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Arduino Use in Education Systems to Monitor the Noise in Schools Classrooms in Qatar

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Abstract

Many students suffer from the sound of air conditioners and others suffer from light intensity in classroom. The air conditioners and light intensity affect the efficiency and quality of education. Urduino is used a lot in industrial areas because there is a lot of noise pollution. Additionally, it can be used in high traffic regions as well as to monitor noise in different parts of the city. It can also be used in education systems to monitor the noise in classrooms. The purpose of this study was to monitor the noise in classrooms by Arduino Nano that interfaced with a Sound Sensor.

A study was conducted to determine the ambient sound and light intensity of a convenience sample at school during September, October and November 2021. Six classrooms' samples corresponding to hourly fractions of the average sample broken down into the following periods: from 10:00 am to 2:50 pm. Sound levels were measured to assess acoustic conditions. Light levels were measured to assess light conditions. Each classroom from 1 to 6 was tested the ambient sound intensity and light using an Arduino.

Noise varies with time and place. The sound level varies between 27.5 dB and 65 dB with the average sound level in the classrooms was 43.53 dB greater than recommended sound level limit of 35 dB. The light intensity varies between 62.50 lux and 208.5 lux. The average light levels around the recommended 300 lux. Everyone emphasized the quality of using the device to measure the noise level in the classroom. The use of the device leads to monitor the noise of the air conditioner or replacing it.

The device has the potential to significantly change the noise pollution monitoring system at school. Researchers recommend all students and authorities the importance of the Arduino.

Keywords: Sound, Light, Pollution, Classroom, Arduino

Introduction

Noise pollution is a problem that affects millions of people worldwide. Over the last few years, many researchers have devoted their attention to the design of wireless acoustic sensor networks (WASNs) to monitor the real data of continuous and precise noise levels and to create noise maps in real time and space [1]. Different studies have shown that noise pollution is currently one of the greatest environmental threats to people's health, leading to increased risk of cardiovascular disorders, hypertension, sleep disturbance, stress, etc., and it is negatively influencing productivity and social behavior [2].

The Arduino platform is widely used in education of physics to perform a number of different measurements [3]. More, a wide range of experiments and solutions are shown where sensors and the Arduino platform are used to teach physics efficiently and attractively while the cost is kept very low [4].

The Arduino platform is widely used in physics education. It has low cost and many additional components are available. A lot of application examples can be found in the papers, including building devices to measure temperature [5], pressure [6] and many more in various experiments to teach physics attractively [7].

In an article at Make online, intitled, "Why the Arduino Won and Why It's Here to Stay". Another articles describe the world of microcontroller development kits and how the Arduino has captured the hearts of many non-engineers [8].

We can use Urduino in industrial areas as there is a lot of noise pollution. It can also be used in education systems to monitor the noise in classrooms. It can be used in heavily traffic regions as well as monitor noise in different parts of the city. Many students suffer from the sound of noise pollution in classroom. The noise pollution affects the efficiency and quality of the education. What drove many students thinking that can understand such a modern world around them. One may think that there are even more Urduino use in education than before [7]. Several research works have reputed in very similar aspects. An earlier approach to noise mapping proposed a smartphone based sensing [9]. Do excessive noise levels negatively affect the quality of life of students in schools? The purpose of this study was to monitor the noise in classrooms by Arduino Nano that interfaced with a Sound Sensor.

Materials and Methods

Study Site

Presentation of Sampling Stations

The study employed an observational cross-sectional design conducted at Simaisma Secondary school for Boys. This area is located in Qatar. It is the lowest populous city in Qatar. For our study, 5 stations with distributed along the school were chosen taking into account various activities identified in the area (Figure 1).

Classroom 1: it is located upstream from the computer classroom.
Classroom 2: it is near the nurse's classroom.
Classroom 3, 4 and 5: they are between the toilet's professors and toilets students.
Classroom 6: it is near the supervisors' classroom.

Geographical coordinates of stations of the Simaisma Secondary School for Boys and their characteristics were presented in Table 1.

