OULU UNIVERSITY OF APPLIED SCIENCES

# UNDERSTANDING TEACHER AWARENESS OF ENVIRONMENTAL CONDITIONS THAT AFFECT TEACHING AND LEARNING

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**ABSTRACT**

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Environmental factors such as light, sound, temperature, humidity and air quality can have a negative impact upon student outcomes (Barrett, 2015). However, little is known about educators' knowledge of what these factors are and how they affect learning, as well as how they can detect and measure them as no studies appear to have been carried out on this matter. In addition, there is the issue of what can be done to modify and rectify these environmental issues in learning environments.

This research seeks to understand teachers understanding of the issues, whether or not they currently monitor environmental factors and whether or not they feel that they can do anything about the issue. Ultimately, this research seeks to ascertain if a monitoring device could potentially be of value to teachers. The study builds off of a number of key studies on the negative effect of variables such as light, sound, air-quality and temperature upon learning. The research was conducted via an online survey of teachers from across the world, with questions focusing on the severity of issues related to the environmental factors, frequency of these issues, as well as enquiring about monitoring and modifying environments. The results were analysed to identify patterns and trends, as well as being subjected to correlation tests.

Results showed that environmental factors do concern teachers on a regular basis, and that they are a challenge to monitor and modify. It also showed that the most pressing factors related to light, sound and temperature – and that this is partly due to the fact they are the easiest variables to monitor and control.

This research shows that teachers have elementary understanding of environmental factors that influence learning; however, they lack precise and specific mechanisms to monitor and control conditions within the learning environment. This finding demonstrates that there is a case for monitoring devices, and potentially devices to modify conditions to be employed in school in order to address these matters. Findings could be used by teachers, school leaders and hardware/software providers to develop solutions to sub-optimal environments.

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Keywords: learning environments, environmental factors, monitoring, teacher awareness

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# 1 INTRODUCTION

## 1.1 Background

Studies have shown that non-optimal learning environments significantly impact upon student concentration, motivation and inevitably attainment. Barrett et al (2015) undertook a comprehensive review of studies of learning environments across the United Kingdom and found that environmental factors can negatively influence learning by up to 16%. Learning environments play a significant role in terms of the efficacy of teaching and learning; however little thought is given to how to maintain the space following its construction as it is often too challenging or too expensive to remedy. Anecdotally, teachers often feel that something is not right about their learning spaces, but there is a dearth of empirical information for teachers to definitively understand that there is an issue with their classroom. This research has been undertaken in order to bring attention to this issue, and to make teachers more aware that environment plays a significant role in student attainment.(Mahony, 2011)

## 1.2 Context.

The average cost of building an educational establishment in the United Kingdom was found to be up to 2,900 pounds (3.3K Euro) per Sqm (Guardian, 2012) and resolution of the architectural problems is often prohibitively expensive on top of this cost. In addition, existing buildings require significant retrofitting to meet accepted norms and expectations. (Mahony, 2011)

Research has shown that conditions for learning can significantly impact outcomes (Cheryan, 2014). Barrett et al (2015) showed that classroom design could negatively impact upon student attainment by up to 16% - Environmental factors were deemed to be responsible for 49% of this figure, with 28% being due to student individualisation and personalisation of their space, and the remainder being down to how stimulating the environment was – i.e. colour and complexity. However, it remains to be seen how aware teachers are of these factors and of their significance upon learning.

This study aims to address the following questions:

1) How teachers perceive various environmental conditions and associated problems in their own learning environments?
2) How frequently do these conditions manifest as problems ?
3) Can teachers monitor the conditions in question?
4) Can teachers adjust the environmental factor?

By understanding if teachers are aware but unable to monitor or adjust conditions gives credence to the idea that assistance is needed to highlight the issues at hand. Therefore, this study will work to demonstrate the severity of problems associated with environmental conditions? which in turn may point to the need for a remedy that may be of potential value to all school stakeholders.

# 2 SIGNIFICANCE AND SCOPE

## 2.1 Background Research

Like in any biological system, there are optimal conditions for human activity. A number of studies have been undertaken in the educational space (Barrett, 2015; Cheryan, 2014; Higgins 2005).
Most notably, Barrett et al set out to identify the impact of the physical classroom features on the academic progress of 3766 students in the UK. They researched the effects of 10 particular environmental factors of the classroom upon students' learning rates and compared the findings of previous reports to their research to see if the data and experiences could be corroborated. This study was found that school design could have an impact of up to 16% upon students learning, of which almost half of this figure was down to environmental factors.

Whilst many factors can also have a significant impact upon learning, the biggest impacts noted in the Barrett (2015) study were due to light, temperature air quality and sound. In addition, Tian (2020) found that reducing humidity in hot rooms has a significant positive impact upon learning outcomes. Below is a brief summary of each environmental condition that is being studied – Temperature, humidity, air quality, sound and light; and the research undertaken upon them in relation to impact upon learning and on learning environments themselves.

### 2.1.1 Lighting

Barrett's study found that light alone contributed 3.4% of the 16% impact of class design. There have been numerous studies undertaken upon the effect of light upon learning (Goven, 2010; Rautkylä, 2010; Mott, 2012, Dahlan 2015, Sleegers 2012). Studies indicate that issues related to light fall into two main types: the type of light and the amount of light. Winterbottom (2009) found that school lighting is generally excessively harsh (Slater, 1993), and that colour temperatures are too high (Wilkins, 1990). This is exacerbated by the fact that classrooms in the UK are

often over lit with minimal ability to control the levels of lighting (Winterbottom, 2009). Further work by Goven et al (2010) showed that when light levels are raised from 300 to 500 lux, students' progress is raised in reading, writing and maths. This shows that the amount of light is crucial when developing fundamental skills that underpin future learning. The work of Rautkylä et al (2010) showed that changing the type of lighting has a significant impact upon concentration and alertness in afternoon lectures, helping to beat the post lunch slump. A common conclusion of these identifies the need for lighting to be monitored, and intervention should be taken when necessary to ensure students benefit from a key contributing factor to their learning.

### 2.1.2 Humidity

In comparison to other variables in this trial, humidity is relatively less researched. This may be due to the complex nature of humidity - Kakitsuba (2018) stated that humidity itself is not an independent variable itself but is highly dependent upon temperature. That said, Tian (2020) undertook a study that showed at high temperatures, reduction of humidity from 70% to 50% results in significant improvement in cognitive tests.

Humidity has also been shown to have an impact on both teacher and student health. In 2013, YLE reported about the scale of environmental issues in Finland and stated that The Trade Union of Education (OAJ) estimates that every day a quarter of a million children and adults attend schools with internal air problems. The union claims the bill for repairing the mould and damp problems is likely to run to a billion euros. Taskinen(1999) studied two schools in a Finnish community - one with moisture and humidity problems and one without. It was found that students attending the school with moisture problems suffered from prolonged wheezing and coughing more frequently than students who attended a school with no moisture issues. Korppi (2003) found that students attended schools afflicted with moisture issues had a significantly higher level of IgG antibodies to mold (Penicillium notatum) than those who did not. With humidity, it seems to be that there is a sweet spot - Angelon-Gaetz (2016) noted that when relative humidity levels were too low, or too high – 30-50% is the advised range for US classrooms – the rate of respiratory infections for teachers was raised by a moderate level. Therefore, it is of

interest to understand if this is a common issue, and how frequently this matter occurs.

### 2.1.3 Temperature

Temperature also plays a significant role in student performance. Barrett's work sought to verify studies undertaken in the 1950s, that showed cognitive speed decreased as temperatures rose. Research from 2007 (Wargocki, 2007) showed that the optimum temperature for cognitive processing in mathematics and language tests was 20C. They also demonstrated that as temperature rose above this level, cognitive processing speeds dropped –this equated to approximately 2% for every degree C raised. A recent study by Goodman et al (2018) showed that for every day where temperatures were in the 90s (Over 32C) meant one-sixth of 1 percent of a year's learning was lost, while days over 100 degrees (37C) had an effect that was 50 percent larger. This data also showed that weekend heat had no significant impact upon learning –suggesting that the fundamental affecting factor was temperature in learning environments. This loss of learning was eradicated when schools utilized air-conditioning. These studies suggest that through careful control of temperature, learning loss can be significantly reduced and further suggests that there are clear parameters, if controlled properly, can benefit students significantly.

### 2.1.4 Air Quality

The quality of air in classrooms has been well researched with various factors having been studied (Lowe, 2018 Ahmed, 2017, Satish 2012, Petersen 2015, Wargocki 2020,). The most common aspect has been Carbon Dioxide concentration, since it is a by-product of respiration and a potential indicator of overcrowding in a classroom. Satish et al (2012) posed the question of CO2 being an 'indoor pollutant' , i.e. being an emission that impairs normal biological operations –normal atmospheric levels of CO2 lie at around 400ppm. Studies found that levels of 600 ppm had no significant impact upon learning. However, Satish et al found that classrooms will often reach figures of 1000-2000ppm due to the respiration of students. The study showed that students exposed to 1000ppm

had significant decreases of cognitive ability in 6 out of 9 tests, and this increased to 7 out of 9 at 2500ppm. Oxygen levels in classrooms could also be a comparable measure of CO2, as O2 levels drop and CO2 levels rise as a result of respiration. It was also found that raising O2 was possible through judicious use of plants (Kaufeldt, 1999,) and that planting one plant per 1000sqft of classroom could have an impact of up to 10% upon productivity.

Other studies have looked at particulate matter and pollutants. For example, in 2018, a study of elderly Chinese people showed that prolonged exposure to airborne pollution reduced cognitive ability significantly –even to the level of several school grades (Zhang, 2018). Whereas another study from Sweden showed that students who were exposed to higher levels of air pollution over a 3.5-year period were more likely to require medication for psychiatric disorders (Oudin, 2016). It is imperative that air quality is monitored and flagged as being a significant aspect of the learning environment. Barrett's work showed that air could have a 1.5-2% impact upon students.

### 2.1.5 Sound

A final area for consideration is sound. It is well known that noisy environments are not conducive for optimal learning. Shield et al (2003) carried out a significant review of studies related to classroom acoustics and found that prolonged exposure to noise affected students language attainment (Hetu, 1990), and that if a classroom undergoes acoustic redevelopment attainment improves (Mackenzie, 2000). The research of Picard et al 2001 shows that noise in excess of 75dB has negative impacts upon learning.

Whilst there is a huge amount of data upon what affects learning, there is very little research upon the awareness of teachers and students about their learning environments. This forms the stem of the research objectives for this project. Parameters can be readily derived from this data in order to produce a functional prototype that alerts users to sub-optimal conditions for learning.

# 3 METHODOLOGY

## 3.1 Research Background

### 3.1.1 Research Objective

The objective of the study was to ascertain the level of teacher awareness about environmental conditions within their learning environments, and to understand if they are able to monitor or modify the situation. The reason for doing this is to understand what teachers know about their learning environments, and to raise awareness of the factors affecting learning. In turn, this should manifest in positive action to rectify sub-optimal learning environments.

The assumptions are that the data generated by such a study should stimulate discussions within schools about how learning environments can be improved. In turn, a demand for increased information should in turn be reflected in the demand for mechanisms to monitor environments.

### 3.1.2 Research Motivation

Currently, awareness of environmental factors that affect learning is relatively limited among practitioners. There have been few studies to ascertain the level of teacher awareness of environmental factors that impact upon learning.

Therefore, this study will attempt to address this gap by exploring the level of awareness among teachers and, whether these are significant, and whether or not these teachers are able to do anything about it.

The aim of the research is to collect data to help determine if the deployment of an Internet of Things (IoT) device will be of value in the classroom to teachers. An IoT device is in essence a bank of sensors that are constantly monitoring the learning environment and sending information to a central point. The device is permanently connected to the internet and is constantly sending information to the cloud. Data is

analysed there, and insights are generated for users – With already accessible technologies, this type of device could detect environmental conditions through sensors and inputs and notifying users via a dashboard and notification system - in this case notifications to teachers or administrators that the learning environments are sub-optimal. By notifying teachers of sub-optimal learning conditions, there should in theory be marginal gains in learning (Barrett, 2015; Cheryan, 2014; Higgins 2005).

