A STUDY ON THE INDOOR ENVIRONMENTAL QUALITY OF HIGH SCHOOLS IN TIRANA. THE EFFECTS ON STUDENTS PERCEPTION.

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Approval sheet of the Thesis

This is to certify that we have read this thesis entitled

"A STUDY ON THE INDOOR ENVIRONMENTAL QUALITY OF HIGH SCHOOLS IN TIRANA. THE EFFECTS ON STUDENTS PERCEPTION.''

and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name Surname: Deamishel Hoxha

Signature: _____

ABSTRACT

A STUDY ON THE INDOOR ENVIRONMENTAL QUALITY OF HIGH SCHOOLS IN TIRANA. THE EFFECTS ON STUDENTS PERCEPTION.

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Since the beginning of the 2000's there has been a focus on a new aspect of architecture, the Indoor Environmental Quality. Shortly addressed as IEQ, this term refers to the quality of a building's environment in relation to the health and wellbeing of those who occupy space within it. It sums up all the physical conditions of an enclosed environment, which are separated into: thermal comfort, Indoor Air Quality (IAQ), aural comfort, visual comfort and acoustic comfort. Research indicates that the indoor environmental qualities of school classrooms have a major effect in the student performance and wellbeing. Factors such as temperature, humidity, CO2 concentration can play a major role in the interactivity and productivity of a student, especially the ones of younger ages. Most of the public high schools in Albania have been built decades ago without proper study of the conditions, furthermore there is an overcrowding of students in classrooms that causes congestion of the space. The aim of this study is to evaluate the conditions in which high school students expose themselves and to, compare them to the comfort standards then come to a conclusion of the effect it has on them. The study is composed of two main parts; firstly there will be used environmental sensors to keep track of the levels of temperature, humidity, CO2 and dew point, and then the students are given questionnaires to fill, to gather information about their situation in the classroom. The study takes place the months of May to June. Three schools with different characteristics (geographical position, demographic position, building materials) are chosen in the study. There is a prominent problem in the temperature during summer months, especially lack of ventilation and cooling supplies and air quality. This study presents a correlation between the

perceived IEQ and the factors that affect it, mainly building condition and urban context.

Keywords: *Indoor Environmental Quality, thermal comfort, aural comfort, relative humidity, dew point.*

ABSTRAKT

NJE STUDIM MBI CILESINE E AMBIENTEVE TE BRENDSHME TE GJIMNAZEVE NE TIRANE. EFEKTET NE PERFORMANCEN E STUDENTEVE.

Hoxha,Deamishel

Master Shkencor, Departamenti i Arkitektures

Udhëheqësi Assoc. Prof. Dr. Sokol Dervishi

Që nga fillimi i viteve 2000 ka pasur një fokus në një aspekt të ri të arkitekturës, Cilësisë së Ambientit të Brendshëm. Ndryshe i adresuar si IEQ, ky term i referohet cilësisë së mjedisit të një ndërtese në lidhje me shëndetin dhe mirëqenien e atyre që zënë hapësirë brenda saj. Përmbledh të gjitha kushtet fizike të një mjedisi të mbyllur, të cilat ndahen në: komoditeti termik, cilësia e ajrit të brendshëm (IAQ), komoditeti aural, komoditetin vizual dhe rehatia akustike. Hulumtimet tregojnë se cilësitë mjedisore të mjediseve të shkollave kanë një ndikim të madh në punën dhe mirëqenien e nxënësve. Faktorët si temperatura, lagështia, përqendrimi i CO2 mund të luajnë një rol të madh në interaktivitetin dhe produktivitetin e një studenti, veçanërisht ato të moshave të reja. Shumica e shkollave të mesme publike në Shqipëri janë ndërtuar disa vite më parë pa studim të duhur të kushteve, për më tepër ka një mbipopullim të nxënësve në klasa që shkakton mbingarkesë të hapësirës. Qëllimi i këtij studimi është të vlerësojë kushtet në të cilat nxënësit e shkollave të mesme ekspozohen dhe t'i krahasojë ato me standardet botërore, pastaj të arrijnë në përfundimin e efektit që ka mbi ta. Studimi përbëhet nga dy pjesë kryesore; së pari do të përdoren sensorë mjedisorë për të ruajtur nivelet e temperaturës, lagështisë relative, CO2 dhe depikes se veses, dhe pastaj nxënësve u jepet pyetësorë për të plotësuar, për të mbledhur informacion rreth gjendjes së tyre në klasë. Studimi zhvillohet në muajt maj-qershor. Tre shkolla me karakteristika të ndryshme (pozicioni gjeografik, pozita demografike, materialet e ndërtimit) janë zgjedhur në studim. Ekziston një problem i dukshëm në temperaturë gjatë muajve të verës, sidomos mungesa e furnizimeve të ftohjes dhe

cilësisë së ajrit. Klasat e mbipopulluara kanë nevojë për ventilim dhe kontroll të duhur të temperaturës.

Fjalët kyçe: *cilesia e ambientit te brendshem,komforti termal, komforti aural, lageshtia relative, pika e veses.*

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I would like to thank the principals and the very helpful staff of the three high schools I have included in my studies, Turgut Ozal High School, Wilson High School and Qemal Stafa High School. They have been vey professional and supportive with the ongoing of my studies. I would also like to thank the students who have shown great responsibility in filling the questionnaires and looking after the monitoring devices in the classrooms.

This has been a long and rewarding journey of five years that have shaped who I am today, both academically and personally. Now that my studies came to an end I would like to recognize the passion and professionalism that all of our professors have shown in teaching us and creating with us architecture students. I am particularly grateful to have followed my Master's Thesis with my mentor Assoc.Prof.Dr. Sokol Dervishi. It is an honour to work with somebody who is so educated, informed and passionate about the topic and very willing to share knowledge and give advice. The dedication my professor showed to my master's thesis has given me a very positive mindset throughout the whole process.

Lastly, I would like to thank my family for being my backbone and inspiration and my family for having helped me pursue my dreams and encouraged me to keep going even when I had my bad days.

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CHAPTER 1

INTRODUCTION

In this chapter is included a brief overview of the reasons why the topic was chosen and the objectives of the thesis. Furthermore it is included a brief overview of the scope of works and the organization of the thesis.

1.1 Problem statement

Children usually spend their time mostly in indoor environments. Although the hours spent are not the same in each country, all children spend 5 days a week (Monday to Friday) in school. If the building is problematic, it may expose them to thermal issues and/or to contaminants that might be present in the air of the classrooms. Indoor environmental quality (IEQ), is determined by factors and by pollutants developed indoors and also outdoor environment. Schools environments have been studied in comparison to offices or other buildings (Wargocki, et al., 2005) but unlike adults, children may sometimes be unable to properly channel the problem and clearly express it by themselves. Compared to adults, children are more prone to illnesses generated by pollutants in the environment, due to the fact that their bodies are still developing and do not have high resistance. Childrens developing lungs breathe in a higher volume of air in relation to their body weight compared to adults. (Cartieaux, et al., 2011). School buildings are usually built with lower operation funds than other buldings, so they may present more indoor environmental quality problems. (Mendell & Heath, 2005)

Some of the factors which impact indoor air quality are molds, particles, formaldehyde, bacteria, allergens, and volatile organic compounds.(Zhao, et al., 2008). This makes proper ventilation a crucial factor affecting IEQ of buildings. Mechanical ventilation is known to reduce the amount of pollutants that may enter from outdoors.

The age of the building is might be an indicator of the IEQ, but may not always be correct. It is common sense that old buildings may not have proper ventilation or heatings systems, while a new or a newly renovated building, may have may have a better mechanical ventilation system that reduces the amount of pollutants brought inside with air. Proper insulation may be lacking or degraded in some old construction, thus the environment is more exposed to cold (Espejord, 2000). Cosntruction materials vary according to the year of construction and the funds available for it. However, materials used for building construction

also play an important role in the IEQ, even in new buildings there might be particles that release toxic particles. Some materials that affect IEQ, found in Old School buildings are asbestos and lead (Flynn, et al., 2000).

'Air pollutants are responsible for a wide array of health problems. The main factors that define the problem are the duration of time and frequency for which the person is exposed to the pollutant, the type and toxicity of the pollutant and of course the amount of pollutant.' (Nandasena et al., 2010). Some of the health problems that are a consequence of indoor environmental pollutants happening to children, include asthma and allergies, breathing difficulties, pneumonia and other respiratory tract infections or problems. This may affect the students' performance at school. 'Unhealthy children tend to perform worse in school and the health problems might persist or get worse as the person gets older. Poor health comes usually from lower economical status and it can be a factor for dangerous behaviors when the person is grown. (Eide, et al., 2010).

1.2 Thesis objective

This thesis aims to extend the knowledge on the existing state of the indoor environmental quality of schools in Tirana. School buildings around Albania have always been problematic, due to the fact that most of them are old buildings. However, in the last 5 years, reconstruction of many schools is happening, and also new schools are being built. For the purpose of this study 3 relatively new school buildings, two of which have been build in the last five years and onw of which has been totally reconstructed during the same time, have been chosen. The study does not aim to consider schools which are already known to be in a miserable condition, but to rather consider new buildings and see how the construction methods have resulted. The 3 schools are located in three very different contexts thoughout Tirana, however all of them have a similar problem with overheating during the summertime, while the environment is generally more comfortable during winter months. This is due to the fact that these buildings do not posess any cooling devices, but also the ventilation is lacking. This study aims to measure the deviations that the classrooms have when compared to the standart optimal conditions of temperature, relative humidity and dew point.

1.3 Scope of works

The work starts with a thorough literature review, which has been gathered from reliable online articles and libraries. After the literature review, starts the process of gathering information about different school buildings in Tirana, until the decision for which schools to study is made. 3 high schools in Tirana will be taken into study. The high schools have very similar caracteristics in building design but are located in different urban contexts. After permission has been given by the respective authorities of each school, work continues with the questionnaires. Approximately 110 questtionaires are spread in each school, in different grade 10 clasrooms. These questionnaires aim to gather information about the level of comfort students experience in their classrooms. One classroom is chosen out of each school for conducting further study. A data logger device is placed in each one of the three classrooms, to keep track of the temperature and relative humidity of the ambient for 3 weeks. After three weeks the devices are gathered and the data is analyzed in computers. The final work is developing a correlation between the factors that affect IEQ and the way students perceive it, trying to understand what can improve the situation and answering the thesis questions.

1.4 Organization of the thesis

This thesis is divided in 5 chapters. The organization is done as follows:

In Chapter 1, the problem statement, thesis objective and scope of works is presented. Chapter 2 is a review of all the most relevant writings on the opic of the master's thesis. In Chapter 3, you may read a more detailed methodology that was used for this master's thesis. In Chapter 4, are the results and explenations of the study. In Chapter 5, conclusions and recommendations for further research are stated.

CHAPTER 2

LITERATURE REVIEW

The chapter of literature review is the result of months of thorough research in the school library and on the internet. To make the concepts easier to understand the literature review chapter is divided into nine sections that describe the different elements and factors of IEQ and other studies made on the topic.

2.1 Elements of the the IEQ.

Indoor environmental quality (IEQ) refers to the quality of a building's environment in relation to the health and wellbeing of those who occupy space within it.Indoor Environmental quality is made up of a resulting sum between physical, chemical and biological actors. Pollutants in the chemical classification are considered to be the products created by combustion like machinery fuels, Volatile Organic Compounds and gases (CO2, CO, O3, SO2, NOx, etc) (Dales, et al., 2008). Biological pollutants are from nature or animals.They are considered to be allergens, dust, bacteria and moulds. The physical factors of indoor environment quality are the easiest to percept out of the abovementioned. They enhance the experience of the body in a certain environment. Physical conditions are considered to be, temperature, humidity, air pressure, air movement, air humidity. These factors can combine with the indoor factors in creating the perceived IEQ.

2.2 Factors affecting IEQ

Climate, construction of the building, building occupants, mechanical systems and pollutants (microbes, excessive moisture, construction materials, and pollutants coming from the outdoor environment) are some of the factors that affect IEQ. Human generated odours, like cosmetic products, body odour, cleaning products, waste production etc, affect the overall IEQ of a place, especially smaller areas. Pollutants coming from the building system include asbestos, volatile organic or inorganic carbons, old HVAC systems that bring in dirt and light

particles, system leaks. The contaminants that come from outdoors include fume from vehicles, pollen from plants, waste emission, dirty air etc. (US EPA., 2010).

2.2.1. IEQ and Ventilation

Ventilation is to provide a space with fresh air by causing air flow throughout it. Ventilation process by which 'clean' air (normally outdoor air) is intentionally provided to a space and stale air is removed, by natural or mechanical means, to or from any room. Ventilation is the exchange between indoor and outdoor air. This is a helpful tool in removing excessive moisture, odour and contaminants as well as bringing fresh air from the outside to keep a balance of comfort. It can be done naturally, or mechanically. Natural ventilation is possible to be optimized by opening windows for outside air to circulate the indoors. Mechanical ventilation systems circulate fresh air using ducts and fans, rather than relying on natural airflow. It is done with the usage of air handling unit (AHU) which cleanses outside air that will go indoor by removing the contaminants present in it. Some of the different types of mechanical ventilation systems are: a) mechanical exhaust ventilation, in which a fan continually extracts the right amount of air from the indoor environment thus keeping it clean, and b) mechanical supply and exhaust ventilation system, where fans continually introduce and also extract the air from indoors.

Improper ventilation is associated with short-term illneses, inflammations of the air tracts, asthma and respiratory problems. A study implemented in Shanghai,China, on 10 naturally ventilated schools, came to the final conclusion that asthma symptoms in students were happening because the polluted air from traffic was let inside the classes. (Mi, 2006). Poor ventilation systems may also become a source of odorous and congested air.

2.2.2 IEQ and Building Condition

With technology and construction methods that are always evolving, it is clear new buildings have different characteristics from the old ways of construction. These differences and the age of the building, and the materials used for construction, have a large impact on the indoor environmental quality. Usually old buildings have problems with asbestos or moulds, and ventilation systems, if present, may be not properly functional, but most of the time only

windows are used. On the other hand new buildings tend to have proper ventilation and isolation, and less degradation.

However new buildings might also present problems. A study that took place in Sweden and involved eight primary schools discovered high levels of Microbial Volatile Organic Compounds and plasticizers in new buildings, which bere being emmited from the materials used for construction.(Kim, et al., 2007).

BRI, meaning building-related illnesses are a group of illneses that are caused by being exposed to a certain problematic environment consistently. These include complaints of specific symptoms such as cough, chest tightness, fever, chills, allergies and muscle aches which may require a long recovery time and also risk to become chronic to the person subjected. BRI symptoms and patterns are as follows: complaints of specific symptoms like, chest tightness, fever, chills, and muscle aches and breathing or cough irritation. They are evident even long after the occupant no longer visits the place. There are four ways of how BRI agents can cause illness;toxic, immunologic, irritant or infectious,. Some of these factors may need more than one mechanism to be filtered.

Sick building syndrome (SBS) is a very common phenomenon in schools. It can also occur in new buildings. Sick Building Syndrome is used to describe a situation in which the occupants of a building experience acute health- or comfort-related effects that seem to be linked directly to the time spent in the building. No specific illness or cause can be identified. (Saijo, et al., 2011).

2.2.3 IEQ and Thermal Comfort

Thermal comfort is the condition of mind which expresses satisfaction with the thermal environment and is assessed by subjective evaluation. This comfort is a resultant of the body's heat exchange with the environment (ASHRAE standard 55, 2004). This directly effects a person's total environmental contentment, wellbeing, and performance in the activities (Van Hoof, et al., 2010) The indoor temperature that is seen as an optimal for thermal comfort should be about 24-26 degrees Celsius (Andersen and Gyntelberg, 2011).

The main parameters that affect thermal comfort are:air temperature,mean radiant temperature,air speed, relative humidity,activity (metabolism),clothing andsubjective factors.

(ASHRAE standard 55, 2004). Comfort is increased in air-conditioned and ventulatedrooms. Increased air exchange can make an improvement in the air quality and thermal comfort (Cartieaux, et al., 2011).

2.2.4 IEQ and Dew Point.

Dew point is the atmospheric temperature (varying according to pressure and humidity) below which water droplets begin to condense and dew can form.

In high temperatures, the human body naturally produces sweat to cool itself down and this cooling effect is directly related to the time it takes for the sweat to evaporate. This time and rate that perpiration takes to dry is dependent on the amount of moisture that is in the air. If the air is saturated with moisture, evaporation will be slower and the human body will be more uncomfortable.

As the air surrounding one's body is warmed by body heat, it will rise and be replaced with other air. If air is moved away from one's body with a natural breeze or a fan, sweat will evaporate faster, making perspiration more effective at cooling the body. The more unevaporated perspiration, the greater the discomfort.

Discomfort also exists when the dew point is low. Dry air sucks moisture from the skin caysing it to dry up and crack. It will also dry out the respiratory airways and eyes.

Table 1 *comfortability related to dew point.*

Temperature of dew point	**Level of comfort**
Higher than 26°**C**	Severely high. Serious problems for asthma related illneses
24-26°**C**	Extremely uncomfortable
21-24°**C**	Very humid, bearable
18-21°**C**	Somewhat comfortable
16-18°**C**	Comfortable for most people
13-16°**C**	Comfortable for all
10-12°**C**	Very comfortable
Lower than 10°**C**	Starts to feel dry and worsens.

2.3 Affect of IEQ in humans.

The tools that are created to measure the factors of IEQ are all based in the comfortability of the human body. A person, even though they might be unable to clearly identify surrounding environmental issues, has a general feeling of comfort when the parameters of the environment are optimal. Under optimal conditons, people are healthier and generally more energized and productive. On the other hand, if there are issues with the indoor environmental quality, complications from discomfort, to more serious illneses may arise.

