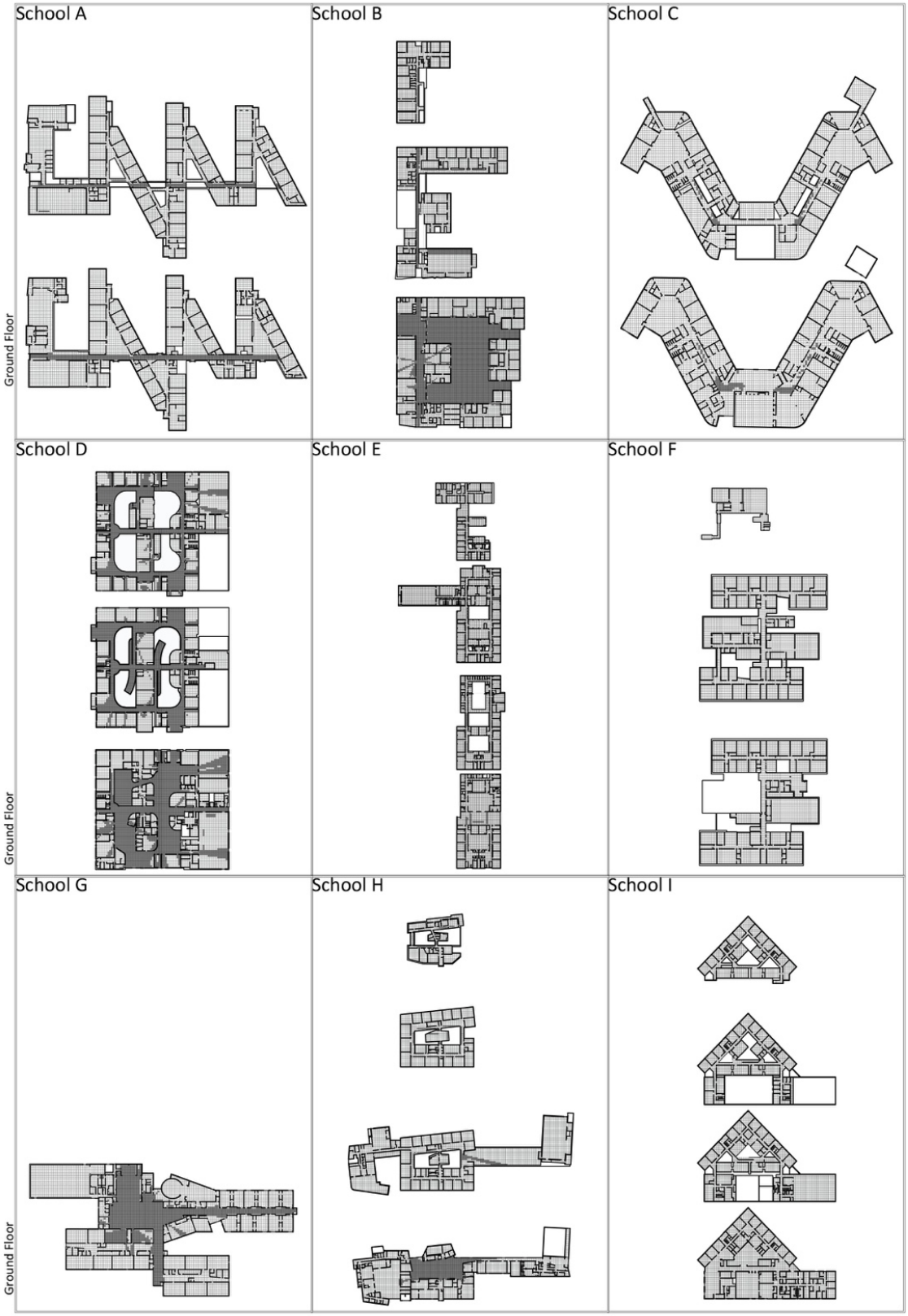


Figure 23: Visual Mean Depth 3 Turns or Less

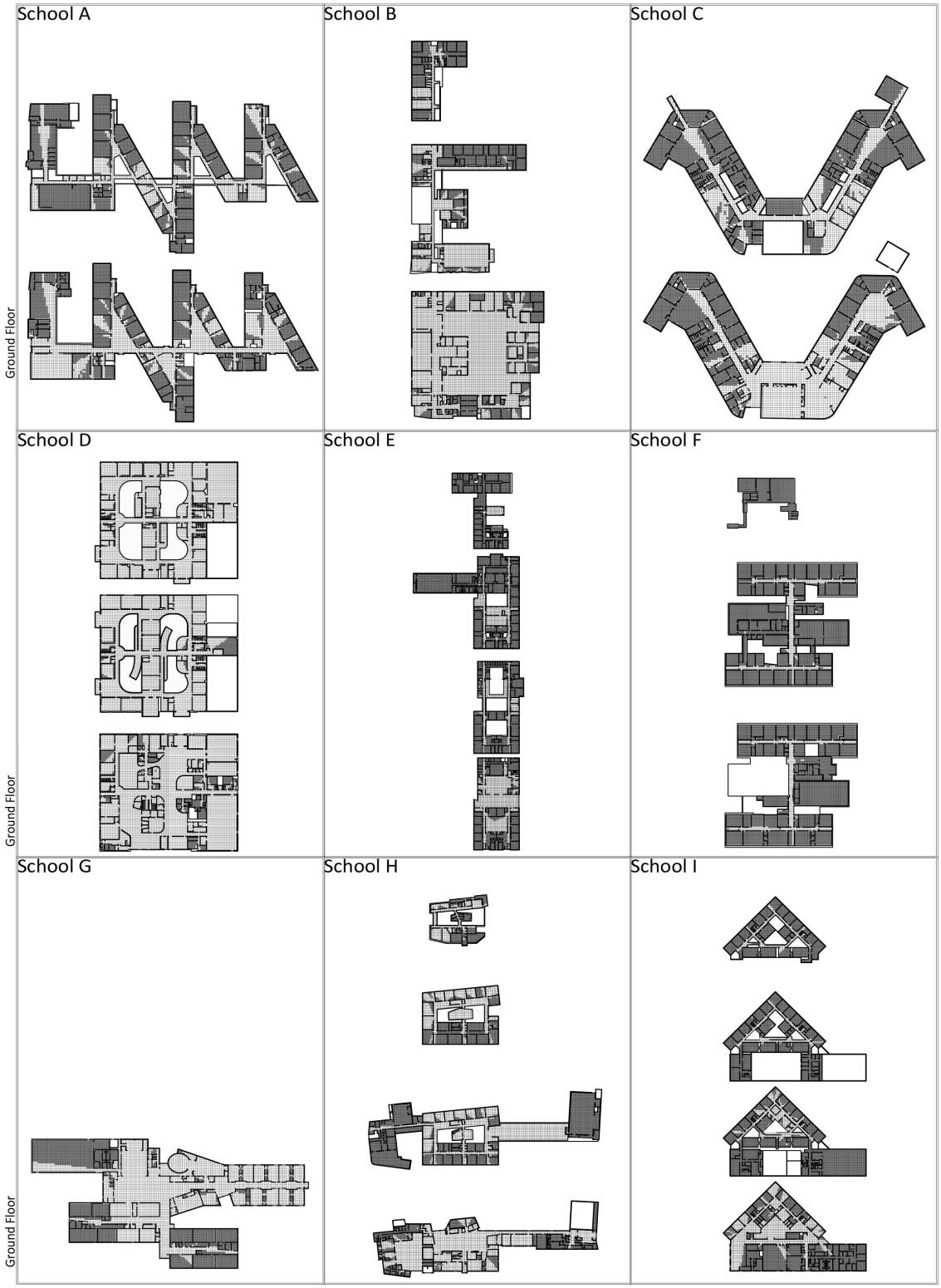


Figure 24 Visual Mean Depth 4 Turns and Above

Figure 25: Visual Step Depth from the Entrance of the Nine Schools

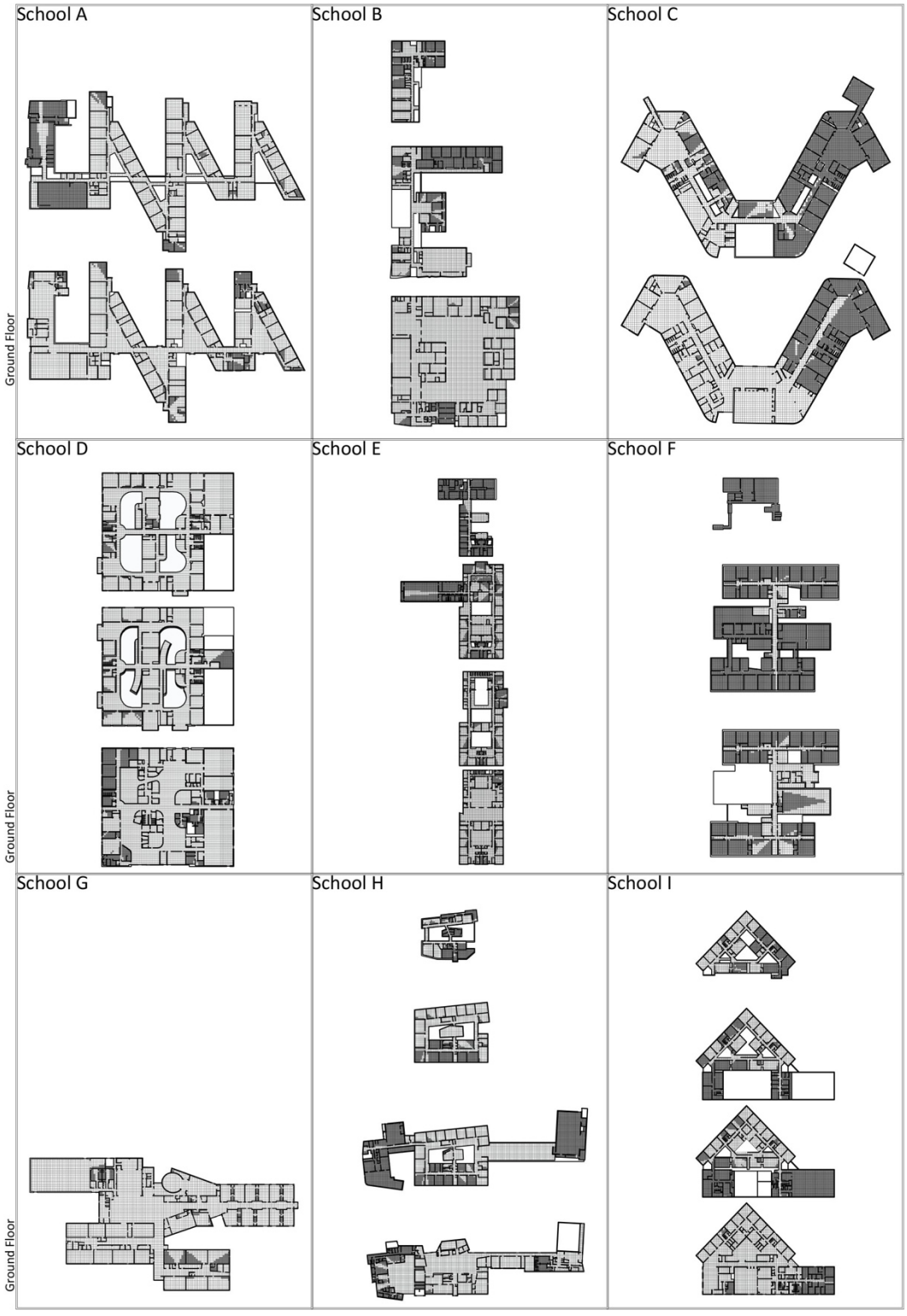
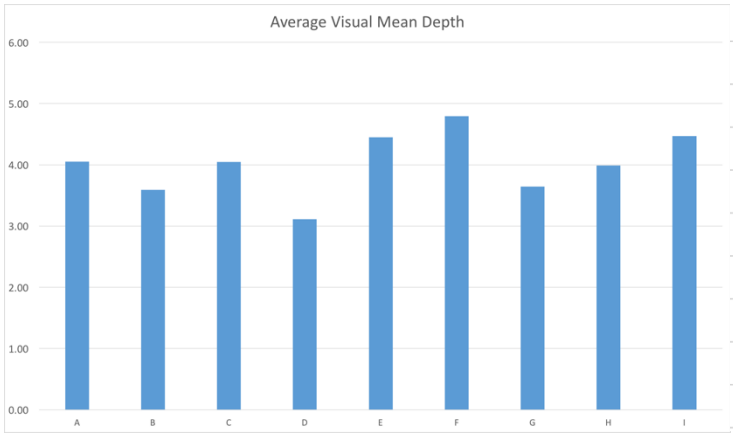


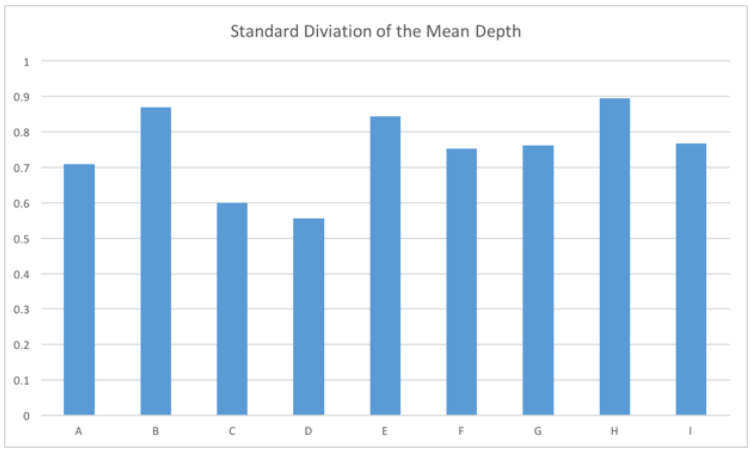
Figure 26: Visual Step Depth > 3 Turns From the Entrance



Ranking	
D	3.11
B	3.59
G	3.64
H	3.99
C	4.04
A	4.05
E	4.45
I	4.47
F	4.79

Ranking	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
Average Visual Mean Depth of the Whole School Building									
	D	B	G	H	C	A	E	I	F

Figure 27: Average Visual Mean Depth and Schools' Ranking



Ranking	
D	0.56
C	0.60
A	0.71
F	0.75
G	0.76
I	0.77
E	0.84
B	0.87
H	0.90

Ranking	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
Standard Deviation of the Visual Mean Depth of the Whole School Building									
	D	C	A	F	G	I	E	B	H

Figure 28: Standard Deviation of the Mean Depth and Schools' Ranking

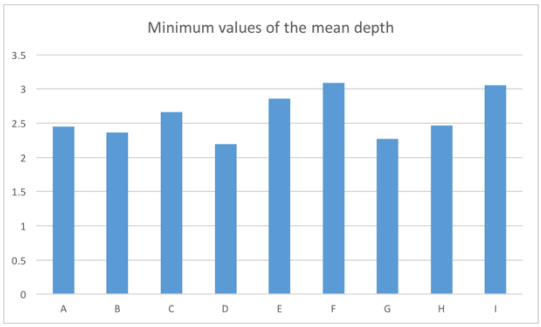


Figure 29: Minimum Vales of the Mean Depth

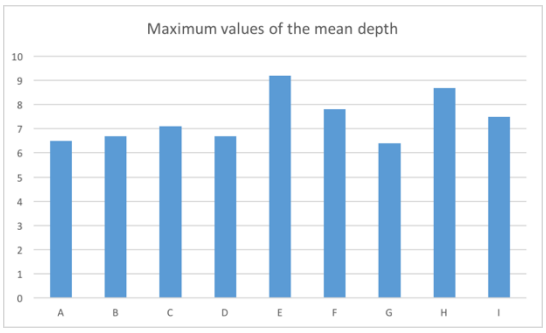


Figure 30: Maximum Vales of the Mean Depth

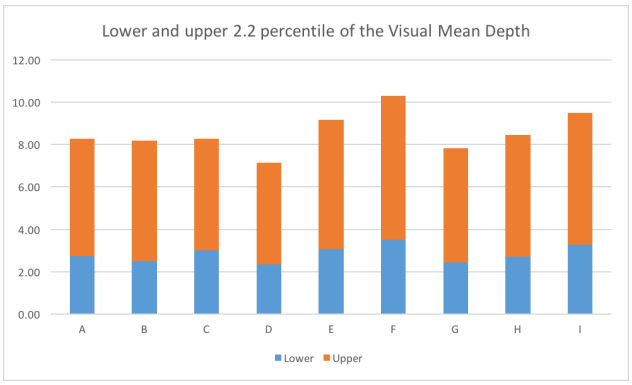


Figure 31: Lower and Upper 2.2 Percentile of the Mean Depth

4.2.1.2 Spatial Configuration Observations and Summary of the Nine Schools

From the previous analysis, School D also has the lowest average VMD, lowest standard deviation, lowest minimum value and finally lowest value for the 2.2% lower percentile (3 standard deviation steps from the mean). School F is the exact opposite (ranked 9th) in the previous aspects except for the standard deviation where the highest value belongs to school H. School C has average values compared to every other school. School H is also in the middle, but it has the highest value of standard deviation which affected its over all position in the comparison. Further comparison of the results is provided using the coloured histograms for the frequency (count) of 12 ranges of values (*figure 32*). This visualisation gives an idea about the distribution of values across the range and the distribution of areas within each range of depth. This is because the grid of analysis of the VGA was assigned to 1000 mm. Therefore, each one-grid unit (one count) is actually one square metre. The more the values are shifted to the left (red zone) the higher the performance of the building in terms of visibility (low VMD), i.e. more integration and higher chances of students to meet, mix and initiate socialising patterns. School D is ranked first in terms of having the biggest portions of values at the left end of the spectrum. Again, school F ranks last, as it lacks count for the values at the left (red) end of the spectrum.

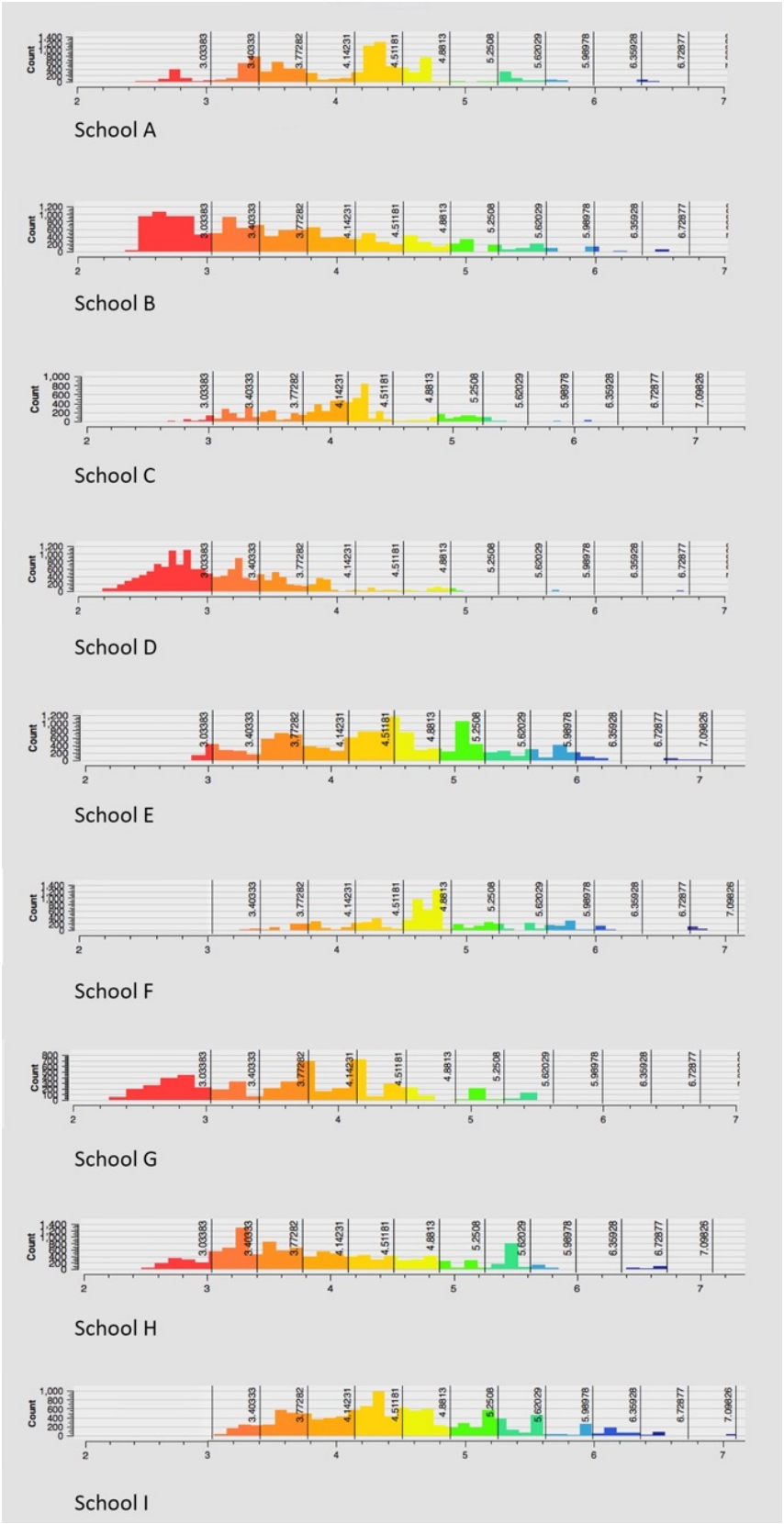


Figure 32: Histogram of the Distribution of Visual Mean Depth Values

4.2.1.3 Conclusions for Every School Derived from the Analysis

School A

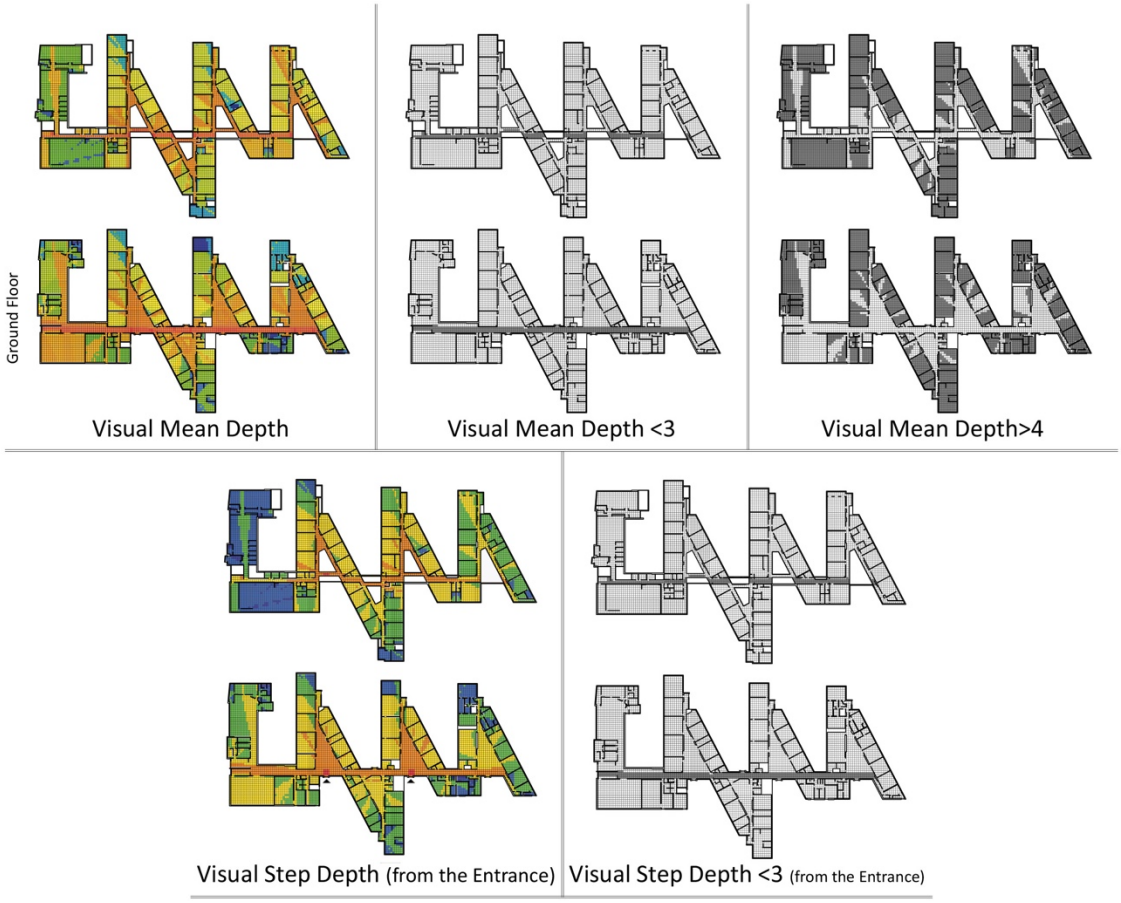


Figure 33: Syntactic Analysis (School A)

The analysis (*figure 33*) shows that the three main social and gathering areas located in the courtyards have an average of 3.4 for the VMD. Most of the learning spaces (98%) lie in the areas with a VMD more than four. The primary horizontal circulation axis is the most visible route in the school followed by the vertical secondary branches. The importance of the courtyard is portrayed in results of the upper first floor VMD (*figure 34*) compared against the values of the VMD of the same building without the visual connectivity achieved through the two atria (*figure 35*). The two figures are compared using the same colour range which show the drastic difference. The design of the atria allowed for visibility that decreased the average VMD of the whole floor from 6.7 to 4.1.