If teachers have greater access to environmental information, by using an IoT device, then they should be able to rectify issues more rapidly and reap the gains accordingly. It is hypothesized that this information could raise awareness of the factors that affect learning, as well as potentially modifying behaviour and environments as a secondary result. Modification of environment is the most likely outcome as schools will already have been built and it is difficult/almost impossible to retro engineer an entire campus. Therefore, the research question is: “are teachers aware of the impact of environmental factors upon learning in their classrooms, and are they able to monitor or modify them?”

## 3.2 Data Collection

### 3.2.1 Data collection rationale

A quantitative approach is principally used for data collection in this study. The primary reason for this is that it significantly reduces resources and is a more rapid mechanism to collect statistical data. Bryman (2001) argues that a quantitative research approach is the research that places emphasis on numbers and figures in the collection and analysis of data. Statistical data usage reduces the time and effort, which the researcher would have invested in describing the results (Daniel, 2016)

Quantitative data collection and analysis make generalisation possible with this type of approach. The research study using this type of research tool is conducted in a general or public fashion because of its clear objective and

guidelines and can therefore be repeated at any other time or place (Shank, 2007).

A key strength of a quantitative approach is that it reduces potential bias. Denscombe (Denscombe, 1998) describes quantitative research as “researcher detachment”. The issue of researcher being bias with either his data collection or data analysis will be reduced when the researcher is not in direct contact with the participants. As a result, the objectivity of the researcher will not be compromised. And this is also a potential effect of respondent anonymity (Muijs, 2004; Litchman, 2006; Bryman, 2012; Creswell, 2009).

### 3.2.2 Process of Collection

In order to collect data, a survey was composed focusing on teachers’ perceptions about environmental conditions in their learning environments, as well as their ability to measure and modify these conditions. The survey can be found in the appendix. The majority of the questions were designed to ensure that a definitive answer was given – for example, simple scales and yes/no responses. Open responses were only solicited when confirming how teachers measure or modify conditions. The reason for this approach was to ensure rapid data collection, and ease of analysis.

Issues of ethics and confidentiality were addressed through an anonymised survey – no participant was required to give their name, and any participant who wanted to have a copy of the report or wanted to discuss how data was used, was invited to send an email to the researcher. The header statement also stated that the data would be used for the purpose of this project, and that data would not be shared for non-academic purposes.

The survey was posted on Google Forms during March and April 2020 and was shared across a number of platforms – namely, LinkedIn, Twitter, Facebook, and Instagram. The posts were targeted at education groups and communities to encourage teachers to respond. The location of the teacher was recorded; however, no focus was made to encourage a particular group to respond. The

survey was left open for one month to encourage a maximum number of respondents, as well as repeat posts being made to direct teachers to the survey.

Google Forms was selected as it was the simplest tool to produce a multi-page survey, as well as ensuring that all data was immediately logged in a spreadsheet. This allowed for easy data cleansing, and simple analysis of the responses. Data cleansing was necessary, as some respondents answered questions despite their previous responses negating the need for an answer.

### 3.3 Data Analysis

Predominantly, the data was analysed using descriptive statistics. This was to ensure that all information is simplified and presented in a clear and concise fashion. Central tendencies for all numerical values will be calculated to demonstrate the nature of the data. Inferential data can be drawn for a limited tranche of the information – for example is there a link between teachers' perception of a problem and the frequency of the issue? For this, tests such as a Pearson Correlation test was employed to ascertain if there is a relationship between these factors.

### 3.4 Potential Limitations of the Method

There are a number of limitations of using an online survey. One is selection bias online surveys utilise links that mean the population is not screened in the same way as a face to face survey. Due to the nature of link sharing , those who responded to the survey link are indicative of the members of a particular Personal Learning Community (PLC). However, face-to-face approaches are generally more time consuming and expensive – so they were disregarded as an appropriate tool

Another key issue is that online survey response rates are generally low and also vary extremely. Also, another issue is that there is no way to ensure online

respondents who start a survey actually finish it. The easiest way to counteract this issue is via a simplified survey design.

Data cleansing is required for some questions – notably asking the exact tools teachers use to measure or modify environmental conditions. In order to make sense of the data, some degree of classification is required, and this may lead to minor skewing of data.

# 4 RESEARCH FINDINGS

## 4.1 Focus

The following section will outline the findings from the survey with a focus: Ascertaining the perception of the effect of environmental factors upon Teaching and Learning, and the ability of staff to observe and measure these variables:

1. Temperature
2. Humidity
3. Air quality
4. Light
5. Sound level

## 4.2 Research Findings

40 teachers from 18 nations, and from 4 continents were surveyed for this study. This implies that the information was obtained from a diverse population.

### 4.2.1 Temperature

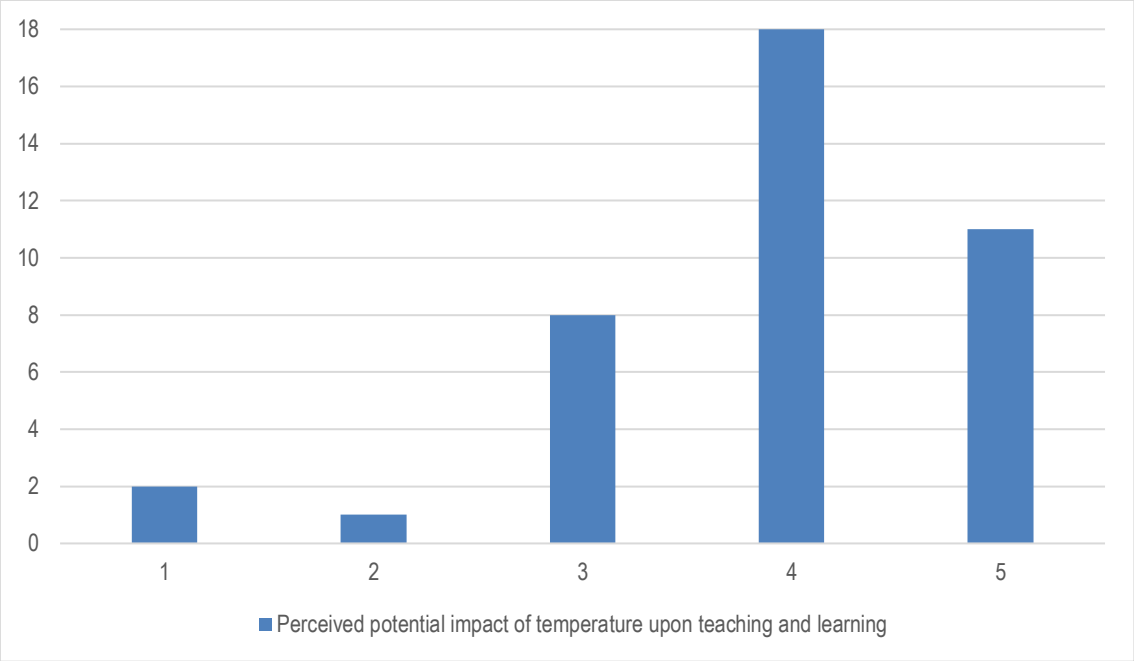


*Figure 1: Teacher Perception of the impact of temperature upon teaching and learning*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 3.875 | 4 | 4 |

Temperature is classed as a medium to highly (Score 3-5) significant issue in 92.5% of responses. This shows that it is a factor that seriously concerns educators. This indicates teacher perception, however, as opposed to a definitive identification of classroom issues.

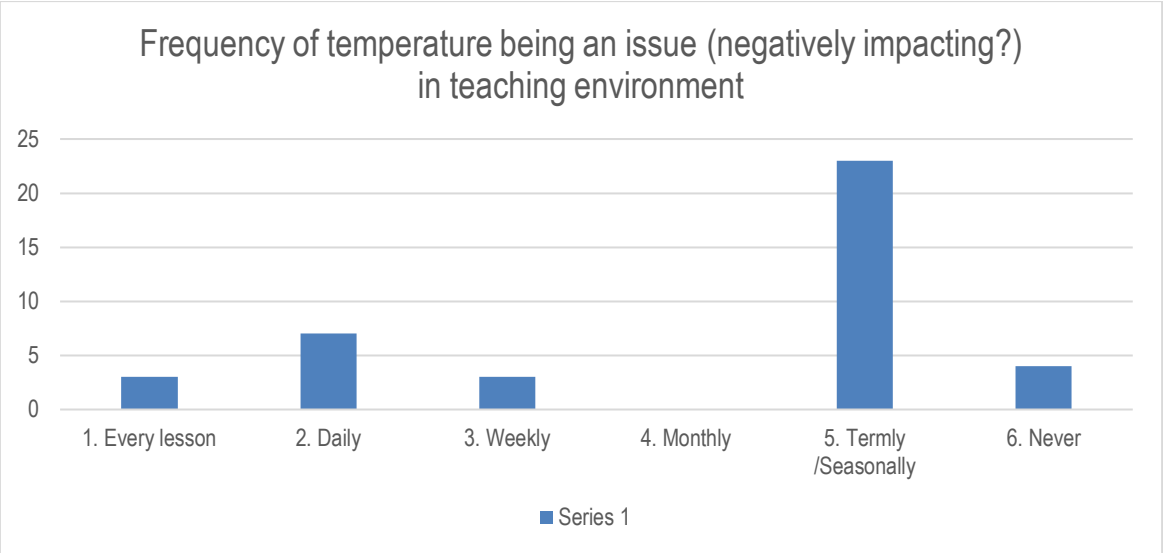


*Figure 2: Perceived frequency of temperature negatively impacting upon teaching and learning*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 4.25 Monthly | 5 Termly | 5 Termly |

The majority of teachers see temperature as a seasonal issue – there was also no significant geographical link to the frequency of this being an issue. In order to ascertain if teachers' opinions of the severity of the problem were related to frequency, a simple Pearson test was applied.

Pearson tests range from -1 to 1 – the value of -1 indicating a perfect negative correlation, and a value of 1 representing a perfect positive correlation. With these two variables, a score of 0.182 is indicative of a very weak to almost no correlation between these two factors. Therefore, it is highly unlikely that these two factors are linked.

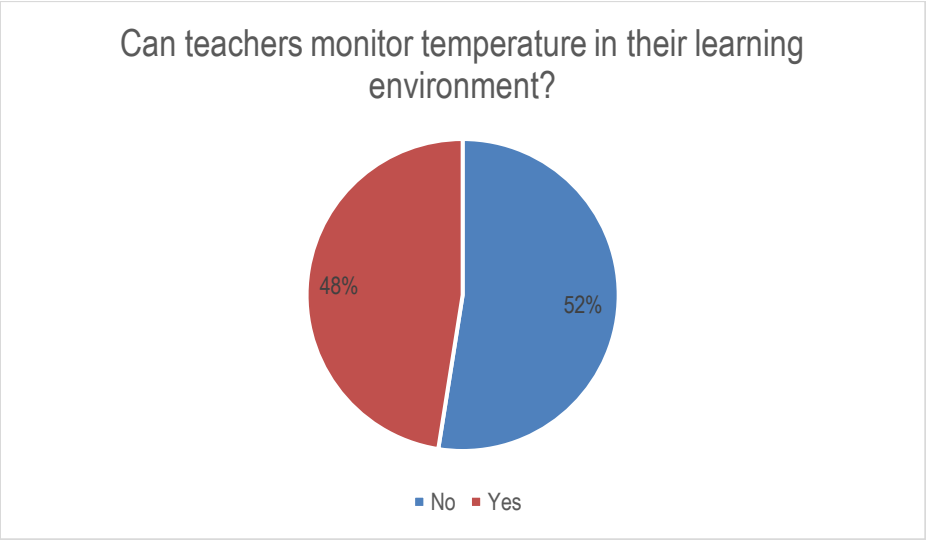


*Figure 3: Ability of teachers to measure temperature in their learning environment*

Just over half of all respondents are unable to measure temperature in their classrooms – in addition, it should be noted that scores of 3+ for severity of the issue do not seem to correlate to the ability to measure temperature in the learning environment. The scores are equally distributed.