2.3.1. Health and IEQ

Studies have proved that the quality of indoor air which contains contaminants at an increased concentration will aggravate existing health conditions such as asthma, allergies or cause simpler symptoms such as headaches and cough (Flynn et al., 2000). The pollutants found indoors may be chemical or biological. Moulds, Bacteria, VOCs, POMs (particle bound organic matter), and micro particles have been confirmed as a catalyst of health problems amidst school children (Cartieaux, et al., 2011). Biological contaminants can aggravate existing asthma or allergies (Dales, et al., 2008).

Lung function in youg ages can be affected by environmental or chemical contaminats such as tobacco smoke or fumes. (Dales, et al., 2008). Two other components that cause problems for children, creating asmathic traits are Microbial Volatile Organic Compounds and plasticizers .(Kim, et al., 2007). When there is no thermal comfort in classrooms of young children there may rise problems such as headaches, eye and respiratory illnesses, stomach problems and drowsiness. (Andersen & Gyntelberg, 2011).

2.3.2. IEQ and Student Academic Performance

There many studies made on IEQ and its link on student performance.

A study carried out in U.S.A found a considerable association between improper ventilation and student performance in classrooms. it studied 50 schools in a new district in USA. One random room was studied for each school. The CO2 levels were measured for two days. The general building information and the HVAC systems were studied. Structural details and use of materials were an important input. Apart from the ventilation rates and air comfort, thermal comfort was also studied. It used 3 components in its methodology, sensor input, questionnaire, academic test results. This study finalized with a modest link with students who had better IEQ performing better in schools. (Shaughnessy, et al., 2006). A study that was implemented later, also claimed substandard ventilation in classrooms was found to have a linear relationship with performance (Haverinen-Shaughnessy, et al., 2011)

SeonMi Choi (2014) The purpose of this study was to investigate the relationship between indoor environmental quality (IEQ) in a set of university classrooms and students' outcomes, i.e., satisfaction with IEQ, perceived learning, and course satisfaction. Data collected from students (N = 631) of University of Minnesota were analysed to test a hypothesized conceptual model by conducting a path analysis. Findings suggested that IEQ of the classrooms, such as thermal conditions, indoor air quality, acoustic conditions, lighting conditions, furnishings, aesthetics, technology, and view conditions, was associated with positive student outcomes. Implications for classroom design were discussed with suggestions for future research.

(M.C. Lee et al 2011) This study investigates the relationship between Indoor Environmental Quality (IEQ) and learning performance in air-conditioned university teaching rooms via subjective assessment and objective measurement. Together with the data of air temperature, relative humidity, air speed, mean radiant temperature, CO2 concentration, equivalent sound pressure level, horizontal illumination level, occupant activity and clothing insulation level measured in four classrooms and four large lecture halls, self-reported learning performance (in calculating, reading, understanding and typing) and perceived IEQ are evaluated. The study also reveals that all IEQ complaints have similar impact on learning performance and there is a good correlation between learning performance and the number of complaints.

Fadeyi et al (2014) This study presents findings of indoor environmental quality (IEQ) investigations conducted in elementary schools′ classrooms in the United Arab Emirates (UAE). High occupancy density was observed in majority of the studied classrooms. Observations during walkthrough investigations could be used to explain measured IEQ data. Poor IEQ conditions in the studied classrooms highlight the need for further research investigation to understand how poor classrooms′ IEQ condition could influence students′ health, comfort, attendance rate, and academic performance.

CHAPTER 3

METHODOLOGY

3.1 Overview of the study and hypothesis.

The teaching and learning process has always got room for improvements. One thing that can be architecturally studied is the indoor environmental quality which consists of Thermal Conditions, Indoor Air Quality, Acoustic Conditions, (Lighting Conditions, Furnishings, Aesthetics, Technology, Vibration Conditions, and View Conditions. It is known that there is a relation between student performance and IEQ, but not exactly to what extent. This paper is focused mainly on the temperature and air quality of one chosen classrooms in three different schools.

The hypotheses presented by this paper are:

1. During the summer months, due to the lack of cooling systems the indoor environmental quality is not comfortable.

2. The measured IEQ conditions are reflected in the students' questionnaires.

3. The urban context directly effects the IEQ.

4. The classroom student density directly effects the IEQ.

3.2 Selecting the schools and the classrooms.

This part of the study is the very beginning and is a crucial step, which will heavily influence the results. In general, many school buildings in Albania are in a deteriorating state. Within the time the latest political party is in force, reconstruction of old schools and construction of new buildings has been taking place and is being planned for the future. The three schools chosen

for this study are the Qemal Stafa High School, the Turgut Ozal High School and the Wooldrow Wilson High School in Tirana. All of these institutions have been built (Turgut Ozal, Wooldrow Wilson), or reconstructed (Qemal Stafa), during the same period of time around the year 2015. They have very similar building characteristics as shown in the following table.

Table 2. Physical characteristics of chosen high schools.

School name	Turgut Ozal	Qemal Stafa	Wilson
Construction year	2014	2016	2015
Construction material	Brick, concrete,steel	Brick,concrete,steel	Double brick wall, concrete,steel
Façade	Double glass windows	Double glass windows	Double glass windows
heating	Central heating radiators	Central heating radiators	Central heating radiators
ventilation	Natural (window)	Natural (window)	Natural (window)

There are two main differences between the schools. Firstly, Qemal Stafa is the most populated school out of the three, with approximately 10 more students per classroom compared to the other two schools. Secondly, the schools are located in very different urban contexts (figure 1).

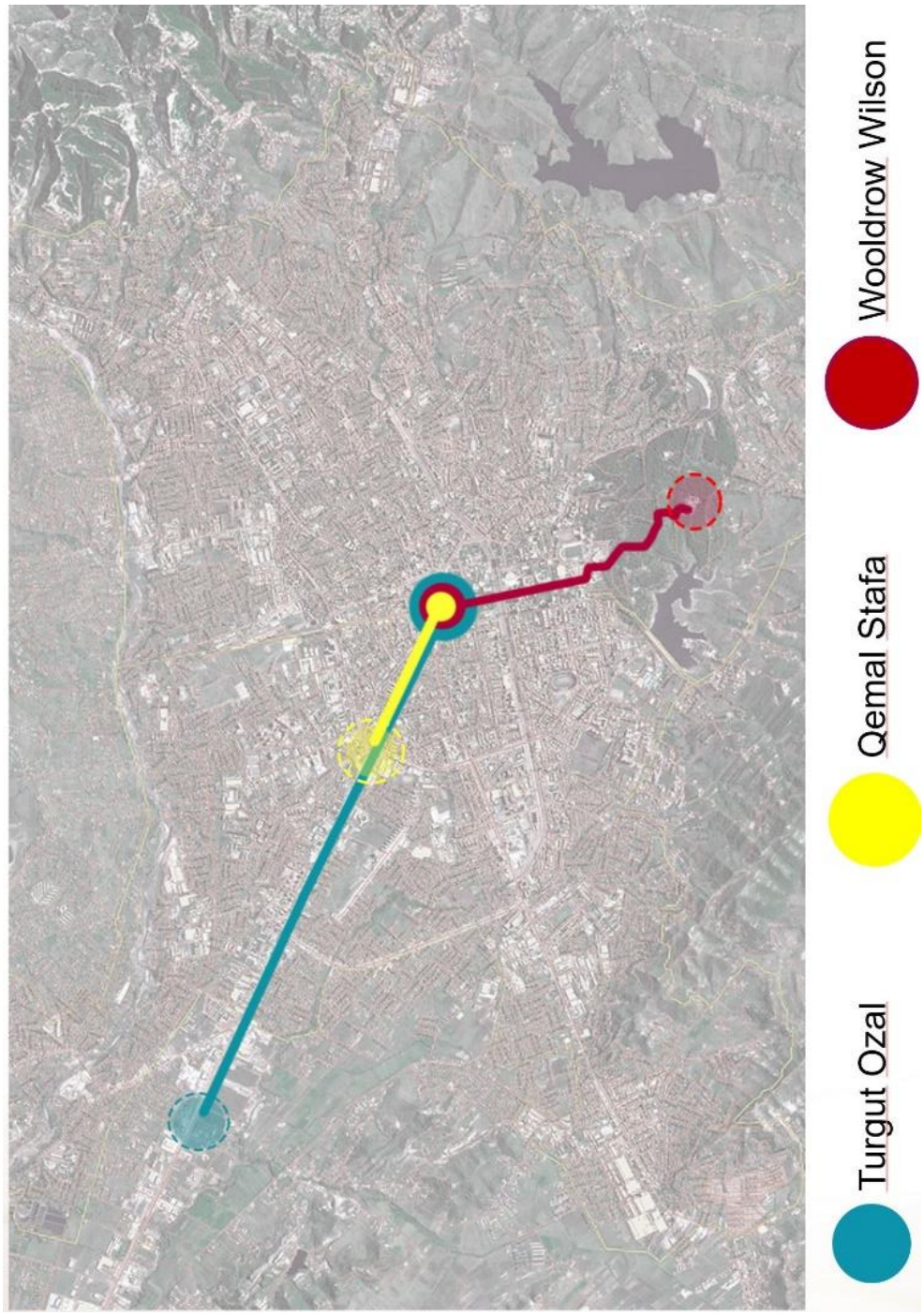


Figure 1. Proximity to center .

Woldrow Wilson High school is located in a forested area of the city. (Figure 2).

Qemal Stafa is located in the heart of the city, a very urbanized and congested space.(Figure 3)

Turgut Ozal is located in the suburbian area near the highway. (figure 4)

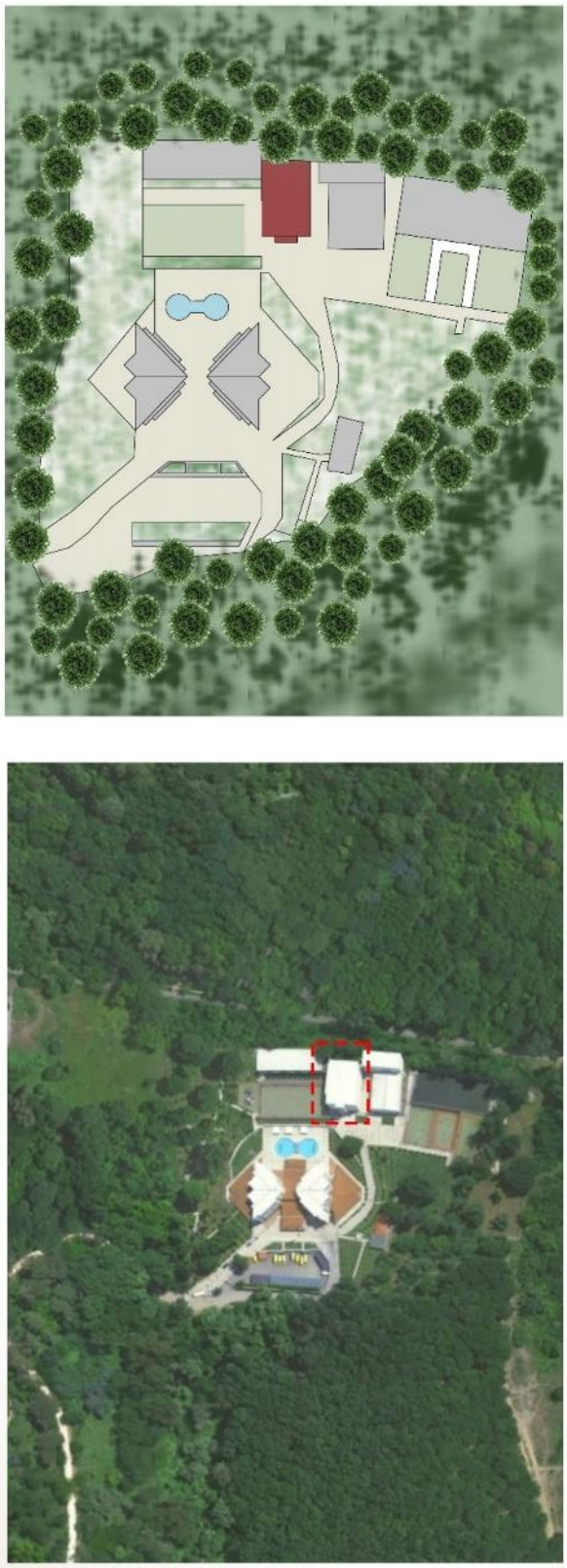


Figure 2*-Location of Wilson High School*

Figure 3*-Location of Qemal Stafa High School*

Figure 4*-Location of Turgut Ozal High School*

3.3 Gathering data by the questionnaires.

Questionnaires for this research are used to gather information about the perception off the indoor environmental quality of selected classrooms. The sample size is about 100- 120 questionnaires per each school, approximately 4 different classrooms. The questionnaires are formulated into 3 different sections, one for the seasonal comfort in winter, one for the seasonal comfort during summer and one for the current state of being. The questionnaires are made using the likert 5 scale,from -2 which is *'completely disagree'* to +2 which is *'completely agree'*. The answers from the questions are then translated into exel data and graphs. They are anonymous, and only ask questions regarded to health and well being within the classroom. The questionnaires are created keeping in mind the main principles of ethical issues is studies (refer to appendix).

3.4 Monitoring by data loggers.

After the questionnaires are analyzed and the proper classrooms are chosen, in three selected classrooms there will be installed data loggers which measure temperature, relative humidity and dew point. Data will be gathered over a three weeks period in May and June. The tools used are by Voltsoft Company. This data will be collected once in the end and it will be compared to the students' answers, do they reflect the presumptions made by seeing the digital data.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Questionnaire results.

Approximately about 100-120 questionnaires were spread out in each school. A first attempt with the questionnaires was made in March but there were spread out only about 30 questionnaires in each schools so the results could not be completely reliable. Together with the pedagogic staff the decision was made to widen the sample size, in order to be able to have a generic idea of the IEQ of the entire school. I specifically chose other classrooms with different geographic orientations, to broaden the study. New questionnaires were handed in the beginning of May 2018. The questionnaire was created by using the 5 scale Likert model. The answers were calculated by looking at the mean and medium values of each classroom, then looking at the school as a whole.

4.1.1 Turgut Ozal High School questionnaire results.

From the questionnaires spread out at Turgut Ozal High School, 93 of them were usable for the purpose of this study. The four classrooms studied show quite similar test results. In general there is a general sense of satisfaction throughout the winter months, but problems throughout the summer months with the heating. Turgut Ozal had the highest number of students suffering respiratory illneses such as asthma or sinusitis, approximately 30% of students questioned.

In the following tables is the content of each of the classrooms studied in the questionnaire.

class 10.B	Pjesa e dyte					Pjesa e trete					Pjesa e katert						
	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 6	Pyetja nr. 7
Mean	0.894737	-0.15789	0.947368	-0.15789	-0.84211	-0.57895	-0.26316	-0.26316	-0.10526	-1	0.684211	0.578947	-0.52632	-0.15789	-0.10526	1.157895	0.631579
Mode	2	0	2	1	-2	-1	-1	-2	2	-2	1	0	-2	-1	-2	2	0
Standard Deviation	1.32894	1.167293	1.223551	1.384965	1.462994	1.464991	1.407997	1.593114	1.523692	1.452966	1.293257	1.017393	1.428613	1.384965	1.663154	1.118688	1.164785
Minimum	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Maximum	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Count	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19

class 10.C	Pjesa e dyte					Pjesa e trete					Pjesa e katert						
	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 6	Pyetja nr. 7
Mean	1	0.333333	0.933333	-0.06667	-2.8	-0.8	-1.4	-1.06667	0.133333	-0.46667	0.066667	1	-1.33333	0	-0.13333	1.2	0.666667
Mode	1	1	1	0	-2	-2	-2	-2	0	-2	1	2	-2	1	1	2	2
Standard Deviation	0.845154	1.175139	1.032796	1.032796	5.401058	1.373213	0.985611	1.162919	1.355764	1.641718	1.279881	1.069045	0.9759	1.195229	1.45733	1.014185	1.290994
Minimum	-1	-2	-1	-2	-22	-2	-2	-2	-2	-2	-2	-1	-2	-2	-2	-1	-2
Maximum	2	2	2	2	1	2	1	1	2	2	2	2	1	2	2	2	2
Count	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15

class. 10D	Pjesa e dyte					Pjesa e trete					Pjesa e katert						
	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 6	Pyetja nr. 7
Mean	-0.21053	-0.42105	0.157895	0.263158	-0.26316	-0.78947	-1.21053	-0.94737	0.157895	-0.68421	0.210526	0.684211	-1	-0.73684	-0.36842	0.473684	0.210526
Mode	-1	-1	0	0	0	-2	-2	-2	0	-2	0	1	-2	-1	-1	0	1
Standard Deviation	1.084176	z	0.764719	1.407997	1.284182	1.228321	0.854982	1.129094	1.30227	1.108183	1.031662	1.056863	0.942809	0.805682	1.42246	1.073334	1.134262
Minimum	-2	-2	-1	-2	-2	-2	-2	-2	-2	-2	-1	-1	-2	-2	-2	-1	-2
Maximum	2	2	1	2	2	2	1	1	2	1	2	2	0	1	2	2	2
Count	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19

class 10.G	Pjesa e dyte					Pjesa e trete					Pjesa e katert						
	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 6	Pyetja nr. 7
Mean	0.611111	0	0.666667	0.666667	0.111111	-1.61111	-1.27778	-1	0.666667	0	0.055556	0.666667	-0.61111	-0.38889	-0.72222	0.166667	-0.05556
Mode	1	0	1	2	0	-2	-2	-2	2	-2	1	1	0	0	-1	0	0
Standard Deviation	1.036901	1.236694	1.455214	1.283378	1.367217	0.697802	0.751904	1.084652	1.283378	1.644957	1.433721	1.084652	1.195033	1.144752	1.319784	1.424574	1.161754
Minimum	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Maximum	2	2	2	2	2	0	0	1	2	2	2	2	2	2	2	2	2
Count	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18

***Figure 5** Questionnaire results for the separate turgut ozal classrooms*

Due to the similarity in the response from the questionnaires the decision for choosing a classroom from Turgut Ozal College was made based on the sun path. Since the study is based on temperature, the chosen classroom is oriented to south where it will get the most sun exposure. One classroom was chosen for futher study (Classroom 10 D). (fig6)

Figure 6 *Chosen classroom for turgut ozal high school*

4.1.2 Wilson High School questionnaire results.

There were 55 reliable questionnaire answers from the Wilson High School. 3 classrooms were studied in total in this school. The classrooms at Wilson also show similar results within one another. Out of 55 students only 2 claim to have respiratory problems, particularly asthma. The students' answers have shown that the environment does not give them headaches or respiratory problems. Also the students claim to be very content with the environment during all seasons.