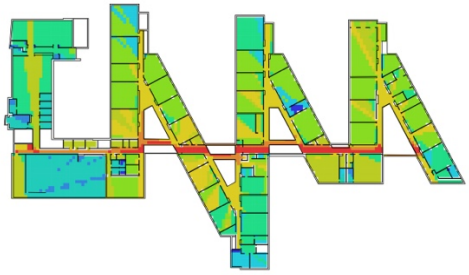


Figure 34: Upper floor Actual VMD

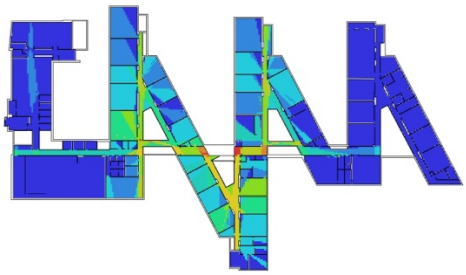


Figure 35: Upper floor VMD Without Courtyard Visual Connection

School B

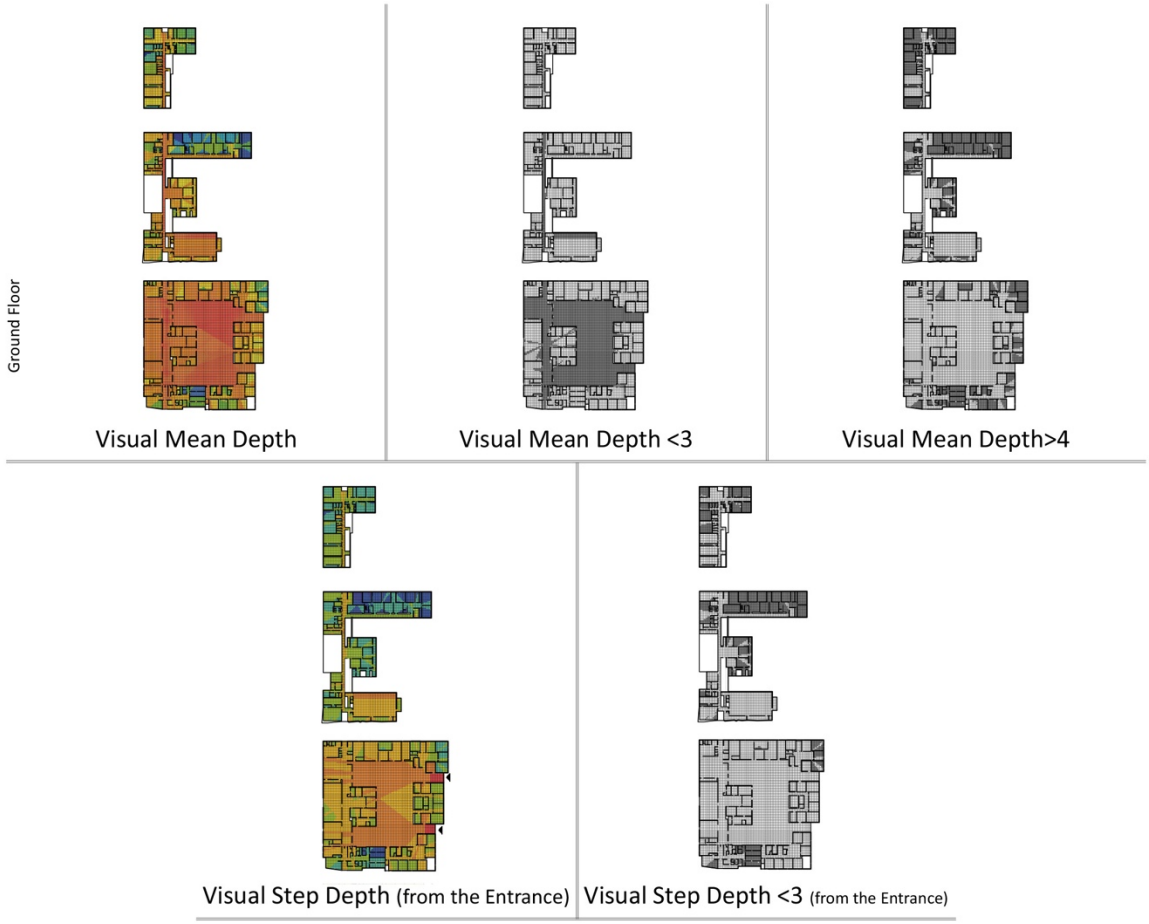


Figure 36: Syntactic Analysis (School B)

The existence of the courtyard enhanced the visual connectivity within the ground floor (*figure 36*). The main social central space located in the ground floor has an average of 2.6 for the VMD. However, there is a drastic increase in the VMD between the ground floor and the other floors reflected in the standard deviation (second highest). All the

learning spaces (99.6%) lie in the areas with VMD values more than four. This is mainly due to the absence of visual connectivity across floors. To be more specific, the design does not maximise the benefits of having a courtyard and favours more privacy/isolation for the upper learning spaces. The results of the upper floor VMD are almost the same as if the building was designed without an atrium (*figure 37 and 38*).

Figure 37: First Floor Actual VMD

Figure 38: First Floor VMD Without the atrium Visual Connection

VSD results (*figure 36*) show how the main cluster of classes on the first floor is very deep in the system with an average of 5 turns from the entrance. The main vertical axis of circulation is the shallowest backbone of the school. However, being un-centralised (more shifted to the left side) affected the balance of the floor plans making the right hand side learning spaces more segregated. This effect was further amplified because the secondary horizontal axis was obstructed by an enclosed staircase which broke the continuity of the circulation. Also, the learning spaces are not directly linked to the circulation corridor, but are deeper in the floor plan (clearly illustrated in the thresholds' filters).

School C

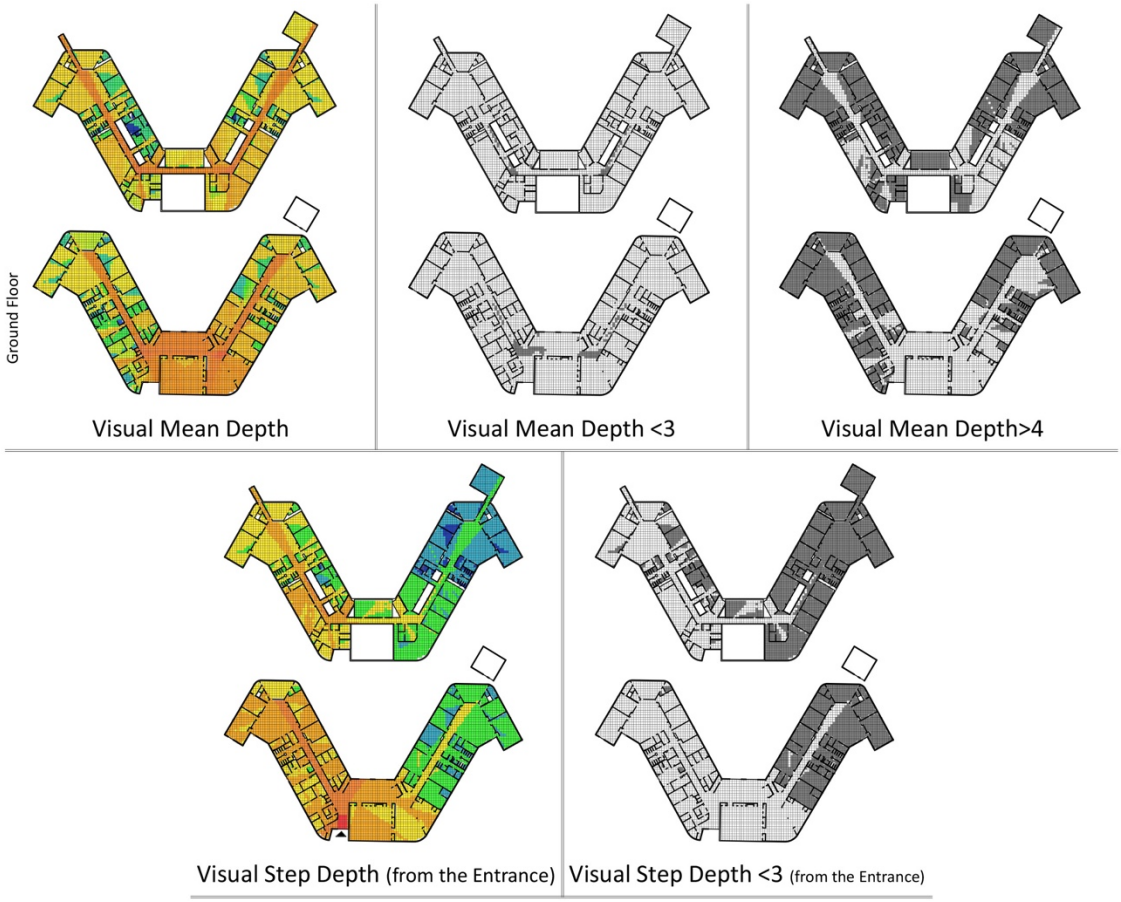


Figure 39: Syntactic Analysis (School C)

Although the school has no major atrium that might enhance the visual connectivity across floors, the VMD (*figure 39*) is in the the middle ranking among the 9 schools with no drastic variation across floors (second lowest standard deviation). This is achieved through a powerful circulation grid spreading across the plans and minimal labyrinth-like areas. Unlike the previous two schools, there is only one axis of circulation as the most visible backbone of the school. Although the building appears to be symmetrical in its form, VSD shows that the shift of the entrance towards the left (with walls restricting the visual connectivity to the right hand side) resulted into an overall shallower spaces on the left hand side from the entrance.

School D

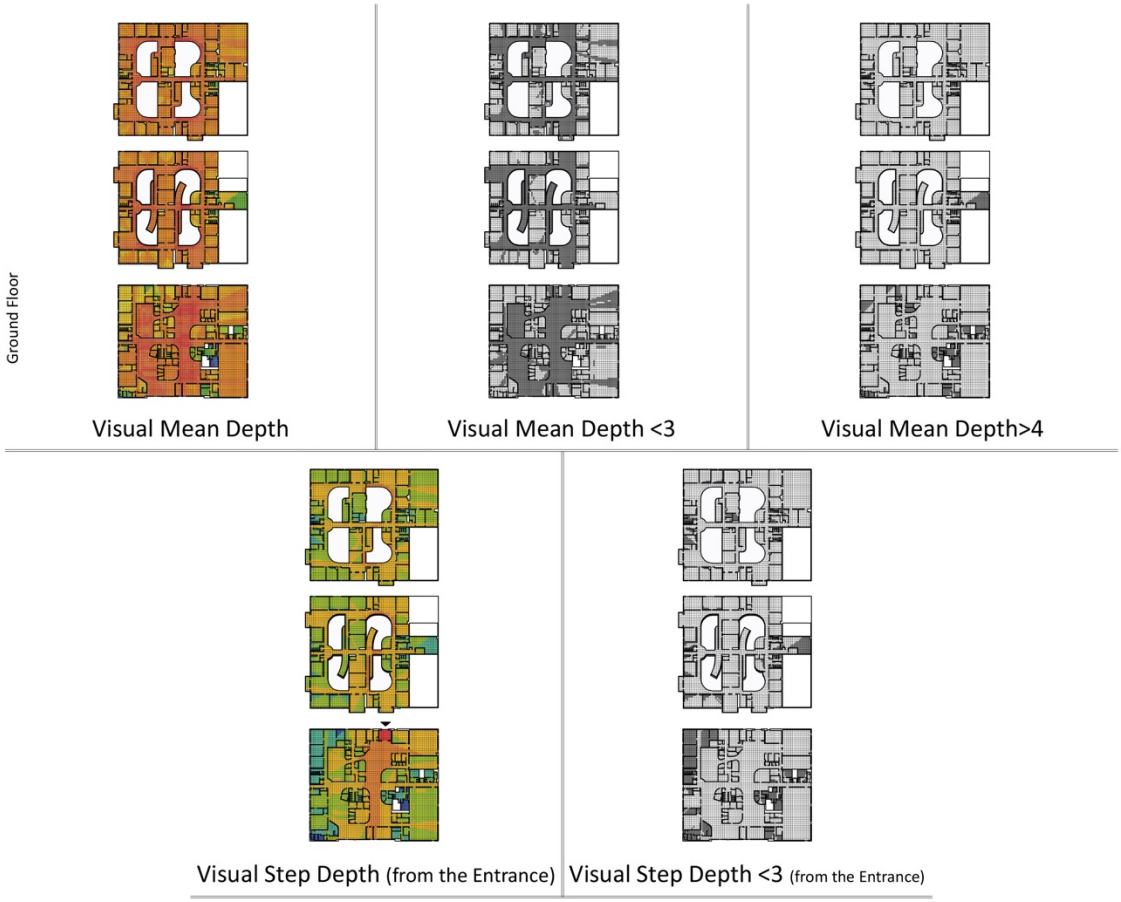


Figure 40: Syntactic Analysis (School D)

School D is ranked first in terms of visual connectivity (lowest average VMD) with a monotonic distribution, due to the power of having a courtyard creating an extremely porous open ground floor plan. Unlike other schools (especially B and E, where the openness is gradually constrained across the upper floors), school D has four upper atria with a rectangular circulation grid. All the learning spaces and the socialising spaces (except the sports hall) lie in the areas with mean depth less than three. The VSD yields all the building except 6 spaces (excluding the services areas) to be reachable within 3 turns from the entrance (*figure 40*).

School E

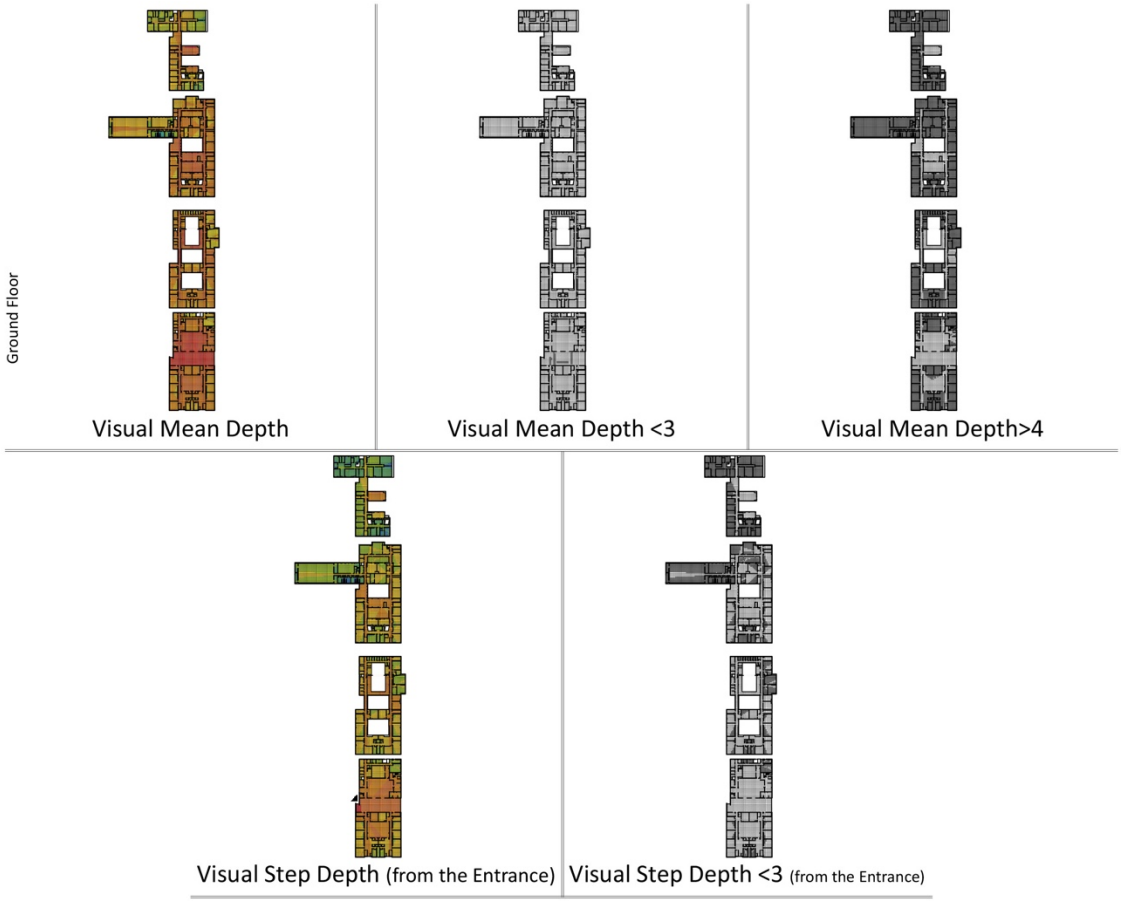


Figure 41: Syntactic Analysis (School E)

School E is considered the middle line between the closed environment (school F) and the other extreme of complete openness (school D). School E provides a design that features 3 middle courts (*figure 41*) showing as 3 atria on the first floor, but are then reduced to a single atrium on the other floors. In other words, the over all visibility is reduced gradually and the privacy starts to increase in terms of enclosures. Figure 42 shows the steady increase in VMD between the ground, first and second floor, but the third floor is relatively more private (steeper increase).

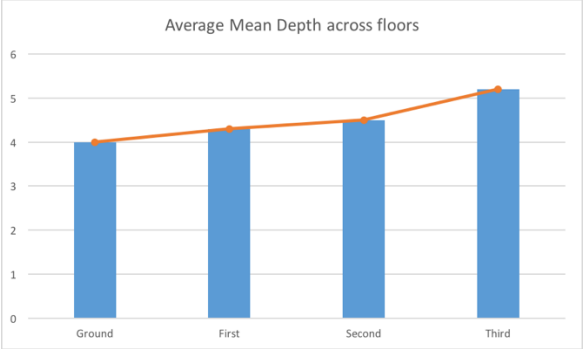


Figure 42: Increase in the Average VMD Across Floors

School F

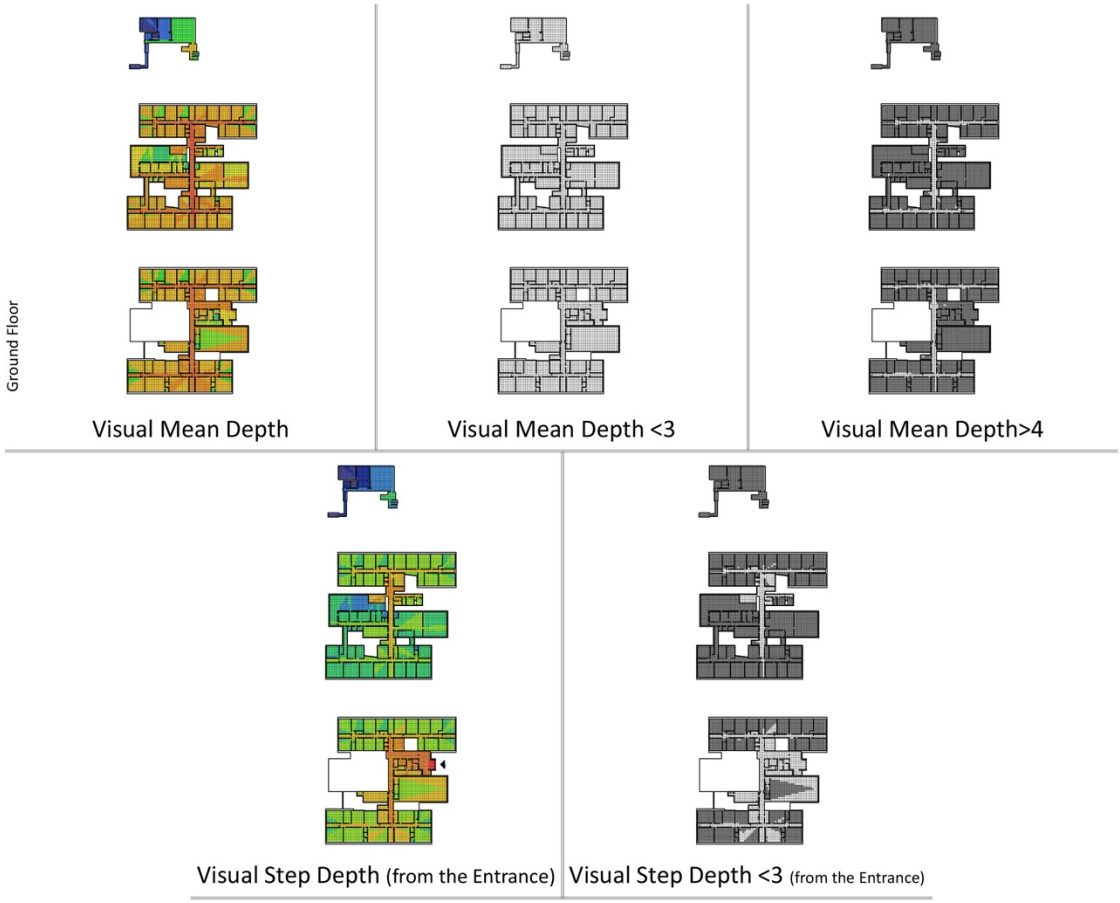


Figure 43: Syntactic Analysis (School F)

Similar to school C, the design of school F is based on closed plans with no atria or visual connections across the floors, however, the following reasons lead to the overall high VMD of the plans (*figure 43*). Firstly, the circulation is highly controlled in terms of access points and limited connections between various zones. Secondly, the stripped

floor plan is formed of elongated clusters having a labyrinth-like layout. Thirdly, the plans have short broken circulation corridors. The VSD shows the deep isolation of the learning spaces (art studios) on the third floor, which are more than 5 turns away from the entrance (specifically 6,7 and 8 for each of the three studios).