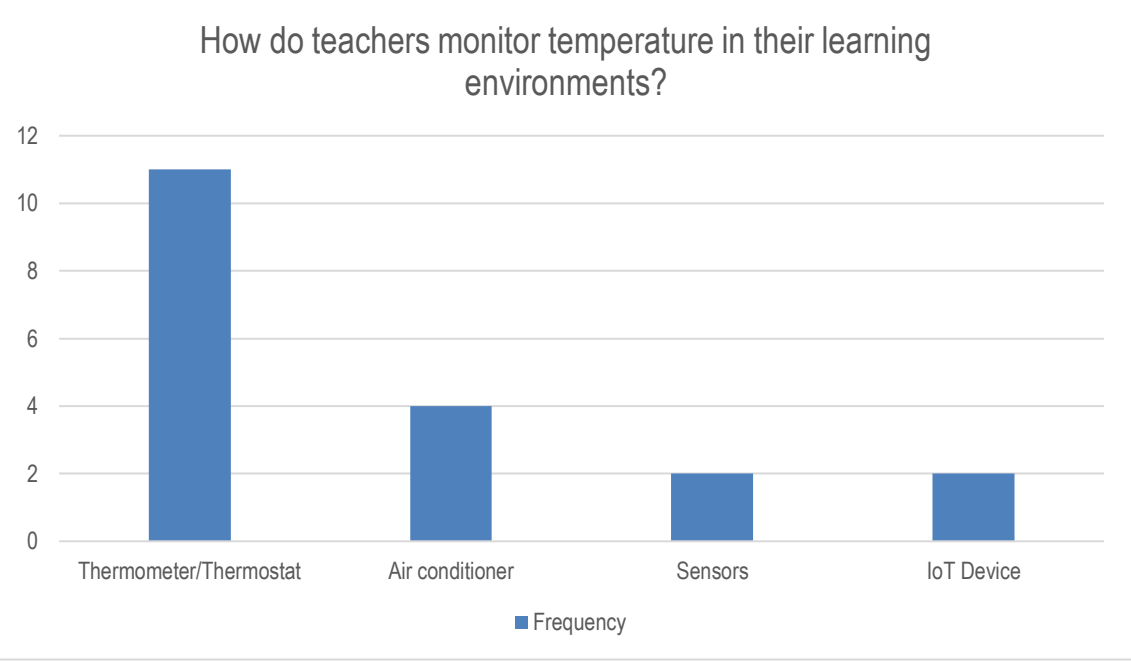


*Figure 4 How teachers monitor temperature in learning environments*

Of the 19 respondents who are able to monitor the temperature in their learning environment, the vast majority (15/19 respondents) used thermometers/or

thermostats in some form to monitor the temperature in their learning environments. Only 10.5% of respondents used a bespoke IoT device to monitor temperature in their classrooms. This implies that very few schools actively invest in monitoring of conditions.

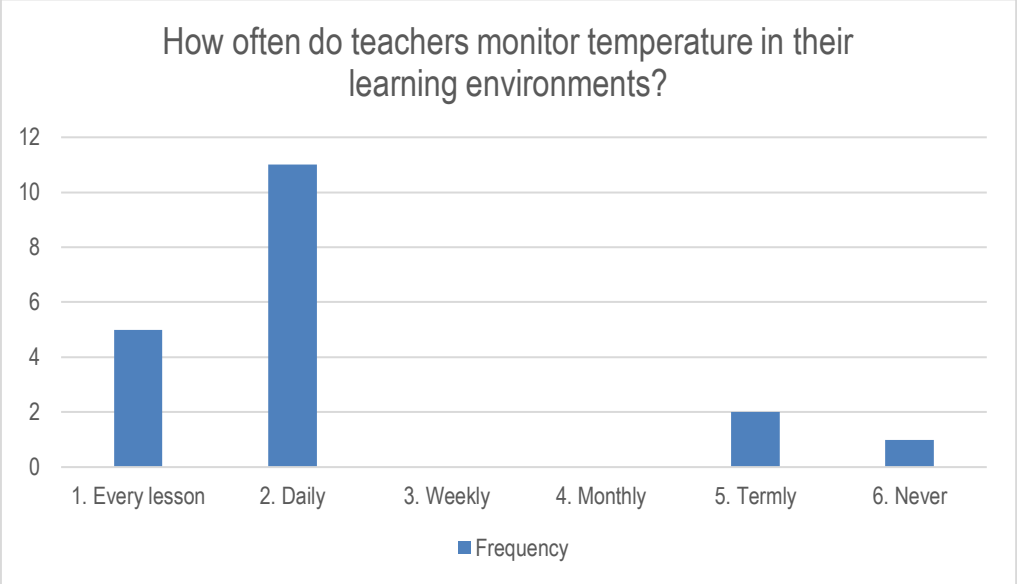


*Figure 5 How often teachers monitor temperature in their learning environment*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 2.26 Daily | 2 Daily | 2 Daily |

When a teacher has a device to monitor temperature, they use it regularly – whether or not this implies that teachers are aware of this variable is debatable, but it can be inferred that teachers would not monitor the temperature unless they believe it is important to do so. This would suggest that teachers are aware of the impact of temperatures upon learning.

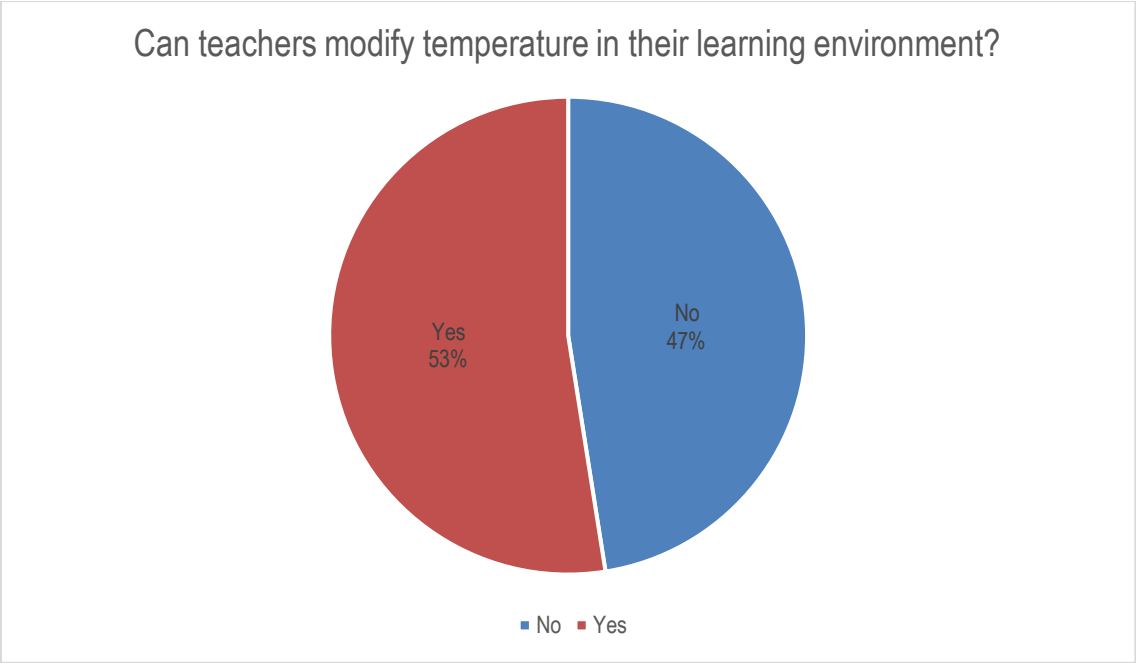


*Figure 6 Ability of teachers to modify temperature in their learning space*

Just over half of teachers are able to adjust the temperature in their classrooms. This coincides with the ability to monitor temperature – of the 21 respondents that can modify temperature, 16 of these were also able to monitor temperature – this suggests that there could be a correlation between the ability to monitor temperature and the ability to modify this variable. Of these 21 respondents, 17 used heating and colling systems to modify temperature, and the remaining 4 used windows or doors to air their rooms.

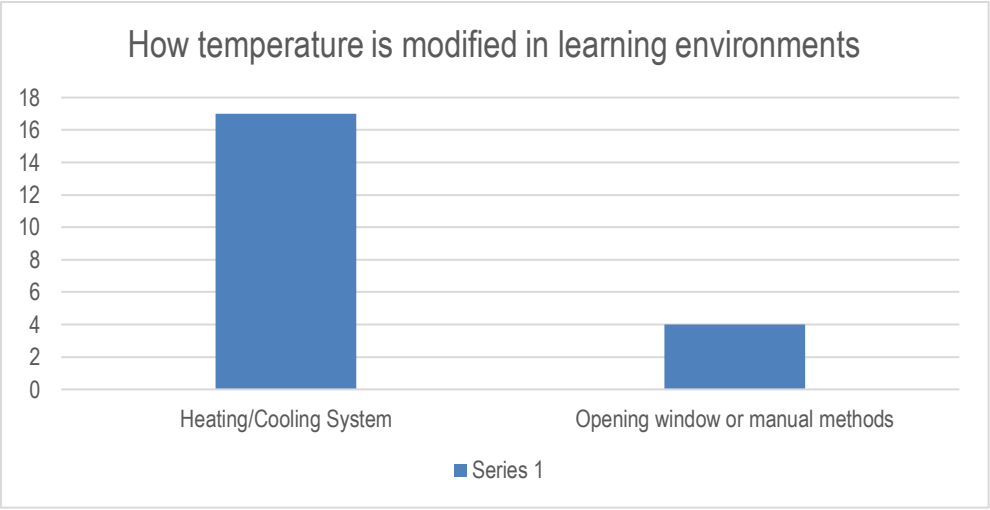


*Figure 7How teachers modify temperature in their learning environments*

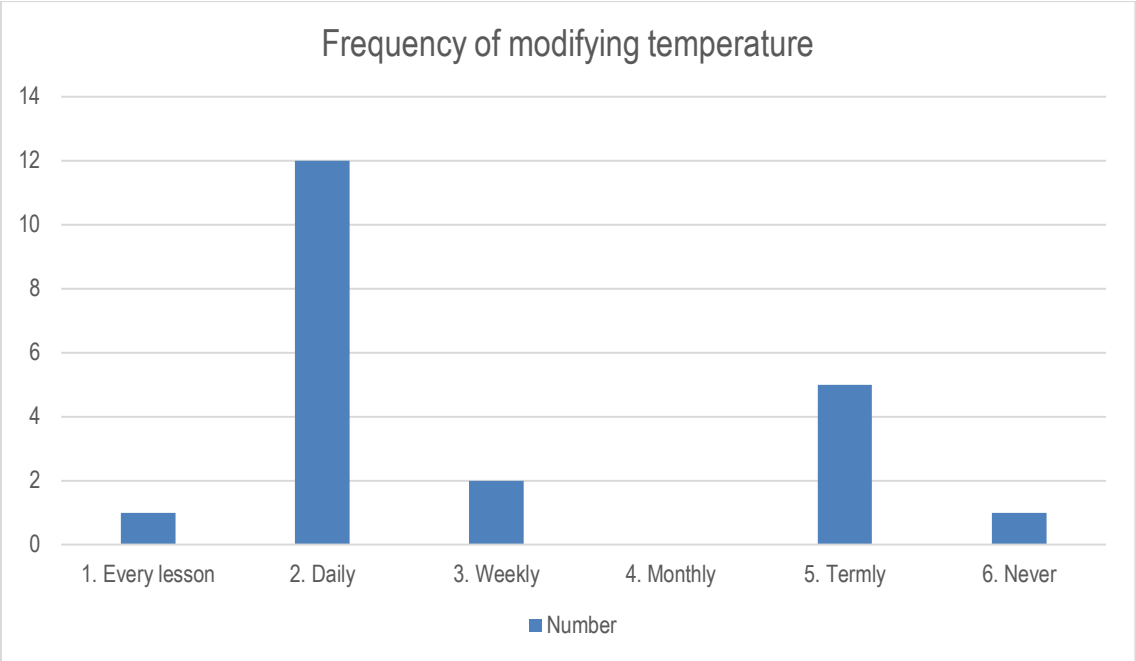


*Figure 8 How frequently teachers modify temperature in their learning environments*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 2.95 Daily | 2 Daily | 2 Daily |

It appears that most teachers change temperature on a regular basis – around 62% of respondents who are able to modify temperature do so at least once a day. All but one of these respondents all had some mechanism to monitor temperature. This further reinforces the idea that if teachers are able to adjust conditions and are aware of the variable they are more likely to make adjustments.