9	Pjesa e dyte					Pjesa e trete					Pjesa e katert						
	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 6	Pyetja nr. 7
Mean	1.12	1.12	0.94	-0.35	-1.00	0.88	0.94	0.88	-0.82	-1.59	1.35	1.29	-1.06	0.71	1.29	1.18	0.76
Mode	2	2	2	-2	-2	2	2	2	-2	-2	2	2	-2	2	2	2	1
Standard Deviation	1.11	1.05	1.20	1.54	1.32	1.17	1.25	1.36	1.47	0.94	1.17	1.10	1.30	1.40	1.21	1.07	1.30
Minimum	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Maximum	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2
Count	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17

10	Pjesa e dyte					Pjesa e trete					Pjesa e katert						
	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 6	Pyetja nr. 7
Mean	1	-0.1	-0.65	0.85	0.55	0.8	0.7	1.35	0.75	0.45	1.25	1.05	-0.5	0.95	0.8	1.35	1.3
Mode	2	-2	-2	0	2	2	2	2	2	1	2	2	-2	2	1	2	2
Standard Deviation	1.12	1.55	1.53	1.09	1.50	1.28	1.34	1.14	1.45	1.47	1.02	1.15	1.50	1.15	1.32	1.09	1.03
Minimum	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Maximum	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Count	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20

11	Pjesa e dyte					Pjesa e trete					Pjesa e katert						
	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 6	Pyetja nr. 7
Mean	0.94	1.35	1.29	0.88	0.94	1.30	-0.50	-0.35	-0.65	1.00	-0.10	1.29	1.18	0.80	0.70	1.29	-0.65
Mode	2	2	2	2	2	2	-2	-2	-2	2	-2	2	2	2	2	2	-2
Standard Deviation	1.20	1.17	1.10	1.17	1.25	1.03	1.50	1.54	1.53	1.12	1.55	1.21	1.07	1.28	1.34	1.21	1.53
Minimum	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Maximum	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Count	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16

Figure 7 *Wilson High School questionnaire results*

The classroom chosen at Wilson High School was also oriented to North, it was the 9th grade of the school. Classrooms located to the south were used for lab classes.

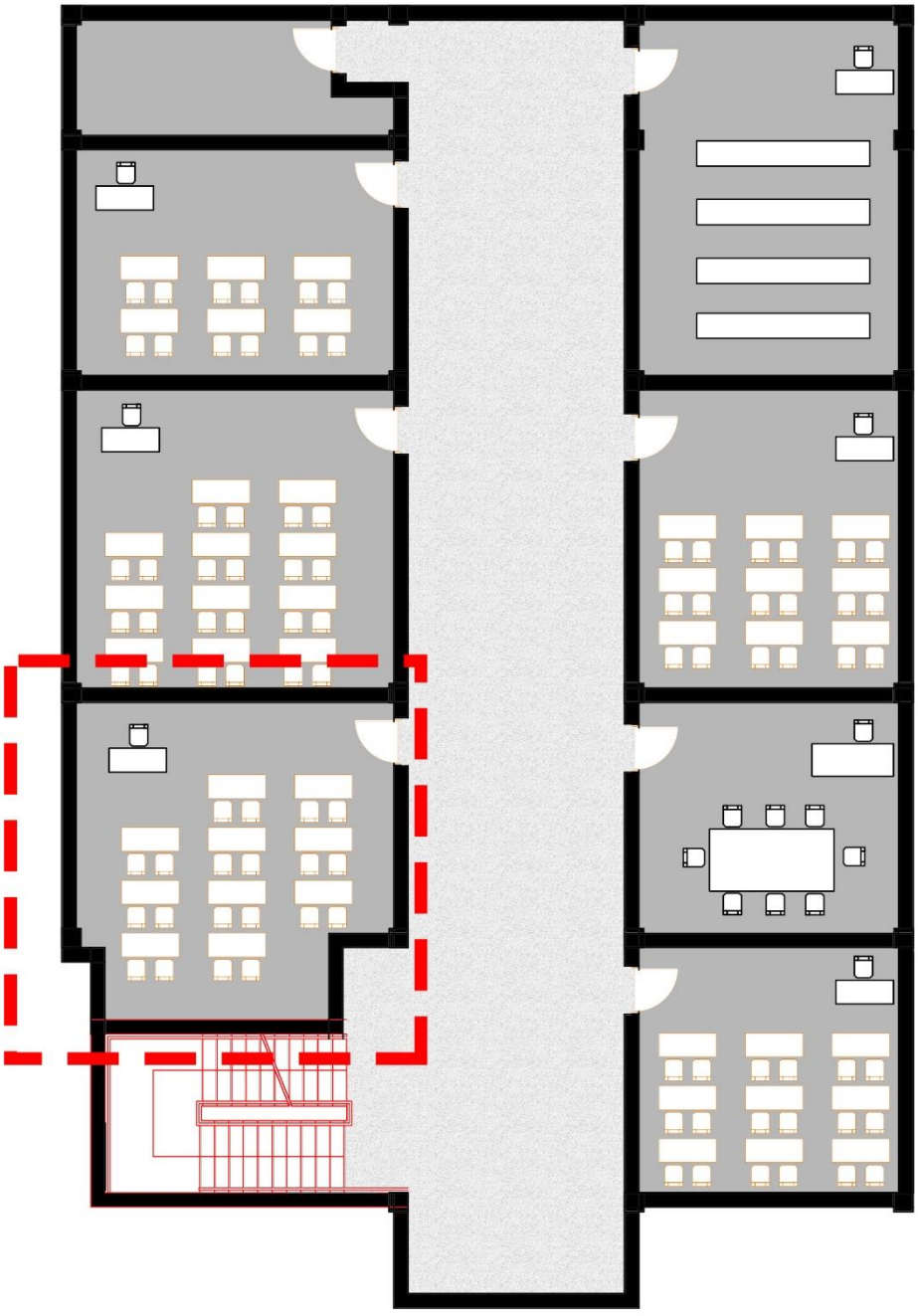


Figure 8 *Wilson High School chosen classroom*

4.1.3 Qemal Stafa High School questionnaire results.

Out of the questionnaires spread out at Qemal Stafa High School, 120 of them were usable for the purpose of this study. The four classrooms studied show quite similar test results. In general there is a general sense of satisfaction throughout the winter months, but problems throughout the summer months with the heating. The number of students suffering respiratory illneses such as asthma or sinusitis, approximately 24% of students questioned.

In the table is the content of each of the classrooms studied in the questionnaire.

The classroom chosen at Semal Stafa School is at the east of the school.

Figure 9 *Qemal Stafa High School Chosen Classroom*

	Pjesa e dyte					Pjesa e trete					Pjesa e katert						
	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 6	Pyetja nr. 7
Mean	0.48	-0.04	-0.11	-0.19	-0.48	-0.63	-0.96	-0.70	0.00	-0.56	-0.07	1.07	-1.41	-0.41	-0.19	0.41	0.00
Mode	1	0	0	0	0	-1	-1	-2	1	0	0	1	-2	0	-2	1	0
Standard Deviation	1.22	0.98	1.37	1.33	1.12	1.28	1.09	1.20	1.54	1.22	1.17	1.14	0.89	1.19	1.55	1.28	1.24
Minimum	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Maximum	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2
Count	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27

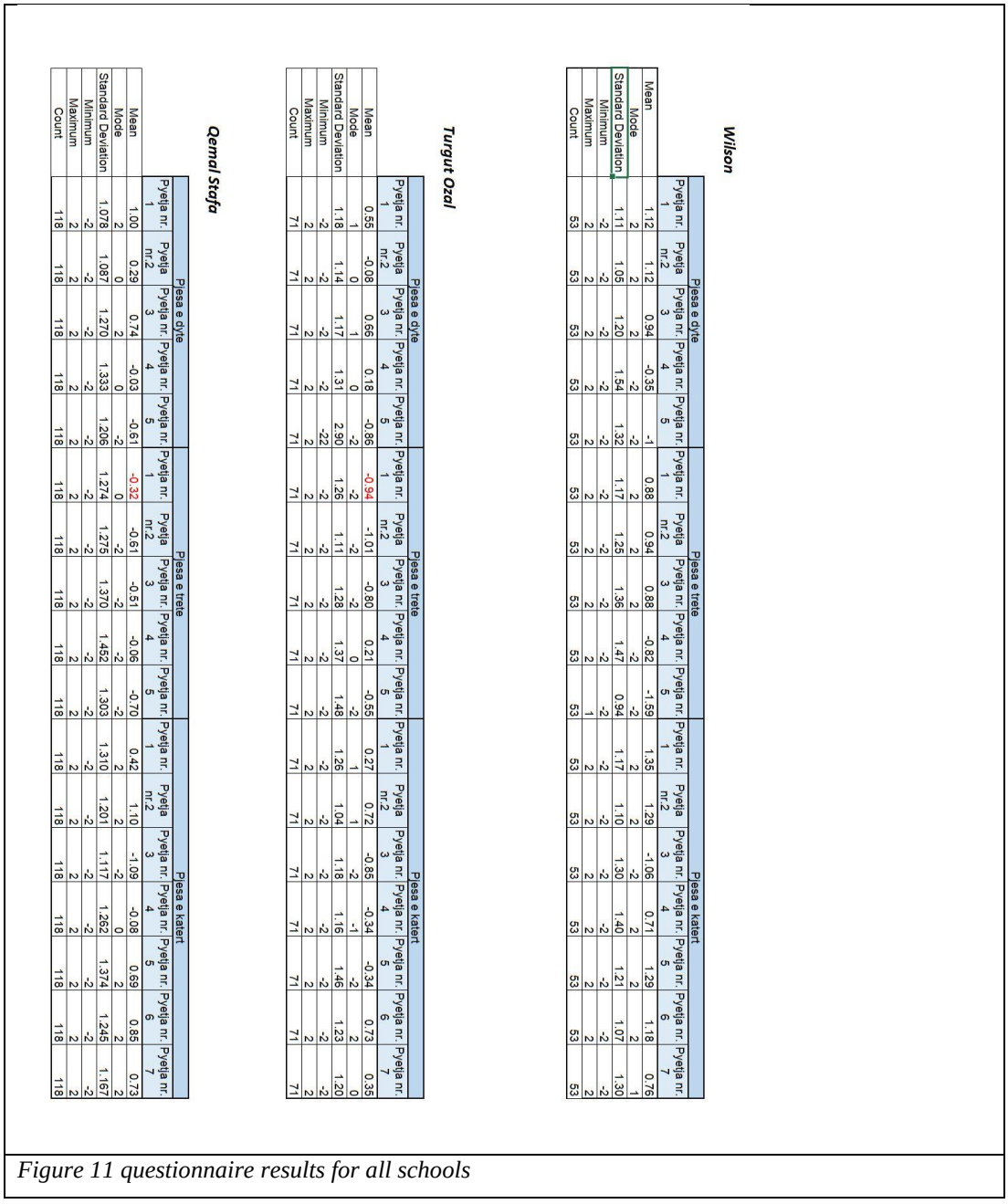
	Pjesa e dyte					Pjesa e trete					Pjesa e katert						
	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 6	Pyetja nr. 7
Mean	0.90	0.29	0.32	0.13	-0.42	-0.52	-0.68	-0.55	0.23	-0.61	0.45	1.00	-1.23	-0.23	0.71	0.74	0.84
Mode	1	1	1	1	-2	-1	-1	-1	2	-2	2	2	-2	0	2	2	2
Standard Deviation	1.01	1.16	1.19	1.41	1.41	1.12	1.08	1.34	1.43	1.36	1.41	1.32	0.99	1.12	1.35	1.46	1.07
Minimum	-1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Maximum	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2
Count	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31

	Pjesa e dyte					Pjesa e trete					Pjesa e katert						
	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 6	Pyetja nr. 7
Mean	0.92	0.12	1.19	0.50	-0.58	-1.12	-1.46	-1.15	0.12	-0.50	-0.19	1.23	-1.58	-0.54	0.73	0.69	0.50
Mode	1	0	2	1	-1	-2	-2	-2	0	-2	0	2	-2	-2	2	1	0
Standard Deviation	1.06	1.11	1.10	1.27	1.10	0.91	0.76	1.22	1.42	1.39	1.23	1.18	0.81	1.33	1.15	1.05	1.14
Minimum	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Maximum	2	2	2	2	2	0	0	2	2	2	2	2	0	2	2	2	2
Count	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26

Figure 10 *Qemal Stafa High School Questionnaire results*

4.1.4 Cummulative questionnaire results.

In this section, there will be a more thorough analysis of the general information that are mentioned above for each school, question by question. The results are represented by graphs, showing the percentage of the answers for each question, while comparing the results of the 3 schools with each other. The questions are all of the likert scale format, ranging from -2 (strongly disagree) to +2 (strongly agree).



Wilson

	Pjesa e dyte					Pjesa e trete					Pjesa e katert						
	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 6	Pyetja nr. 7
Mean	1.12	1.12	0.94	-0.35	-1	0.88	0.94	0.88	-0.82	-1.59	1.35	1.29	-1.06	0.71	1.29	1.18	0.76
Mode	2	2	2	-2	-2	2	2	2	-2	-2	2	2	-2	2	2	2	1
Standard Deviation	1.11	1.05	1.20	1.54	1.32	1.17	1.25	1.36	1.47	0.94	1.17	1.10	1.30	1.40	1.21	1.07	1.30
Minimum	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Maximum	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2
Count	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53

Turgut Ozal

	Pjesa e dyte					Pjesa e trete					Pjesa e katert						
	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 6	Pyetja nr. 7
Mean	0.55	-0.08	0.66	0.18	-0.86	-0.94	-1.01	-0.80	0.21	-0.55	0.27	0.72	-0.85	-0.34	-0.34	0.73	0.35
Mode	1	0	1	0	-2	-2	-2	-2	0	-2	1	1	-2	-1	-2	2	0
Standard Deviation	1.18	1.14	1.17	1.31	2.90	1.26	1.11	1.28	1.37	1.48	1.26	1.04	1.18	1.16	1.46	1.23	1.20
Minimum	-2	-2	-2	-2	-22	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Maximum	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Count	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71

Qemal Stafa

	Pjesa e dyte					Pjesa e trete					Pjesa e katert						
	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 1	Pyetja nr.2	Pyetja nr. 3	Pyetja nr. 4	Pyetja nr. 5	Pyetja nr. 6	Pyetja nr. 7
Mean	1.00	0.29	0.74	-0.03	-0.61	-0.32	-0.61	-0.51	-0.06	-0.70	0.42	1.10	-1.09	-0.08	0.69	0.85	0.73
Mode	2	0	2	0	-2	0	-2	-2	-2	-2	2	2	-2	0	2	2	2
Standard Deviation	1.078	1.087	1.270	1.333	1.206	1.274	1.275	1.370	1.452	1.303	1.310	1.201	1.117	1.262	1.374	1.245	1.167
Minimum	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Maximum	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Count	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118

Figure 11 questionnaire results for all schools

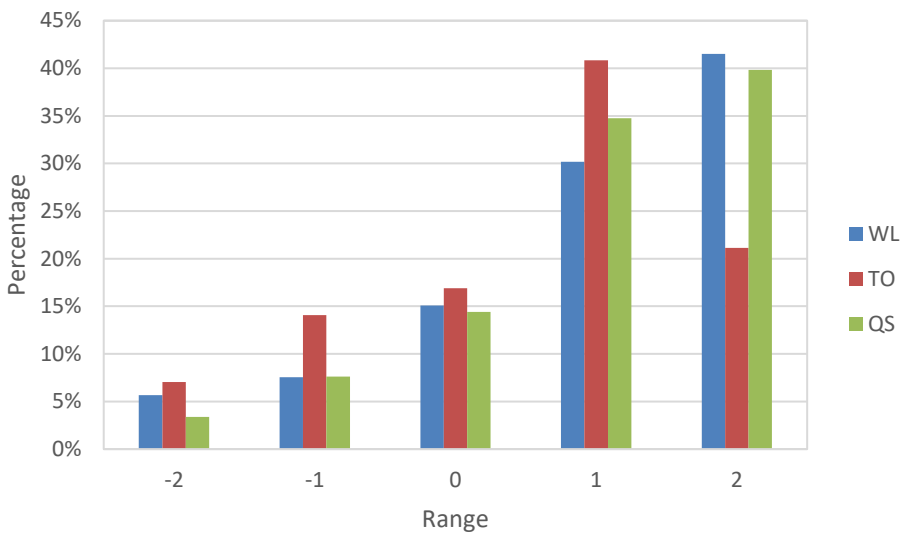


Figure 12*Question 1 " During the winter months, I am content with the overall IEQ " , part 2*

WL refers to Wilson High School, TO refers to Turgut Ozal High school and QS refers to Qemal Stafa High School

The second part of the questionnaire is used to understand the IEQ during winter months. This graph, figure 12, shows that the biggest percentage of positive answers, meaning the students enjoy the classrooms indoor environmental quality during winter months, is in the Wilson High School, with a percentage just above 40%. It is closely followed by Qemal Stafa with a percentage of just a little bit under 40%. Turgut Ozal has a high percentage of above 40% at the answer +1 but has a bigger amount of students who choose the negative answers like -2 and -1. In this case Qemal stafa has the lowest number of students who aren't pleased with the interior temperature during winter.