School G

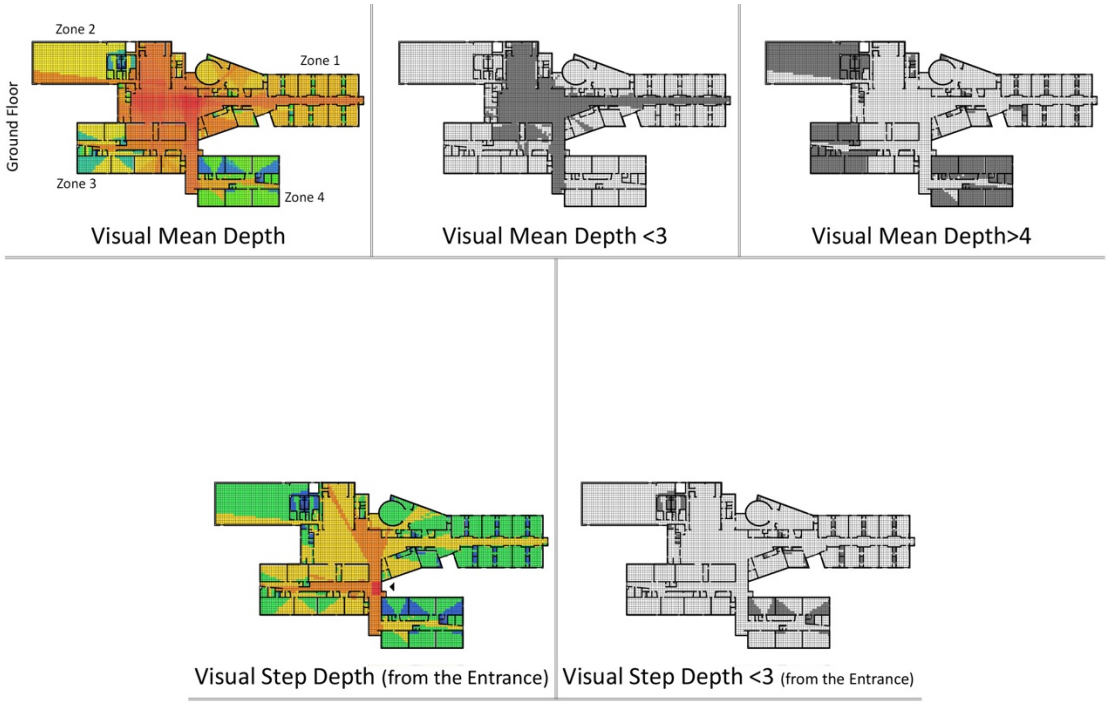


Figure 44: Syntactic Analysis (School G)

G is the only one-storey school. Its plan is divided into four main zones linked by a central circulation grid. The VMD (*figure 44*) reveals the similarity in the values for three of the zones (average = 3.6, 3.7 and 3.8) except the fourth lower right zone which is deeper than the others (average = 4.5). The floor plan organisation dictates that one circulation artery is visually deeper in the whole system. The result is that the whole area linked through this corridor is visually separated from the rest of the school building. The VSD shows that only one zone (lower left) is two steps away from the entrance, which is quite shallow. The other three zone are still not very deep with an average of three turns.

School H

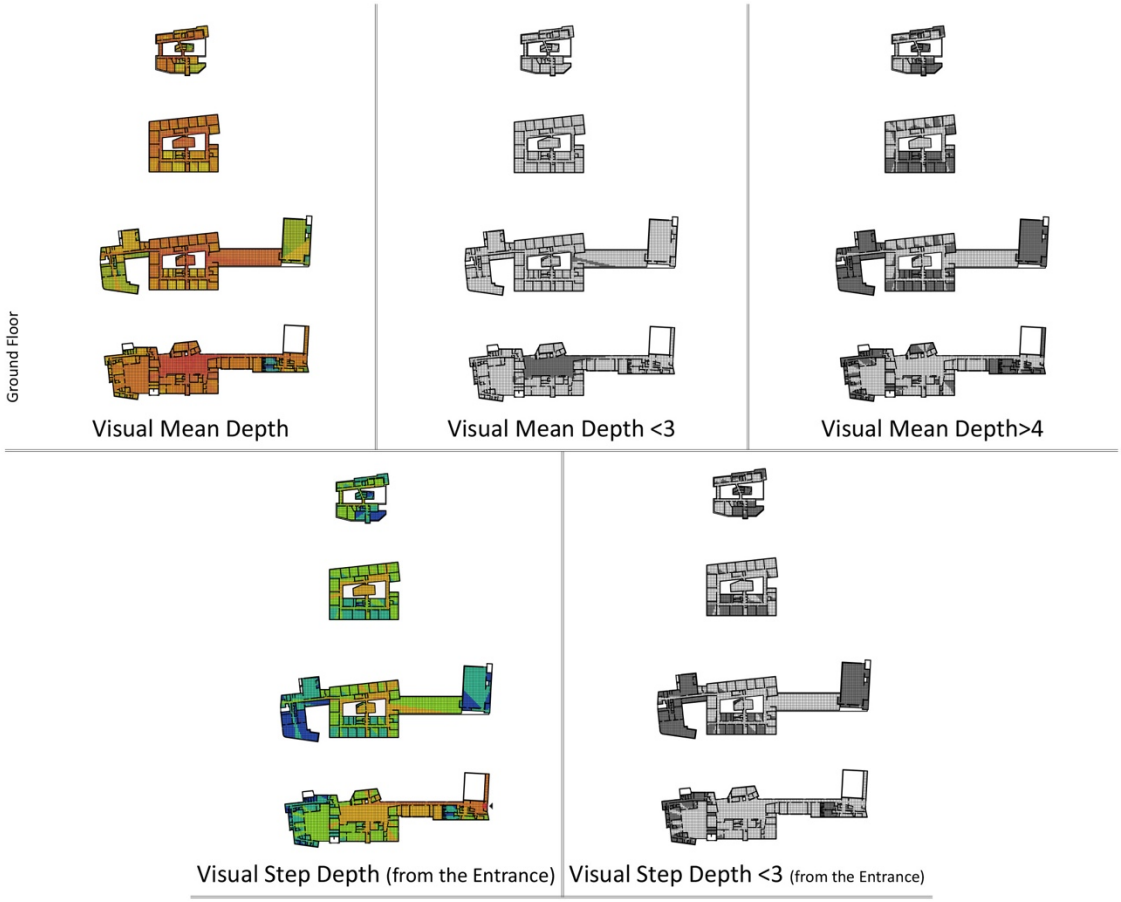


Figure 45: Syntactic Analysis (School H)

The floor plan is formed of a central zone that is linked to two other zones (right and left). This form continues in the ground and first floor before being reduced just to the central zone in the second and third floor. Although the VMD (*figure 45*) shows a monotonic distribution of values within the central zone around the courtyard and atria in all of the floors (standard deviation = 0.56 for this area), the variation in the values of the VMD start to increase as spaces get further from the centre and deeper into the two sides (especially the right wing). Thus the standard deviation rises to 0.90 for the whole floor area including the two wings as well as the whole building which is the highest value among all the schools. Opposite to school G, where the location of the central entrance facilitated the visual connection to the rest of the plan, the VSD shows that the main entrance of school H is situated in the furthest right end of the school causing an unbalance in the depth of many learning and socialising spaces from the

entrance. The learning spaces in the left wing on the first floor have a value of 5 for their step depth (quite deeper than the rest of the plan).

School I

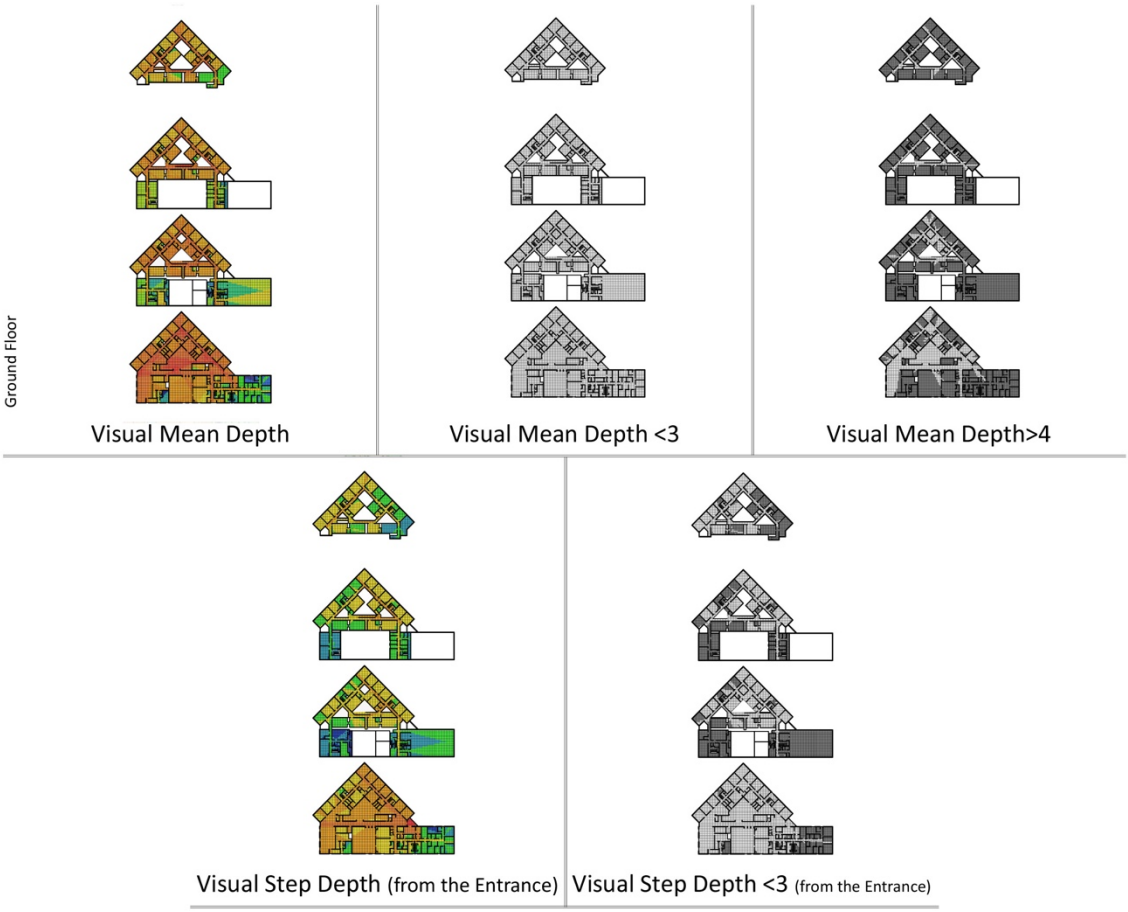


Figure 46: Syntactic Analysis (School I)

Although the school design has a courtyard, the VMD average (*figure 46*) is quite high (second highest of all the nine schools). The building does not seem to benefit from the visual connection a courtyard can provide. On the upper floors, the learning spaces have small windows overlooking the courtyard. The ground floor seems to be divided into two zones: the triangular space with the courtyard and the lower rectangle. The two zones are connected using a horizontal axis of circulation, but there are only limited points of access between the two zones (3 gateways). One of the gateways is relatively deeper than the others which results in amplified visual deepness for the whole zone accessed through this gateway. Surprisingly, the VSD (*figure 46*) illustrates that the

learning spaces on the first and second floor are actually less than 3 turns, which is relatively shallow. While the performance of the courtyard and atria do not payoff, the vertical circulation (5 staircases, 1 of which is opened) is compromising for connecting the floor plans of the building.

4.2.1.4 Comparison Between the Nine Schools

School	A	B	C	D	E	F	G	H	I
Simplified outline									
Existence of Courtyard/ Atria	Yes, only in 3 of the 4 zones of the plan	Yes, but not every space overlooking the courtyard has visual connectivity to it.	Yes, but very narrow elongated atria on the upper floor	Yes, Perfectly utilised in all floors	Yes, but visibility constrai-ned with increase in levels	No, causing lack of visibility between floors	Courtyard maximises visibility within the floor. No atria, it is a single floor	Yes, utilised in the central areas of the floors, but visibility decrease across wings	Yes, but not every space overlooking the courtyard has visual connectivity to it.
Unique features	Direct connection between the learning and social spaces on the ground floor due to the unique finger-like form	Upper floor spaces overlook the courtyard but the visual connection is blocked. Design preferred to maintain the privacy of these areas	Symmetri-cal form and almost in the design of spaces, but the minor changes caused asymmetry in the configurati-onal analysis results	The ideal example of openness-s, porosity and maximisi ng the revenues from a courtya-rd	Middle ground solution between extreme openness and complet-ely enclosed floor plans.	Very limited visibility within and across floors. Main focus on maximisin-g spaces for classroo-ms. Very little social spaces.	Zoned plan (clusters) around the central courtyard. Visual segregation of one artery connecting 1 of the 4 zones lead to amplified segregation of the whole zone.	Stretched Floor plan design. The central space with the courtyard and atria is visually integrated. Segregation increase across the wings leading to a high variation of VMD between the centre and the far ends.	The lack of homogene-ity in the form; split of the plan into two zones with limited connecting access points (gateways) affects the configurati-onal analysis results

Table 5: A Spatial Comparison

4.2.2 Buildings Spatial Organisation and Comparative Quantitative Data of the Nine Schools

The organisation of certain spatial features and their relations to each other in the school plans are also important to evaluate the spatial performance of the nine school. In this section, the main focus is on the entrances, circulation, socialising spaces, learning spaces (together with their services), vertical circulation and toilets. Before starting the discussion about each feature, figure 47 shows the distribution of areas for each function within the nine schools which will be referred to a lot in the coming section.

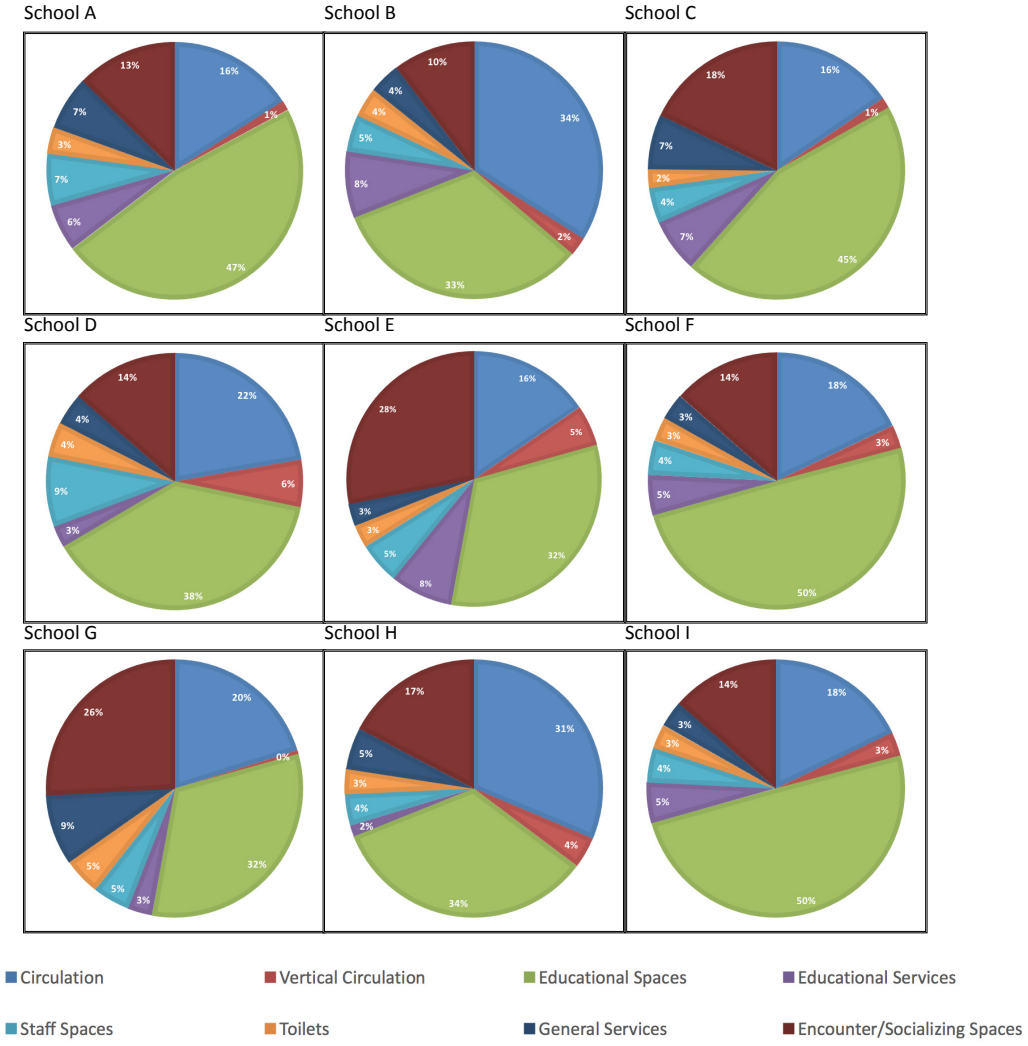


Figure 47: Areas Distribution Within the Nine Schools

4.2.2.1 Entrance Design

The entrance is evaluated in terms of being able to minimise the visual depth of the rest of the building from it as a starting point. Table 6 shows the decrease in values between the VMD and the VSD. School A has the most connecting entrance location which decreased the visual depth by 40% from the mean value. School C has the second least decrease which is caused by the shifted entrance (to the left) within a symmetrical plan (discussed in school C analysis).

	AVG Visual Mean Depth of the building	AVG Visual Step Depth (entrance)	Change in value (decrease)	% change (decrease)
A	4.05	2.41	1.64	40
B	3.59	2.45	1.14	32
C	4.04	3.28	0.77	19
D	3.11	2.49	0.62	20
E	4.45	3.01	1.44	32
F	4.79	4.12	0.67	14
G	3.64	2.46	1.18	32
H	3.99	3.08	0.91	23
I	4.47	3.17	1.30	29

Entrance Potential to Minimise the Visual Mean Depth									
Ranking	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
School	A	G	B	E	I	H	D	C	F

Table 6: Comparing the VMD and the VSD of the Nine Schools

4.2.2.2 Circulation

The circulation of the school building (and almost any other building) is the main driving force of movement and encounters which are considered the generic function of every building (Hillier 1996). Calculating the percentage of circulation of the total area within each school (*figure 48*) and observing their wide spectrum of values reflect the potential of the circulation spaces to afford patterns of co-presence which is according to Hillier (1996) a major factor in stimulating social activities. Moreover, the width of corridors (*figure 49*) plays an important role in triggering or inhibiting the potential of students' socialisation especially during the through movement from one place to

another. In simple words, it conveys the potential of students hanging out in the corridors.

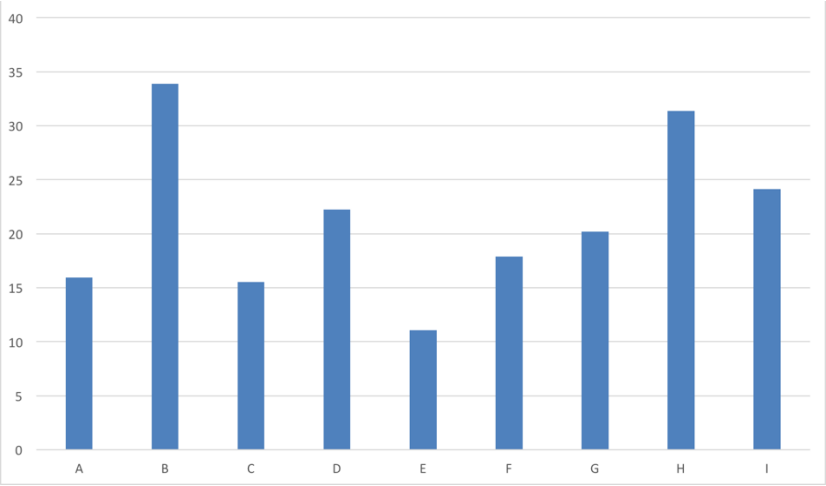


Figure 48: Percentage of Circulation Out of the Total Area

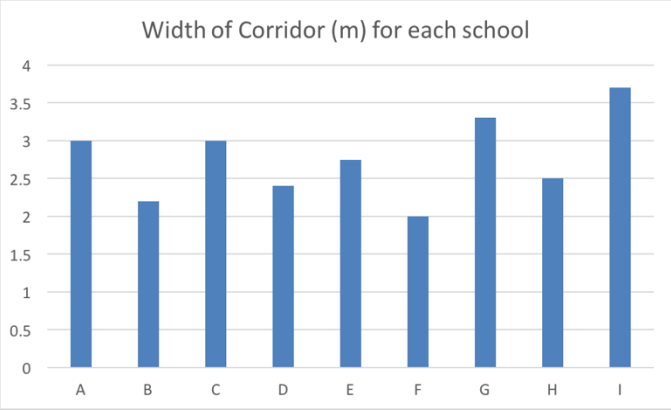


Figure 49: Width of Corridors in Each School (Based on the Primary Axis)

The second feature of circulation is its form and hierarchy. While the design of circulation appears to be homogenous within each school, syntactic analysis shows that there is a hierarchy in terms of the visual depth of each corridor. For example, within school A, the hierarchy in the VMD of the circulation corresponds to the hierarchy in the design of the circulation; the primary horizontal axis (VMD=2.75) and the secondary grid lines perpendicular from it (VMD =3.6). The power of the primary axis lies in its continuity across the plan. On the contrary, the two axis of circulation in school B appear to be equally important in their design hierarchy, but the analysis reveals different VMD values between both (VMD = 2.58 and 3.61). The syntactic analysis also

clarifies the effect of having two separate grids of circulation which are linked at various points (discussed in school I chapter 4 section 2.1.3).