### 4.2.2 Humidity

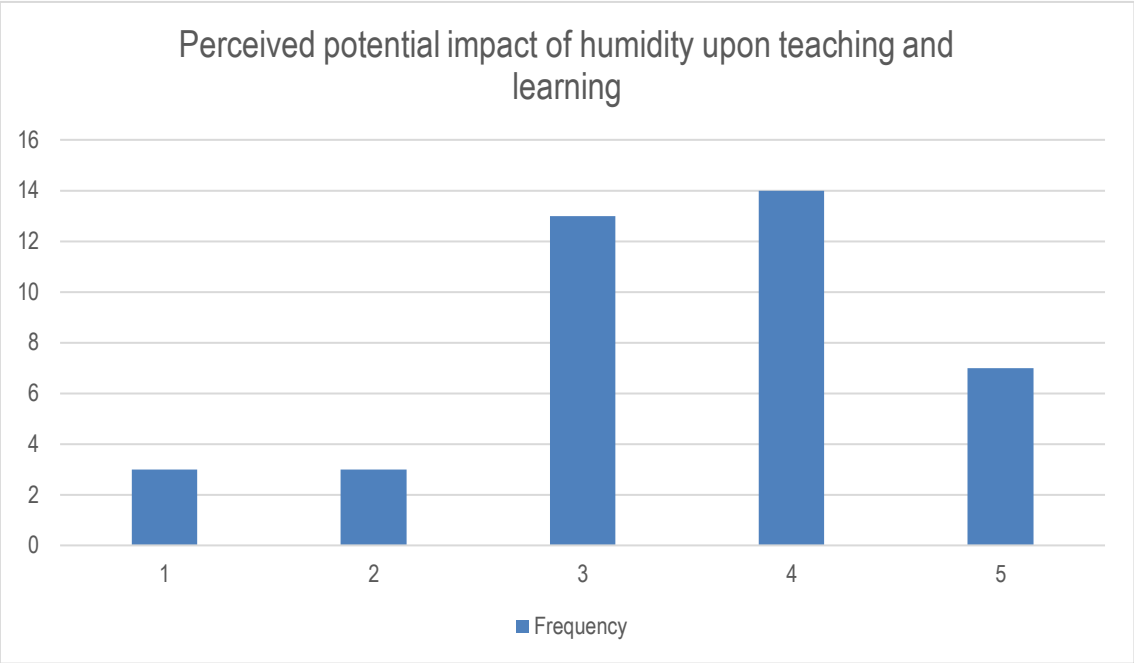


*Figure 9: Teacher Perception of the impact of humidity upon teaching and learning*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 3.65 | 4 | 3 |

A vast majority of teachers see humidity as a significant problem. When asked to score humidity on a scale of 1-5 as to potential impact upon teaching and learning, 85% of respondents scored the issue a 3 or more. There also seems to be no relationship between the scoring and the geography of the respondents.

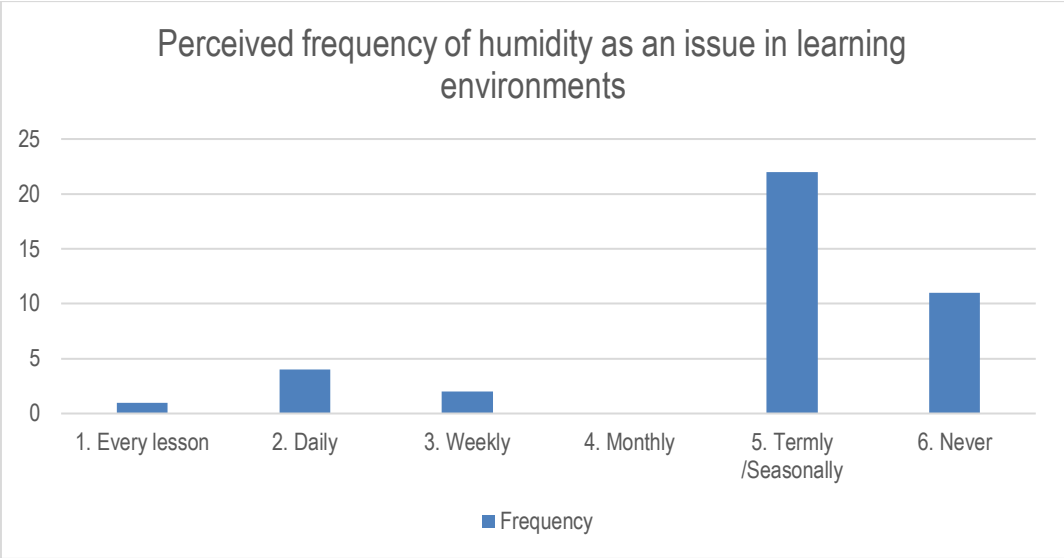


*Figure 10: Teachers perception of the frequency of humidity as an issue in learning environments*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 4.775 Monthly | 5 Termly/Seasonally | 5 Termly/Seasonally |

Humidity is seen as a less frequent problem than temperature. The majority of respondents feel that humidity is related to seasonal factors. There is no clear geographical link to humidity being classed as an issue, as diverse geographical locations from UK, UAE, Finland, Malaysia, Kazakhstan and Kenya reported humidity as a termly or seasonal issue.

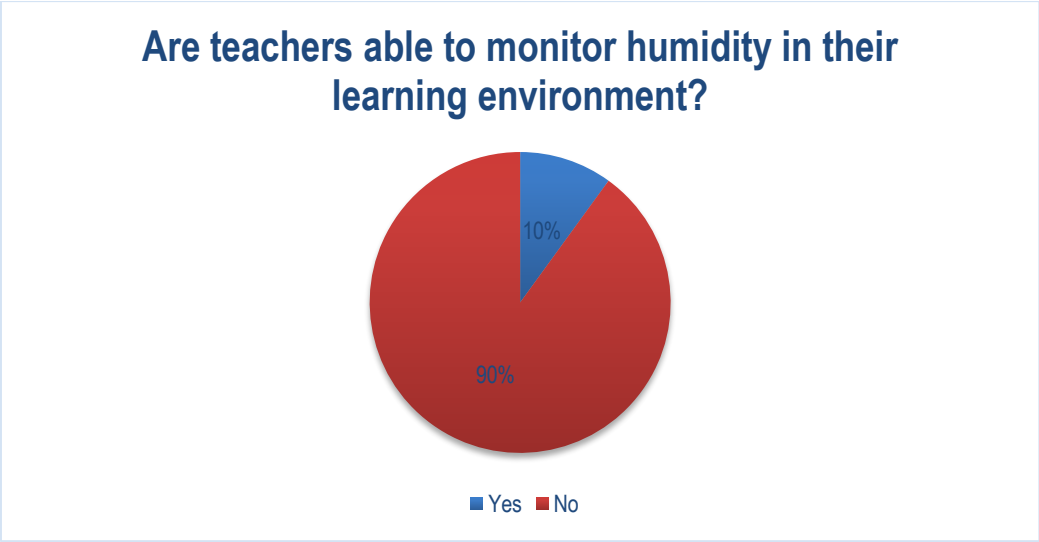


*Figure 11: Ability of Teachers to monitor humidity in learning environments*

Monitoring of humidity in schools is exceptionally rare – only 10% of teachers report that they are able to measure humidity in their learning environment. Of those 4 teachers who reported the ability to monitor humidity, three reported that they monitor humidity is through inbuilt sensors. The remaining respondent said that they use their own senses. However, it is very rare for teachers to be able to make accurate measurements of humidity in their classroom

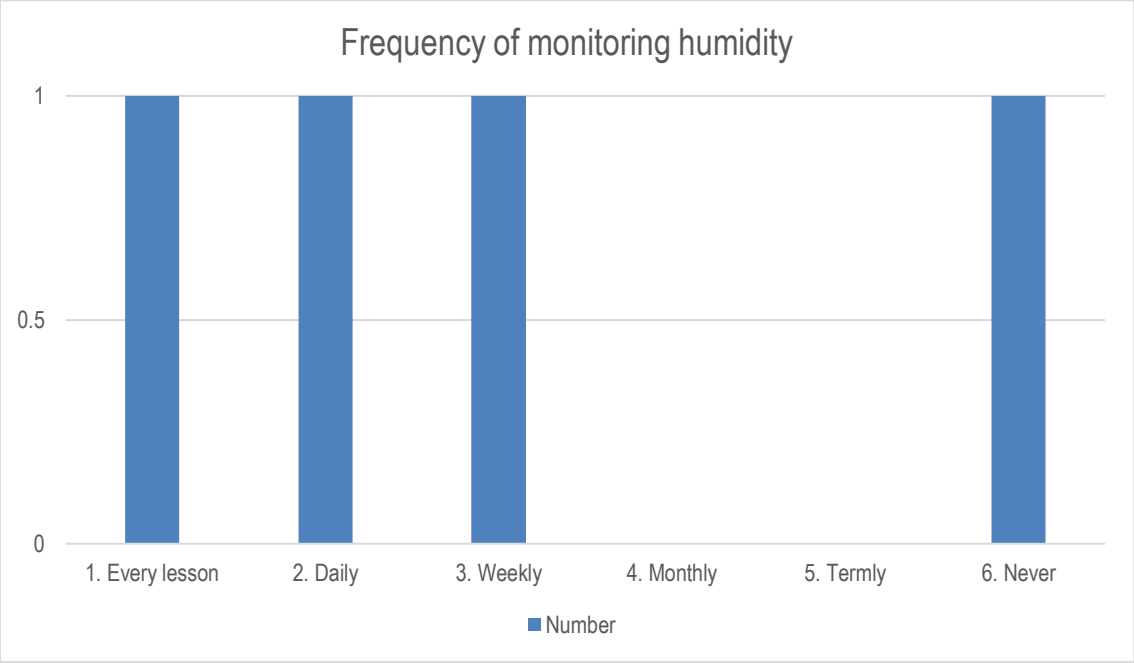


*Figure 12: Frequency of humidity monitoring in learning environments*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 3. Weekly | None | 2.5 – Daily/Weekly |

There is no clear pattern in terms of monitoring humidity – each response is different and there is no dominant pattern. Therefore, it is difficult to link frequency of checking humidity and the severity of the issue.

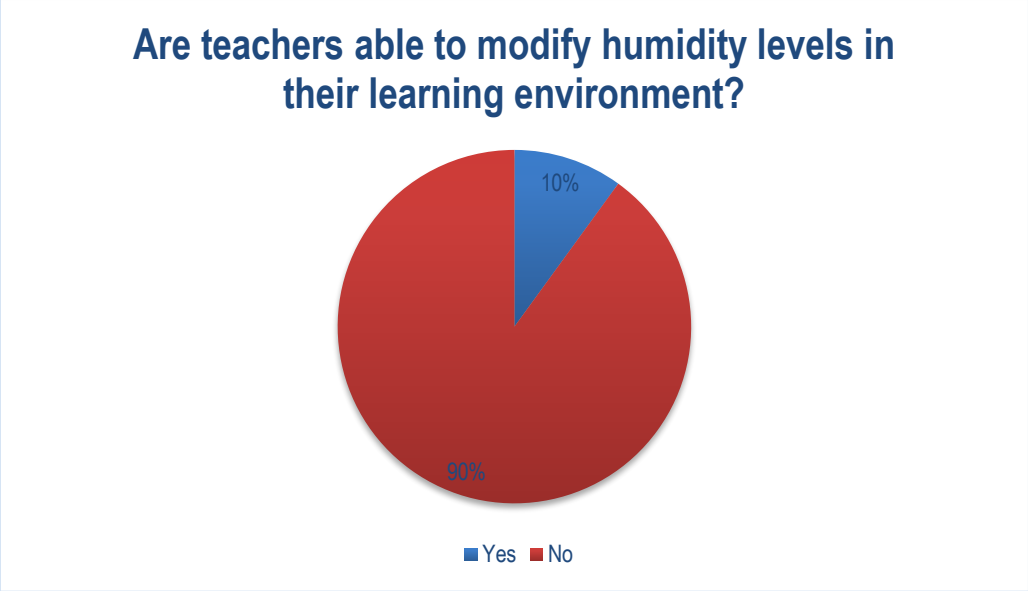


*Figure 13: Ability of teachers to modify humidity in their learning environment*

The ability to adjust humidity is noted in a similar way as that of being able to monitor the variable. However, it should be noted that only two of the respondents who reported that they could monitor humidity could change this variable – there appears to be no clear relationship between monitoring and modifying the variable in this case, however there is a statistically insignificant sample size to report on.