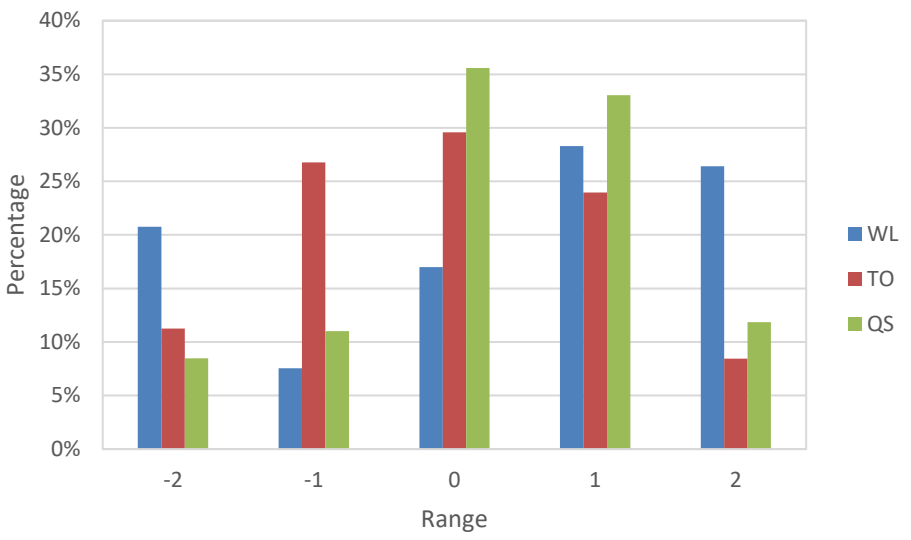


Figure 13,*Question 2 " During the winter months, the air quality within the classroom is optimal" , part 2*

The second question is about the overall perceived air quality in the classroom during the winter months. In figure 13, we see the answers from Wilson High School seem quite unstable in this question. There are 27% answers at +1 and 26% at +2, which is higher than the negative answers of -1 and -2. However, having 22% of the students answering at -2, is also a considerable vote, so the result is not very stable. Turgut Ozal has probably the most neutral general answer with 30% at 0 and almost equal percentages at the other answers. It is noticeable that in this case students from Qemal Stafa are mostly satisfied with 35% of students choosing the answer 0(neutral) and about 33% choosing the answer +1(slightly agree) and 12% choosing the option +2(strongly agree), significantly more than the negative answers.

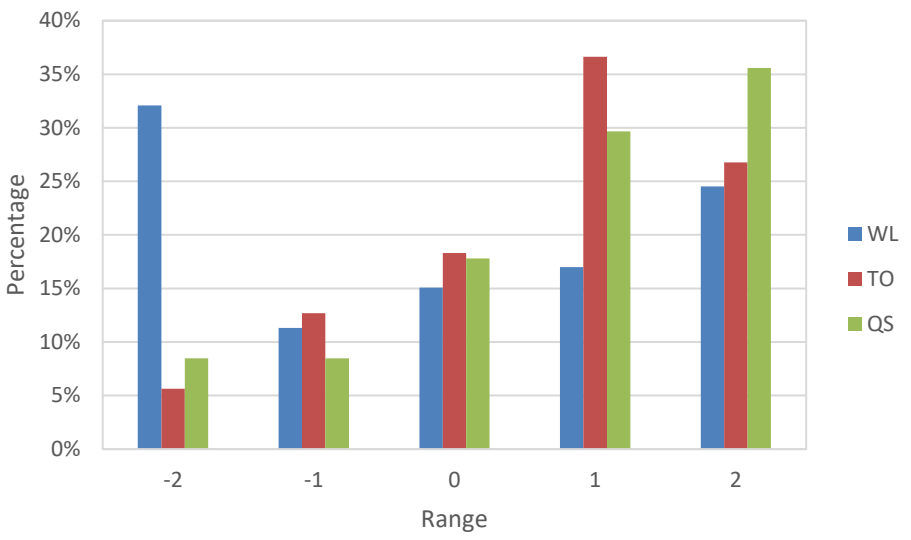


Figure 14,*Question 3 "During the witnter months the classroom temperature is optimal " , part 2*

Looking at the results of this question, in figure 14, we see that the highest rate of satisfaction is found in the Qemal Stafa High School, followed by the Turgut Ozal high school. Wilson High School once again displays a separation of the answers from -2 to +2 that is not very clearly indicative, but a clue is that the most chosen question by students is -2 with just above 30% .

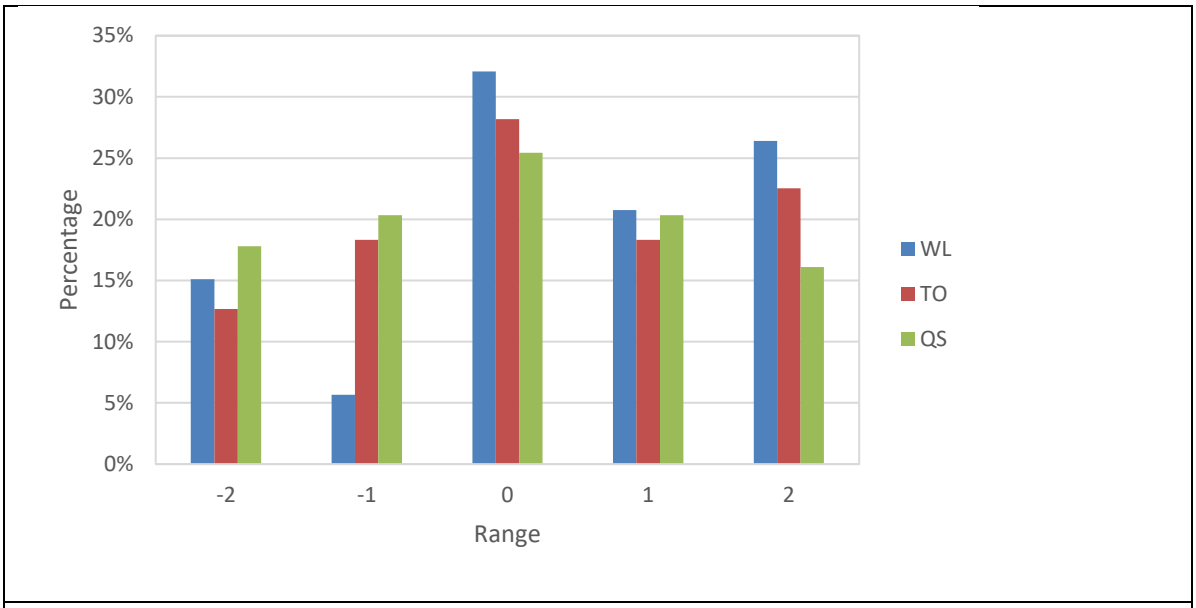


Figure 15,Question 4 " The classrooms indoor environment gives me headaches" , part 2

The fourth question aims to find how many students health is affected directly by the environment, in terms of headaches.In figure 15, we can see that most of the students, from all the high schools have chosen answer 0, meaning neutral. Wilson High School students show the highest amount of dissatisfaction, with about 27% choosing the answer +2 which means that the classroom environment does give them headaches.

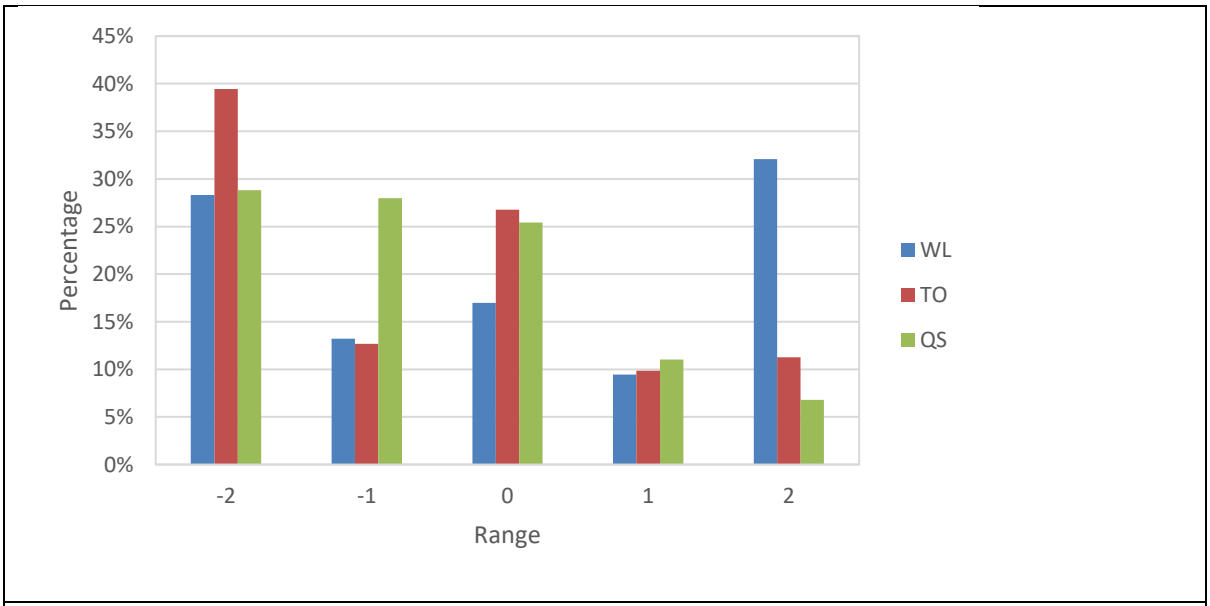


Figure 16 Question 5 " the classroom environment causes me to catch a cold or seasonal viruses" , part 2

In this question, 40% of the Turgut Ozal high school students have responded with -2. This makes Turgut Ozal the school where students have less problems with viruses and colds. Qemal Stafa students also show they are less prone to illneses because of the classroom environment. Wilson students have a rate of just above 30% of the students who chose the answer +2 which means they have the highest level of students who have health problems due to the school environment.

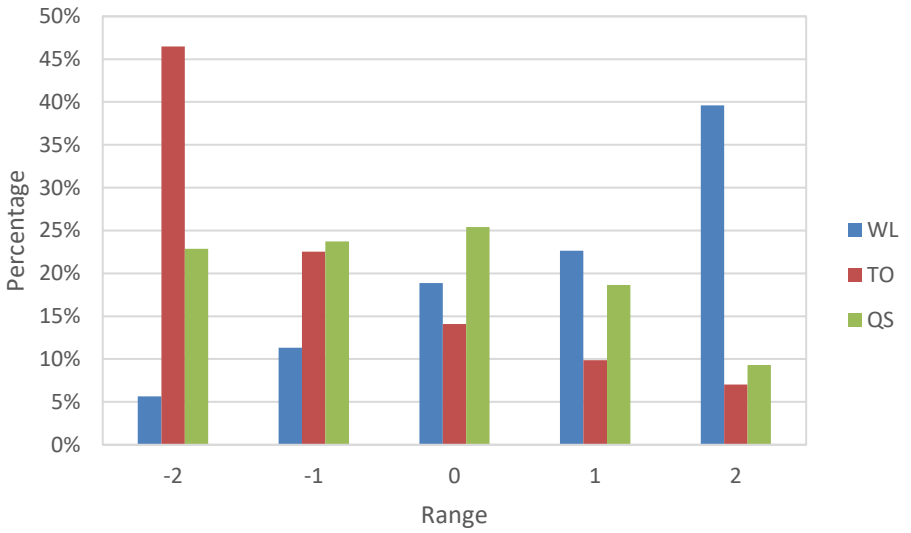


Figure 17 Question 1 "During the summer season I am very content with the classroom IEQ " , part 3

Part three of this questionnaire is about the satisfaction during the spring summer months. The first question is about the overall environmental satisfaction within the classroom. In figure 17, we see a very big difference between Wilson High School, which has about 40% of students choosing +2, meaning that they are comfortable with the overall environment, compared to 45 percent of the Turgut Ozal students that have chosen the answer -2 which means they are not satisfied with the environment. Qemal Stafa High school has a more evenly spread out result which however leans toward the negative answers.

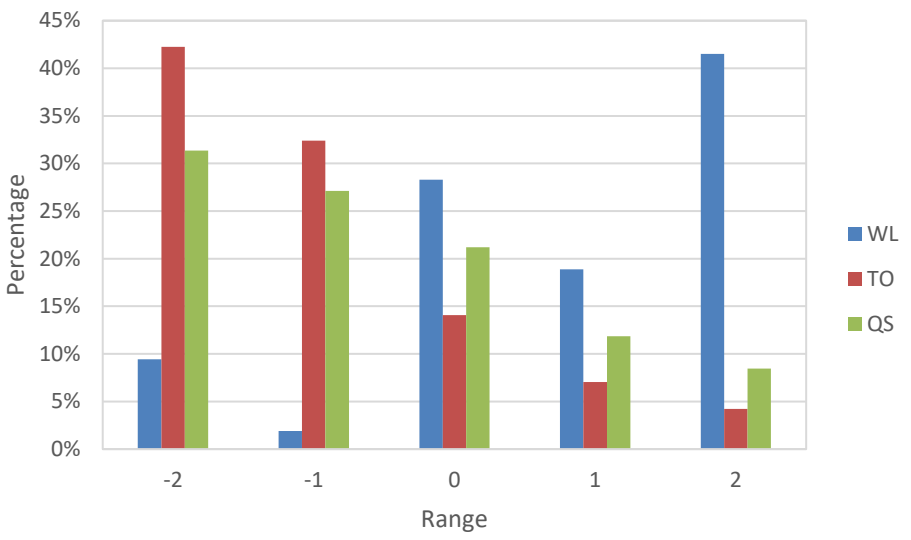


Figure 18, Question 2 "During the spring summer months am very happy with the air quality in the clasroom" , part 3

In figure 18 we can see the answers regarding the question about the air quality of the classroom during the spring and summer months. Wilson High School shows a high rate of satisfaction with about 42% of students choosing answer +2. Turgut Ozal shows a high rate of dissatisfaction with about 43% of students choosing the -2 answer. Qemal stafa high school also shows a high rate of dissatisfaction with most of the students choosing the answers -1 and -2. Air quality seems to be of great concern at Turgut Ozal High school.

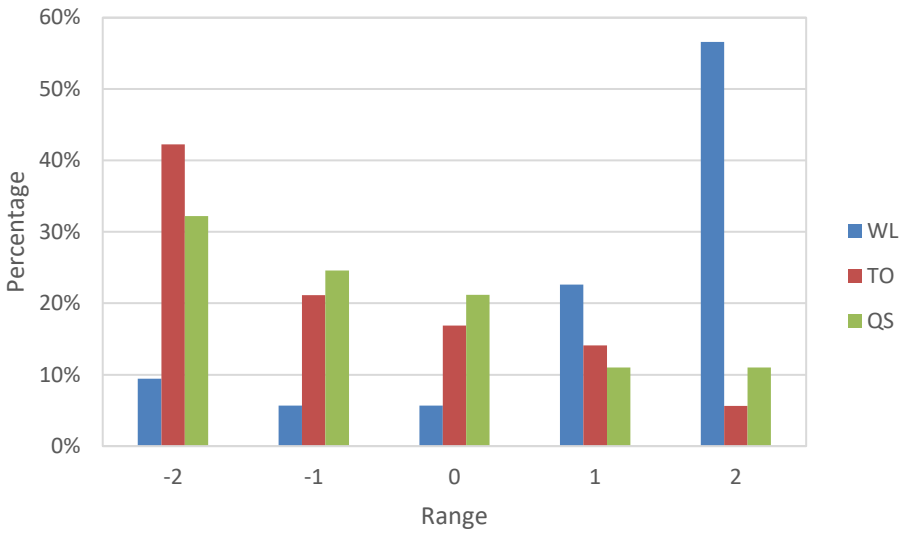


Figure 19, Question 3 " during the summer months the classroom temperature is optimal" , part 3

In figure 19 are the percentages of answers given by students about the classroom temperature being perceived optimal or not. Wilson High School Students have the most positive results to this question. Approximately 58% of the students have chosen the answer +2(strongly agree). Turgut Ozal students have mostly chosen -2, at 40 %, that means the temperature must be more uncomfortable at Turgut Ozal high school. Qemal Stafa High School also shows negative test results, but less than Turgut Ozal.

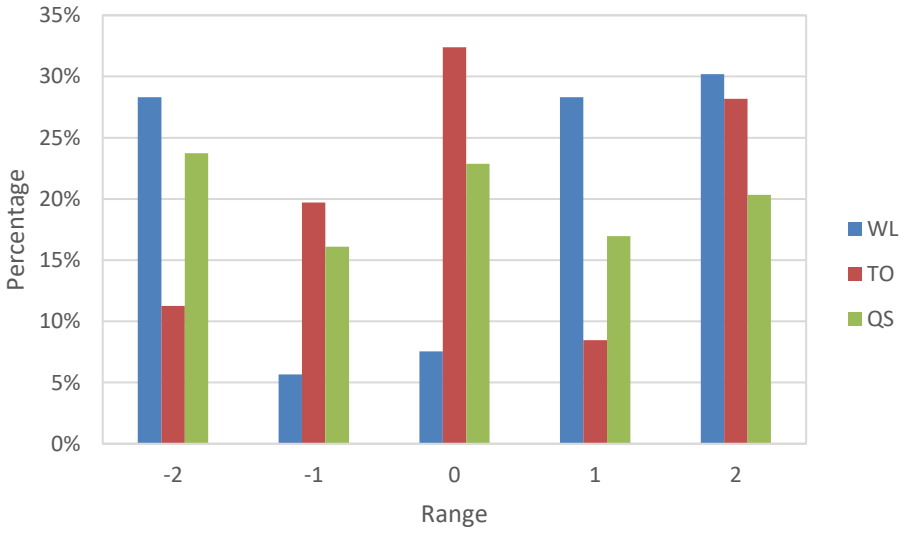


Figure 20 Question 4 "the classroon environment gives me headaches " , part 3

In figure 20, there are the answer percentages to finding out if the classroom Indoor Environmental qualiy, gives the students headaches or no. Wilson students seem to be divided mostly into the extremes with 30% at +2, 27% at 1 and 27% at -2. That ca translate into most of them getting headaches from the classroom. In Qemal Stafa High School the answers are spread out almos evenly to all the altrenatives, so it seems to be very dependend on the personal perception of place. Turgut Ozal High School also has a high rate of students who choose +2, meaning they have problems with headaches in class, but the biggest percentage is at the neutral alternative.