Vertical connection is also a major component in the building circulation. In fact, the importance of vertical circulation lies in its potential to provide visual linkage before its ordinary function of physically connecting the floors together. The optimum design for maximum visual connection would be the open staircase. However, most of the staircases in the school plans are closed (for fire safety reasons). Yet, there are small areas of visual connectivity across floors. The distribution of staircases across the floor plan is a key criterion in lowering the reachability of certain areas to other spaces. School I step depth from the entrance is an example (discussed in School I chapter 4 section 2.1.3).

4.2.2.3 Socialising Spaces

The importance of the social spaces inside the school building is equal to (if not more than) the importance of the learning spaces (literature review chapter2 section3). Within the school building, there are certain factors that shape the spatial characteristics of the social spaces. Beside their areas (*figure 50*), other factors include their variety in terms of types or layouts (*figure 51*), the existence of courtyards and atria (*figure 52*), and the percentage of outdoor gathering spaces (*figure 53*).

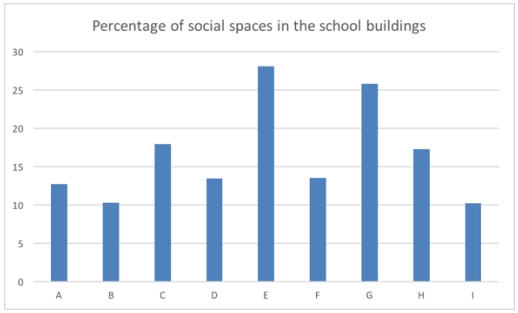


Figure 50: Percentage of Social Spaces

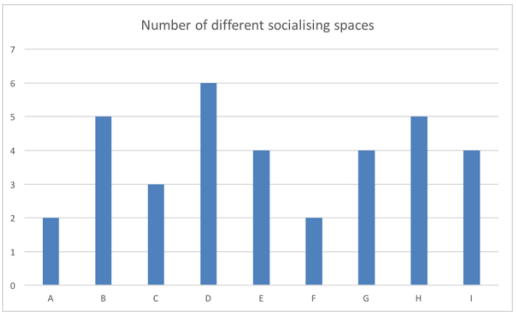
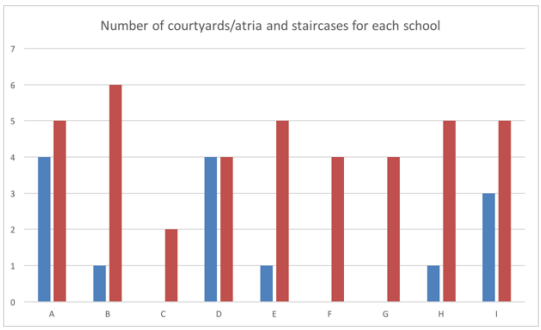


Figure 51: Number of different social spaces



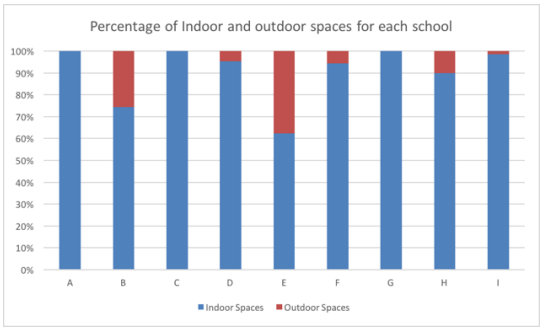


Figure 52: Number of Atria (Red) and Staircases (Blue) *Figure 53: Percentage of Indoor and Outdoor Areas*

Furthermore, Circulation plays an important role in highlighting the socialising spaces. Studying the two spatial elements and their relation (*figure 54*) shows that in some schools (D, B, C and G) the primary or secondary axis of circulation pours into the main social spaces. So to reach some areas of the plan, the students and staff will have to cross the social common space. Consequently, social spaces function as by-products of natural movement. If socialisation is proportional to the users' encounters, then this design layout would increase the potential of students' socialisation, as the social spaces become part of the students' through movement. It also increases the natural surveillance by the staff on the students' gathering spaces. However, School E and F are the complete opposite, where social spaces do not overlap the circulation, which means that the potential of mixing the students and their encounters is only reliant on the ability of theses spaces to act as attractors for the students (destinations).

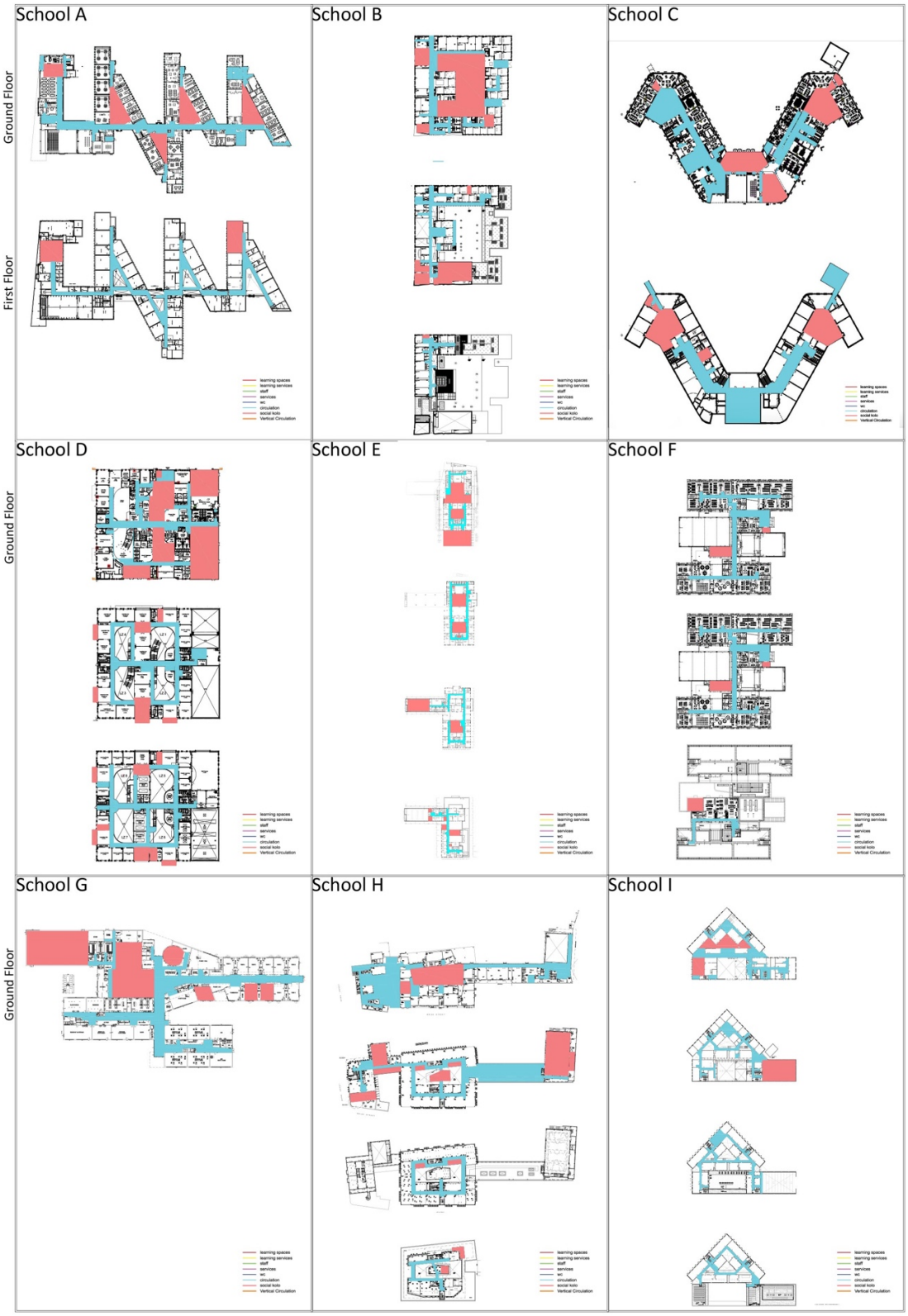


Figure 54: Spatial Relations (overlap) Between Circulation and Social Spaces

Speaking of natural surveillance, segregated areas and blind spots within school buildings are considered social prohibiting factors. Figure 56 shows the test of isolation of the toilet zones (using the values of the VMD) within all the nine school buildings. Some toilets lie in the most segregated spots (school D, E and I). Yet, to be fair, in the most segregated situations, none of the schools have any blind spots at the toilets' zones in the plan, due to the adoption of the open toilet layout (*figure 55*) which is always linked to the corridor with no visual barrier.

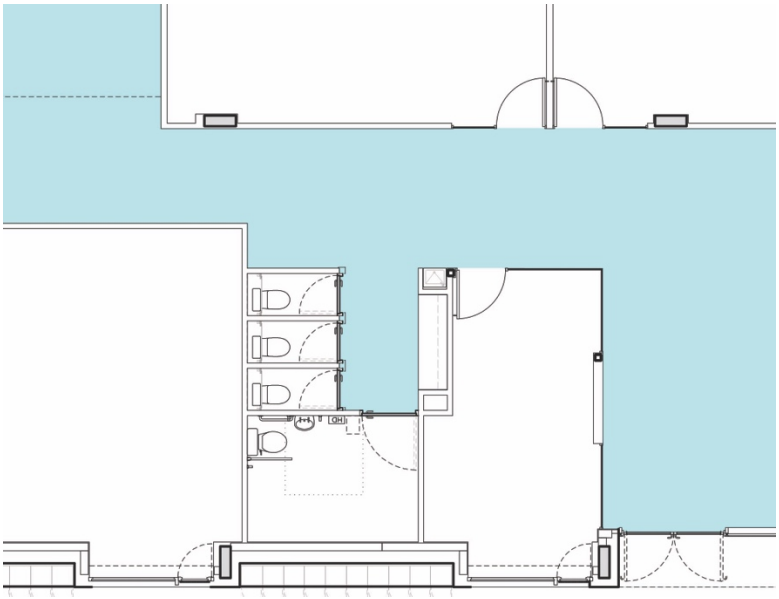


Figure 55: Open Layout of the Toilets with direct connection to the circulation

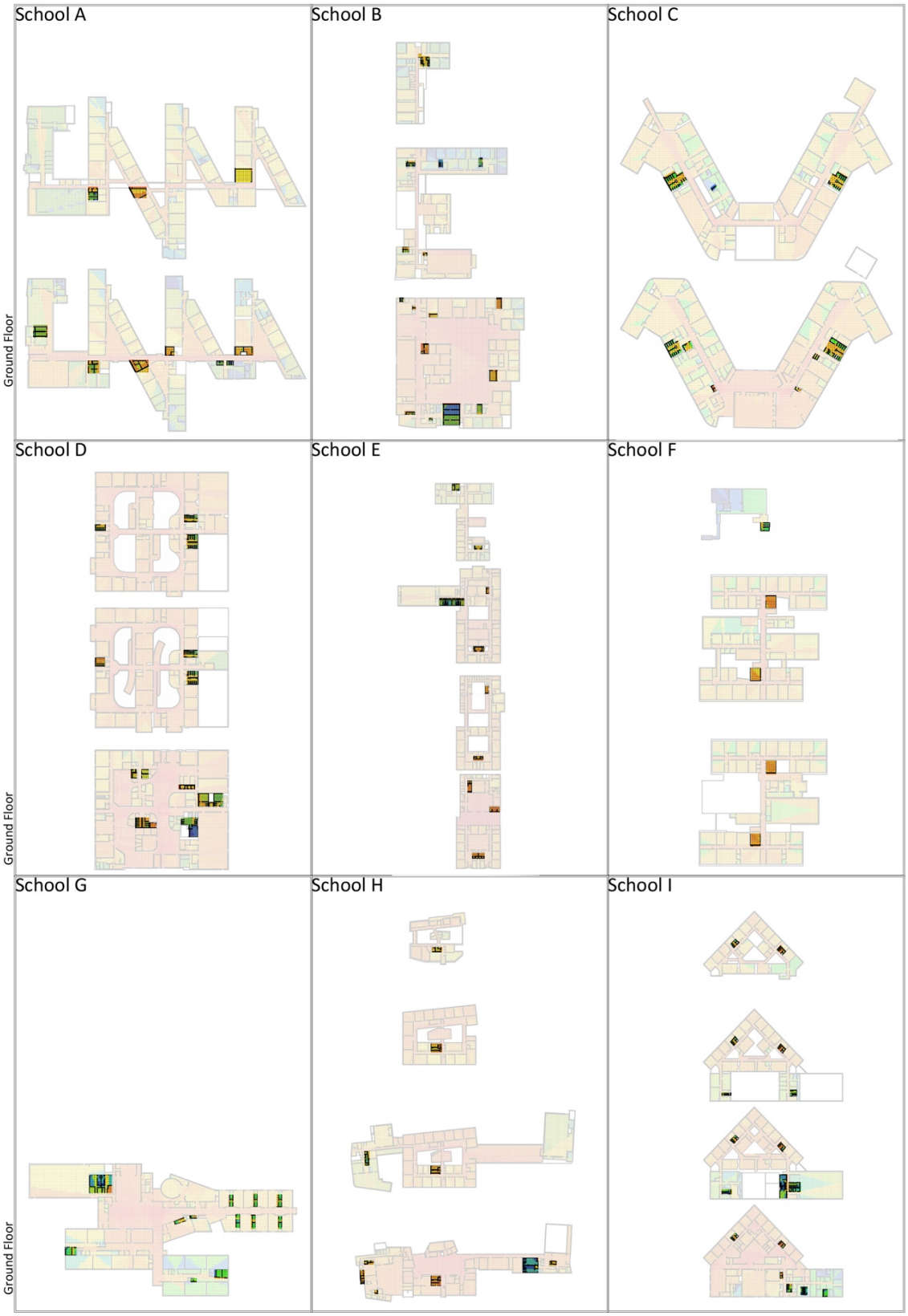


Figure 56: Visual Mean Depth of the Toilet Zones

Having mentioned the importance of the social spaces, it is important to compare the configurations of social spaces. Geographic information system (QGIS) is used to extract the syntactic values for the VMD only for specific areas (*figure 57*). Observing figure 58, the overall average for one school is not an indication for the depth of its social spaces since the social spaces are shallower than the average VMD (except school F). In general, all the schools' social spaces are deeper than 2 turns of VMD and the values are highly dispersed across the spectrum (from 2.9 to 5.3). School D has the lowest average for the VMD, which is mainly because of the high visual connection between all the floors. Figure 59, 60 and 61 shows a summary of these findings. Two main observations could be concluded from these histograms. Firstly, discontinuity in the configurational VMD values (shown as wide gaps of missing histograms) within certain ranges for the social spaces (example: school H) explains the lack of organisational design hierarchy between the social spaces; their dispersion across separate locations of varying VMD. Secondly, the larger and more open the social spaces are, the higher the condensation of the count in less number of bars at the left end of the spectrum (school B and E).

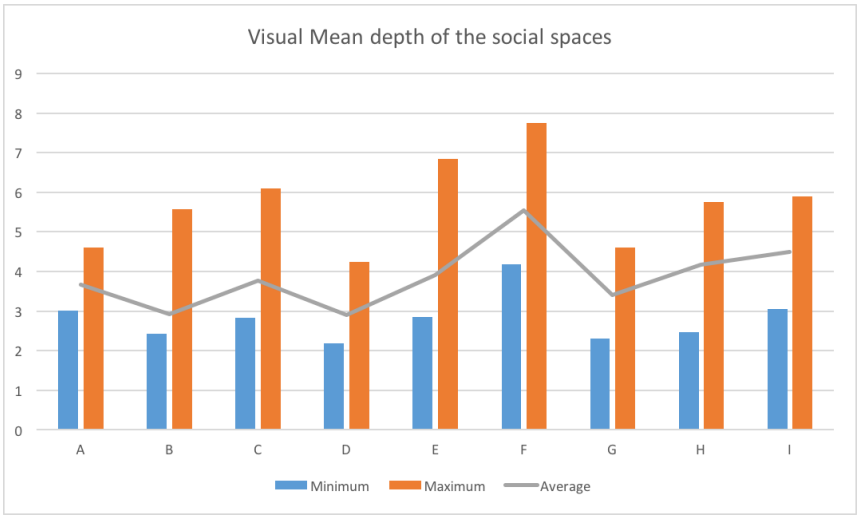


Figure 57: Average, Minimum and Maximum Visual Mean Depth of the Social Spaces

	A	B	C	D	E	F	G	H	I
Overall AVG VMD	4.05	3.59	4.04	3.11	4.45	4.79	3.64	3.99	4.47
AVG VMD of social spaces	3.67	2.93	3.77	2.91	3.9	5.54	3.4	4.18	4.49

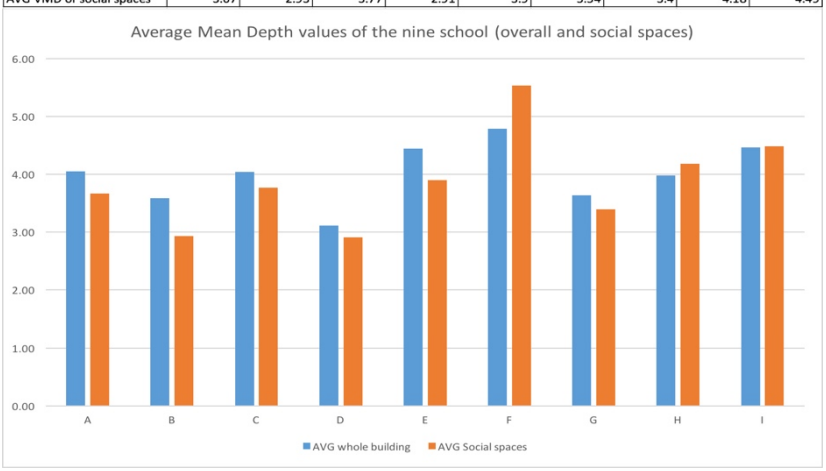
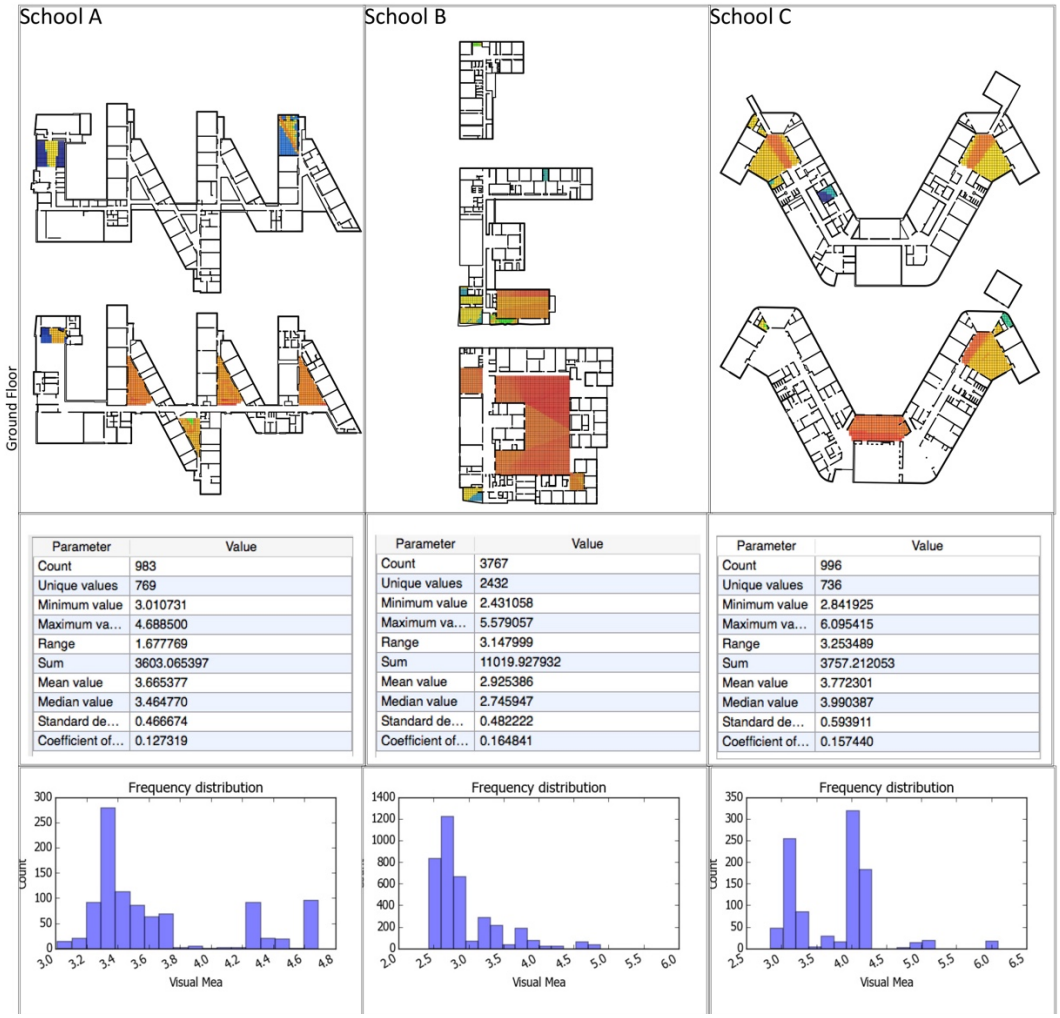


Figure 58: Average Visual Mean Depth of the Whole Building and Only the social Spaces



Parameter	Value
Count	983
Unique values	769
Minimum value	3.010731
Maximum va…	4.688500
Range	1.677769
Sum	3603.065397
Mean value	3.665377
Median value	3.464770
Standard de…	0.466674
Coefficient of…	0.127319

Parameter	Value
Count	3767
Unique values	2432
Minimum value	2.431058
Maximum va…	5.579057
Range	3.147999
Sum	11019.927932
Mean value	2.925386
Median value	2.745947
Standard de…	0.482222
Coefficient of…	0.164841

Parameter	Value
Count	996
Unique values	736
Minimum value	2.841925
Maximum va…	6.095415
Range	3.253489
Sum	3757.212053
Mean value	3.772301
Median value	3.990387
Standard de…	0.593911
Coefficient of…	0.157440

Figure 59: Social Spaces Mean Depth, Mathematical Attributes and Histograms of the Values Distribution (School A, B and C)