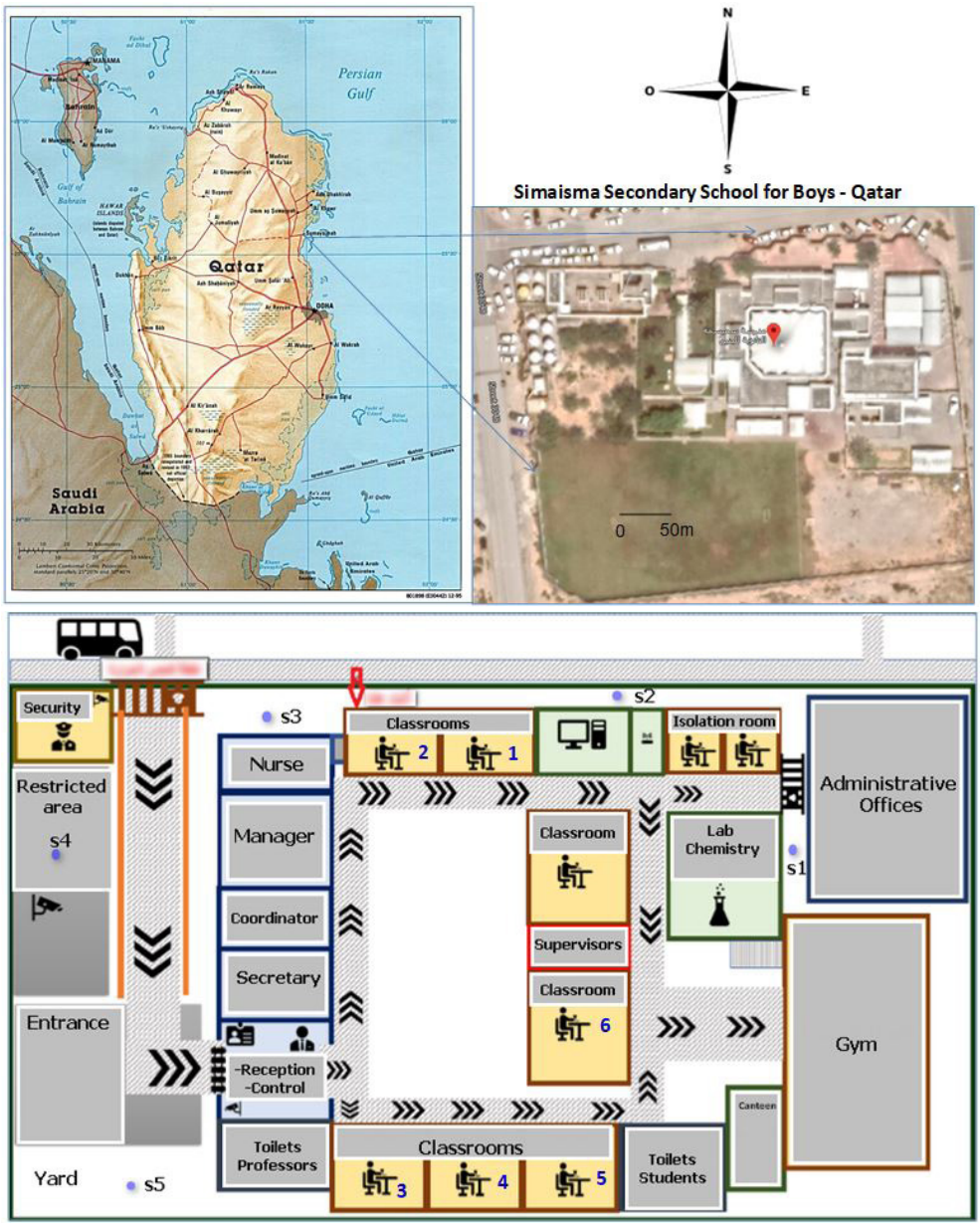

Figure 1: Map of the study area and classrooms of sample collection in Simaisma secondary school for boys (Qatar).

Classroom	Classroom 1	Classroom 2	Classroom 3	Classroom 4	Classroom 5	Classroom 6
Longitude (E)	51°48'58"	51°48'57"	51°48'52"	51°48'48"	51°48'51"	51°48'56"
Latitude (N)	25°57'30"	25°57'33"	25°57'32"	25°57'39"	25°57'28"	25°57'32"
X Lambert	1.3852296	6.6681666	6.6094487	6.1954893	6.0522776	6.1522776
Y Lambert	4.8201278	2.3686218	4.3736238	1.3309864	1.0385157	1.2685157

Table 1: Geographical coordinates of classroom of the Simaisma Secondary School for Boys

For the study of the acoustics and light level of the Simaisma Secondary School for Boys, two physicals characteristics have been the subject of a temporal and spatial monitoring: sound level and light level. Six classrooms selected and visited in Simaisma Secondary School for Boys for three periods as soon as September, October and November during 2021 (Table 2).