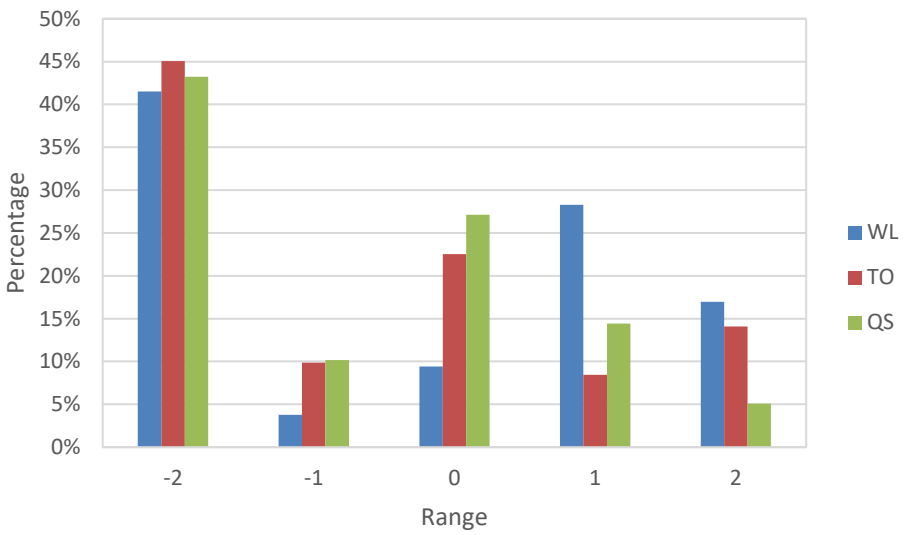


Figure 21 Question 5 " The overall classroom environment causes me asthma, congestion or allergies " , part 3

Looking at figure 21, in all 3 of the chosen schools the biggest percentage of people have chosen the -2 answer, meaning most of them do not get problems because of he environment. In the other alternatives, Wilson gives a higher rate at +1, while Qemal Stafa reaches a higher percentage at the 0, neutral answer.

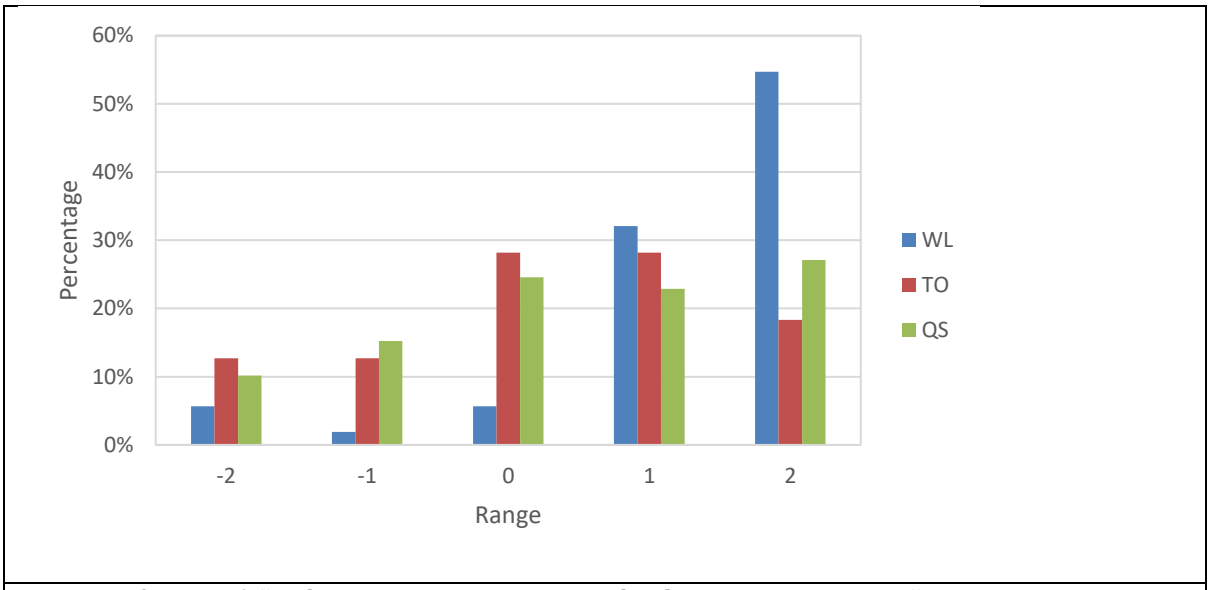


Figure 22 Question 1 "In this moment i am content wit the classroom temperature " , part 4

In figure 22, we se the table from the fourth section of the questionnaire which is abiut momental comfort. We can see that the students of Wilson high school have a high rate of satisfaction during the months of spring when the questionnaires were handed. Qemal Stafa has its highest percentage of answers at +2, by almost 30%. Turgut Ozal has the highest percentage of answers at 0 and 1, both values a little below 30%. From here we can state that the Wilson High School students have a greater satisfaction during the winter months.

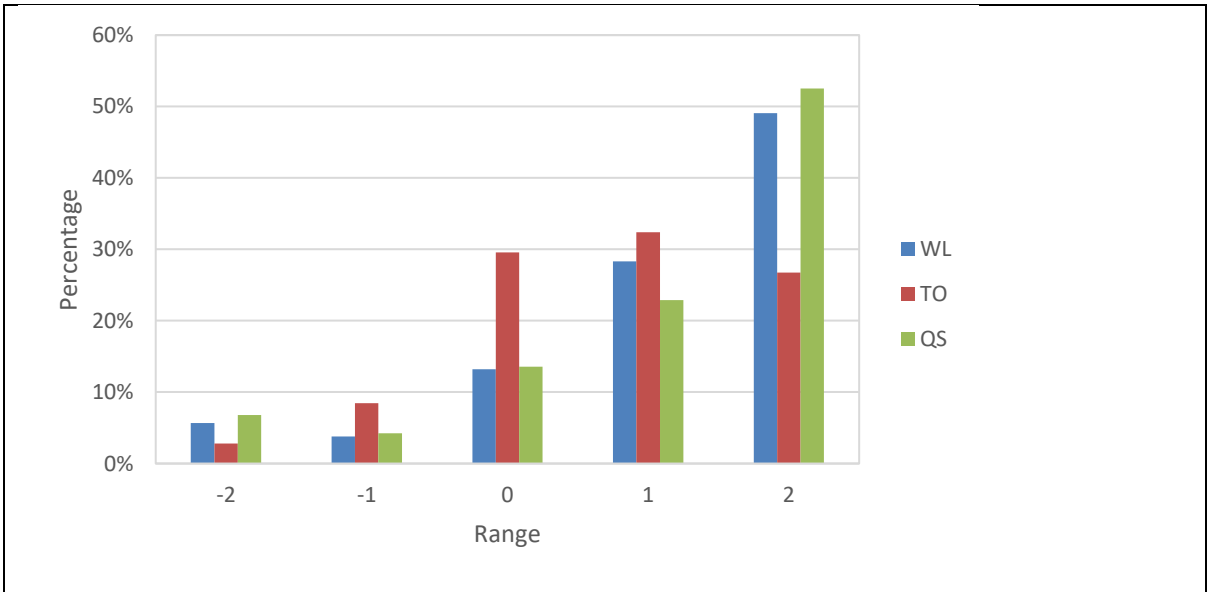


Figure 23 Question 2 "the classroom is warm " , part 4

Next is figure 23. This question was very simple, asking if the classroom was warm (not hot), but a comfortable degree of warm. The schools have almost similar answers except the Turgut Oxal high school. While Wilson and Qemal Stafa are at above 50 % with their answers at +2, Turgut ozal has a more evenly spread out pattern which however focuses on +1 and +2.

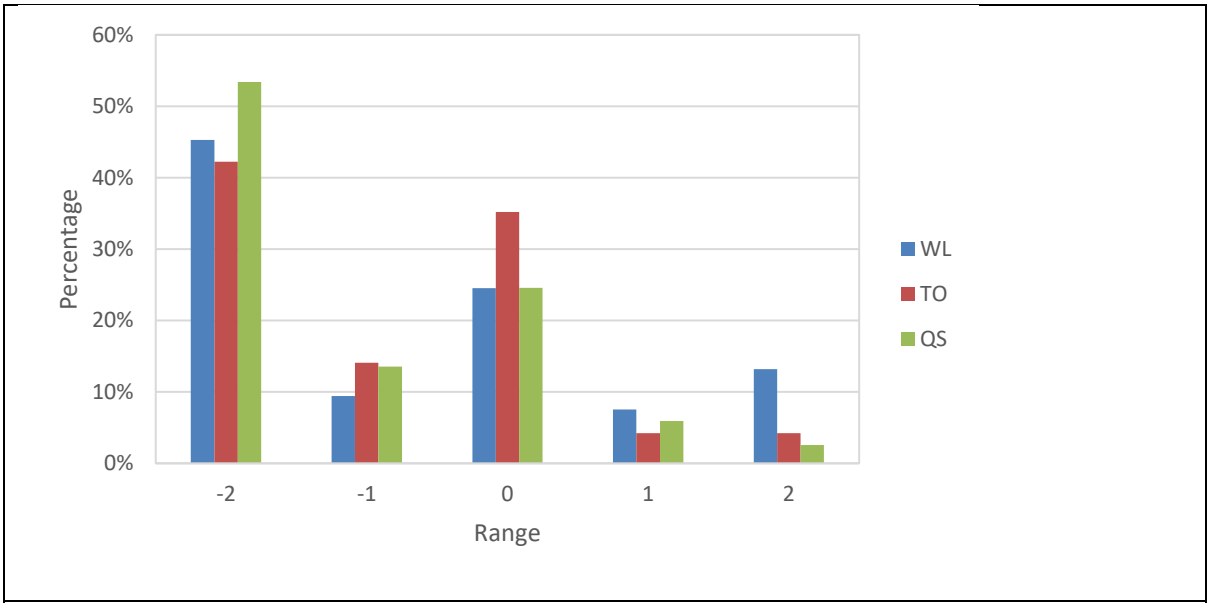


Figure 24 Question 3 "In the classroom it is currently cold " , part 4

Figure 24, is about asking the kids if they perceive the classroom as a cold place. Apart from Wilson high school having a percentage of approximately 12% at answer +2, the rest is pretty structured towards the negative end. Most of the students from all three schools have chosen the -2 answer, meaning the classroom temperature is not currently cold. This has a meaning due to the fact that the questionnaires were handed out in May, which is a month of general warm temperature in Albania.

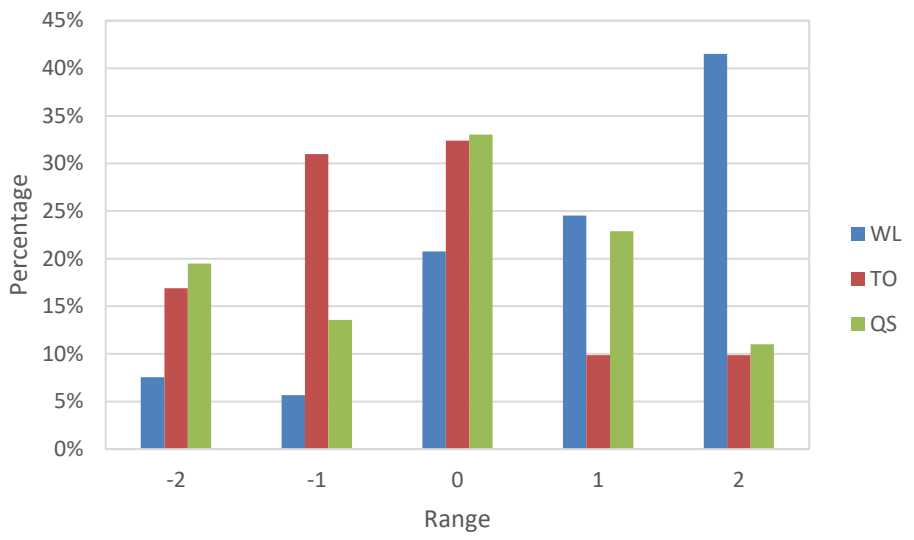


Figure 25 Question 4 " the air quality inside the classrom is optimal" , part 4

In figure 25 we see the answers of the questions about the current indoor air quality of the schools. We see that the majority of Wilson students have chosen +2, making it top answer with above 40%.Turgut Ozal gravitates mostly around -1 and -2. Qemal Stafa has he most answers at the neutral alternative and the rest pf them spread evenly.

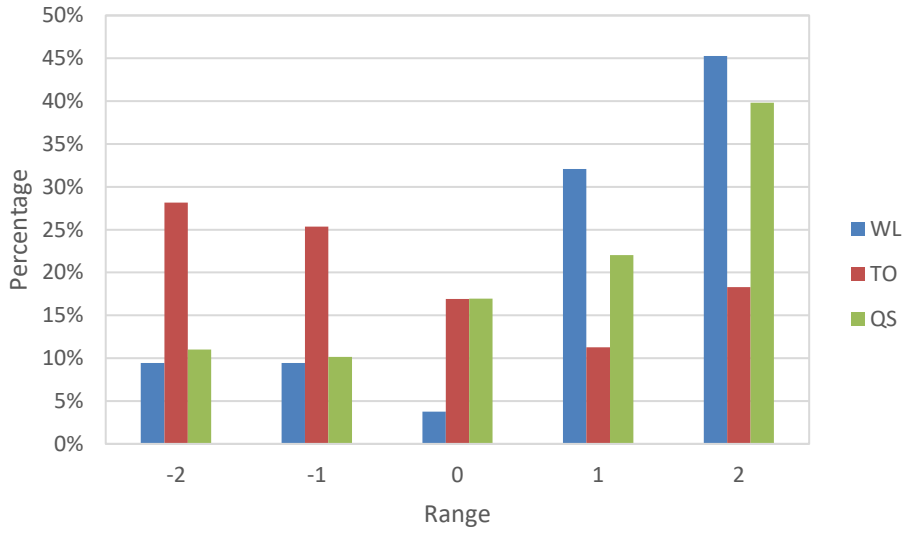


Figure 26 Question 5 "The heating or cooling devices are turned on at the right ime" , part 4

Figure 26 shows the opinion of students on the timings of turning on the heating or cooling devices. Due to the fact that none of the schools have cooling devices, the students seem to haveanswered about the winter months. Wilson and Qemal stafa has the highest rate of satisfaction with both reaching 45% and 40% respectively. The Turgut Ozal School has the highest dissatisfaction rate with about 27 % at -2.

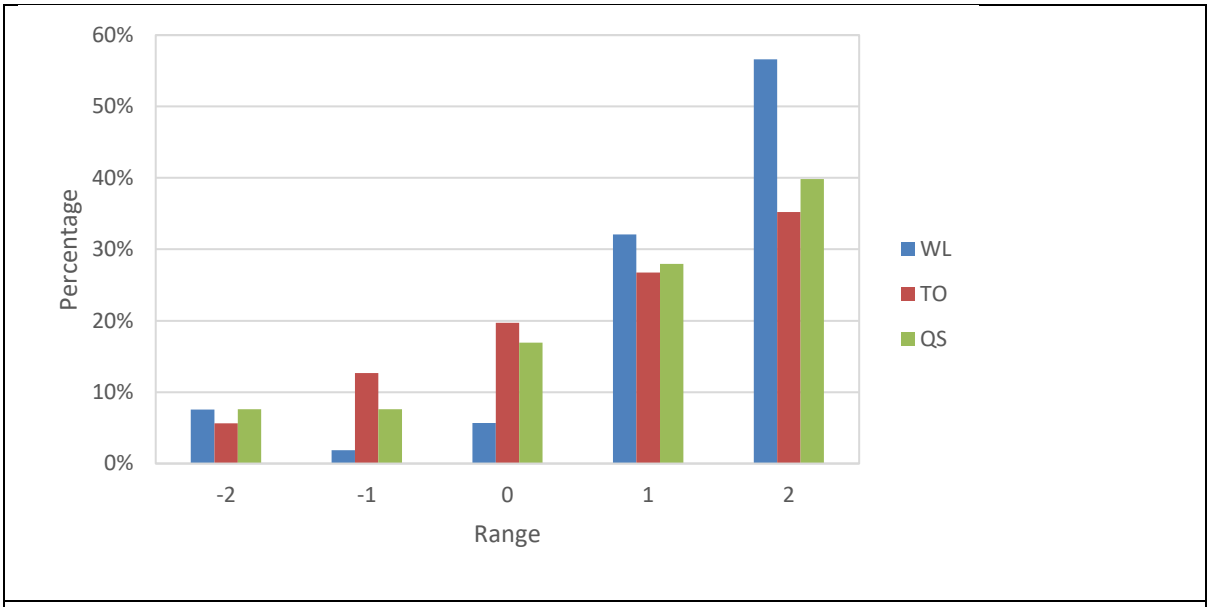


Figure 27 Question 6 " when the devices are turned on the IEQ is comfortable" , part 4

In figure 27, the question is also about the devices used for heating or cooling but since there are no cooling devices students have answered for the winter months. The highest rate of statisfaction comes from Wilson with almost 58%. However even the other schools are quite close to that answer. Qemal stafa asnwers with 40% and lastly the Turgut Ozal school with about 35% at +2.