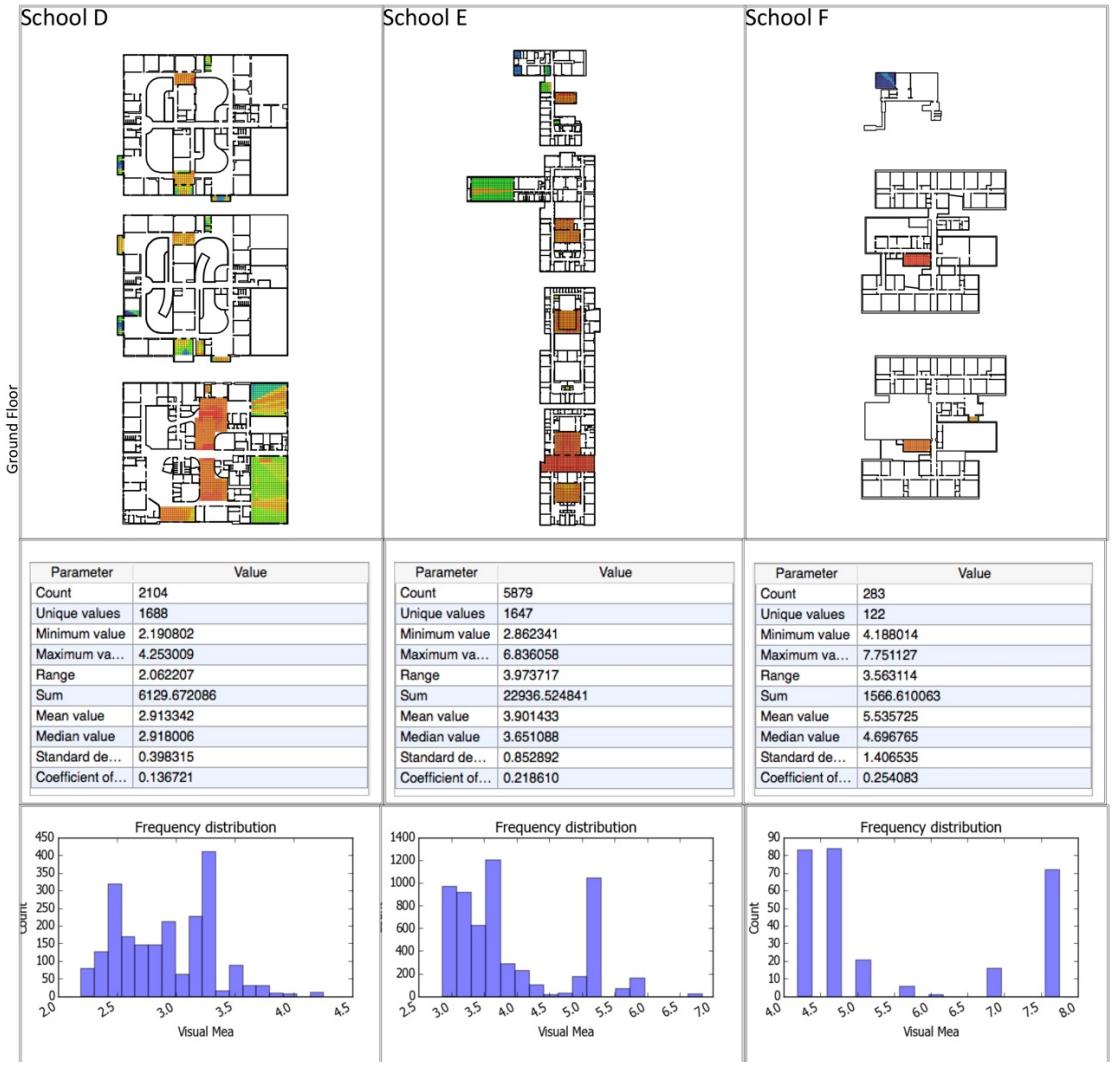


Figure 60: Social Spaces Mean Depth, Mathematical Attributes and Histograms of the Values Distribution (School D, E and F)

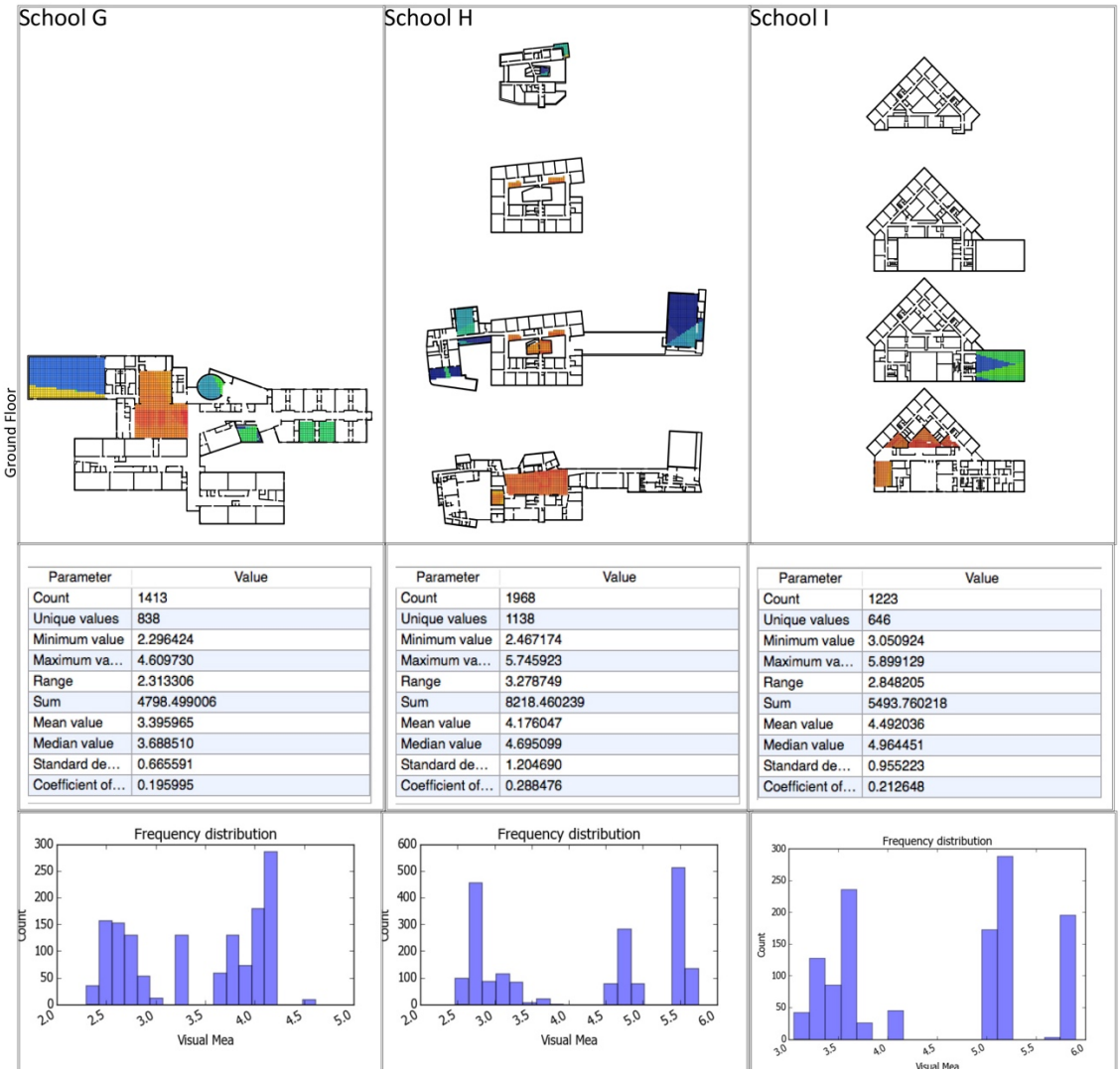


Figure 61: Social Spaces Mean Depth, Mathematical Attributes and Histograms of the Values Distribution (school G, H and I)

4.2.2.4 Learning Spaces

Comparing the percentages of learning spaces in each of the nine schools (*figure 62*) shows that school F is the highest with almost 50% of its area occupied by the learning spaces. School A comes second and school B, E and G are having the least percentage of learning spaces within their buildings.

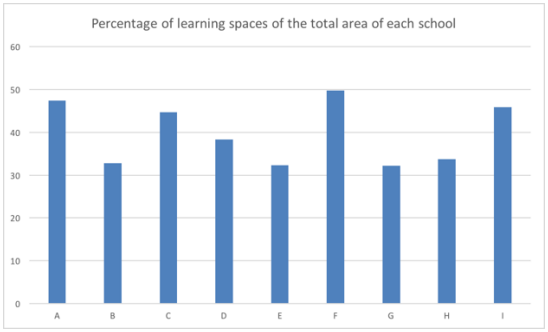


Figure 62: Percentage of Learning Spaces Out of the Total Area

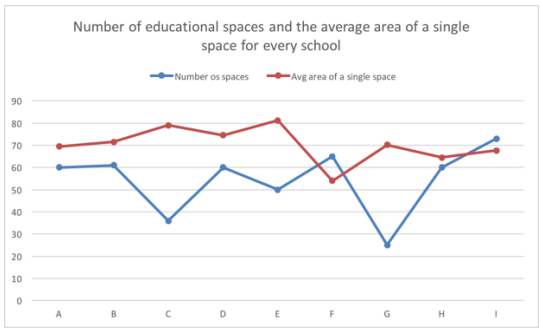


Figure 63: Count and the Average Area of a Single Learning Space

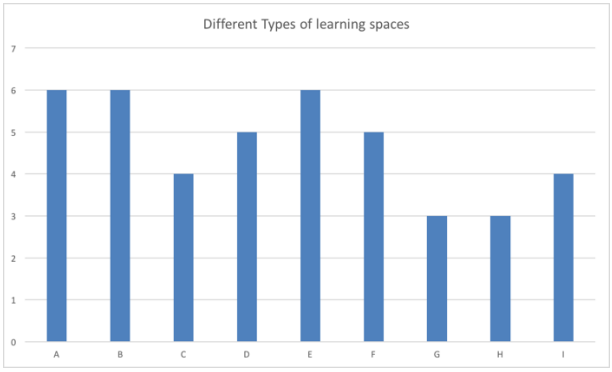


Figure 64: Variation in Learning Spaces (layouts and types)

The next step is to record the count and average area of a single learning space in every school (*figure 63*). Observing the variation in types/layouts (*figure 64*) of the learning spaces suggests that it has no direct relationship with the percentage area of learning spaces or their count. School E, which has the least learning area percentage, retains the most variation in the types of learning spaces. The other schools have a higher percentage of learning spaces but are monotonous in terms of their typical classroom layout. Another aspect to study is the spatial organisation of the learning spaces and the learning services in the floor plans (*figure 65*). It is clear how the learning spaces follow the outline of the building with an even distribution across the plans. This

observation might indicate a possibility of a typical process of zoning where allocation takes place to achieve a certain total area of learning spaces covering the whole plot. In other words, it is not configurationally executed according to spatial relations and organisation that matches the requirements of the learning spaces and their linkage to the social spaces.

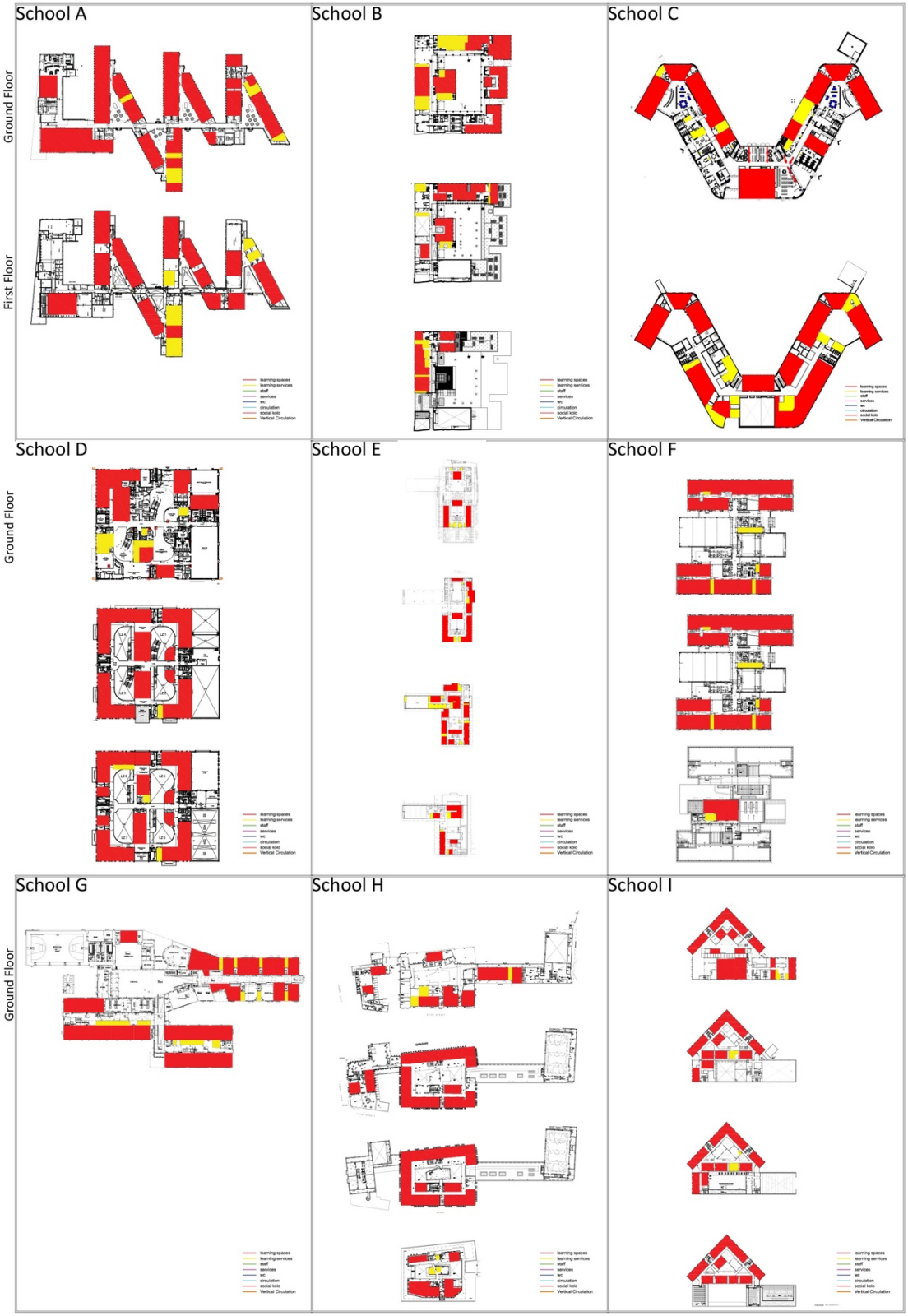


Figure 65: Spatial Relation Between Learning Spaces and Learning Services

Configurational extracts of the learning spaces (*figure 66*) show their VMD values as highly condensed in the spectrum ranging from 4 or 5 turns (except school D 3.24) unlike the VMD of the social spaces where the values for the nine schools are dispersed across the spectrum. Also, the VMD of the learning spaces is higher than the average VMD of the whole school building (except for school I where the two values are almost equal).

	A	B	C	D	E	F	G	H	I
Overall AVG VMD	4.05	3.59	4.04	3.11	4.45	4.79	3.64	3.99	4.47
AVG VMD of learning spaces	4.26	4.14	4.15	3.24	4.8	4.9	4.13	4.12	4.52

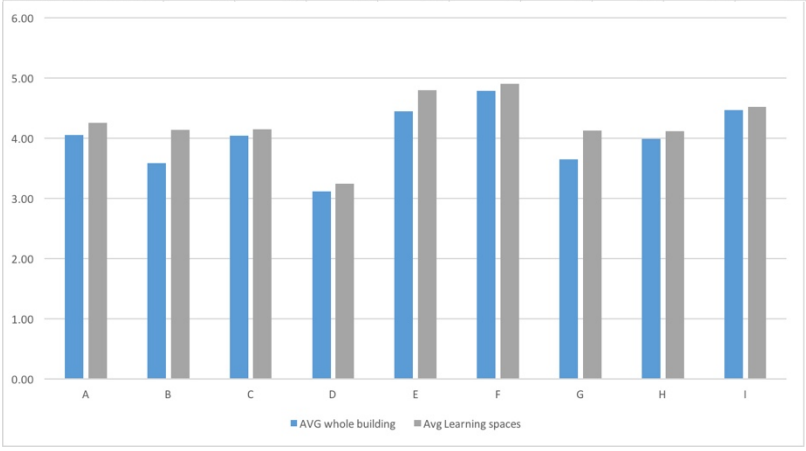


Figure 66: Average Visual Mean Depth of the Whole Building and Only the Learning Spaces

The agglomeration of the VMD values for the nine schools (*figure 67, 68 and 69*) yields the following conclusions. Firstly, the more the number of histograms available, the more variety of learning spaces exist in terms of depth which increases the potential of the spaces to afford various learning formats (ranging from active busy integrated spaces to quiet segregated spaces for high concentration). Schools A, F and G have a low number of histograms and their floor plans are characterised by equally deep monotonous learning spaces forming 32%, 39% and 29% of the total learning spaces i.e. low potential to afford various learning formats (*table 7*).

	A	B	C	D	E	F	G	H	I
Number of filled histograms	13	16	14	15	12	9	11	13	15
Highest concentration in one histogram	1400	500	800	700	2400	1300	500	580	1080
Total of all histograms	4439	4314	2836	4445	8518	3330	1746	3906	4890
% concentration out of the total area (Monotony in the VMD)	32%	12%	28%	16%	28%	39%	29%	15%	22%

Ranking according to affordance of various learning formats (variation in the VMD)	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
	B	H	D	I	C	E	G	A	F

Table 7: Explaining the Learning Spaces VMD

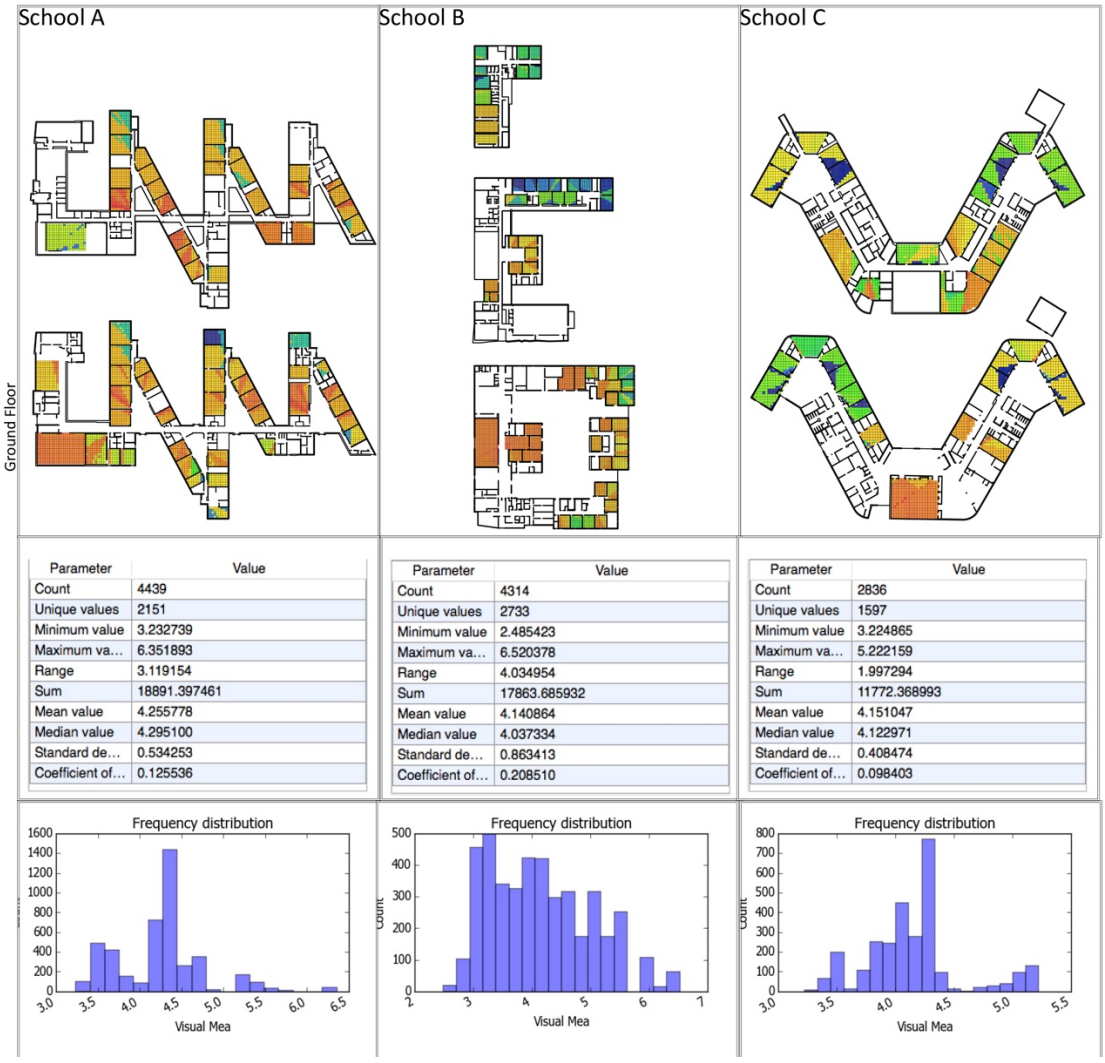


Figure 67: Learning Spaces Mean Depth, Mathematical Attributes and Histograms of the Values Distribution (School A, B and C)

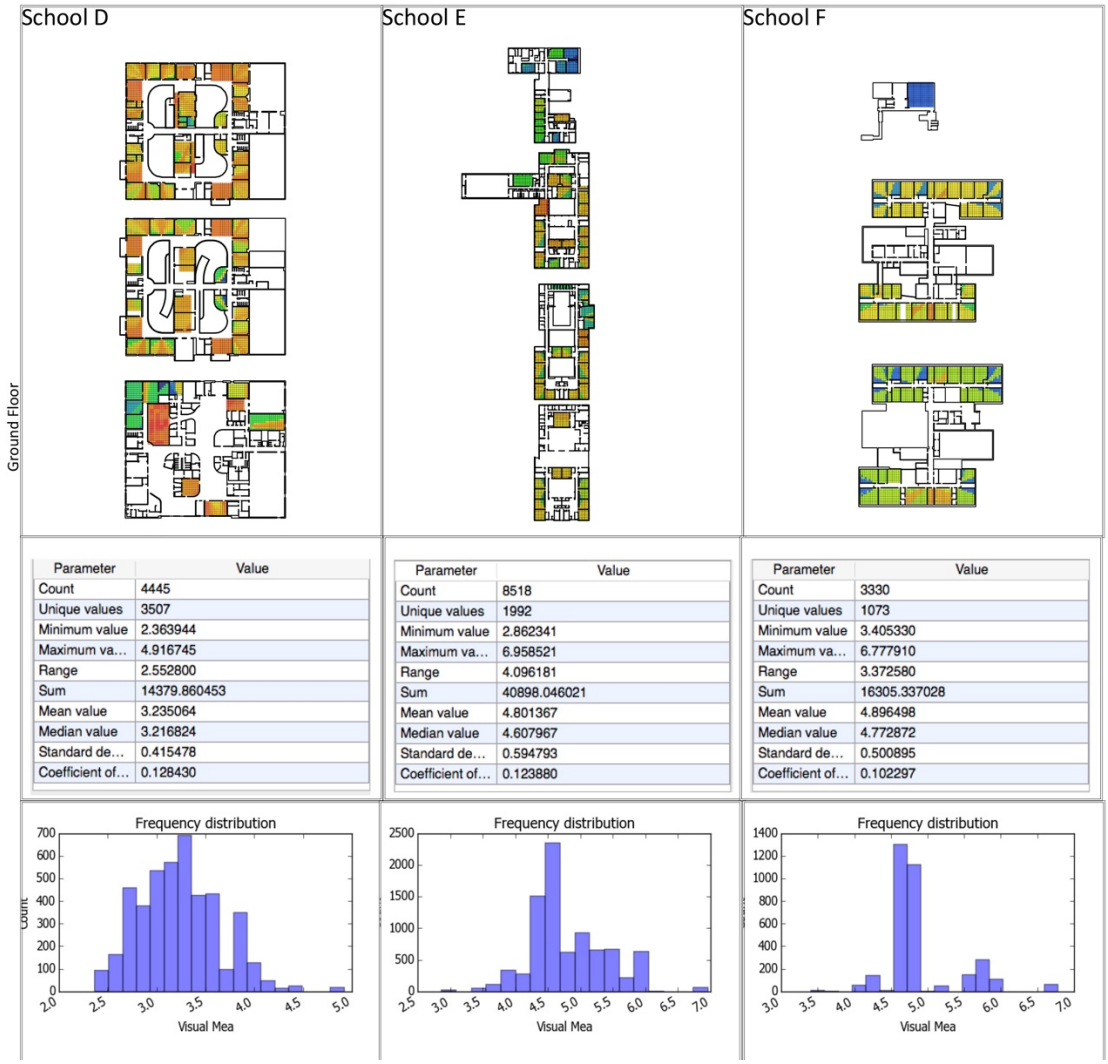


Figure 68: Learning Spaces Mean Depth, Mathematical Attributes and Histograms of the Values Distribution (School D, E and F)

Figure 69: Learning Spaces Mean depth, Mathematical Attributes and Histograms of the Values Distribution (School G, H and I)

5. Findings: The Spatial Performance of the Nine Schools

5.1 Ranking the Schools According to their Spatial Performance

Figure 70 and table 8 show the compilation of the spatial results for the nine schools which are the base for setting up the scoring system and the correlations.