Classroom	Classroom 1	Classroom 2	Classroom 3	Classroom 4	Classroom 5	Classroom 6
September	10H00	10H10	10H20	10H30	10H40	10H50
October	12H00	12H10	12H20	12H30	12H40	12H50
November	2H00	2H10	2H20	2H30	2H40	2H50

Table 2: Date of the campaigns and hours of sample collection

Sampling and Sample Preparation

The sound and light samples were collected at the level of each classroom, during each campaign. In inside, the various parameters were measured.

Analysis Method

The Arduino put in center in all classrooms during lessons. The classroom is far the noise of traffic on the road. Sound levels were measured to assess acoustic conditions. Light levels were measured to assess light conditions. Each classroom from 1 to 6 was tested the ambient sound intensity and light using an Arduino (Figure 2), and data was compared to the WHO value.

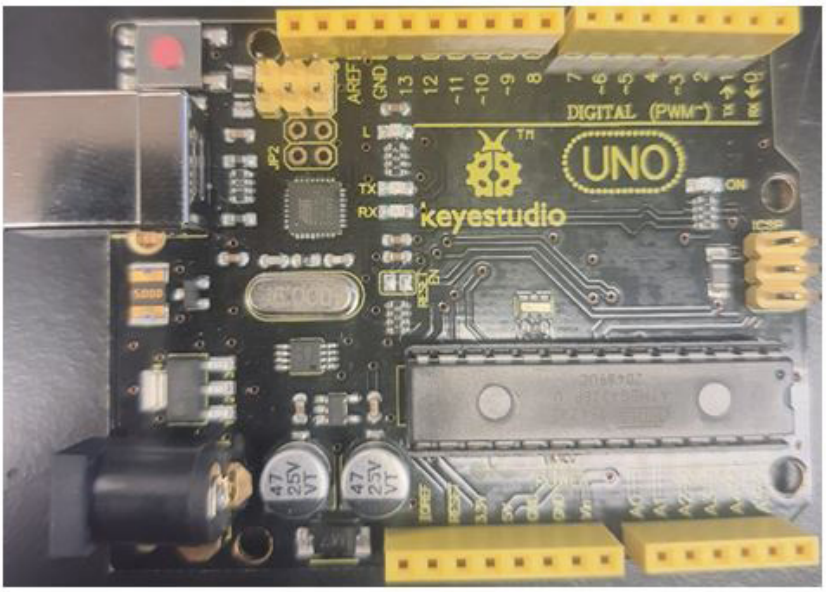

Figure 2: Arduino matrix used in Schools' classrooms

Results

The sound and light levels characteristics in schools' classrooms samples in north of Qatar are presented in Table 3. Noise presented by sound and light levels varies with time and space.

Sound Levels (Acoustics)

In our study, the sound level varies between 27.5 dB and 65 dB with the average is 43.53 dB. Indeed, the lowest concentration (27.5 dB) was measured in classroom 6 during November 2021. While the highest (65 dB) was measured in classroom 5 during October 2021. More, for all classrooms, higher sound level (44 dB) was obtained at 10 am, and lower sound level (43 dB) was detected at 2 pm. This situation could be explained by the sound of the air conditioner that causes the problem for students during lesson.

Light Levels

But the light level varies between 62.5 Lux and 208.5 lux with the average is 128.50 lux. Indeed, the lowest light level (62.5 lux) was measured in classroom 4 during November 2021. While the highest light level (208.5 lux) was measured in classroom 1 during October 2021. The same, for all classrooms, higher light level (129 lux) was obtained at 10 am, and lower light level (128 lux) was detected at 2 pm. This situation could be explained by the increase or decrease of the light level of the classroom.

2021	Classrooms	Sound (dB)	Light (lux)
Sept.	1	44±1	103±1
	2	45.5±2	167.5±2
	3	49±1	104±1
	4	55±1	105±2
	5	60±1	139±1
	6	45±1	163.5±1
Oct.	1	40±1	208.5±1
	2	40±1	175±1
	3	37.5±1	185±1
	4	45±1	145±1
	5	65±1	72.5±1
	6	35±1	97.5±1
Nov.	1	40±1	120±2
	2	40±1	70±2
	3	35±1	122.5±2
	4	40±1	62.5±1
	5	40±1	90±1
	6	27.5±2	182.5±2
Min.		27.5	62.5
Max.		65	208.5
Mean ± S.D.		43.53±9.12	128.50±44.10

Table 3: Mean and Standard Deviation classroom sound and light levels in schools.