All respondents reported that heating or cooling systems such as air conditioning are the mechanisms, they employ to modify humidity in their learning environment.

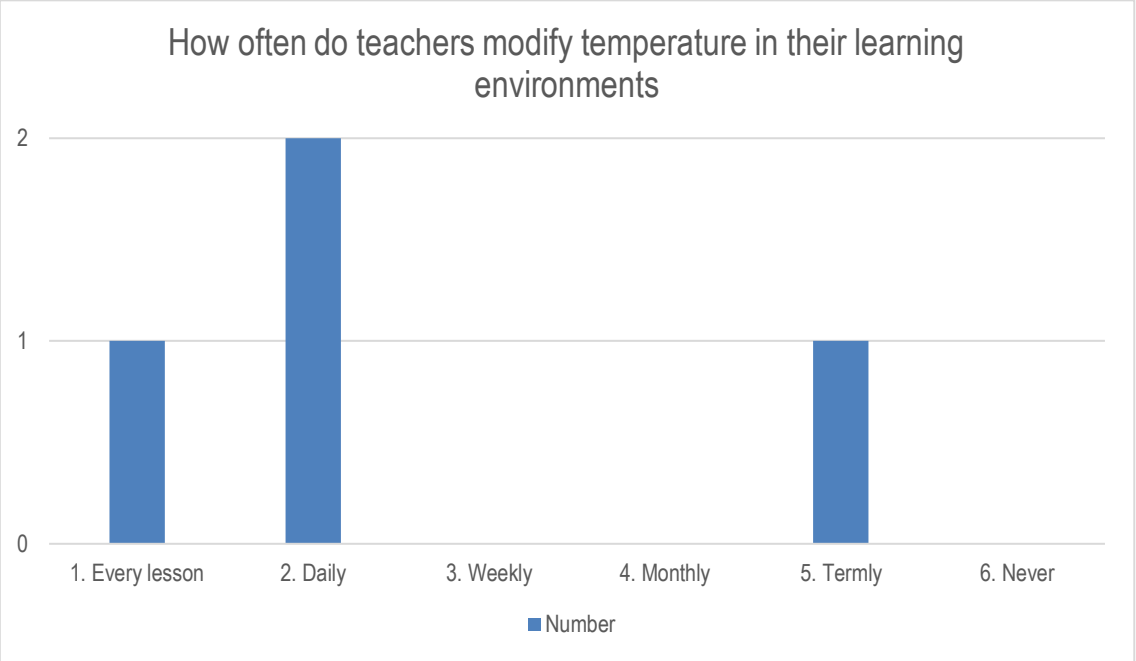


*Figure 14: Frequency of modifying humidity levels in learning environments*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 2.5 Daily | 2 Daily | 2 Daily |

The frequency of adjustment is high when teachers have the tools to make adjustments. However, it is not a statistically significant sample to make generalisations from. However, it could be implied, that teachers who are able to make changes and are aware of humidity frequently make changes.

### 4.2.3 **Air Quality**

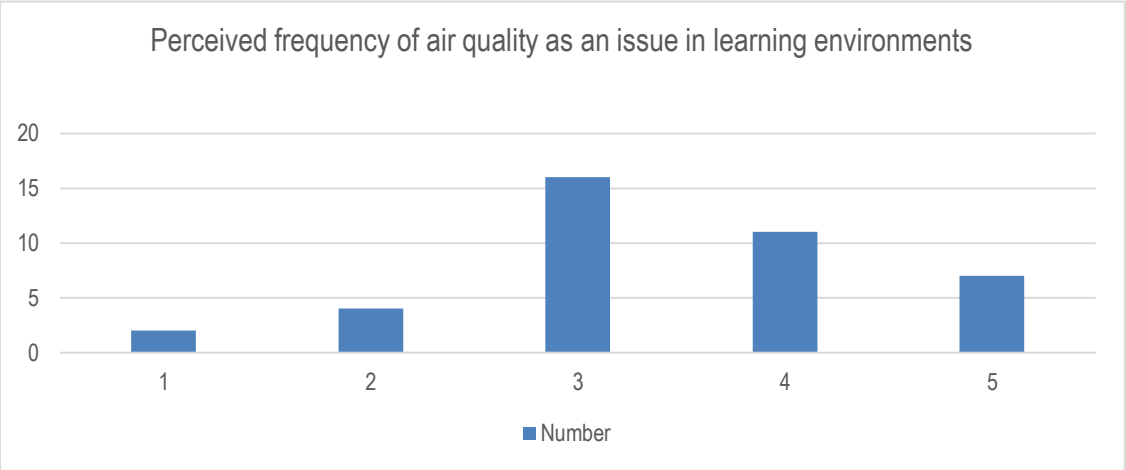


*Figure 15: Teacher Perception of the impact of air quality upon teaching and learning*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 3.675 | 3 | 3 |

The vast majority of respondents feel that air quality has a significant impact upon learning. When asked to score air quality on a scale of 1-5 as to potential impact upon teaching and learning, 85% of respondents scored air quality at least a 3. There is also no clear geographical relationship with this factor – 3 plus scores were reported from over 10 different countries.

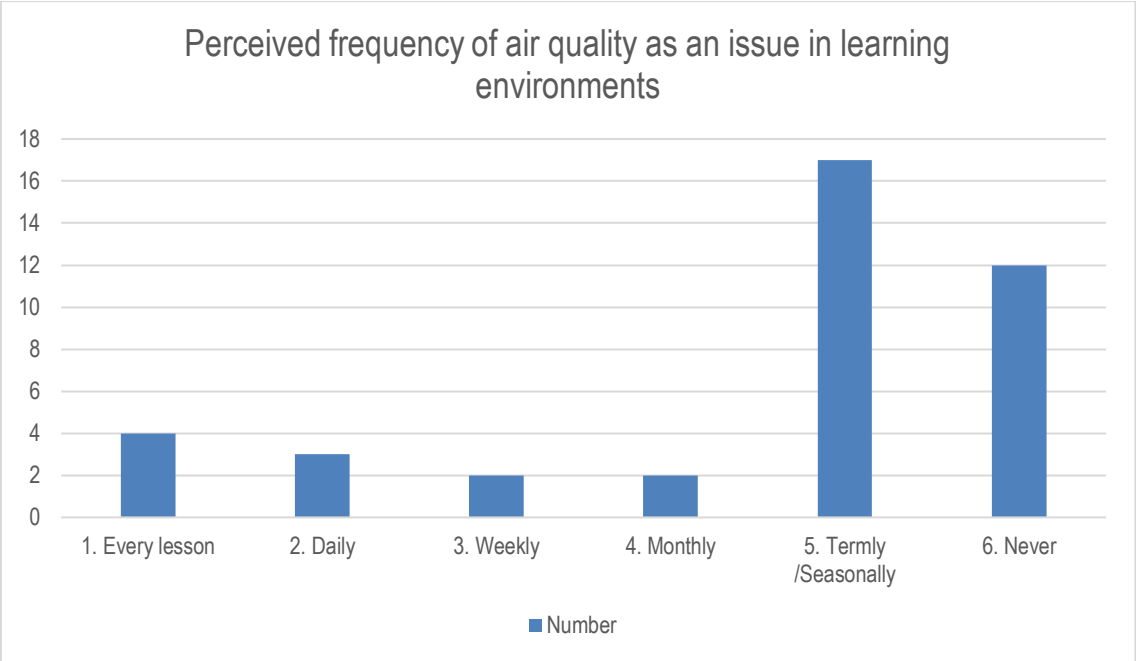


*Figure 16: Teachers perception of the frequency of air quality as an issue in learning environments*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 4.525 Monthly | 5 Termly/Seasonally | 4.5 Monthly/Termly |

Much like humidity, air quality is seen as a seasonal issue. It is seen as a less frequent problem than temperature. There also does not seem to be a connection between geography and frequency of issue, with over 10 different countries reporting seasonal frequency.

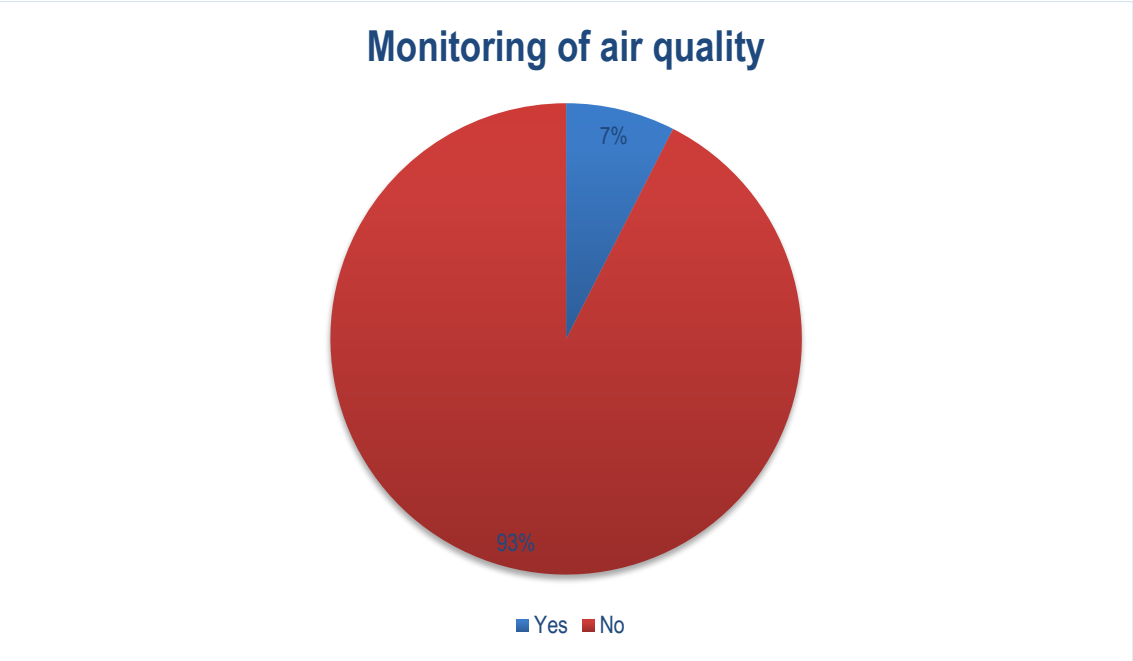


*Figure 17: Ability of teachers to monitor air quality in learning environments*

Measuring air quality in schools is exceptionally rare, despite it being one of the most significant factors in terms of student concentration. Of the 40 teachers sampled, only three responded that they could monitor air quality. Whilst it is seen as a significant issue in the initial question, very few teachers are actually able to monitor the variable.

All the respondents who are able to monitor air quality, do so via a bespoke set of sensors.