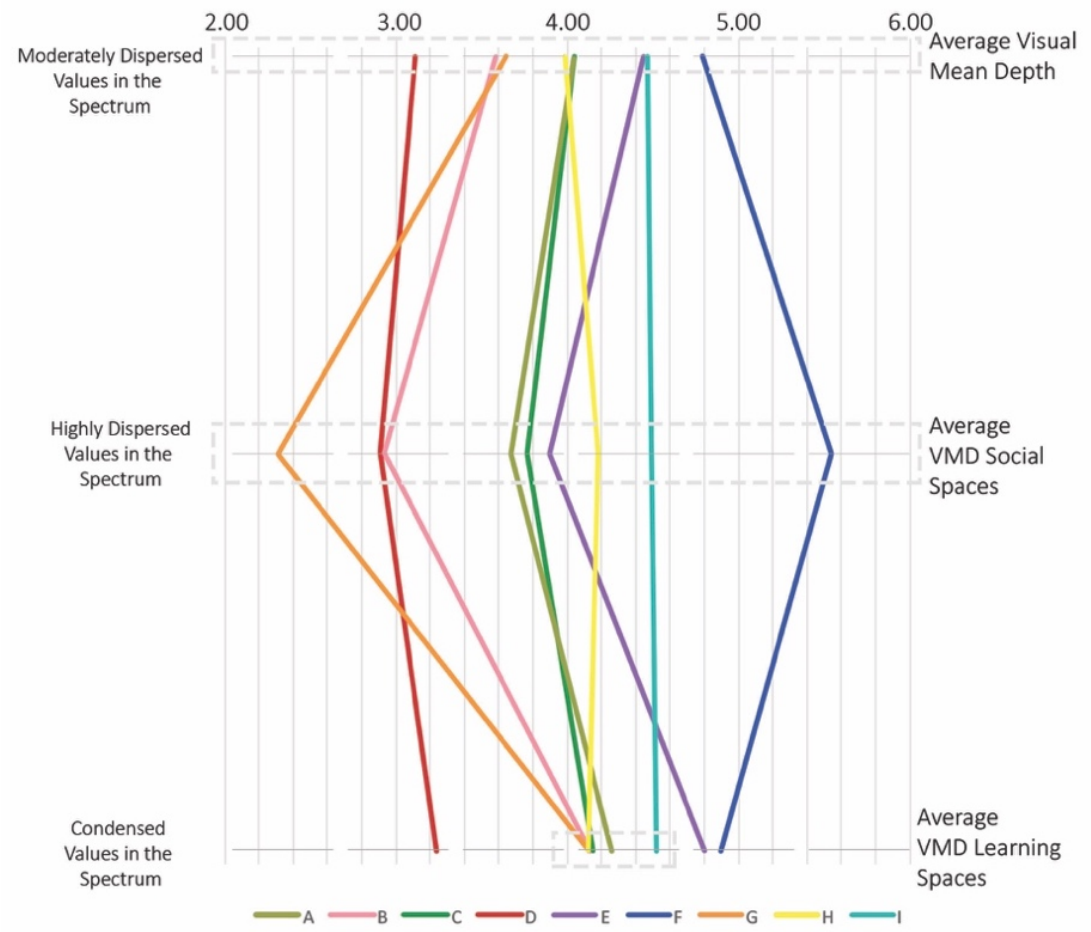


Figure 70: VMD, VMD Social Spaces, VMD Learning Spaces

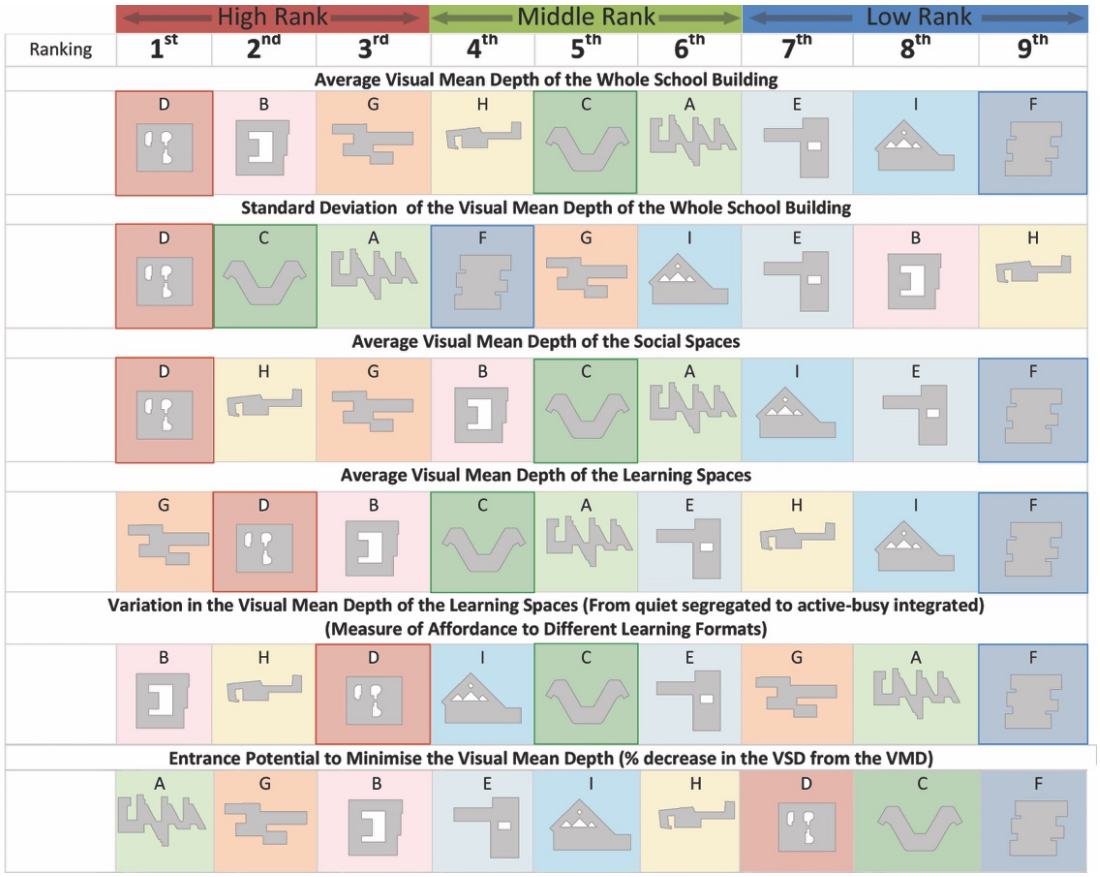


Table 8: The Spatial Performance Ranking

5.2 The Scoring System

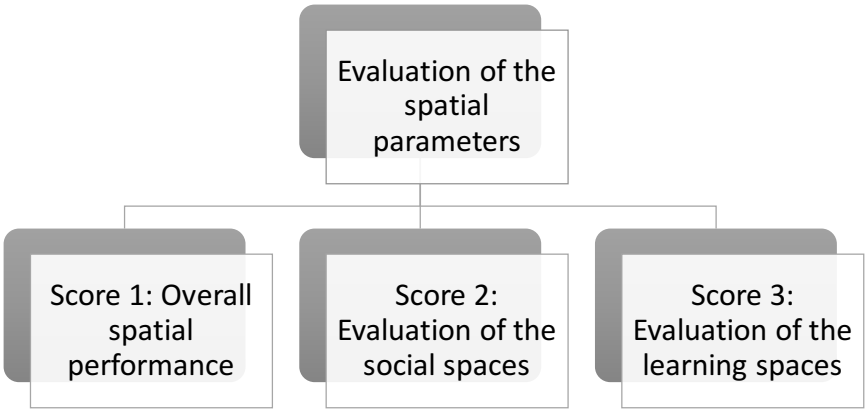


Figure 71: The Three scores

The spatial analysis is summarised and converted into a comparable scoring system of the nine schools. The scores are tested against the students' performance for correlations. The scoring system is divided into three attributes which are: score (1) as

the over all spatial performance of the school building, score (2) as an evaluation for the social spaces within each school and score (3), as an evaluation of the learning spaces (*figure 71*).

Score (1)

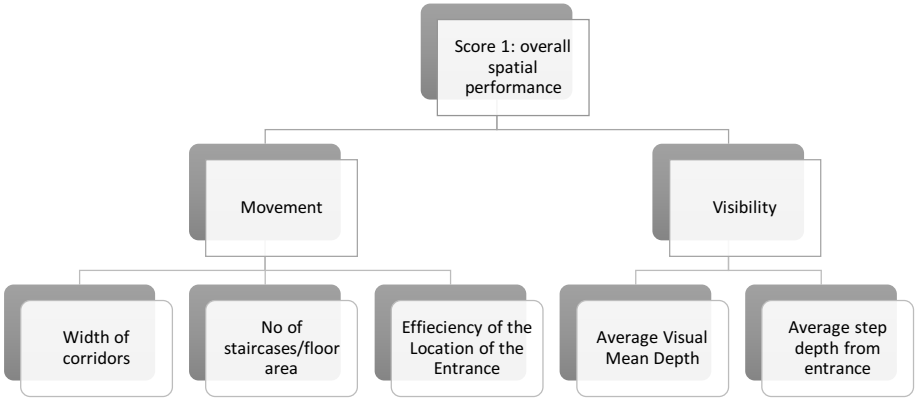


Figure 72: Score 1 Components

The overall performance of the building (score 1) (*figure 72*) is obtained as a compilation of two parameters: movement and visibility. To measure movement, three factors are being considered: width of the corridors, number of staircases per unit floor area and the efficiency of the entrance location (chapter 4 section 2.2.1). Visibility across the building is assessed through the average VMD of the building. Figure 73 shows the results for every school and figure 74 shows the ranking from 1 (most conductive to encounters) to 9 (least conductive).

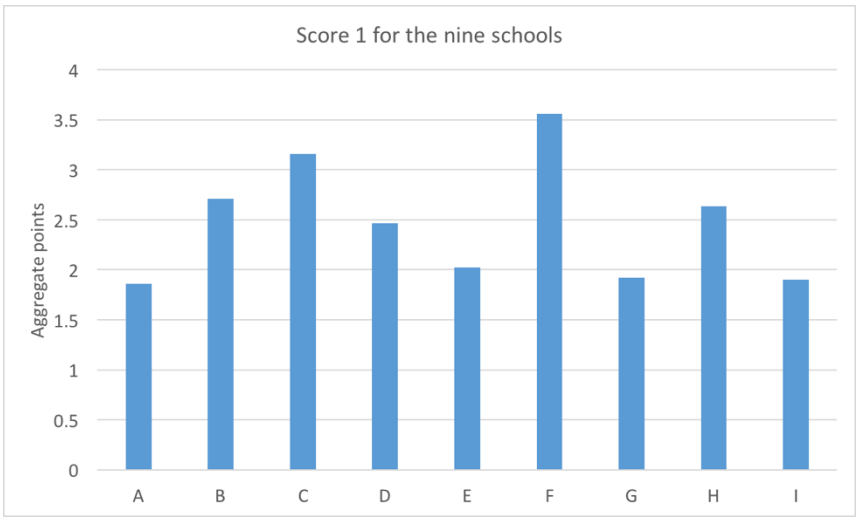


Figure 73: Score (1) The Resulting Score of Every School

SCORE (1)									
Ranking	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
School	A	I	G	E	D	H	B	C	F

Figure 74: Score (1) Ranking the schools

Score (2)

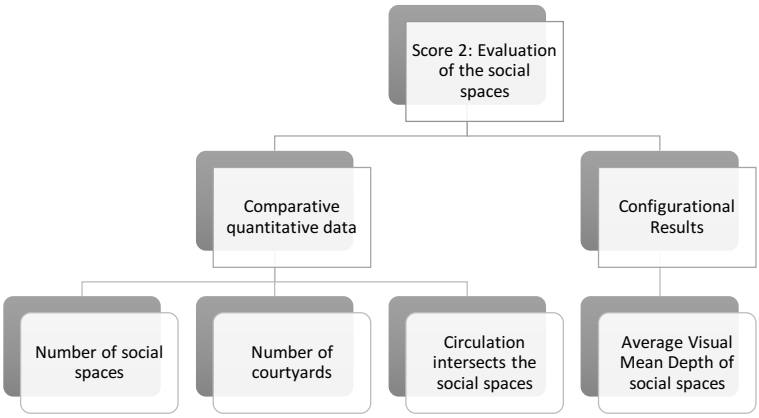


Figure 75: Score (2) components

Score (2) (*figure 75*) which is the evaluation of social spaces is quantified through two parameters: the comparative quantitative data of the schools (number of social spaces, number of atria and whether or not the circulation intersects the social spaces) and the configurational syntactic result (average visual mean depth of only the social areas). Figure 76 shows the results for every school and figure 77 shows the ranking from 1 (most conductive to encounters) to 9 (least conductive).

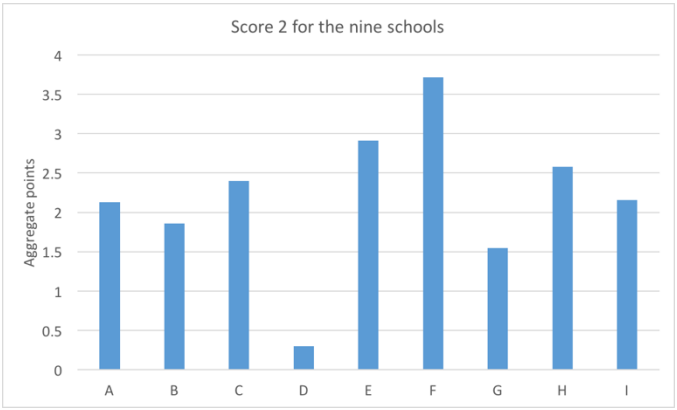


Figure 76: Score (2) The Resulting Score of Every School

SCORE (2)									
Ranking	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
	D	G	B	A	I	C	H	E	F

Figure 77: Score (2) Ranking The Schools

Score (3)

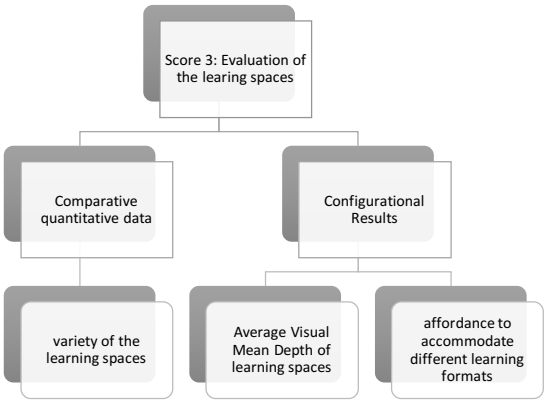


Figure 78: Score (3) Components

Score (3) (*Figure 78*), which is the evaluation of the learning spaces is quantified using the variety of learning spaces layouts (comparative quantitative data), the average visual mean depth of the learning spaces (configurational result) and the affordance of the learning spaces to accommodate different learning formats (chapter 4 section 2.2.4). Figure 79 shows the results for every school and figure 80 shows the ranking from 1 (most conductive to encounters) to 9 (least conductive). Finally, figure 81 presents the three scores.

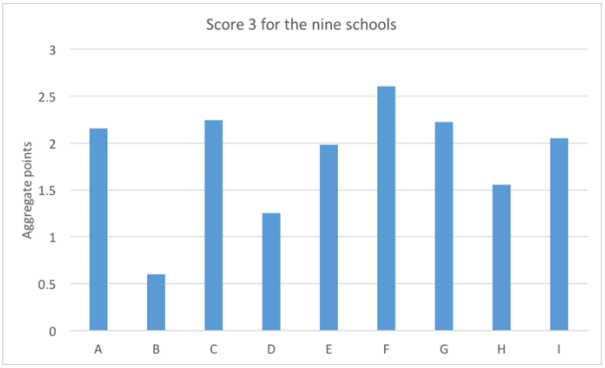
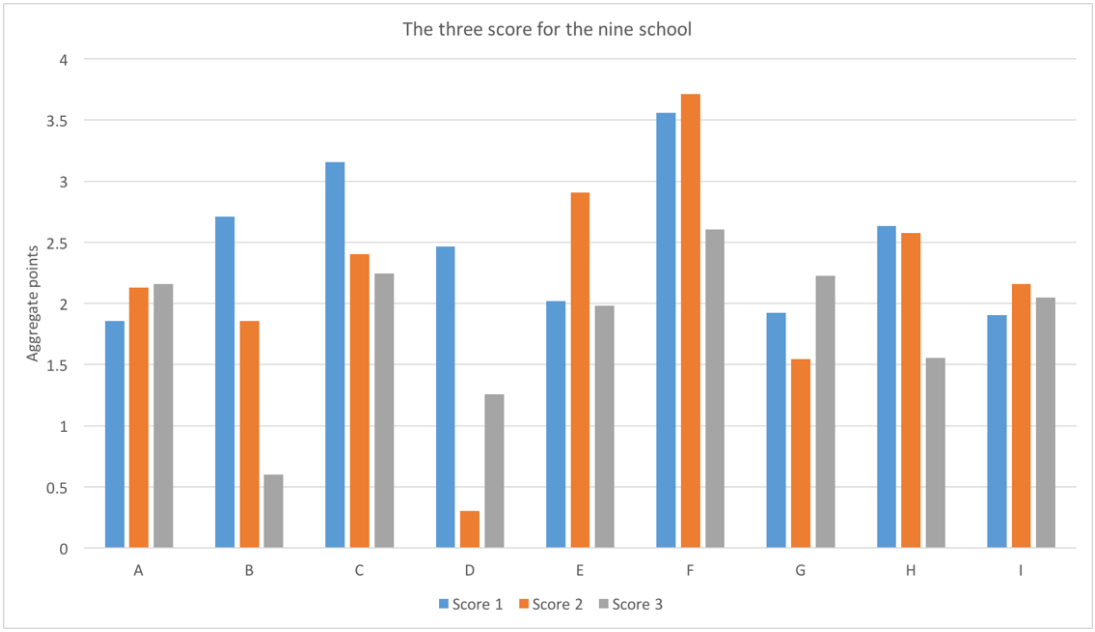


Figure 79: Score (3) The Resulting Score of Every School

SCORE (3)									
Ranking	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
	B	D	H	E	I	A	G	C	F

Figure 80:Score (3) Ranking The Schools From 1 to 9



	High Rank			Middle Rank			Low Rank		
Ranking	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
Score 1									
	A	I	G	E	D	H	B	C	F
Score 2									
	D	G	B	A	I	C	H	E	F
Score 3									
	B	D	H	E	I	A	G	C	F

Figure 81: Summary of All the Scores

5.3 The Correlations

Correlations between the resulting data sets in this research have two types. Firstly, testing students' performance (discussed in Chapter 4 section 1.2) against individual syntactic measures: (average VMD, average VMD of social spaces and average VMD of learning spaces) (*figure 82, 83 and 84*). Secondly, testing the performance of the students against the three scores (Chapter 5 section 2) (*figure 85, 86 and 87*).