Everyone emphasized the quality of using the device to measure the noise level in the classroom. The use of the device leads to monitor the noise of the air conditioner or replacing it.

Sound and Light Level Ranking

The general ranking of sound and light level in time was: October > September > November on the one hand. On the other hand, the general order of monitored sound and light level was: 10 am > 12 am > 2 pm. And, the classroom sound and light levels followed the order in Table 4. This order might be attributed to the different processes: The location of the classroom, the time and the others indicators.

Classrooms	Sound level	Light level
September	5>4>3>2>6>1	2>6>5>4>3>1
October	5>4>1>2>3>6	1>3>2>4>6>5
November	5>4>1>2>3>6	6>3>1>5>2>4

Table 4: Classroom sound and light levels order

Discussion

Sound Level

Qatar municipality recommended 35 dB sound level for effective teaching and learning environment [10]. However, average sound level of 43.53 dB (with SD of ±9.12) was recorded for all the studies classrooms. The sound level measured in our study (43.53 dB) was considerably lower than those previously reported in elementary schools' classrooms (59 dB with SD of ±7.1) in the United Arab Emirates [11].

Walkthrough investigations were conducted to have in-depth understanding of issues that would contribute to measured acoustic condition data. First, major indoor sources that would contribute to sound level include sound generated by air-conditioned systems, mechanical fans, and unavoidable teachers' and students' activities. Second, high classroom sound level would increase students' fatigue during mental memory tasks and would also reduce their tolerance levels, performances, and learning abilities. End, if teachers' performances are compromised, knowledge transfer to students will be compromised. This has been noted by several authors [12].

Light Intensity

Light level and quality would influence students' learning and performance [13]. Illuminating Engineering Society of North America (2000) (IESNA) recommended maintained average illuminance level of 300 lux at 0.8 m working level for elementary school classrooms. Minimum and maximum, and mean of measured light condition for each of the studied classroom can be found in Table 1. Indeed, the mean light level in each of the studied classrooms ranged between 62.5 lux and 208.5 lux. All classrooms had lux levels less than the recommended 300 lux. The light level measured in our study (128.50 lux) was considerably lower than those previously reported in elementary schools' classrooms (385 lux) in the United Arab Emirates [11].

Walkthrough investigations were conducted to have in depth understanding of issues that would contribute to measured light condition data. Firstly, all studied classrooms did not have external window shading device that could prevent glare in the classrooms. On the other hand, poor integration between interior and envelope systems would reduce the potential of maximizing day light in the classrooms [11].

Sound and Light Standards Limits

All classrooms had average light levels (128.50) in the range of 62.5-208.5 lux. Theses classrooms had light levels around the recommended 300 lux (Table 5) (USEPA air quality standards, IESNA lighting and book) [11]. Meanwhile the light level remains near the limit. It is acceptable according to IESNA.

Parameters	Present study	Recommended threshold limit	Quality
Sound level (dB)	43.53	35	Poor
Light level (lux)	128.50	300	Good

Table 5: Standards limits relating to the quality of sound and light levels in classroom at School

Poor lighting, or a complete lack of lighting (in the event of a power failure), may prevent students from seeing possible hazards in education and especially at the laboratory experiments.

Conclusion

The device has the potential to significantly change the noise pollution monitoring system in classroom at school. This study has shown that students in the studied classrooms were exposed to poor sound conditions. The sound level found in our study greater than the limit makes the sound unusable for education's classroom. But the light level remains near the limit. It is acceptable according to IESNA. Light level and quality would not influence Students' learning and performance.

Identified knowledge gaps should be bridged to create environmentally friendly and conducive learning environment for school students.

Researchers recommend all students and authorities the importance of the Arduino. Implementation of this device will provide a low cost and well-organized solution of monitoring the noise at schools.

Conflict of Interest

All authors have no conflicts of interest that are directly relevant to the content of this study.

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Reviewer Disclosures

No relevant financial or other relationships to disclose.

Declaration of Interest

No financial affiliations or financial involvement with any organization or entity with a financial competing with the subject matter or materials discussed in the study.

Consent for Publication

Not applicable.

Availability of Data

All data generated during this review are included in this study

Standards of Reporting

CONSORT guidelines were followed.
Authors Contributions
Authors interpreted and discussed the data, and wrote the first version of the manuscript. All authors read and approved the final manuscript.

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