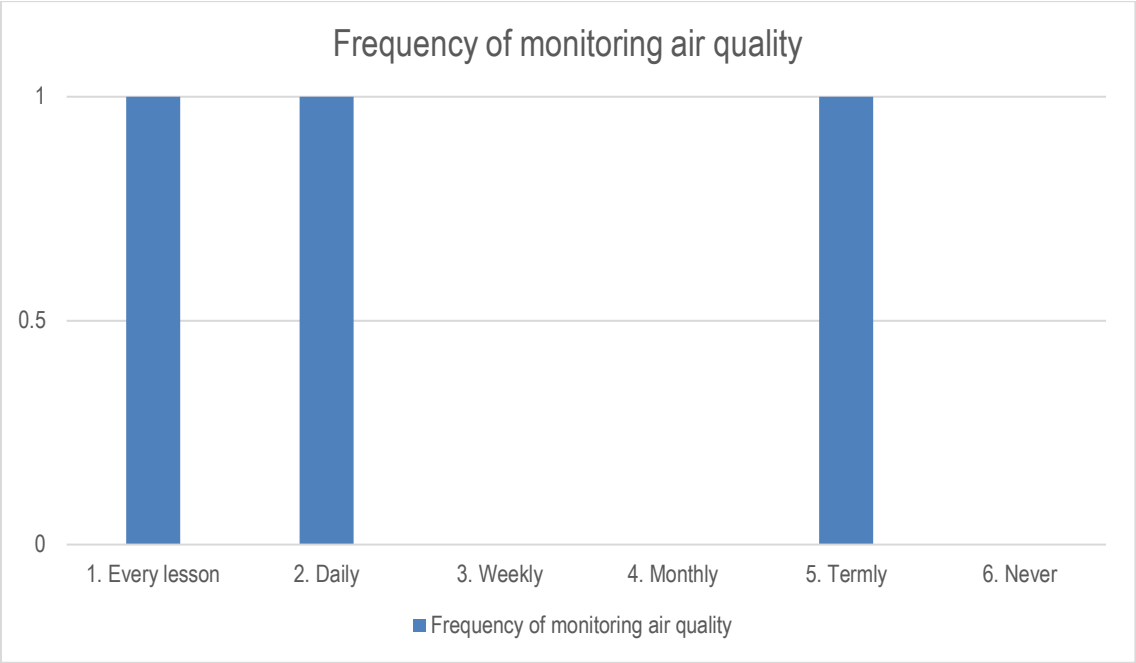


*Figure 18: Frequency of teachers monitoring air quality in their learning environment*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 2.67 Daily | None | 2 Daily |

The frequency of monitoring air quality is highly variable, and in this case statistically insignificant. However, it could be implied that in two thirds of cases where teachers have sensors, they make at least one measurement per day. It can therefore be inferred that there is an elementary awareness of the issue

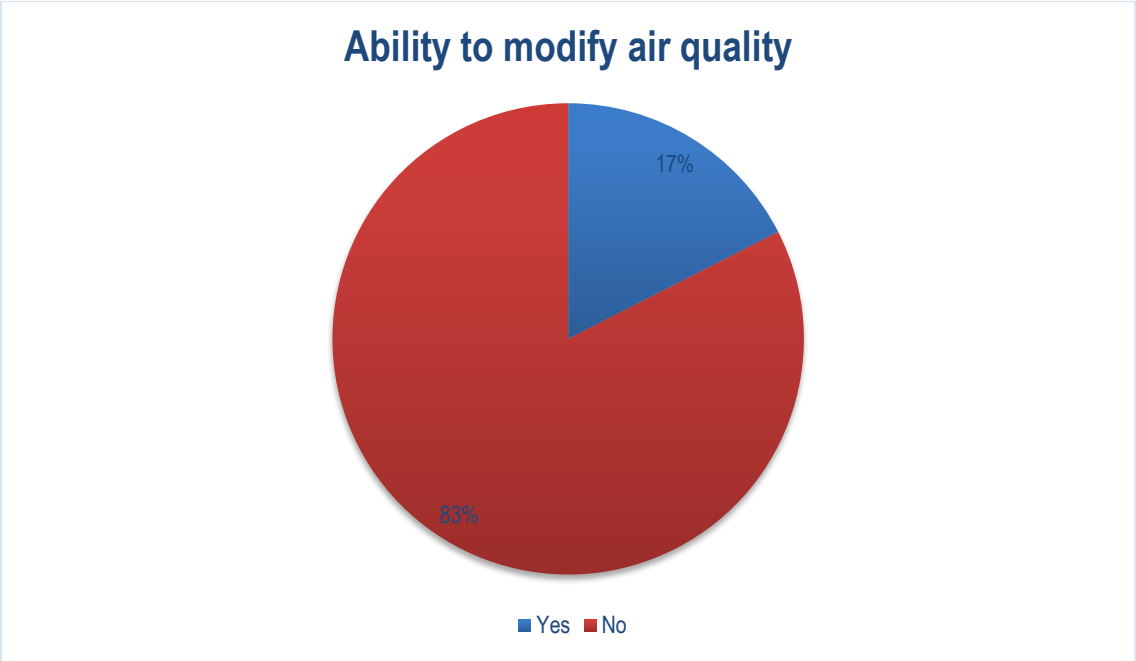


*Figure 19: Ability of teachers to modify air quality in learning environments*

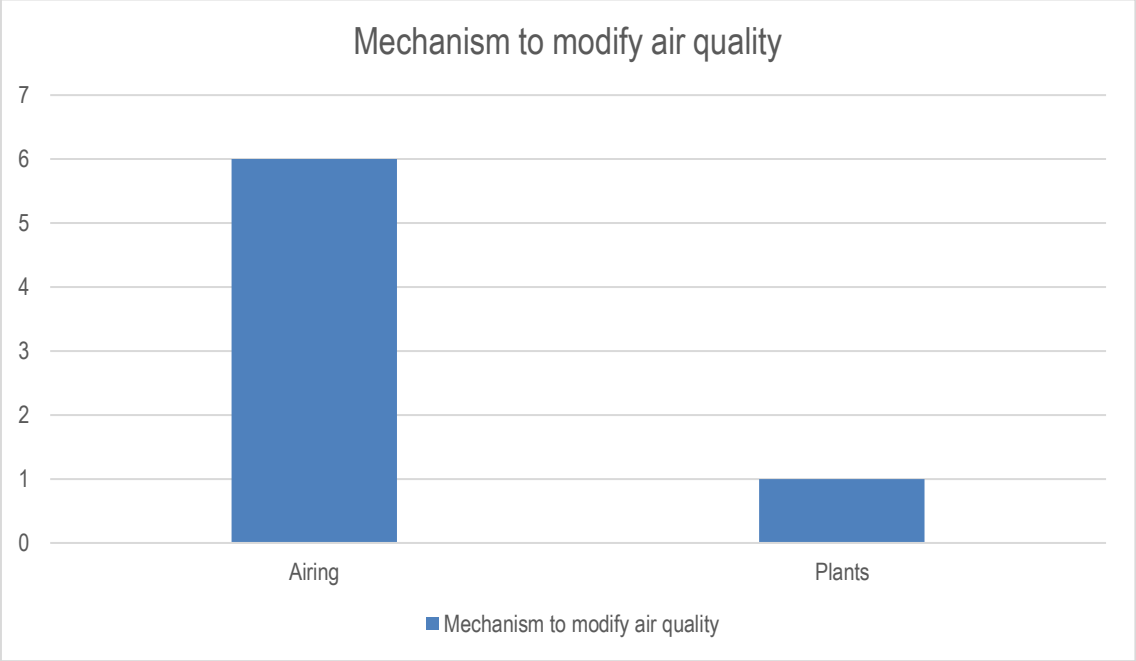


*Figure 20: How teachers modify air quality in learning environments*

7 teachers from the 40 sampled responded that they were able to modify the air quality of their learning environment. Mechanisms to resolve air quality are relatively simple – either simple airing by opening doors or windows (6 out of 7 respondents), or by introducing plants. In essence, the vast majority of teachers

can probably alter air quality, however awareness of the issue appears to be low – as all classrooms have doors or windows for airing.

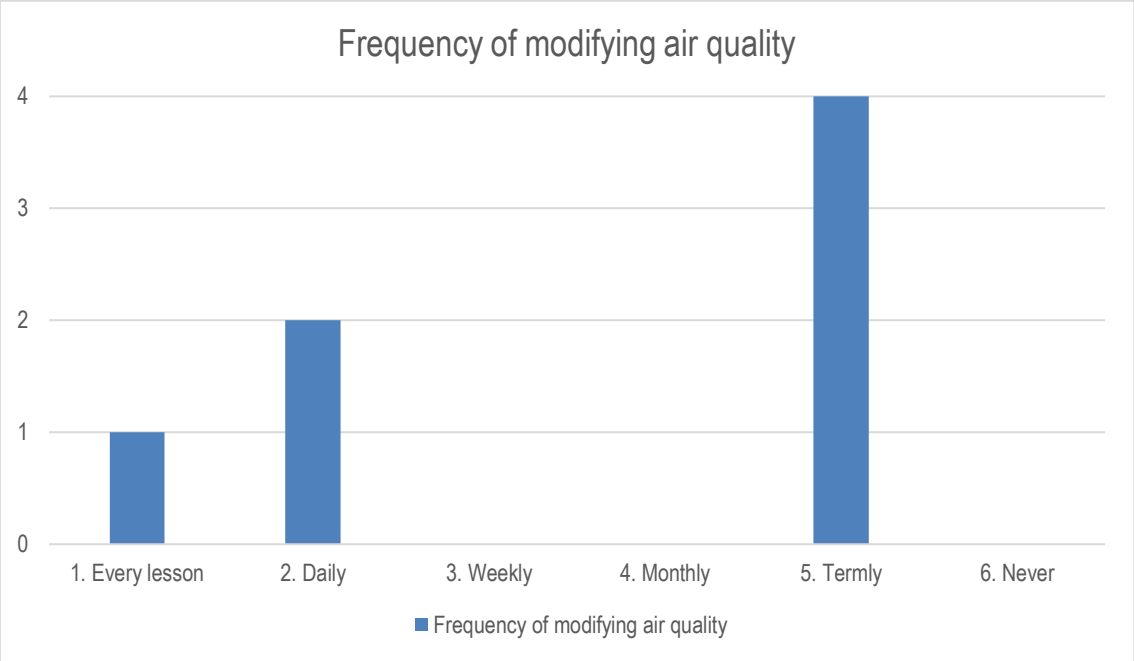


*Figure 21: Frequency of modification of air quality by teachers in learning environments*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 3.57 Weekly | 5 Termly/Seasonally | 5 Termly/Seasonally |

It appears that the majority of teachers see air quality as a seasonal issue and make rectifications on this frequency as a result. The sample is statistically insignificant to draw generalisations from, and it should be noted that there is no clear pattern that can be observed.

### 4.2.4 Light Levels

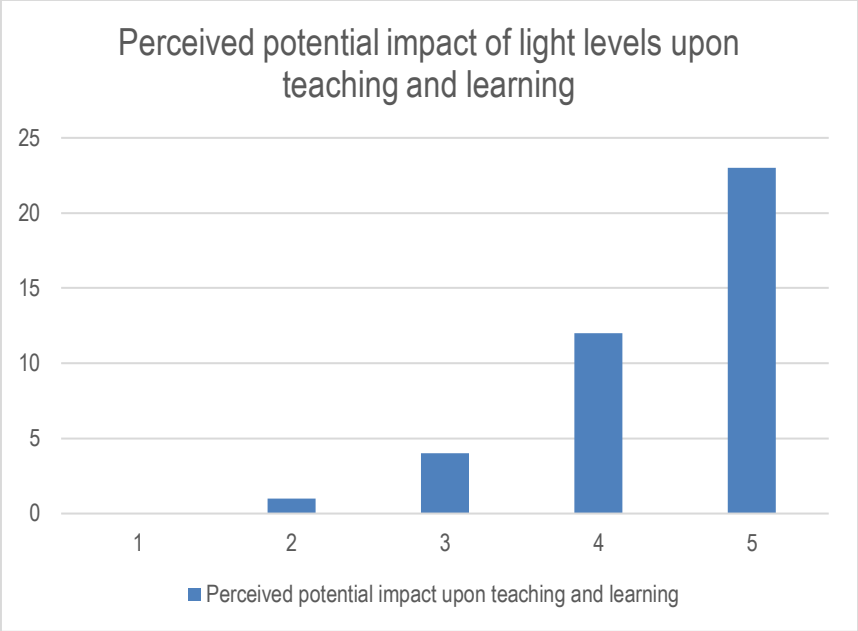


*Figure 22: Teacher Perception of the impact of light levels upon teaching and learning*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 4.425 | 5 | 5 |

Of all the factors measured, light was perceived to have the largest impact upon teaching and learning. First, 39 out of 40 respondents scored it as having a moderate to high impact upon learning (97.5%), and the highest proportion of highly significant (a score of 5) was noted for this variable – 57.5%. This coincides with the work of Barrett (2015) whose research stated that light had the most significant impact upon teaching and learning. This implies that with regards to light, teachers have a relatively high awareness of the importance of this factor upon teaching and learning.