5.3.1 Correlations Type I

	A	B	C	D	E	F	G	H	I
Students' Performance	3.27	1.92	2.165	3.115	0.96	1.49	3.37	1.755	0.92
Average Visual Mean Depth	4.05	3.59	4.04	3.11	4.45	4.79	3.64	3.99	4.47

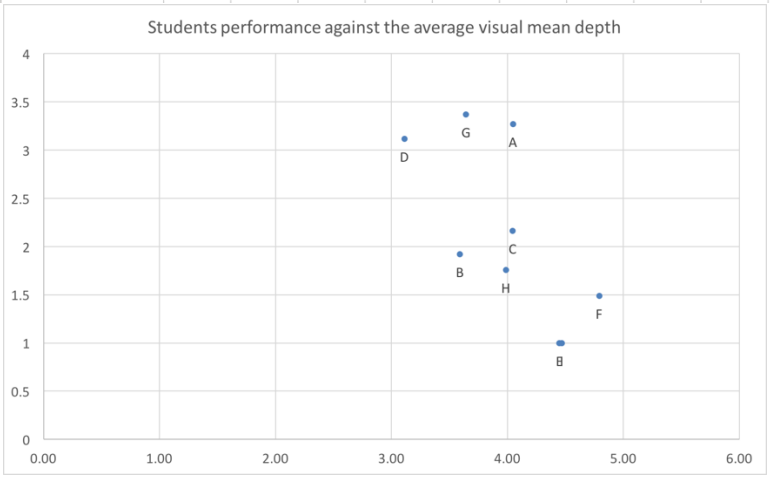


Figure 82: Students' Performance Against the Average Visual Mean Depth

	A	B	C	D	E	F	G	H	I
Students' Performance	3.27	1.92	2.165	3.115	1	1.49	3.37	1.755	1
Average Depth Social Spaces	3.67	2.93	3.77	2.91	3.9	5.54	2.31	4.18	4.49

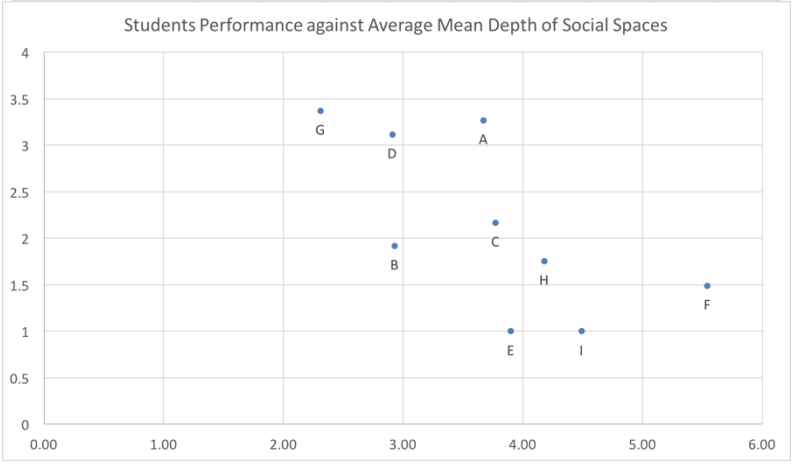


Figure 83: Students' Performance Against the Average Mean Depth of Social Spaces

	A	B	C	D	E	F	G	H	I
Students' Performance	3.27	1.92	2.165	3.115	1	1.49	3.37	1.755	1
Average Depth Learning Spaces	4.26	4.14	4.15	3.24	4.8	4.9	4.13	4.12	4.52

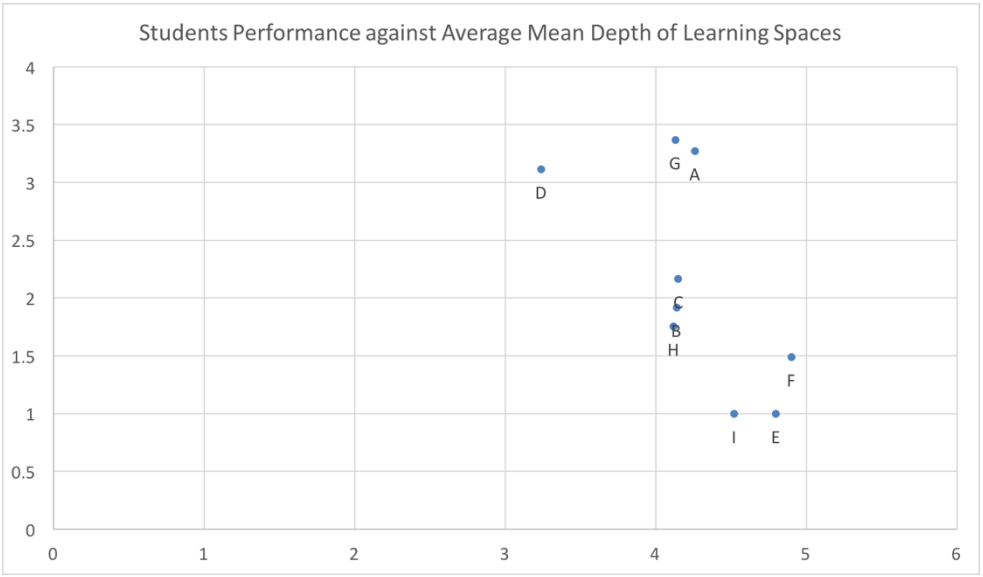


Figure 84: Students' Performance Against the Average Mean Depth od Learning Spaces

5.3.2 Correlations Type II

	A	B	C	D	E	F	G	H	I
Students' Performance	3.27	1.92	2.165	3.115	1	1.49	3.37	1.755	1
Score 1	1.86	2.71	3.16	2.47	2.02	3.56	1.92	2.64	1.90

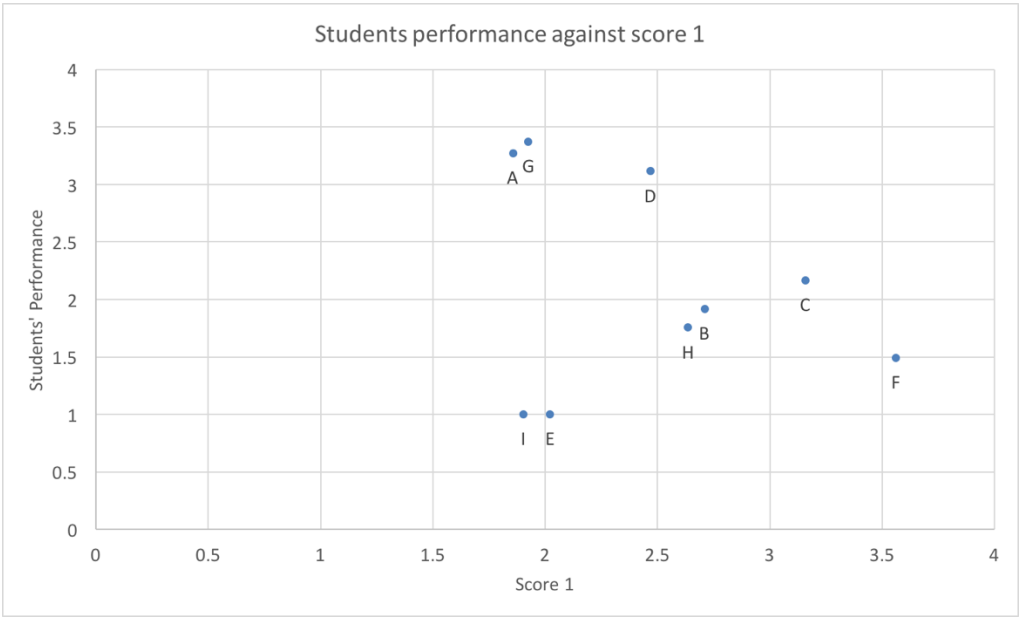


Figure 85: Students' Performance Against Score (1)

	A	B	C	D	E	F	G	H	I
Students' Performance	3.27	1.92	2.165	3.115	1	1.49	3.37	1.755	1
score 2	2.13	1.86	2.40	0.30	2.91	3.71	1.54	2.58	2.16

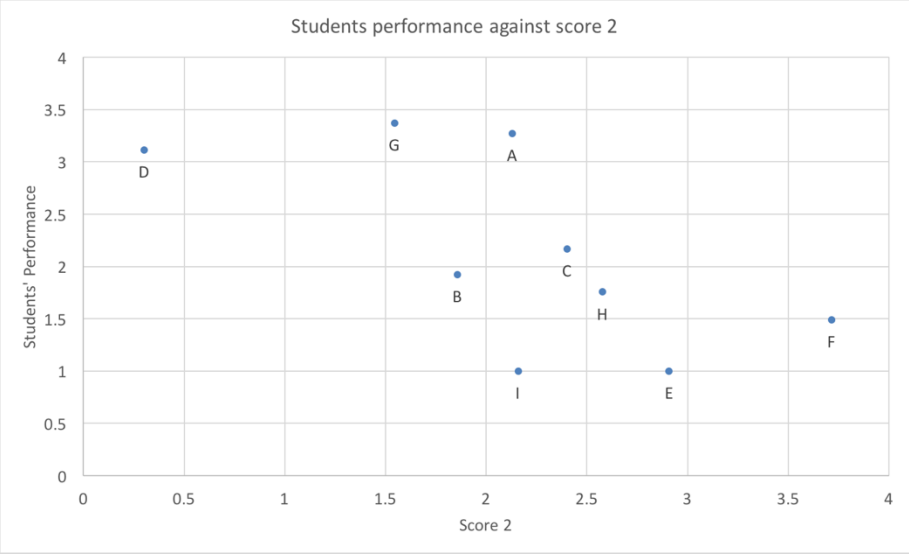


Figure 86: Students' Performance Against score (2)

	A	B	C	D	E	F	G	H	I
Students' Performance	3.27	1.92	2.165	3.115	1	1.49	3.37	1.755	1
score 3	2.16	0.60	2.24	1.26	1.98	2.61	2.23	1.56	2.05

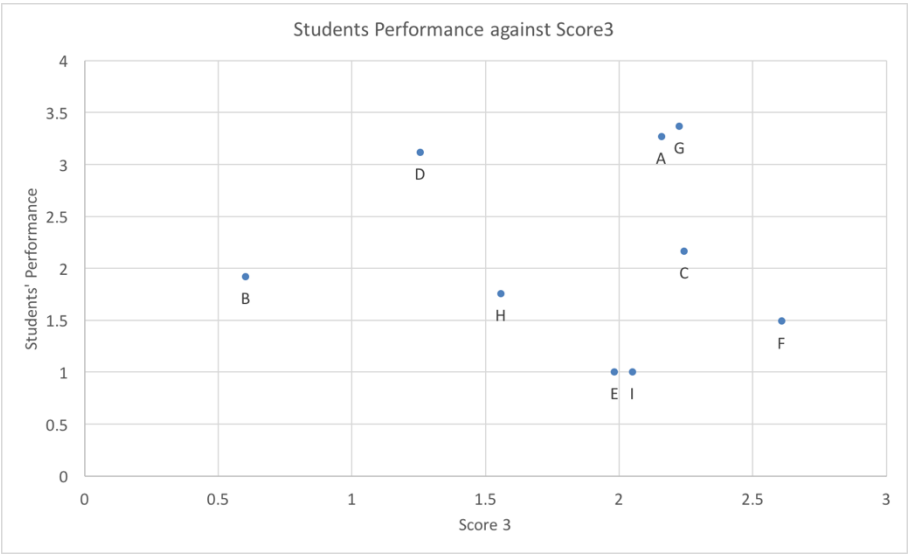


Figure 87: Students' Performance Against Score (3)

5.3.3 Results of all Correlations

The results (*figures 82 - 87*) are supported by calculating the P-value and R2 (*table 9*), in order to describe the correlation.

	P-value	Significance of correlation	R square	Strength
Type I				
Corr (AVG VMD and students performance)	0.033661982	Yes	0.497984013	Moderate
Corr (social VMD and students performance)	0.048147996	Yes	0.449404418	Moderate
Corr (learn VMD and students performance)	0.049567128	Yes	0.445300308	Moderate
Type II				
Corr (score 1 and students performance)	0.59429125	No	0.042573087	NA
Corr (score 2 and students performance)	0.064805153	No	0.406292118	NA
Corr (score 3 and students performance)	0.88569227	No	0.003165058	NA

Table 9: P-value and R2 for all the correlation

Firstly, for type (I) category, there is a significant correlation between the students' performance and the average VMD, VMD of the social spaces and VMD of the learning spaces which is moderately strong. For type (II) category, there is no correlation which suggests that there might be additional unconsidered factors that impacts the relation (some will be discussed in the future studies).

Studying the graphs, scores and the spatial analysis reveals the following observations. Firstly, school H is a moderate environment in terms of all the studies. It lands in the middle ranking of the VMD and its spaces lie over a wide range of the spectrum (variety of integrated spaces and other very enclosed and private ones). Revising its non-spatial parameters, they are all in the middle ranking. Finally, it has moderate results for the students' performance (4^{th}). Secondly, school I might not have a high visual evaluation due to the existence of some segregated areas that affected the overall result. However, when considering other spatial factors like movement (included in score 1), the spatial performance is significantly enhanced. The school lies in the middle range of the learning spaces score (2). School I is ranked first in the non-spatial parameters and the students' performance. Therefore, when the school spatial design and configurations are not holding back the learning process or obstructing the potential

socialisation patterns of the students, the overall environment is suitable and encouraging for the students to excel.

Moreover, concerning the results of school D, in spite of its overall good ranking (first in VMD, VMD of learning space and second in the learning score 3, with a relatively wide gap away from its closest competitors), it does not come in the first or even within the best four schools in terms of students' performance. Revising the schools' non spatial data shows that the students' level of deprivation is also the lowest, but the school is lagging in its management and quality of teaching. These results might give two major conclusions. Firstly, perfect learning spatial conditions (in terms of having a variety of learning spaces layouts) still do not compensate for deficiencies in school management systems and the quality of education being offered to the students. The second conclusion is that there is no correlation between the students' level of deprivation and their grades. It does have a share in the equation, but it does not dictate the level of achievement on its own.

6. Discussion: Implications of the School Design

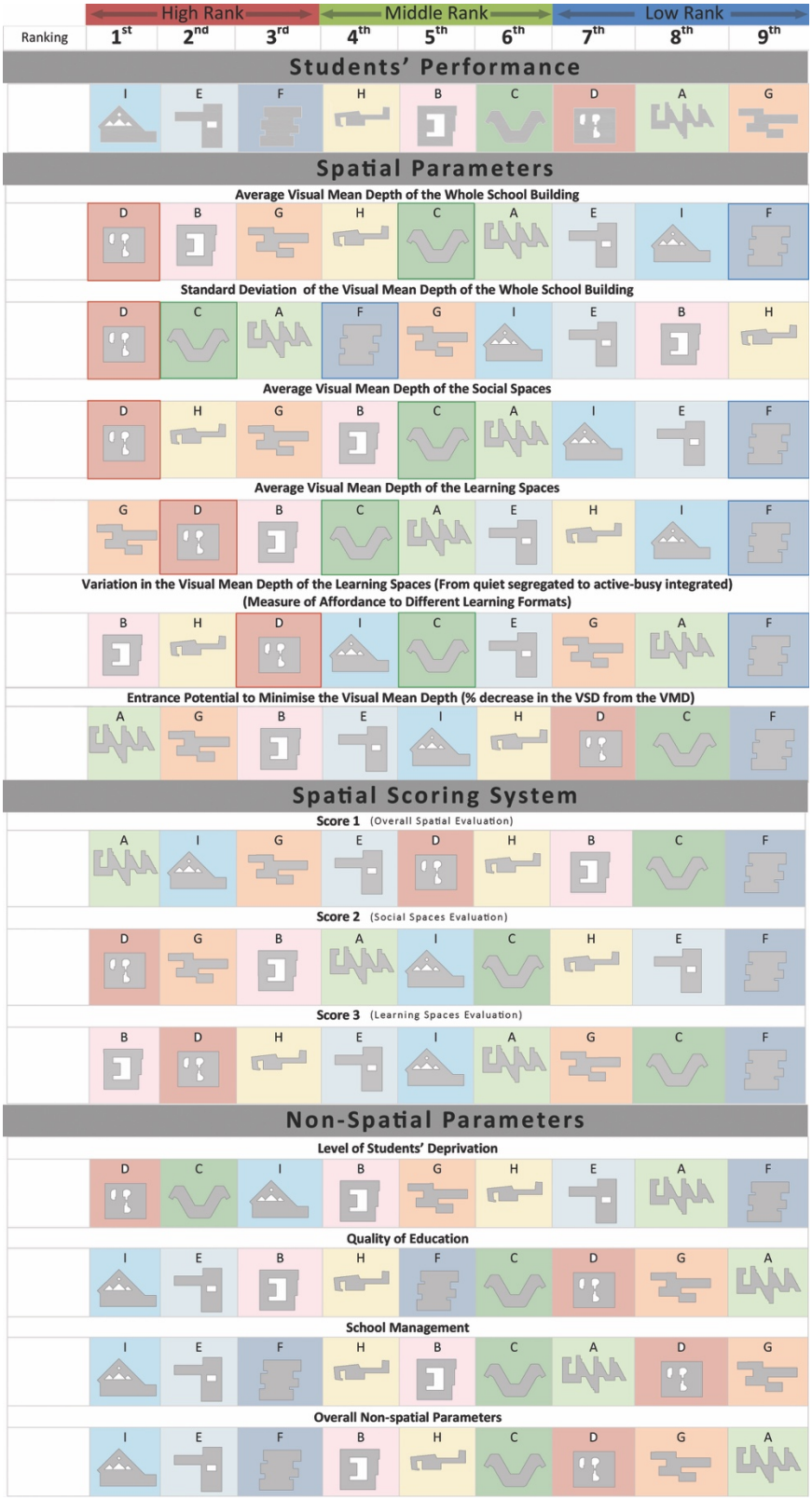


Figure 88: Summary of All The Data and Analysis

Various observations and conclusions will be discussed which are all based on the findings, the results and the spatial data of the nine school (*figure 88*). Although some conclusions might seem to be applicable on every school, still it is necessary to declare that this research is not trying to give general assumptions or absolute conclusions. The research finds out the spatial potential of the nine school buildings which might differ from the actual situation, but helps in understanding the implications of space on learning and socialising. Firstly, concerning the relation between space and the learning process, the results of the study suggests that extreme ends of the spectrum (very integrated and shallow vs very segregated and deep) are not good nor bad for the learning process, because it depends on what format of learning is being implemented, what the space is expected to provide and whether it can afford it or not.

The spatial design of school buildings leads to a relatively open (porous) plan design on the lower level with more connection to the outdoor space. These features allow for more visibility and permeability, as well as create a more pleasant environment for the users than the upper enclosed floors. However, the main learning spaces (which should be prioritised within a school plan) are concentrated on the upper floors. The is no spatial organisation that directly links the learning spaces to the social area (except school A and B). The previous statement does not mean that the learning spaces should be located on the ground floor, but they should be derived from the spatial need of the learning process. If learning is declared as “a social process where new insights are actively constructed in the mind of a learner through a mix of activities and processes” (Sailer, 2015, P.15), and if the school is interested in implementing a weakly framed learning methodology with much freedom to the learner (Bernstein, 1973), then openness, connectivity and flexibility are the spatial criteria for the learning spaces. Therefore, it is not recommended to implement the monotonous layout of learning spaces at the upper floors in the deepest, most segregated parts of the plan, only accessed through narrow corridors. Yet, if privacy and isolation are required for another learning format, then the upper floors are more convenient. The main point is that

allocation during the design process should not be based on the normal top-down zoning process (which is based on area fulfilment and checklists), but should respond to afford the learning process. In simple words, it should be derived from the needs of the learning process.

The size of a single learning space or their total area within a school does not correlate with the level of students' performance. Yet since governmental regulations favour class size around 18 students, the spatial design should consider this population as a guideline in deciding on the single area of a classroom. Moreover, the design should mainly consider the variety in types of learning spaces, as well as the variation in the VMD of the learning spaces, from active busy integrated spaces to quiet segregated spaces for high concentration, in order to increase the spatial potential to afford various formats of learning inside the school building.

Secondly, concerning the relationship between the spatial design, its configurations and the potential of students' socialisation, the form of the building can be considered as one of the factors affecting the socialisation patterns. This idea is not tackled from the aesthetics point of view, but rather from the concept that the form determines the possibilities of circulation, which then affects the movement patterns and encounters which in return formulate the social behaviours (Hillier 1996). For example, when the design of the circulation axis follows the general form/outline of the building, the resulting mean depth values are evenly distributed with less drastic changes across the floor plan (examples: School A and C). When one zone in the floor plan is attached to the other spaces through a single linkage, the visual segregation of the linking circulation results in amplified segregation of the internal spaces (example School G). Furthermore, circulation intersecting the social spaces increases the probability of encounters and thus encourages the development of students' social patterns.

In the end, it is crucial to mention that a courtyard/atria design makes a major difference in the overall openness and visibility across the school building, yet the degree of its contribution is purely dependent on how other spaces are configured in relation to the courtyard which is solely a design decision. Other important spatial components like circulation; its form, its degree of hierarchy (branching) and the distribution of the staircases all subsidise the spatial performance of the school building.

7. Future Studies

As much as this research has attempted to cover most of the topics related to the spatial potential of the school building in terms of the learning process and the students' socialisation, there are still other aspects that should be tackled. Concerning the learning process, the major role of the teachers in education commands a study of their spaces and how they relate to the rest of the building (*Figure 89* shows an idea). Another important study is to focus on the learning spaces, their layouts and furniture, which will impact the learning process taking place inside (*Figure 90, 91 and table 10*). As for the socialising potential, studying the dining and sports halls as main spaces of frequent gatherings will add to the understanding of the social potential within the school premises.