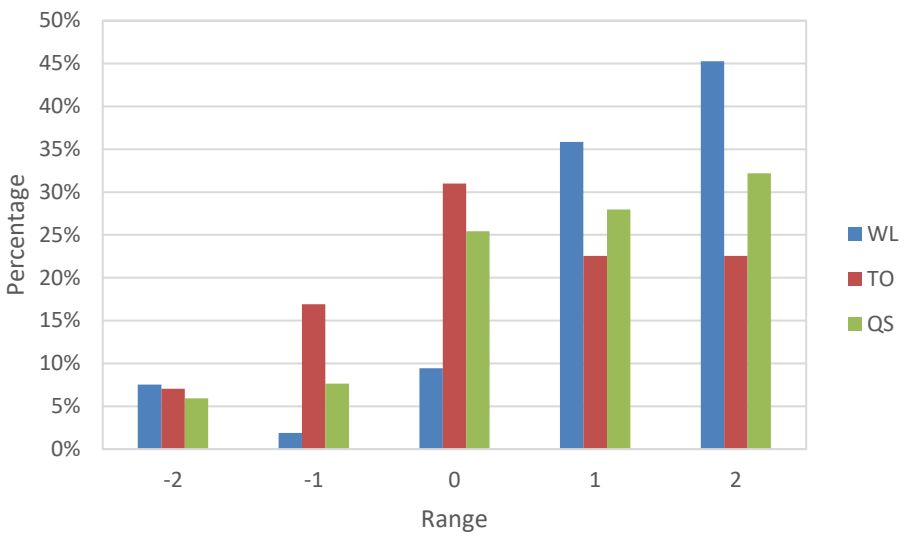


Figure 28 Question 7 "In general the classroom IEQ is comfortable " , part 4

Here, in figure 28, we see most of the positive answers come from Wilson High School which has about 45% of students choosing answer +2. Qemal Stafa High School is next with about 32% of students choosing the alternative +2. Lastly, Turgut Ozal has similar results from 0 to +2. This translates to the students of Wilson high school showing the biggest rate of satisfaction with the IEQ during the summer months, followed second by the Qemal Stafa High school. Out of the three schools Turgut Ozal shows the lowest amount of satisfaction with the IEQ of the classroom.

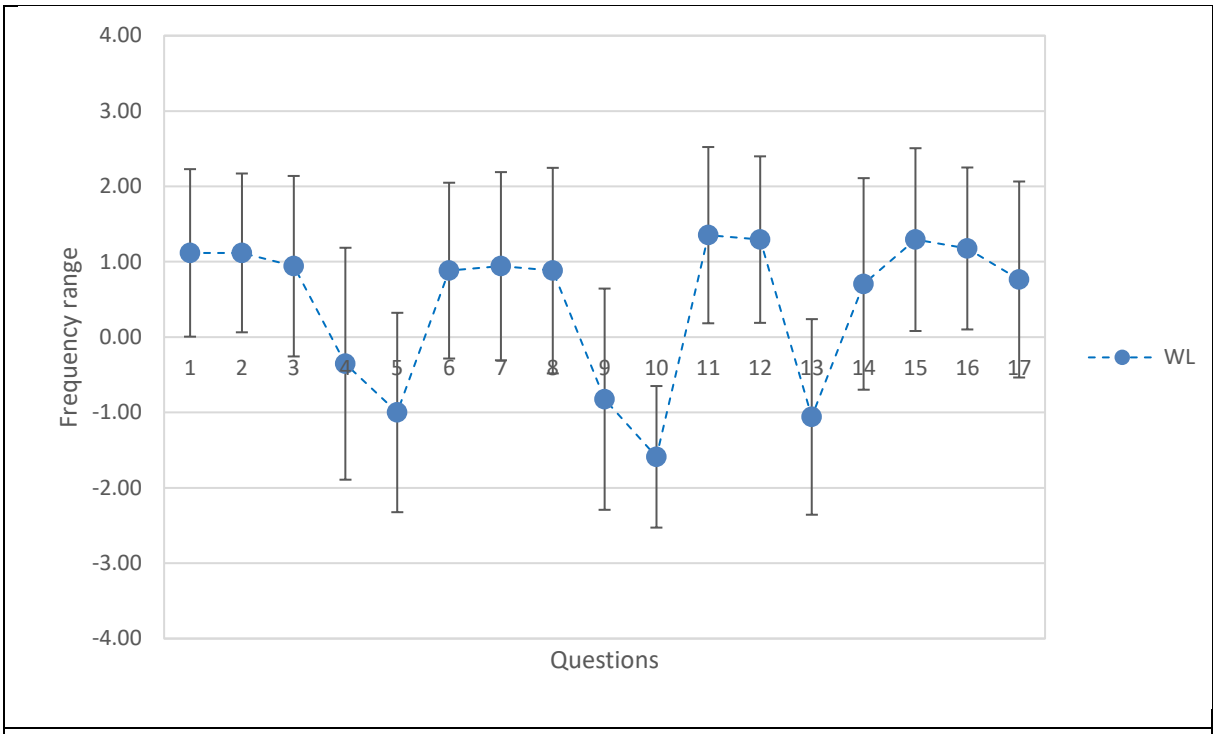


Figure 29 Mean and Standard deviation for all questions, Wilson School (here referred as WL)

Figure 29 shows the mean and standard deviation for all questions of the Wilson High School. A deeper analysis of the questions one by one is detailed above, this chart is helpful to see the consistency in the students answers. The standard deviation is a quantity expressing by how much the members of a group differ from the mean value for the group. In this case, the graph shows most of the answers have a standard deviation of about 2. Questions number 4,5,8,13 and 14 have a standard deviation of about 3, meaning students have given more diverse answers.

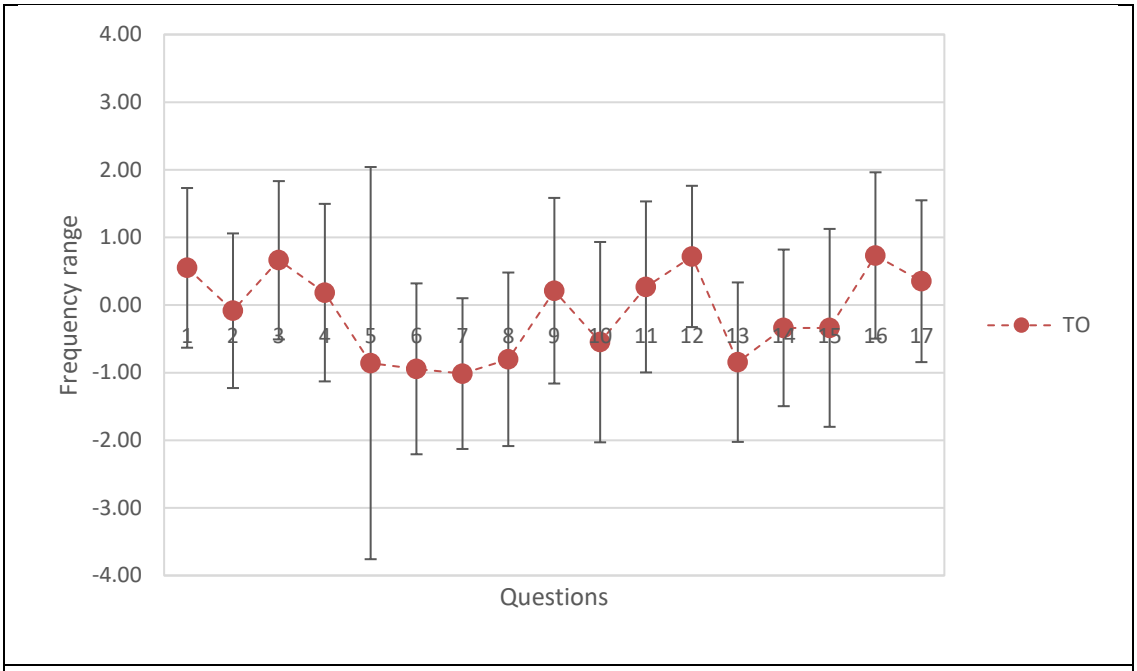


Figure 30 Mean and Standard deviation for all questions, Turgut Ozal School (here referred as TO)

The standard deviation for most of the questions seems to be at 3, which is higher than the Wilson High School Case. This indicates that the answers are more diverse and the results are more broad. Question number 5 in particular has a very big standard deviation which will make it harder to define a certain value as representative for the whole school even though the mean value is calculated.

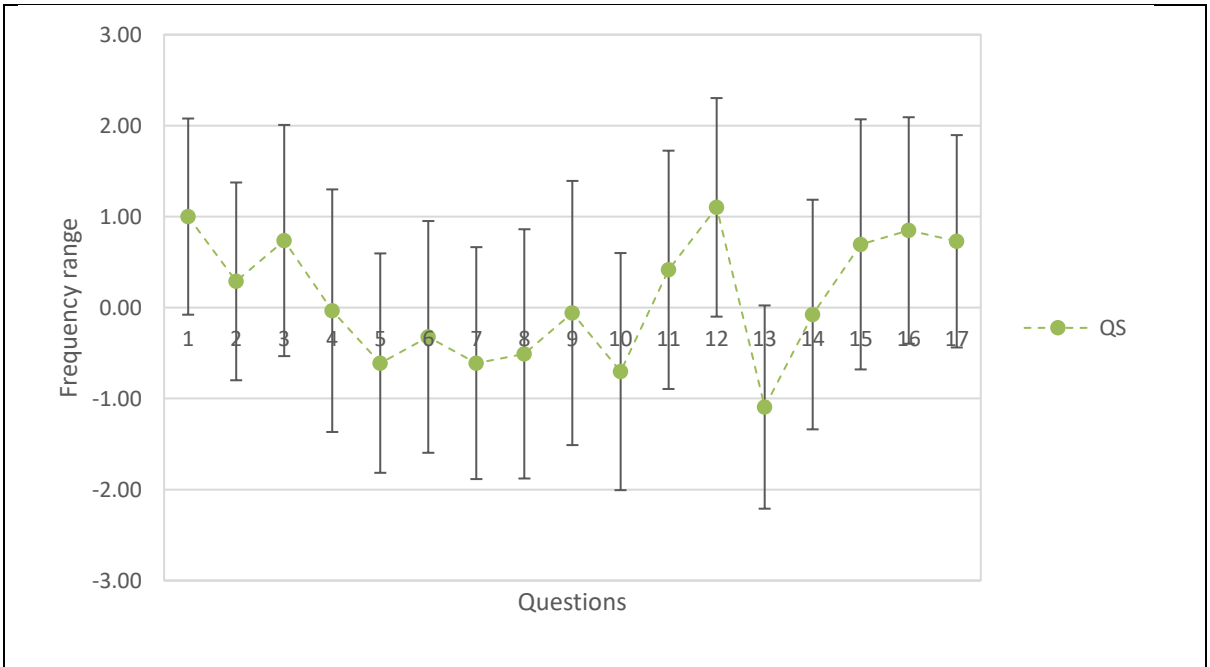


Figure 31 Mean and Standard deviation for all questions, Qemal Stafa High School (here referred as QS)

In figure 31, we can see the results of Qemal Stafa High School answers. The standard deviation from the mean answer seems to be more consistent throughout the answers, compared to Turgut Ozal High School. The standard deviation is about2,5 in all of the questions.

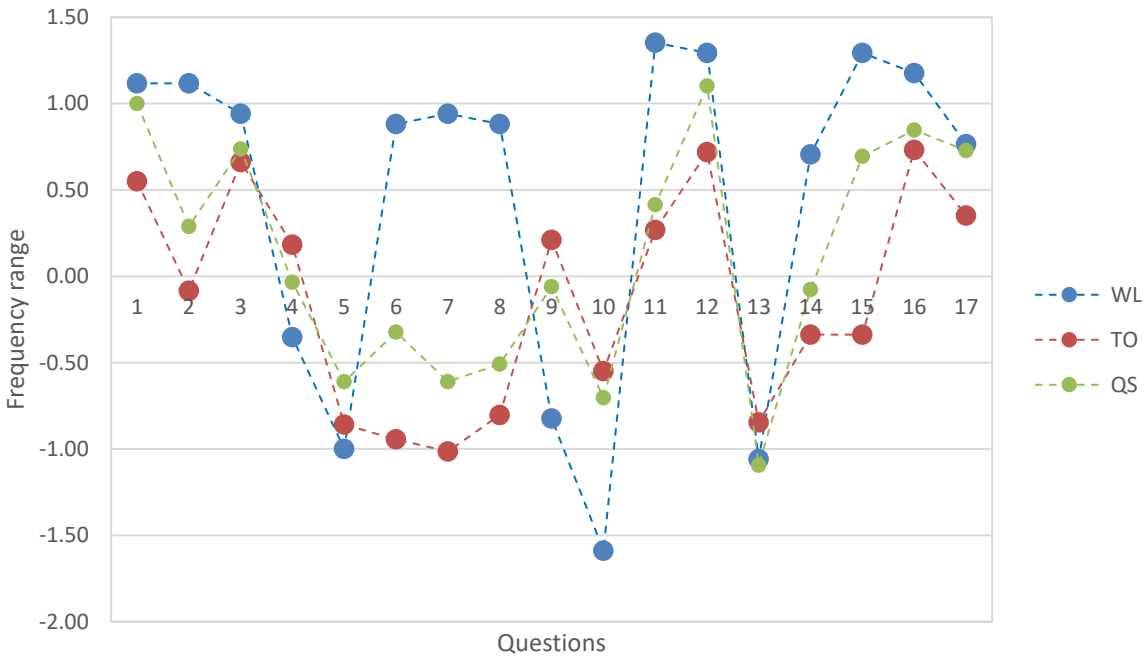


Figure 32 Mean values of all questions, for Wilson School. Turgut Ozal school, Qemal Stafa school (here referred as WL, TO, QS respectively)

In figure 32, we can see the mean results for each question for the 3 different schools compared. from this graph we can understand that Qemal Stafa High School is more similar to Turgut Ozal High school. Wilson High school has answers that are more unique compared to the two other schools.

4.2 Data logging results

Three data loggers were used for this study. The model chosen is from Voltcraft company, named DL-210$^{TH.}$ This sensory device is designed to measure temperature and relative humidity of an environment a prolonged amount of time. Three classrooms were chosen out of each school, as explained previously. The loggers were positioned at the ceiling, approximately 3 meters height. It is recommended for the loggers to be placed at a height above 2,5 meters for better measurement and for safety reasons (out of the reach of hand). The loggers were programmed to record data once every half an hour. Recording time started at all three schools, at 30 May 2018 and ended at 19 June 2018, lasted for 3 weeks.

4.2.1 Qemal Stafa High School data logger results.

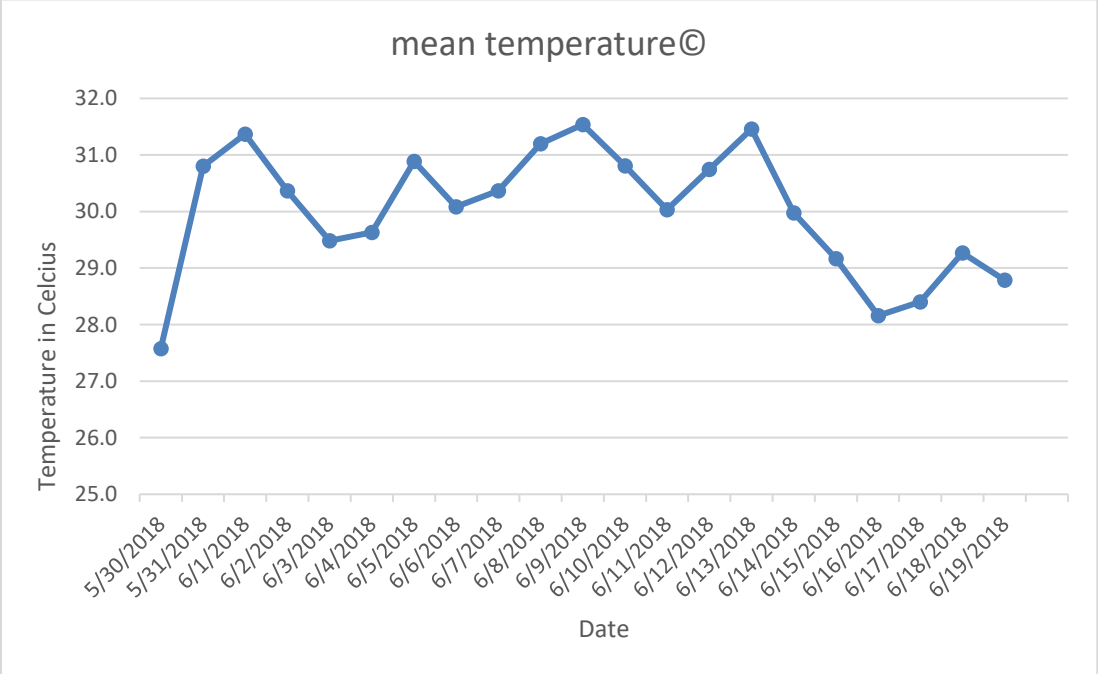


Figure 33. Mean temperature graph for qemal stafa high shcool.

In figure 33, is presented the mean temperature for each day of the measurements. The temperatures range from 27 degrees to near 32 degrees Celcius. The temperatures are above the comfortable criteria.