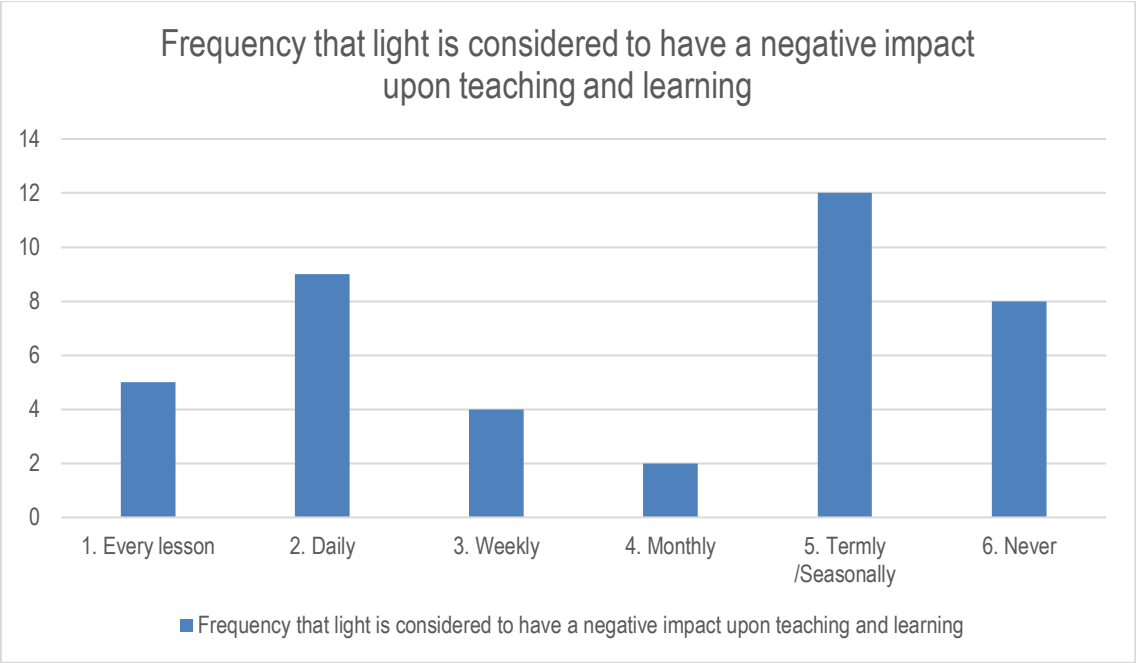


*Figure 23: Teachers perception of the frequency of light levels as an issue in learning environments*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 3.775 Monthly | 5 Termly Seasonally | 4.5 Monthly/Termly |

This figure is interesting in the sense that there appears to be no clear pattern to the frequency of light as an issue – despite the very clear data from the previous question. There could be a number of factors influencing this response. The modal response of termly suggests that architecturally many schools have significant design issues, which means insufficient light is having a negative impact upon teaching and learning. There is no geographical connection to the identification of termly issues either, with multiple countries reporting this an issue.

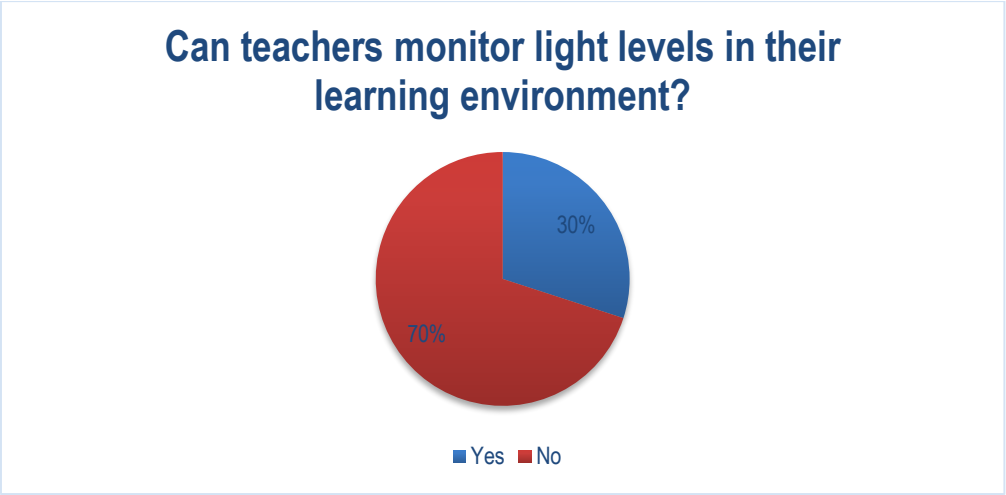


*Figure 24: Ability of teachers to measure light in learning environments*

The vast majority of teachers report that they are unable to measure light levels in their classroom (28 out of 40 teachers)– this is an obvious concern, as teachers have perceived it to have the highest impact upon learning of all environmental factors.

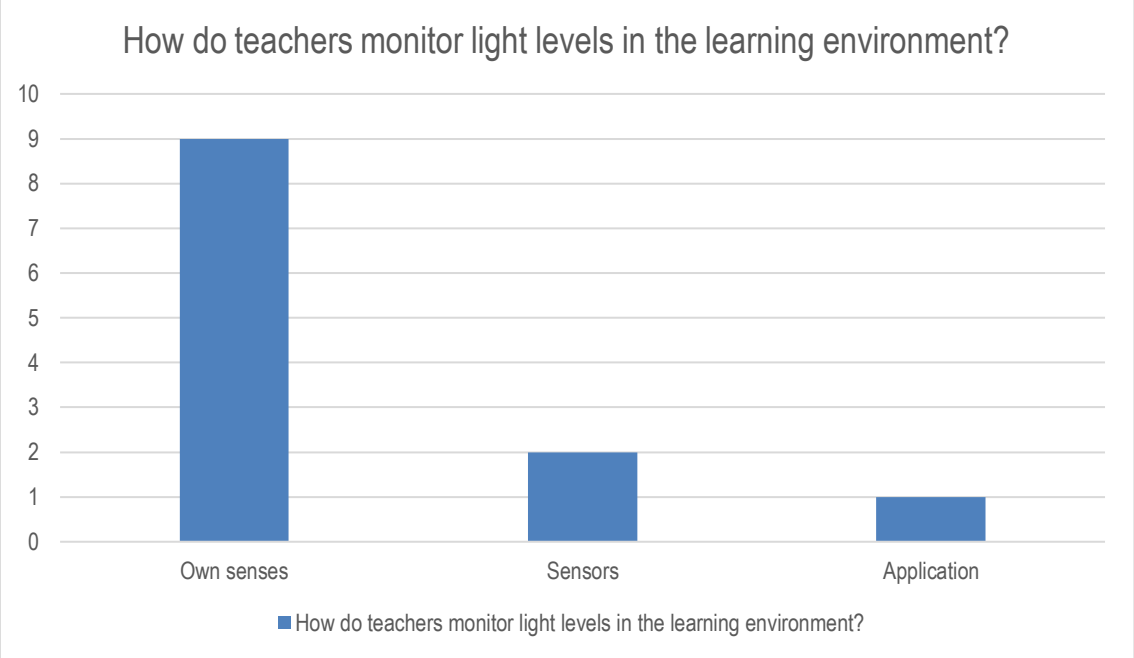


*Figure 25: How teachers monitor light levels in learning environments*

This is also an interesting graph – of the 12 respondents who said that they measured light levels, nine respondents to this question felt that using their own senses was the mechanism they would use to monitor light levels in the learning environment. Based on this response, all teachers have the same tools

available for their use, yet they do not actively monitor the environment with their senses – either this implies that they do not monitor the environment for light levels, or that they do not feel their own senses are an appropriate mechanism for evaluating light levels – or that they do not consider use of this own sight as measurement at all.

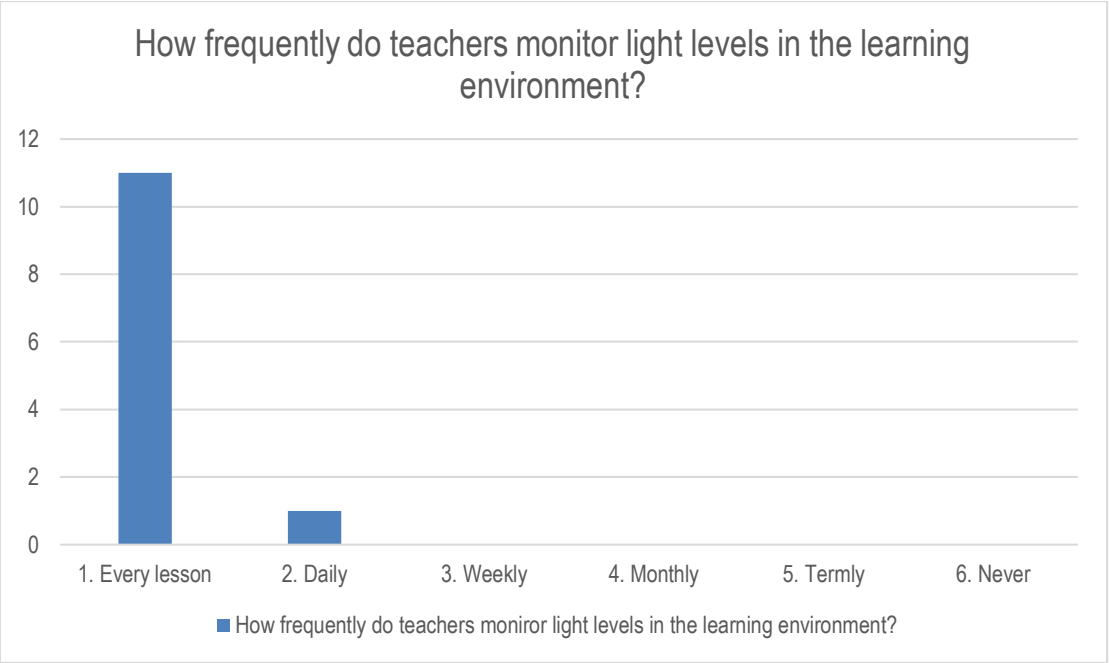


*Figure 26: Frequency of teachers monitoring light levels in learning environments*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 1.083 Every Lesson | 1 Every Lesson | 1 Every lesson |

As light is considered to be the most significant environmental factor by both academics such as Barrett (2015), and by teachers themselves; it is little surprise that when light is monitored, it is monitored very frequently – Of the 12 teachers who monitor light levels, 92% of respondents stated that they monitor light every lesson. This would imply that if teachers have a mechanism to monitor the light levels in the environment, they would frequently analyse the conditions.

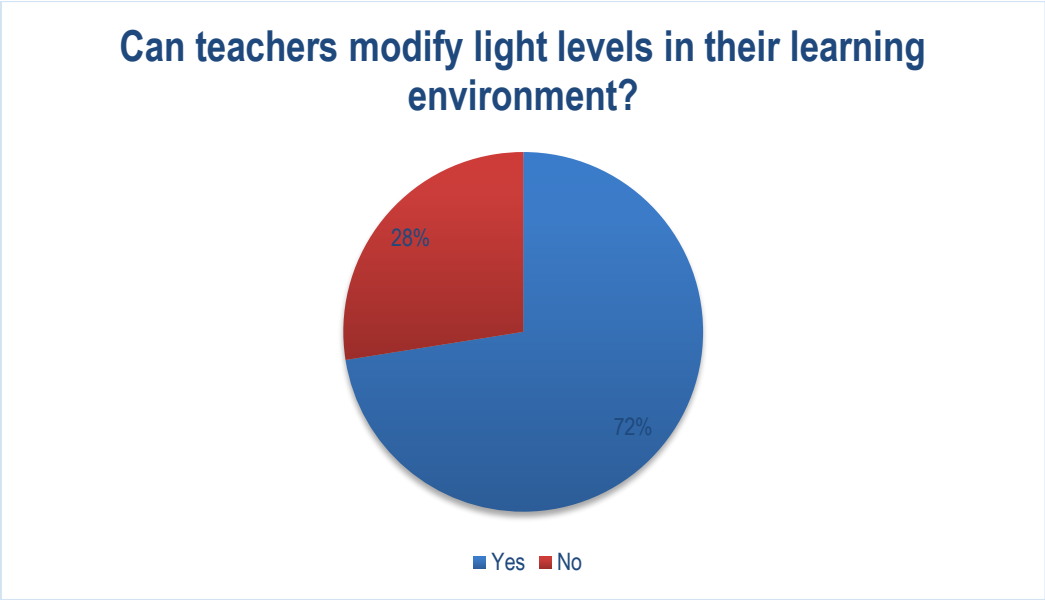


*Figure28: Ability of teachers to modify light levels in learning environments*

Based on responses, light is one of the easiest variables to modify, as it is one of only two variables that the majority of teachers report as being modifiable in their learning environment – 29/40 teachers report that they can modify light levels. If anything, the number seems low, as it is hard to contemplate that not all classrooms have a light switch in them – unless the classrooms are outside or in a locale with limited electricity.