Figure 89: Staff Spaces Location

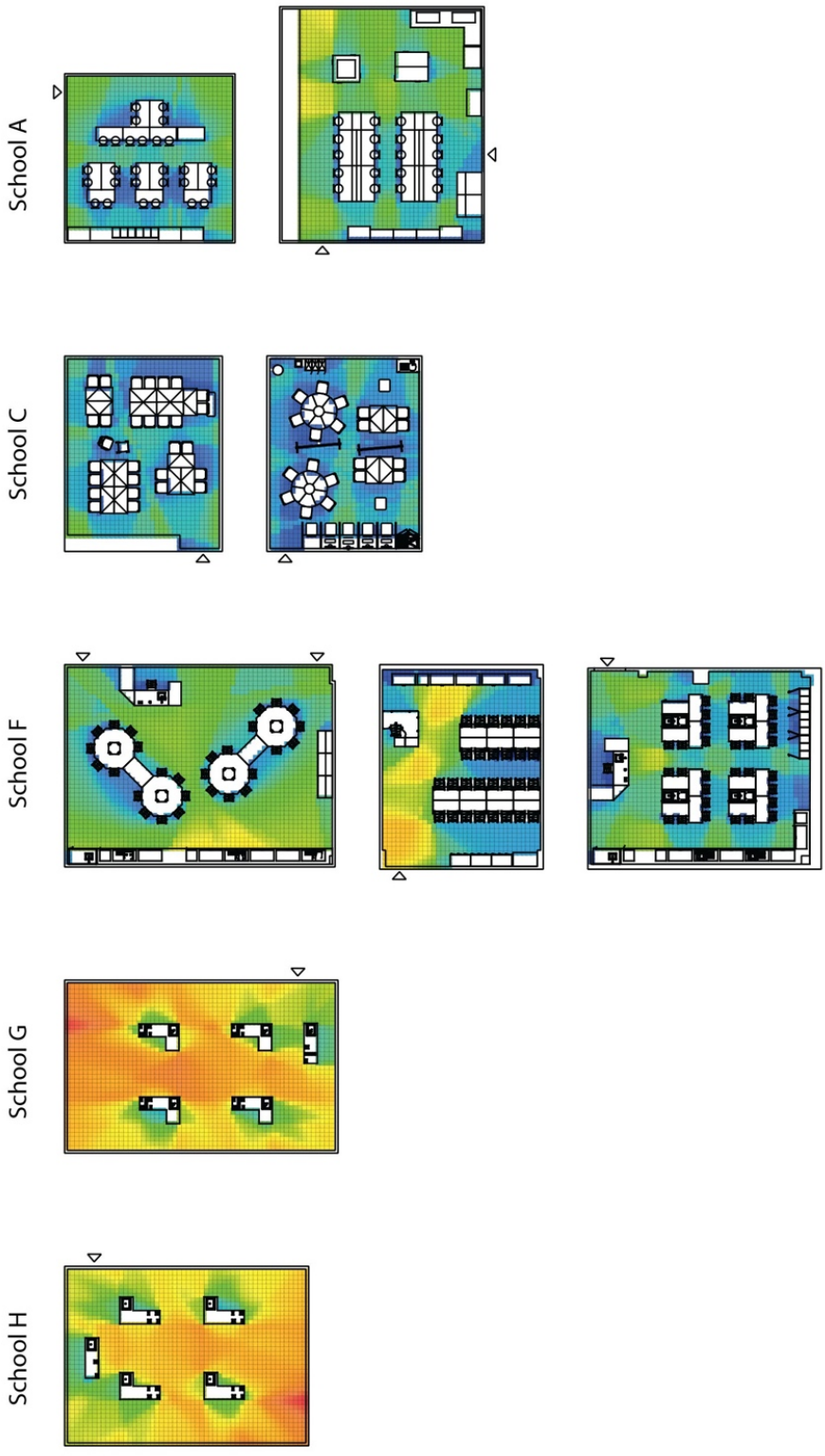


Figure 90: VMD of the Classrooms

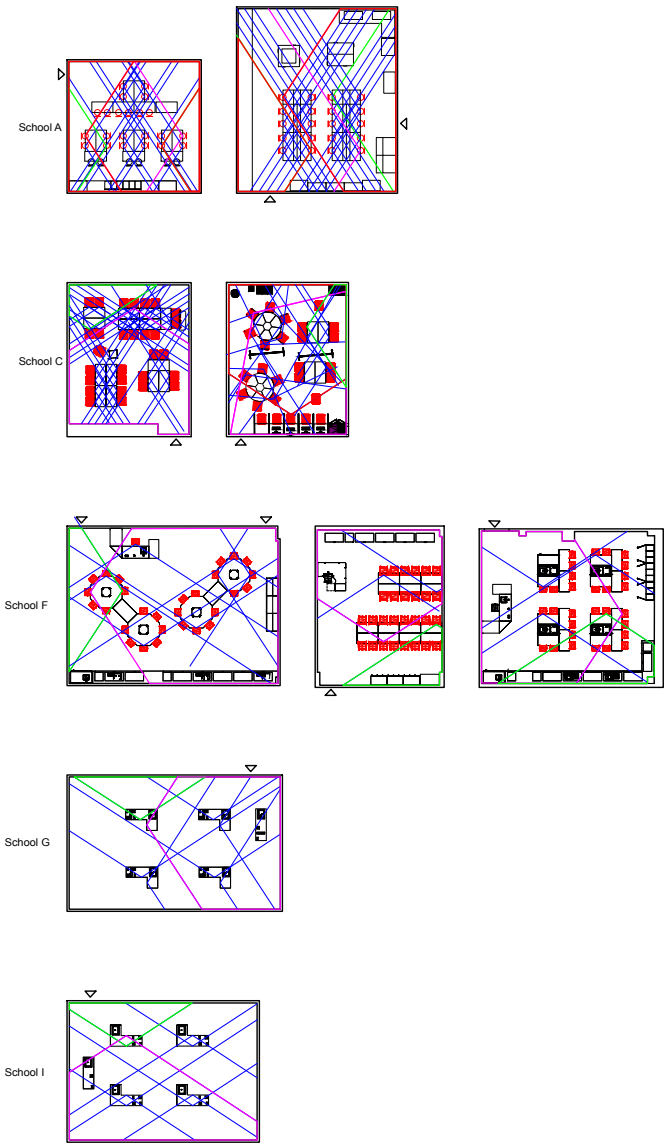


Figure 91: Drafting Student's Angle of Vision From Each Seating In The Classroom

	Small Classroom	Large Classroom	Recti Classroom	Circular Classroom	Circular Classroom	Linear Classroom	Recti Classroom	Lab	Lab
Number of students/room	28	20	28	27	24	28	30	8	8
Area of room	54.8	92.9	54.6	56.7	104.4	62.1	84.1	90.1	83
Maximum Area of vision from a student's seat	38.8	49	38	44	80.7	36.6	56.4	47.1	41.7
Maximum Percentage of vision	70.8029%	52.7449%	69.5971%	77.6014%	77.2989%	58.9372%	67.0630%	52.2752%	50.2410%
Number of other students seen from this seat	28	17.00	23.00	27.00	24.00	23.00	21.00	6.00	6.00
Percentage of other students seen from this seat	100.00%	85.00%	82.14%	100.00%	100.00%	82.14%	70.00%	75.00%	75.00%
Number of students with maximum vision	2	6	3	3	2	4	2	2	4
Minimum Area of vision	7	21	7.3	7.3	13.5	10	20.4	9	9.2
Minimum Percentage of vision	12.77%	22.60%	13.37%	12.87%	12.93%	16.10%	24.26%	9.99%	11.08%
Number of other students seen from this seat	3	5	4	5	6	4	8	0	0
Percentage of other students seen from this seat	10.71%	25.00%	14.29%	18.52%	25.00%	14.29%	26.67%	0.00%	0.00%
Number of students with minimum vision	2	4	2	1	1	2	8	2	4

Table 10: Quantitative data of the classrooms

8. Conclusion

Within the school building, the spatial dimension of students' learning cannot be studied without taking into consideration their socialisation patterns. They are inter-related for two main reasons. Firstly, space is mainly studied from a configurational/ organisational perspective not as spatial fractions each one on its own. It is a 'strongly relational system' (Hillier, 1996); socialising patterns are derived from the movement and encounters in the whole building, not monopolised to the social spaces but actually propagate everywhere including the learning spaces. Secondly, learning (according to contemporary theories of the learning process) is considered as a social process that takes place not just inside the classroom but everywhere in the school building including the socialising and gathering spaces (Sailer, 2015). Due to this inter-relation, this dissertation has developed a framework to describe and explore the spatial potential of the school building to stimulate students' socialisation patterns. It also investigated the potential of the school building to afford different learning formats according to the its spatial organisation. Within the case study of nine schools, the research has illustrated through configurational analysis and comparative studies of various spatial components that space (its design and organisation) is a key player in the social and the academic life of the students inside the school building. However, the spatial parameters on their own are not the only factors since there are other non-spatial parameters in the equation. The study highlights the impact of a courtyard on the visibility across the building. Furthermore, circulation is a primary contributor in the evaluation of the spatial performance of the building and it is heavily influenced by the form of the building, its degree of hierarchy (branching) and the distribution of the staircases in the floor plan. Finally, it is very important to mention how little variations in the building's design can lead to major differences in the configurations.

9. Appendix

All the non-spatial data compiled

	A	B	C	D	E	F	G	H	I
Is the school new?	0	0	0	0	1	0	0	0	1
Total number of pupils on roll	833	796	812	1097	630	1192	916	1163	375
Percentage of SEN pupils with a statement or EHC plan	2.3	2	3.2	1.4	1.4	3.3	2.2	1.7	1.6
Percentage of pupils with English not as first language	53.9	18	3.2	2.6	72.8	86.3	7.8	25.2	42.7
Percentage pupils with English as first language	46	82	96.8	97.2	26.7	13.7	92.2	74.7	51.7
Percentage of pupils eligible for FSM at any time during the past 6 years	78.6	53	53.7	35	30	71.3	66	67.2	21.9
Total Number of Classroom Teachers and Teachers in the Leadership Group (Headcoun	113	62	58	66	48	163	78	115	46
Total Number of Teaching Assistants (Headcount)	31	21	23	28	12	47	61	29	4
Total Number of Non Classroom-Based School Support Staff, Excluding Auxiliary Staf	49	23	22	40	19	40	51	55	5
Total Number of Faculty and Staff	193	106	103	134	79	250	190	199	55
Pupil:Teacher Ratio	8	13.1	14.3	16.9	13.2	7.5	12.5	10.3	12.3
Percentage of pupils achieving 5+ A*-C or equivalents including A*-C in both English :	40	63	47	53		74	33	46	
Percentage of pupils achieving 5+ A*-C or equivalents including A*-C in both English :	35	55	42	48		76	41	66	
Percentage of pupils achieving 5+ A*-C or equivalents including A*-C in both English :	29	46	42	47		83	24	63	
Percentage of pupils achieving 5+ A*-C or equivalents including A*-C in both English :	42	52	36	29		69	28	74	
AVG Scores 4 years	36.5	54	41.75	44.25	#DIV/0!	75.5	31.5	62.25	#DIV/0!
Average points score per GCSE entry per pupil (excluding equivalents)	33.7	35.4	34.9	33.5		42.6	28.8	43	
Management ofsted report grade	4	2	3	4	1	1	4	2	1

Calculating the non-spatial parameters

	A	B	C	D	E	F	G	H	I
Percentage of pupils with English not as first language	53.90	18.00	3.20	2.60	72.80	86.30	7.80	25.20	42.70
Percentage of pupils eligible for FSM at any time during the past 6 years	78.60	53.00	53.70	35.00	30.00	71.30	66.00	67.20	21.90
TOTAL DEPRIVATION out of 4	**2.65**	**1.42**	**1.14**	**0.75**	**2.06**	**3.15**	**1.48**	**1.85**	**1.29**
Rank DEP									
Quality of teaching ofsed %	4	2	3	4	1	2	4	2	1
Pupil:Teacher Ratio % (100%=18 according to gov standards)	44.44	72.78	79.44	93.89	73.33	41.67	69.44	57.22	68.33
Teaching Assistant:teachers ratio %	27.43	33.87	39.66	42.42	25.00	28.83	78.21	25.22	8.70
ALL RATIOS COMBINED OUT OF 4	1.44	2.13	2.38	2.73	1.97	1.41	2.95	1.65	1.54
TOTAL TEACHING QUALITY out of 4	**2.72**	**2.07**	**2.69**	**3.36**	**1.48**	**1.71**	**3.48**	**1.82**	**1.27**
MANAGEMENT PERFORMANCE %	**4**	**2**	**3**	**4**	**1**	**1**	**4**	**2**	**1**
ALL NON SPATIAL PARAMETERS SCORE	**3.12**	**1.83**	**2.28**	**2.71**	**1.51**	**1.95**	**2.98**	**1.89**	**1.19**
AVERAGE GRADE	36.50	54.00	41.75	44.25		75.50	31.50	62.25	
AVERAGE GRADE (INVERTED lower better)	63.50	46.00	58.25	55.75		24.50	68.50	37.75	
AVERAGE GRADE (INVERTED out of 4)	2.54	1.84	2.33	2.23	1.00	0.98	2.74	1.51	1.00
Edu ofsted %	4	2	2	4	1	2	4	2	1
STUDENTS' PERFORMANCE	**3.27**	**1.92**	**2.17**	**3.12**	**1.00**	**1.49**	**3.37**	**1.76**	**1.00**
Dep and quality of teaching	**2.68**	**1.74**	**1.91**	**2.06**	**1.77**	**2.43**	**2.48**	**1.84**	**1.28**

Corr Non-spatial and students' perfromance	R Square	P value
	0.9423	1.3747E-05

A. Total deprivation out of 4 = (% English not first language + %FSM)*4/200

B. Teaching Quality = (Ofsted quality of teaching + ((P:T + TA:T)*4/200))/2

C. School management = Ofsted report score

Non-spatial Parameters score = (A+B+C)/3

Note: another method of calculating the level of deprivation is to know the possibility of occurrence for a child to have English as a second language and a free school meal which is calculated through multiplying both values. The problem within this method is that for some schools, multiplying two small decimals will yield a very small number almost zero which is further reduced in the scale out of four. That is why this method

was not adopted. Both methods yield the same results in terms of ranking simply because (X+Y) is proportional to (X*Y)

Calculated school data

Number of Floors Having Educational Facilities (Excluding Mechanical/Electrical	2	3	2	3	4	3	1	4	4
Total Area of each School in sq.m	10889	15214	8085	17094	15039	10063	5712	14077	15310
Types of Educational Spaces	6	6	4	5	6	5		3	
Number of Different Socializing Spaces	2	5	3	6	4	2	4	5	4
Width of Corridors in metres (the longest corridor)	3	2.2	3	2.4	2.75	2	3.3	2.5	3.7
Number of Staircases	5	6	2	4	5	4	4	5	5
Shortest Distance between Staircases in metres	37	20	35	39	25.7	41	9	6	62
% of Indoor Spaces Area	100	74.3	100	95.3	62.2	94.31581039	100	89.95524615	98.46505552
% of Outdoor Spaces Area	0	25.7	0	4.7	37.8	5.684189605	0	10.04475385	1.534944481
Number of Courtyards and Atriums	4	1	1	4	1	2	0	1	3
Toilet zones / floor	6	5	2	3	3	2	4	3	5
Number of educational spaces	60	61	36	60	50	65	25	60	73
Average area of a single educational space	69.52	71.57	79.06	74.55	81.22	54.02	70.16	64.55	67.67

School Area division

	A		B		C		D		E		F		G		H		I	
Area Division: all in metres		%		%		%		%		%		%		%		%		%
Circulation	1404	15.97	4510.7	33.88	987.8	15.51	2601.3	22.26	1949	15.48	1262	17.89	1102	20.19	3604	31.36	2604	24.15
Vertical Circulation	108.5	1.23	313.7	2.36	86.3	1.36	700.4	5.99	649.8	5.16	211	2.99	27	0.49	449	3.91	476	4.41
Educational Spaces	4171	47.43	4365.7	32.79	2846.1	44.70	4472.8	38.28	4060.8	32.26	3511	49.78	1754	32.14	3873	33.70	4940	45.82
Educational Services	522	5.94	1111	8.35	433.8	6.81	319.8	2.74	998.7	7.93	359	5.09	168	3.08	161	1.40	128	1.19
Staff Spaces	575	6.54	617.3	4.64	283.7	4.46	1034.2	8.85	667.8	5.31	308	4.37	256	4.69	452	3.93	666	6.18
Toilets	294	3.34	497.7	3.74	149.4	2.35	513.2	4.39	365	2.90	215	3.05	257	4.71	361	3.14	283	2.62
General Services	602	6.85	520.3	3.91	436.3	6.85	472.9	4.05	357.1	2.84	233	3.30	484	8.87	603	5.25	580	5.38
Encounter/Socializing Spaces:	1117	12.70	1376	10.34	1143.4	17.96	1569.9	13.44	3538.9	28.12	954	13.53	1409	25.82	1990	17.31	1105	10.25
TOTAL AREA OF SPACES	8793.5	100.00	13312.4	100.00	6366.8	100.00	11684.5	100.00	12587.1	100.00	7053	100.00	5457	100.00	11493	100.00	10782	100.00
Eating Spaces	170	1.93	333.7	2.51	360	5.65	134	1.15	746.1	5.93	0	0.00	340	6.23	559	4.86	200	1.85
Sports Spaces	166	1.89	728.8	5.47	0	0.00	878	7.51	0	0.00	0	0.00	594	10.89	0	0.00	670	6.21
Gathering spaces	160	1.82	316.4	2.38	797.4	12.52	526.7	4.51	2792.8	22.19	370	5.25	354	6.49	723	6.29	0	0.00
Courtyards/atria	620	7.05	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	666	5.79	235	2.18
balconies	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	574	8.14	0	0.00	42	0.37	0	0.00

Scoring System

SCORE 1		A	B	C	D	E	F	G	H	I
Over all spatial performar	Movement	Width of corri (more better)	3	2.2	3	2.4	2.75	2	3.3	2.5	3.7
		Score out of 9	3	8	4	7	5	9	2	6	1
		log score corri	0.47712125	0.90308999	0.60205999	0.84509804	0.69897	0.95424251	0.30103	0.77815125	0
		location of entrance efficiency	40%	32%	19%	20%	32%	14%	32%	23%	29%
		score of 9	1	4	8	7	3	9	2	6	5
		log score	0	0.60205999	0.90308999	0.84509804	0.47712125	0.95424251	0.30103	0.77815125	0.69897
		number stair	5	6	2	4	5	4	4	5	5
		Floor Area	5502	8976	3971	5692	3693	4741	5712	4856	4385
		area/stairs (lower better)	1100.4	1496	1985.5	1423	738.6	1185.25	1428	971.2	877
		score out of 9	4	8	9	6	1	5	7	3	2
		log score	0.60205999	0.90308999	0.95424251	0.77815125	0	0.69897	0.84509804	0.47712125	0.30103
		total score movemnet	1.07918125	2.40823997	2.45939249	2.46834733	1.17609126	2.60745502	1.44715803	2.03342376	1
	Visibility	Visual mean depth AVG	4.05	3.58939846	4.04496409	3.11190195	4.44745315	4.79092369	3.64364703	3.98676454	4.46940188
		rank out of 9	6	2	5	1	7	9	3	4	8
		Log score Meandepth	0.77815125	0.30103	0.69897	0	0.84509804	0.95424251	0.47712125	0.60205999	0.90308999
		total visibility	0.77815125	0.30103	0.69897	0	0.84509804	0.95424251	0.47712125	0.60205999	0.90308999
		TOTAL SCORE 1	1.8573325	2.70926996	3.15836249	2.46834733	2.0211893	3.56169753	1.92427929	2.63548375	1.90308999
		Rank score out of 9	1	7	8	5	4	9	3	6	2

Score 2		A	B	C	D	E	F	G	H	I
Social Spaces Evaluation	comparative quantitative data	number of social sp	2	5	3	6	4	2	4	5	5
		rank out of 9	9	4	7	1	6	8	5	3	2
		score social sp count	0.95424251	0.60205999	0.84509804	0	0.77815125	0.90308999	0.69897	0.47712125	0.30103
		number of atria	4	1	0	4	1	0	0	1	4
		rank out of 9	3	6	9	1	5	8	7	4	2
		log score courty count	0.47712125	0.77815125	0.95424251	0	0.69897	0.90308999	0.84509804	0.60205999	0.30103
		scoial intersect circ	yes	yes	yes	yes	50%	no	yes	50%	50%
		score of 9	1	1	1	1	4.5	9	1	4.5	4.5
		log score corri con	0	0	0	0	0.65321251	0.95424251	0	0.65321251	0.65321251
		Total	1.43136376	1.38021124	1.79934055	0	2.13033377	2.76042248	1.54406804	1.73239376	1.25527251
	Social configura	Mean depth social	3.67	2.93	3.77	2.91	3.9	5.54	2.31	4.18	4.49
		rank out of 9	5	3	4	2	6	9	1	7	8
		Log score social depth	0.69897	0.47712125	0.60205999	0.30103	0.77815125	0.95424251	0	0.84509804	0.90308999
		total config	0.69897	0.47712125	0.60205999	0.30103	0.77815125	0.95424251	0	0.84509804	0.90308999
		TOTAL SCORE 2	2.13033377	1.8573325	2.40140054	0.30103	2.90848502	3.71466499	1.54406804	2.5774918	2.15836249
		Rank score out of 9	4	3	6	1	8	9	2	7	5

score 3		A	B	C	D	E	F	G	H	I
Learning Spaces Evaluation	comparative quantitative data	Variety of learning space	6	6	4	5	6	5	3	3	5
		rank out of 9	3	1	7	6	2	5	8	9	4
		log score var learn	0.47712125	0	0.84509804	0.77815125	0.30103	0.69897	0.90308999	0.95424251	0.60205999
	Learning config	Mean depth learning	4.26	4.14	4.15	3.24	4.8	4.9	4.13	4.12	4.52
		rank out of 9	6	4	5	1	8	9	3	2	7
		log score mean dp learn	0.77815125	0.60205999	0.69897	0	0.90308999	0.95424251	0.47712125	0.30103	0.84509804
		afford various learning formats	8	1	5	3	6	9	7	2	4
		log out of 9	0.90308999	0	0.69897	0.47712125	0.77815125	0.95424251	0.84509804	0.30103	0.60205999
		Total SCORE 3	2.15836249	0.60205999	2.24303805	1.25527251	1.98227123	2.60745502	2.22530928	1.5563025	2.04921802
		Rank score out of 9	6	1	8	2	4	9	7	3	5

10. References

Allen, R., Burgess, S., and McKenna, L., 2014. School performance and parental choice of school: secondary data analysis – research report [online]. Available from: https://www.gov.uk/government/publications/school-performance-and- parental-choice-of-school.

Barrett, P., Davies, F., Zhang, Y., & Barrett, L. (2015). The impact of classroom design on pupils' learning: Final results of a holistic, multi-level analysis. Building and Environment, 89, 118-133.

Bernstein, B. (1973). Class, Codes and Control. Volume 1: Theoretical Studies towards a Sociology of Language. St Albans: Paladin.

Blanchflower, D., & Oswald, A. (2004). Wellbeing over time in Britain and the USA. Journal of Public Economics, 88, 1359–1386

Brown, G. (2004). How students learn. A supplement to the Routledge Key Guides for Effective Teaching in Higher Education Series.

Day, C., & Midbjer, A. (2007). Environment and children: Passive lessons from the everyday environment. Oxford: Architectural.

Durkheim, E. (1893). The division of labour in society. New York: The Free Press.

Dutt, I. (2012). School design and students' relationships with the natural world. Children Youth and Environments, 22(1), 198-226.

Gibbons, S., & Silva, O. (2010). School quality, child wellbeing and parents' satisfaction. Economics of Education Review, 30(2), 312-331.

Gibson, J. J. (2014). The ecological approach to visual perception: classic edition. Psychology Press.

Hillier, B. (1996). Space is the machine. A configurational theory of architecture. Cambridge: Cambridge University Press.

Hinchliffe, P. D. (1973). Movement Problems in Comprehensive Schools. Journal of the Operational Research Society, 24(2), 235-240.

Jonassen, D. (1999). Designing Constructivist Learning Environments. In C. M. Reigeluth (Ed.), Instructional design theories and models: A new paradigm of instructional theory (Vol. 2, pp.215-239). London: Routledge.

Kishimoto, T., & Taguchi, M. (2014). Spatial Configuration of Japanese Elementary Schools: Analyses by the Space Syntax and Evaluation by School Teachers. Journal of Asian Architecture and Building Engineering, 13(2), 373-380.

Ofsted Governmental Report, (2015). School Inspection Handbook. London, p.1-74.

Pasalar, C. (2003). The Effects of Spatial Layout on Students' Interaction in Middle Schools: Multiple Case Analysis. PhD PhD, North Carolina State University, Raleigh.

Pasalar, C. (2007). Spaces for Learning Through Better Social Interaction. In E. Knapp, K. Noschis & C. Pasalar (Eds.), School Building Design and Learning Performance with a Focus on Schools in Developing Countries (pp. 51-60). Lausanne: Comportements.

Sailer, K. (2015). The spatial and social organisation of teaching and learning: The case of Hogwarts School of Witchcraft and Wizardry. In Proceedings of the 10th International Space Syntax Symposium (p. 34). Space Syntax Laboratory, Bartlett School of Architecture, UCL.

Shah, K. (2007). Architectural Quality in School Building Design: A view from India. In E. Knapp, K. Noschis & C. Pasalar (Eds.), School Building Design and Learning Performance with a Focus on Schools in Developing Countries (pp. 25-34). Lausanne: Comportements.

Tse, H. M., Learoyd-Smith, S., Stables, A., & Daniels, H. (2015). Continuity and conflict in school design: a case study from Building Schools for the Future. Intelligent Buildings International, 7(2-3), 64-82.

Vygotsky, L. S. (1994). The Socialist alteration of Man. In R. Van der Veer & J. Valsiner (Eds.), The Vygotsky Reader (pp. 175-184). Oxford, England: Blackwell Publishers.

Vygotsky, L. S. (1978). Mind in Society. Cambridge, MA: Harvard University Press.