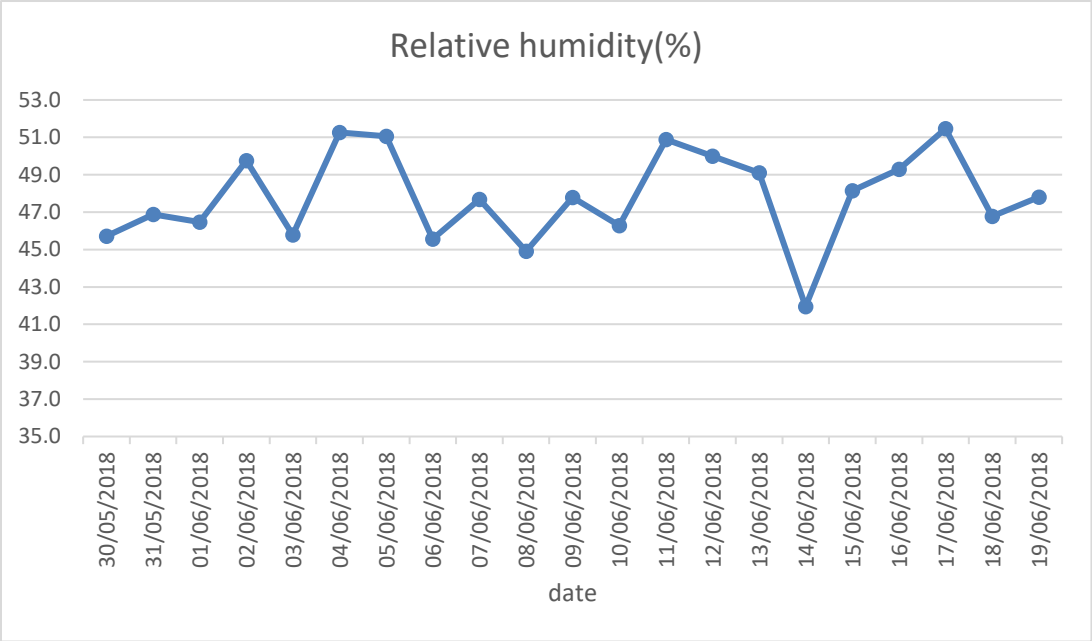


Figure 34. Mean relative humidity graph for qemal stafa high shcool.

Figure 34 shows the graph for mean relative humidity for the Qemal Stafa High School. The human body can't feel changes of relative humidity between the ranges of 25% and 60%.

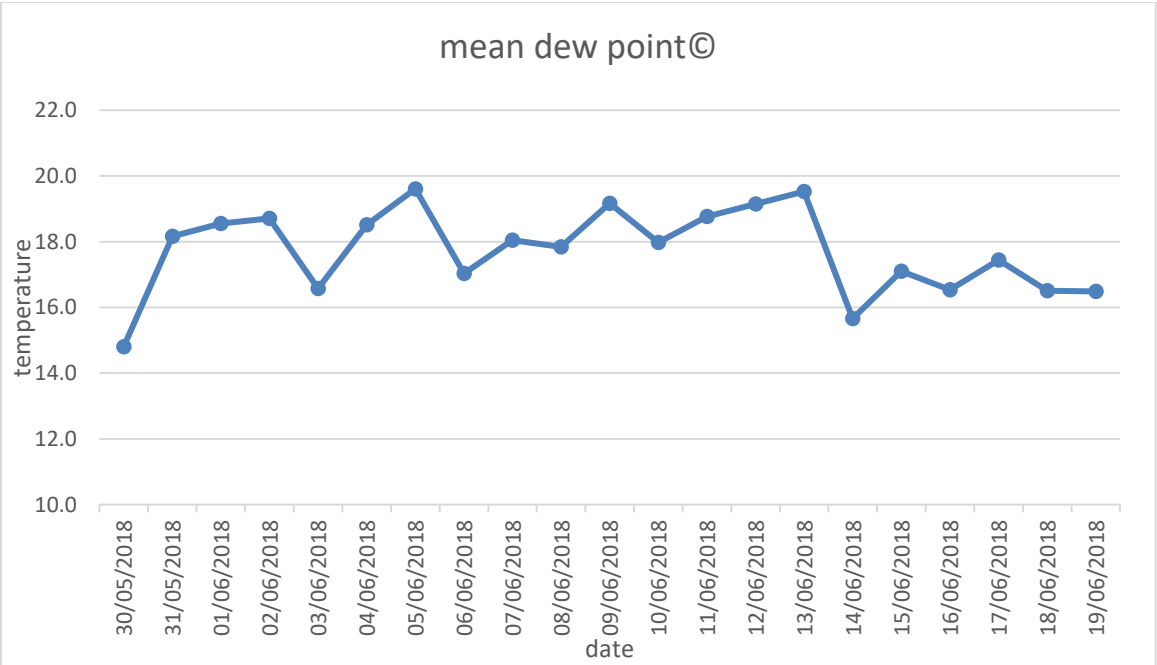


Figure 35. Mean dew point graph for qemal stafa high shcool.

Figure 35 is about the dew point average values in each day of the study. Dew Point Temperature above 18 degrees Celcius starts to feel uncomfortable.

4.2.2 Wilson High School data logger results.

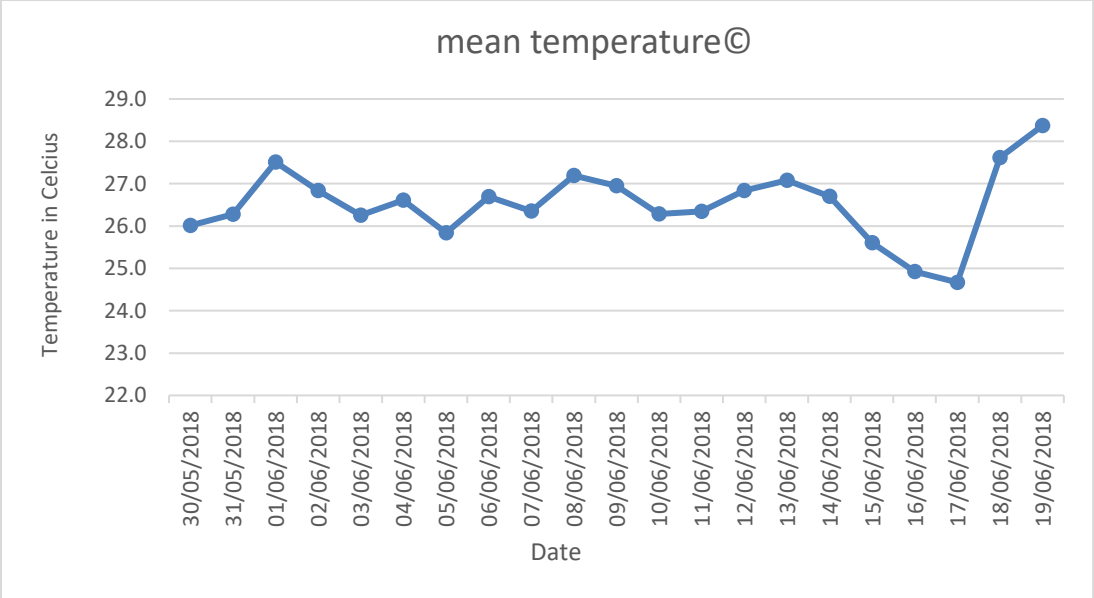


Figure 36. Mean temperature graph for Wilson high shcool.

Figure 36 shows the mean temperature measurements for Wilson High Scool throughout the study. The temperature in Wilson High School is lower than the previous case studied, and closer to the comfort levels.

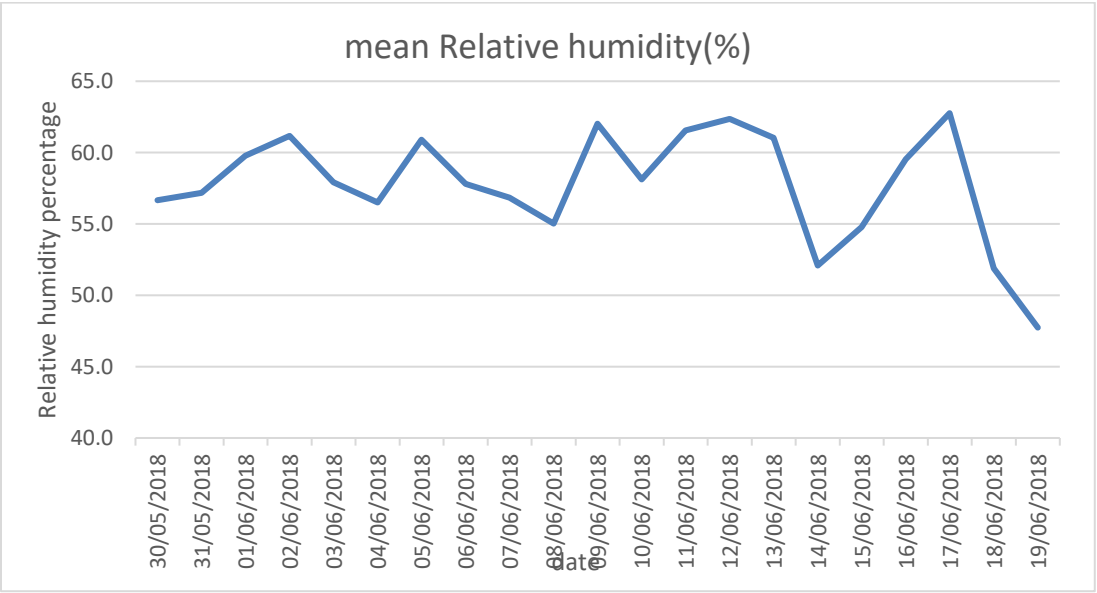


Figure 37. Mean relative humidity graph for Wilson high shcool.

Figure 37 shows the relative humidity values in Wilson High School. The values fall between the comfortable range.

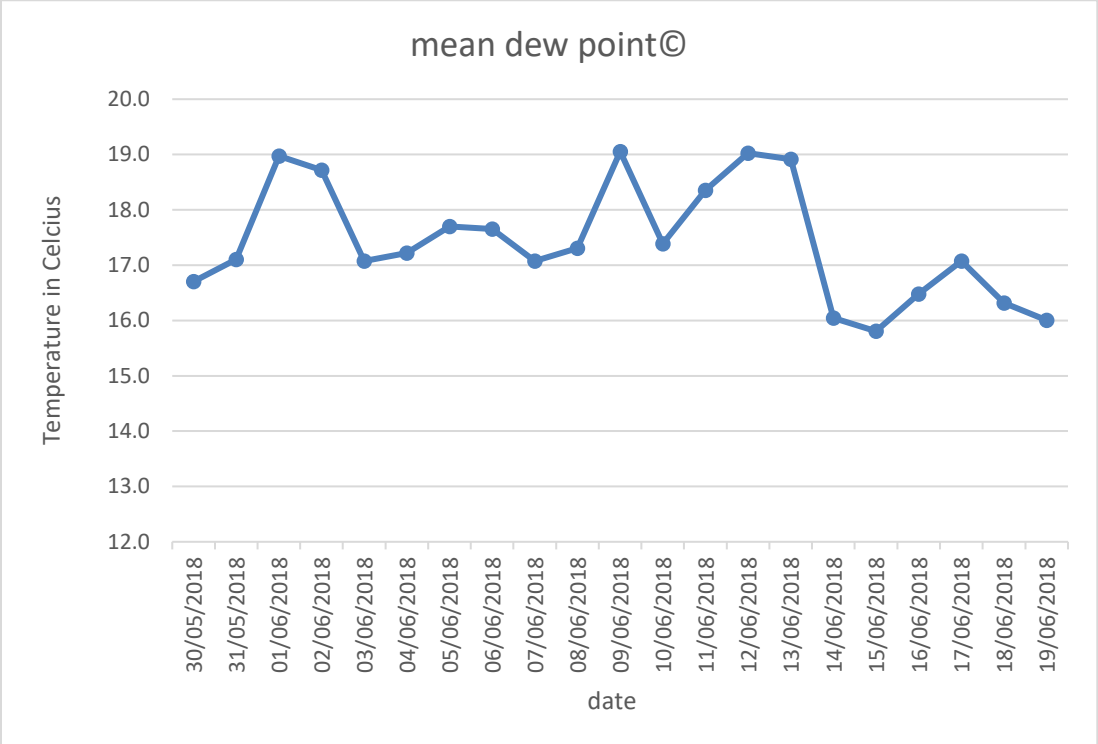


Figure 38. Mean dew point graph for Wilson high shcool.

Figure 38 shows the mean dew point values for Wilson High School. As shown the values are between 16 and 19 which is considered very comfortable.

4.2.3 Turgut Ozal High School data logger results.

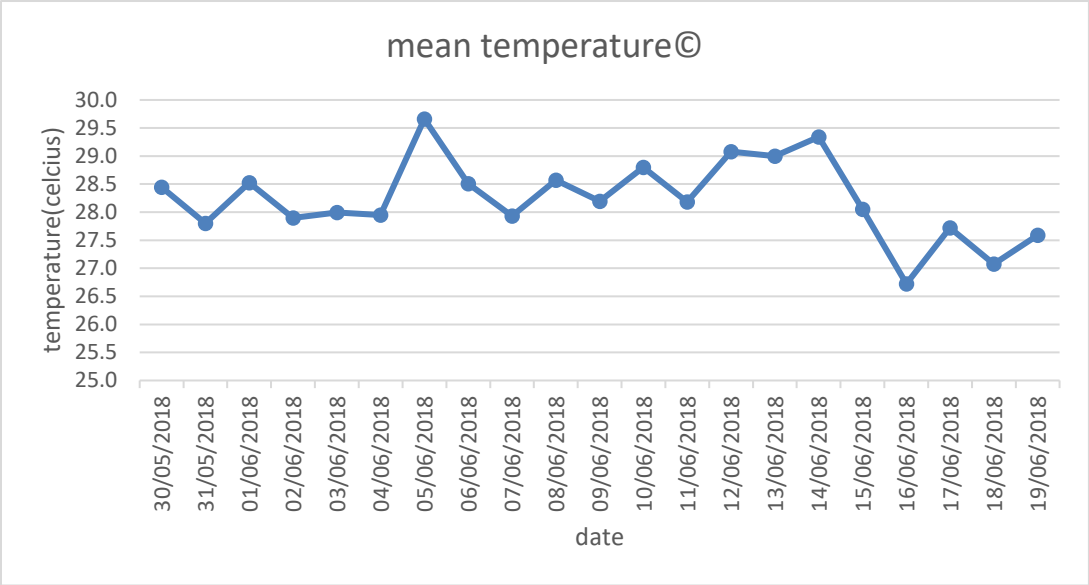


Figure 39. Mean temperature graph for Turgut Ozal high shcool.

Figure 39 shows the mean temperature values for Turgut Ozal High School. There is a greater variation from the other schools in the temperature values. Usually is over 26 degrees celcius, which is considered uncomfortable.

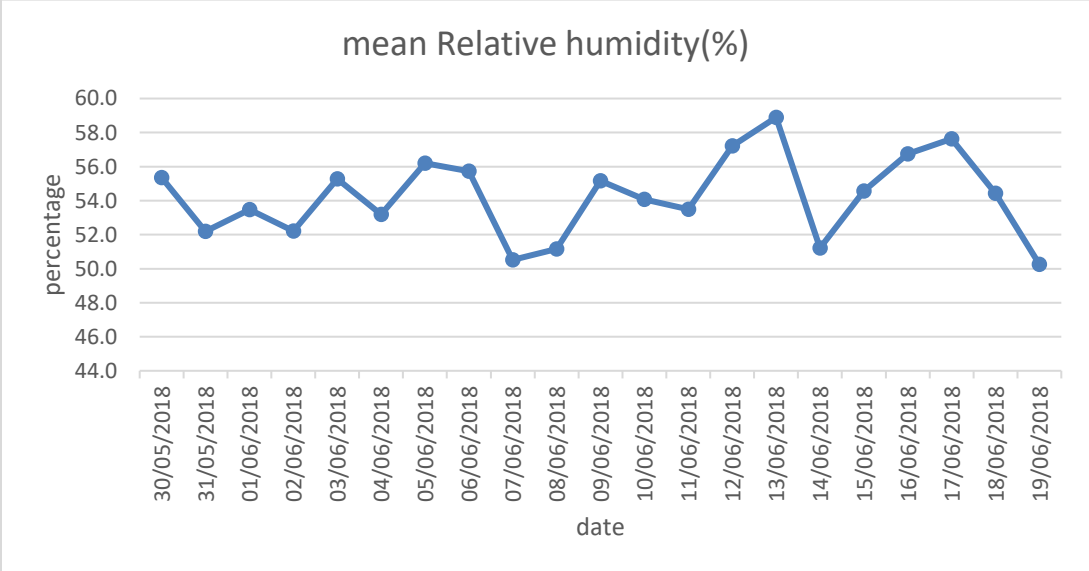


Figure 40. Mean relative humidity graph for Turgut Ozal high shcool.

Figure 40 shows the relative humidity values which seem to be within the comfortable range.

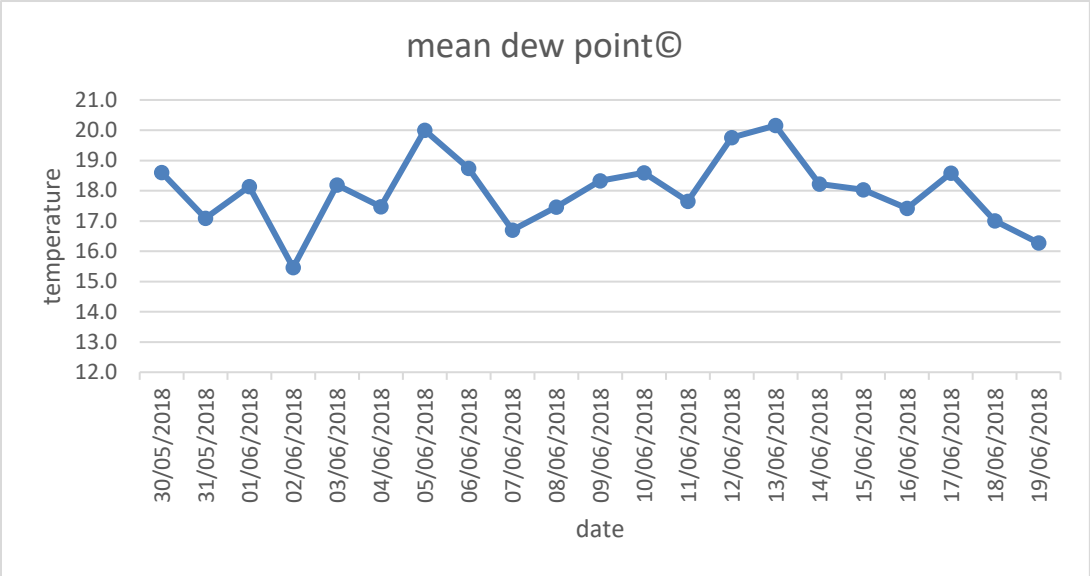


Figure 41. Mean dew point graph for Turgut Ozal high shcool.

Figure 40 shows the dew point graph for mean dew point in Turgut Ozal High School. The range for this school is considered between comfortable and slightly uncomfortable.

4.2.4 Cummulative data logger results.

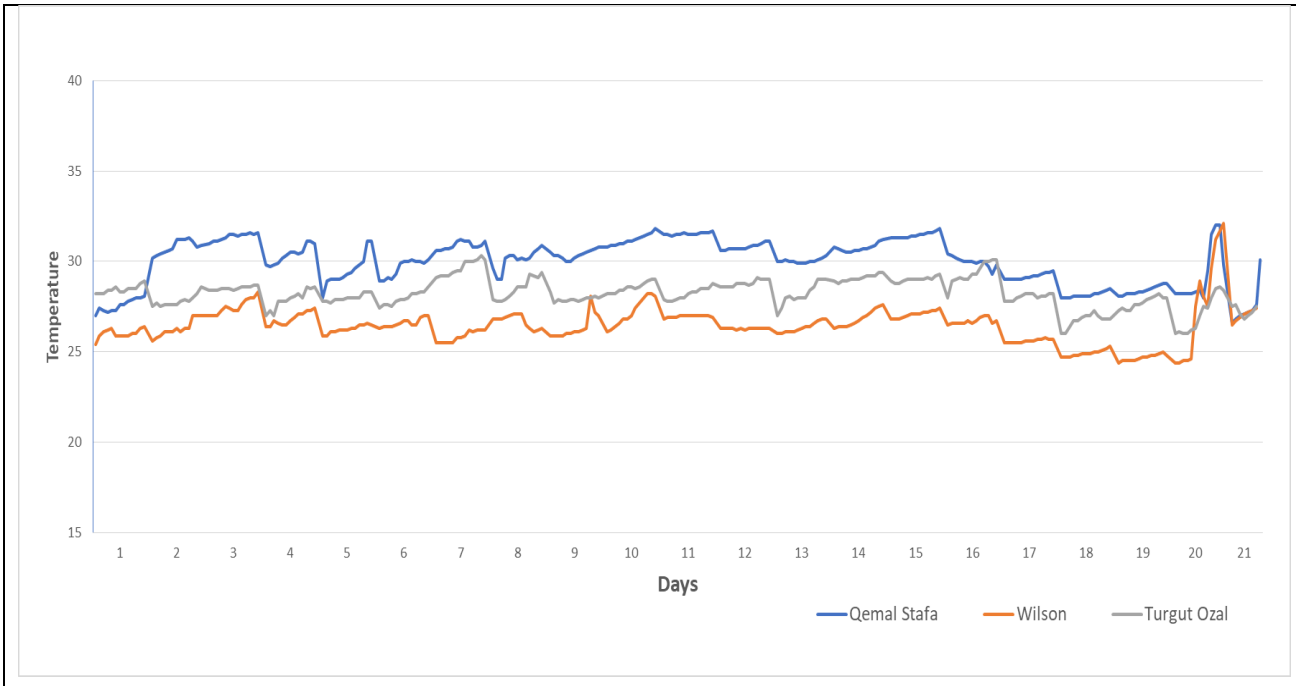


Figure 42. temperature graph measurements for 21 days in 3 schools

Figure 41 illustrates the comparison between the temperature graphs of 3 schools during the measurement times. Qemal Stafa High School has the highest temperature values followed by Turgut Ozal and Wilson High School. It is expected that the students from Qemal Stafa High School are least comfortable with the environment.

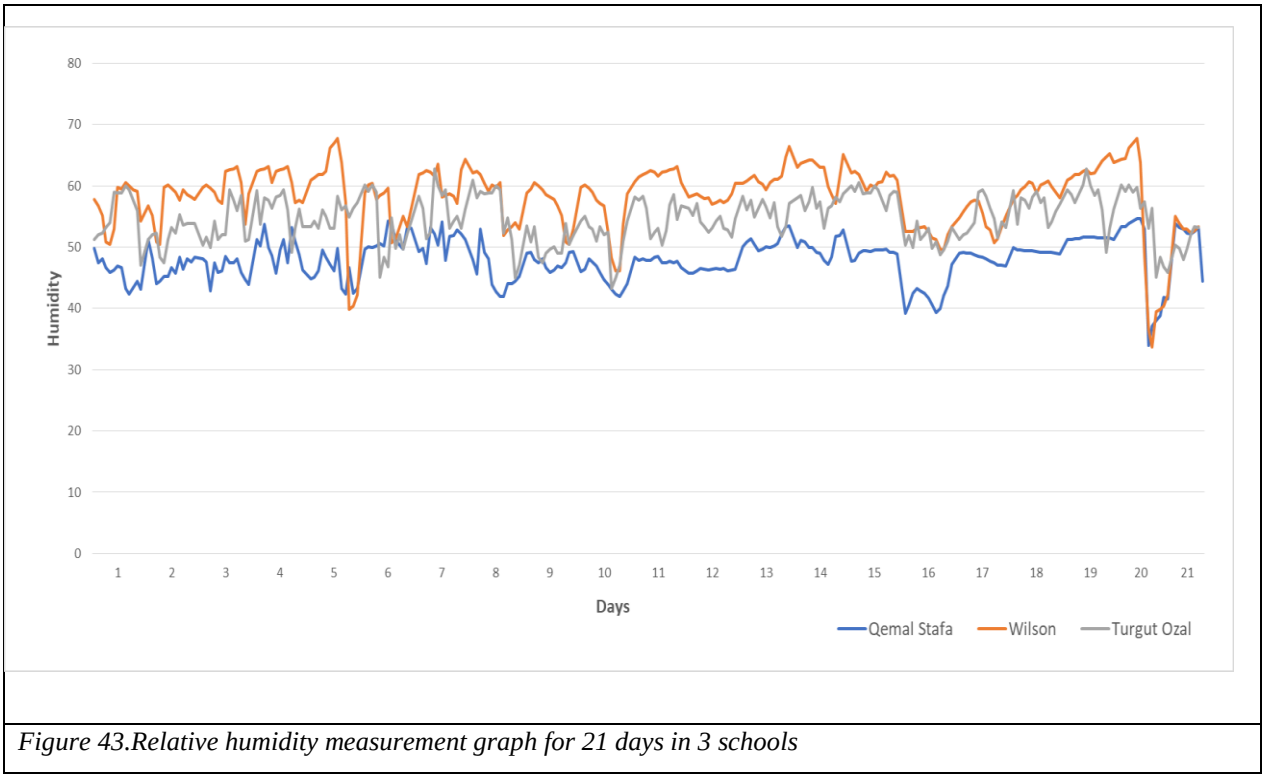


Figure 43.Relative humidity measurement graph for 21 days in 3 schools

In figure 43 are shown the relative humidity measurements for all three schools compared. Wilson High School has the highest humidity level, followed by Turgut Ozal. Qemal Stafa High School has the lowest humidity values, being that the highest temperature rates were found in the school, which would dry out the air.

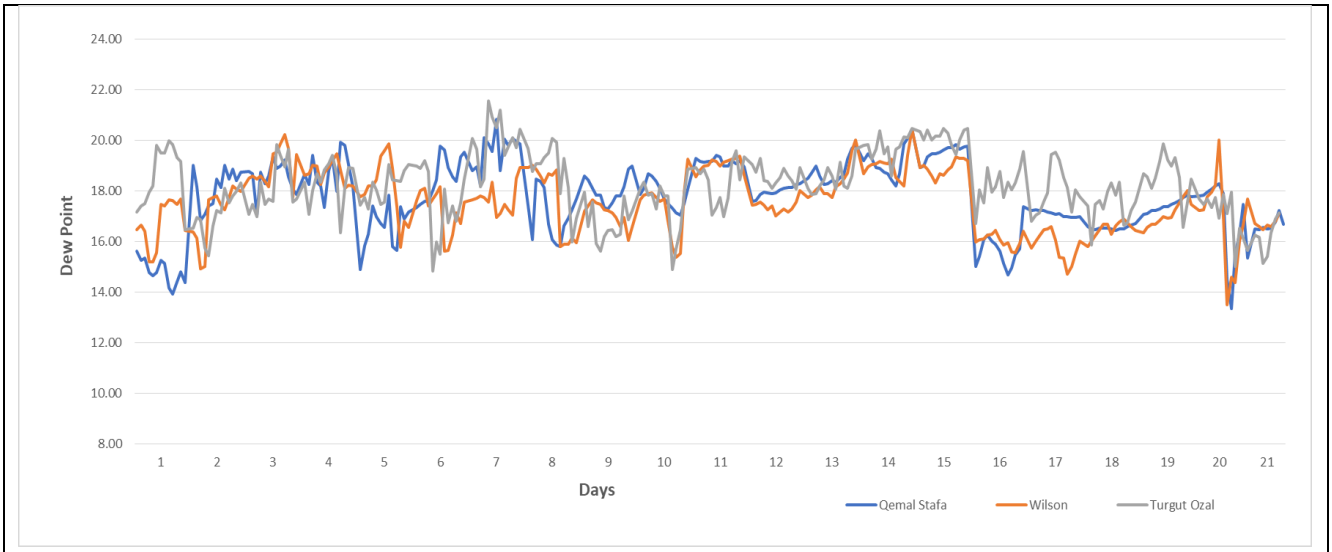


Figure 44 Dew point measurement graph for 21 days in 3 schools.

In figure 44 are shown the dew point measurements for the 3 schools in 21 days. Turgut Ozal High School reaches the highest dew point values from all three schools, while Qemal Stafa reaches the lowest. Wilson High School falls somewhere in between the two.

CHAPTER 5

CONCLUSIONS

In this chapter are included the findings of the study, the discussion and the conclusions.

5.1 Findings

After the study is finished, the data gathered is very valuable for reflecting the conditions of the IEQ in schools and the student perceptions.
Here we see the research questions that are suggested in the beginning, what results have come out of them.

During the summer months, due to the lack of cooling appliances, the temperature is above the standard comfortable values.
The three schools chosen for this study were of very similar characteristics and all three of them lacked any cooling or ventilation appliancies. As you can see from figure 42, the temperature from all the schools is above the comfortable levels of 24-26 degrees Celcius. Wilson High School has the lowest temperatures, therefore is closer to the comfortable value, but is however not in the optimal conditions needed for proper ongoing of a classroom activity.

The urban context directly affects IEQ. Since the only major difference between the 3 schools is the urban context, it is expected that the temperature values are affected by it.
This statement is seen as true after the data logging and the questionnaires. The school located in a crowded urban area, Qemal Stafa High School, has the highest temperature and the lowest humidity levels. Wilson High School has the lowest range of temperature and relative humidity, that is because it is located in a forested area. Turgut Ozal High School, which is located in a suburban area, has the values that fall in the middle of the abovementioned cases.

The findings from data loggers are reflected in the questionnaires.

Apart from the graphs that are above, table 3 shows the mean value of temperature and humidity, related to the mean values of questions asked about temperature and comfort in the spring-summer season.

Table 3

	Mean of result for the question related to temperature	Average temperaure
Qemal Stafa	-0.51	29.99
Wilson	1.15	26.44
Turgut Ozal	-0.8	28.24

	Mean of result for the question related to humidity	Average Humidity
Qemal Stafa	-0.61	47.95
Wilson	0.77	58.16
Turgut Ozal	-1.01	54.23

With the answers ranging from -2(worst) to +2(best), you can understand the students' perception of space. One problem that rises is that even though the indoor environmental quality at Turgut Ozal High School was better than Qemal Stafa High School, students of Turgut Ozal seem the most not satisfied in their answers.

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5.2 Discussions

5.3 Conclusions

As mentioned before there is seen a relationship between the studied variables, also correlation analysis has proven the same direction of relationship. The number observations are not enough for doing regression analysis which means that there is not enough statistical evidence for proving the relation between the dependent and independent variables and creating the regression equation. However the results are clearly seen in the graphs and tables presented. It is clear that there are problems with IEQ of these school buildings, which can be solved by different solutions which can be quick like blinds for the windows or reflective coats for the windows, or more serious like implementing air contioners and ventilation systems.

If this study were to be continuated, it should involve a higher number of classrooms to be measured for creating a wider perspective of the school conditions in Tirana.

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APPENDIX

Pjesa e parë; Informacion

◯ Femër ◯ Mashkull

Sëmundje ekzistuese

◯ Astma ◯ Alergji ◯ Sinozit ◯ Tjeter _____

Përshkruani shkurt rrobat që keni në trup.

_____

Pjesa e dyte; Komforti sezonal, dimer *(vendosni X)*

Nr.	Pyetja	-2	-1	0	1	2
1	Ne muajt e dimrit jam shume i kenaqur me ambientin ne klase.					
2	Ne muajt e dimrit jam shume i kenaqur me cilesine e ajrit ne klase.					
3	Gjate muajve te dimrit temperatura e klases eshte optimale.					
4	Ambienti i klases me shkakton dhimbje koke.					
5	Ambienti ne klase me shkakton grip ose te ftohte.					

Pjesa e trete; Komforti sezonal, vere *(vendosni X)*

Nr.	Pyetja	-2	-1	0	1	2
1	Ne muajt e veres jam shume i kenaqur me ambientin ne klase.					
2	Ne muajt e veres jam shume i kenaqur me cilesine e ajrit ne klase.					
3	Gjate muajve te veres temperatura e klases eshte optimale.					
4	Ambienti i klases me shkakton dhimbje koke.					
5	Ambienti ne klase me shkakton alergji, astma ose mbytje.					

Pjesa e katert; Komforti momental (vendosni X)

Nr.	Pyetja	-2	-1	0	1	2
1	Momentalisht jam i/e kenaqur me temeperaturen e klases.					
2	Ne klase eshte ngrohte.					
3	Ne klase eshte ftohte.					
4	Ajri ne klase eshte i mire.					
5	Pajisjet e ngrohjes ndizen në momentin e duhur.					
6	Kur pajisjet ndizen temperatura në klasë është më e rehatshme.					
7	Në pergjithësi, ambienti në klasë është I rehatshëm.					

Part one; Information

○ female ○ male

Existing illnesses

○ Asthma ○ Alergy ○ Sinusitis ○ other _____

Describe the clothes you are currently wearing.

_____

Part two; seasonal comfort, winter *(place X)*

		Completely Disagree		*neutral*		*completely agree*
Nr.	**Pyetja**	**-2**	**-1**	**0**	**1**	**2**
1	In the winter months I am very happy with the environment in the classroom.					
2	In the winter months I am very pleased with the air quality in the classroom.					
3	During the winter months the temperature of the class is optimal.					
4	Classroom environment causes headaches.					
5	Classroom environments cause flu or cold.					

Part three; seasonal comfort, spring

Nr.	**Pyetja**	**-2**	**-1**	**0**	**1**	**2**
1	In the spring months I'm very happy with the classroom environment.					
2	In the spring months I am very pleased with the air quality in the classroom.					
3	During the spring months the temperature of the class is optimal.					
4	Classroom environment causes headaches.					
5	Classroom environment with allergies, asthma or choking.					

part four; current comfort

Nr.	**Pyetja**	**-2**	**-1**	**0**	**1**	**2**
1	I am currently happy with the classroom temptation.					
2	In the classroom is warm.					
3	In the classroom is cold.					
4	Class air is good.					
5	Heating equipment lights up at the right moment.					
6	When the equipment burns the temperature in the classroom is more comfortable.					
7	In general, the classroom environment is comfortable.					

DATA LOGGER INFORMATION

Technical data

Temperature resolution	0.1 °C
Sample rate	1 min - 24 hrs
Power supply (details)	Lithium battery (CR2450)
Battery life	1 year
Weight	42 g
Humidity reading range (max.)	100 % RH
Humidity reading range (min.)	0 % RH
Temperature reading range (min.)	-30 °C
Channels	2
Humidity reading accuracy	3 % RH
Memory (readings)	20010
Features	PDF generator
Reading accuracy temperature	0.5 °C
Power supply	CR 2450 button cell (1x)
IP rating	IP65
Temperature reading range (max.)	+60 °C
	-30 up to +60 °C
Interfaces	USB
Unit of measurement	Temperature, Humidity
Type	DL-210TH
Category	Temperature data logger, RH data logger
Width	37 mm
Length	19 mm
Sample rate (min.)	1 min
Height	86 mm
Sample rate (max.)	24 h
Calibrated to	Manufacturer's standards (no certificate)

Hoxha, DM 2018

09

A STUDY INDOOR ENVIRONMENTAL QUALITY OF HIGH SCHOOL CLASROOMS IN TIRANA. THE EFFECTS ON STUDENT PERFORMANCE

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