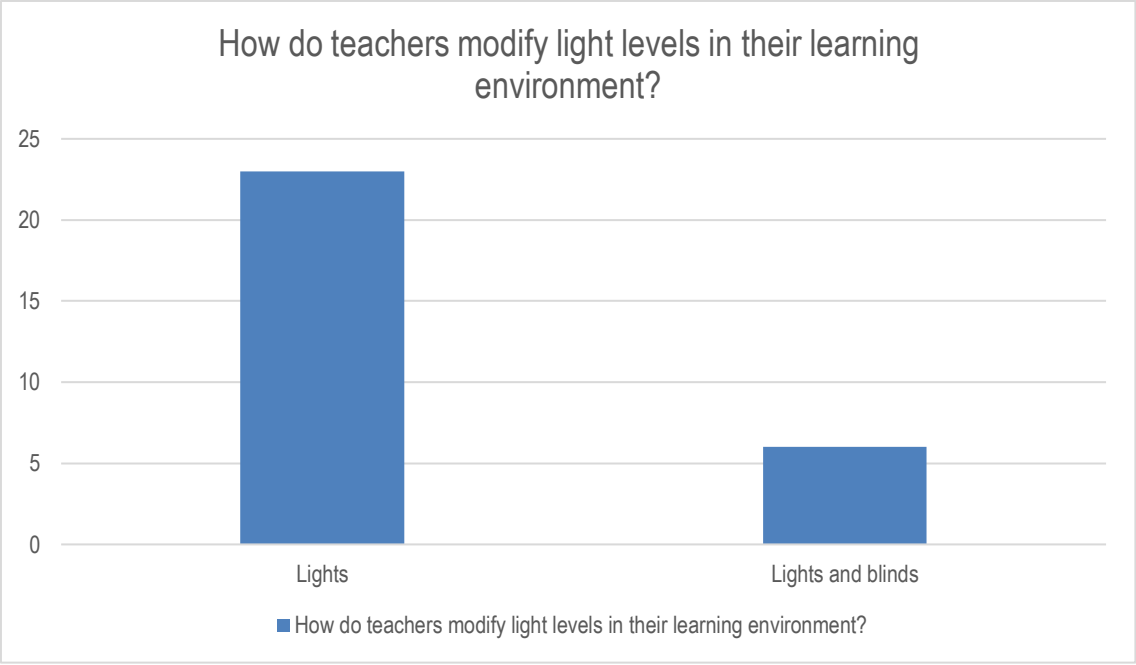


*Figure29: How teachers modify light levels in learning environments*

In all responses to this question, all 29 teachers noted that they use light switches to modify light levels. As was implied in the previous figure, it is somewhat surprising that only 72% of respondents considered they could modify light levels. – some respondents may have interpreted this as changing light levels, as opposed to an arbitrary on/off state. In addition, many teachers reported that they also use blinds – this is to counteract an excess of light. This may explain why many teachers report seasonal and termly issues with light.

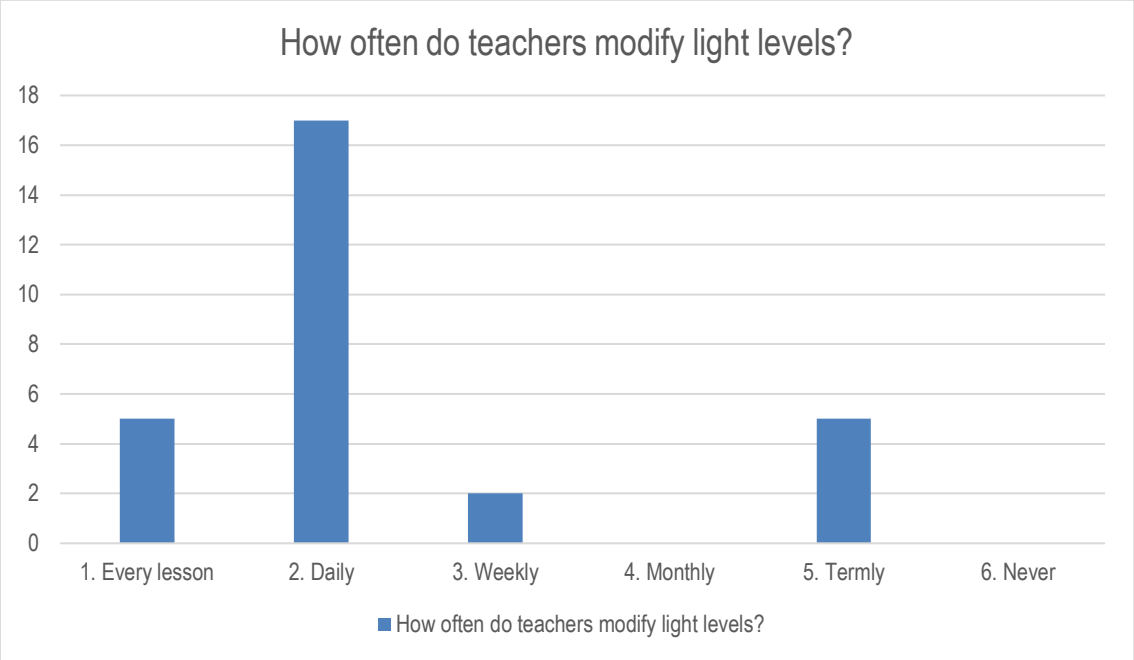


*Figure 30: Frequency of modifying light levels*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 2.41 Daily | 2 Daily | 2 Daily |

As expected for a variable that is reported as being of significant impact upon learning, the 29 teachers frequently modify the variable to ensure learning environments are appropriate. As the frequency of modification is so high, it implies there is a high level of awareness of the importance of light in learning.

### 4.2.5 Sound Levels

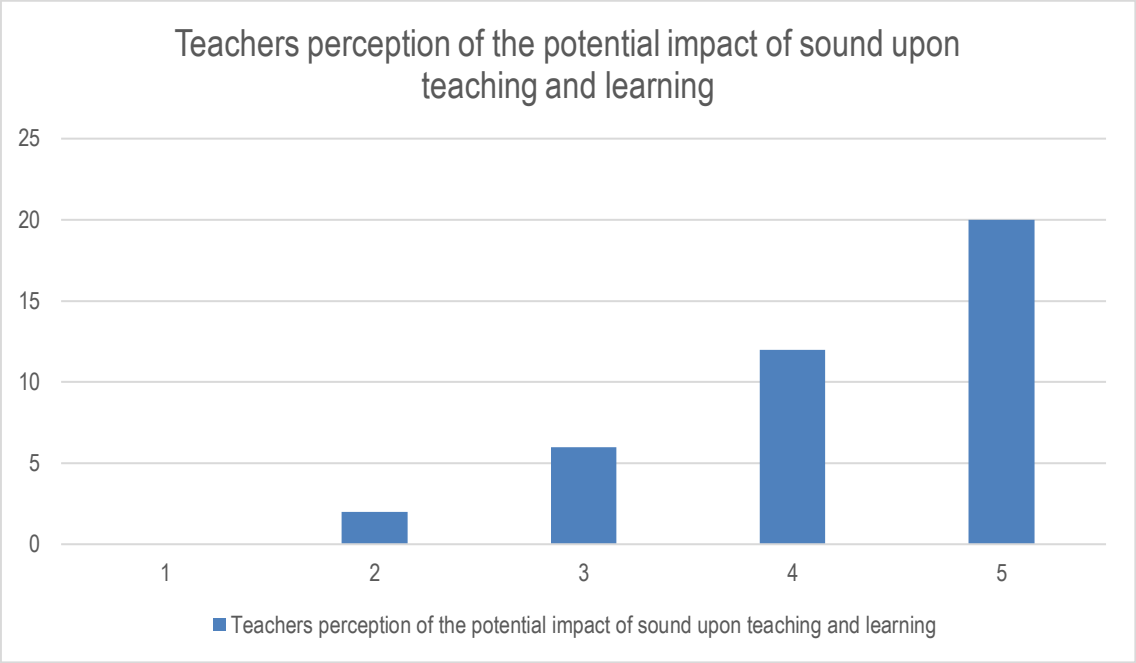


*Figure 31: Teachers perception of the potential impact of sound upon learning*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 4.25 | 5 | 4.5 |

After light, sound is seen as the second most significant environmental variable that impacts upon teaching and learning. 95% of respondents rate sound as having moderate to significant impact upon teaching and learning, with 50% of respondents stating that sound was highly significant in terms of its impact upon teaching and learning. Such high figures imply that there is indeed awareness of the importance of sound levels in learning environments.

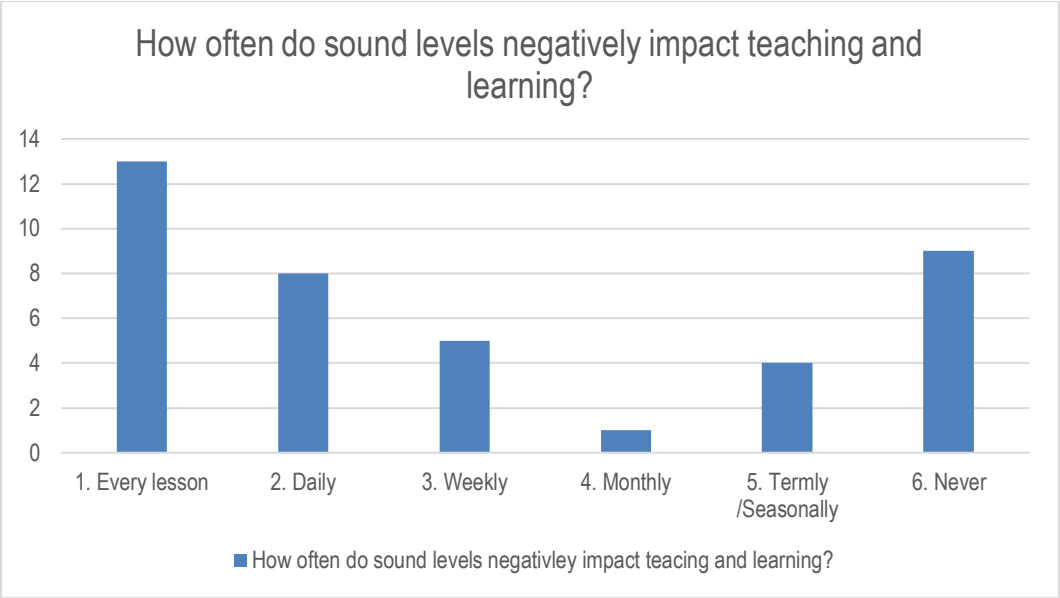


*Figure 32: Frequency that teachers perceive sound to be an issue in learning environments*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 3.05 Weekly | 1 Every Lesson | 2 Daily |

Sound levels are very different to other variables. It can be seen from the figure above that sound is seen as being a far more frequent issue than any other variable. Unlike other variables, sound levels have a very large human component, in the sense that humans are the primary source of the factor – and as a result, it may be somewhat expected that frequency would be skewed significantly towards to the highest levels- rather than being a seasonal issue.

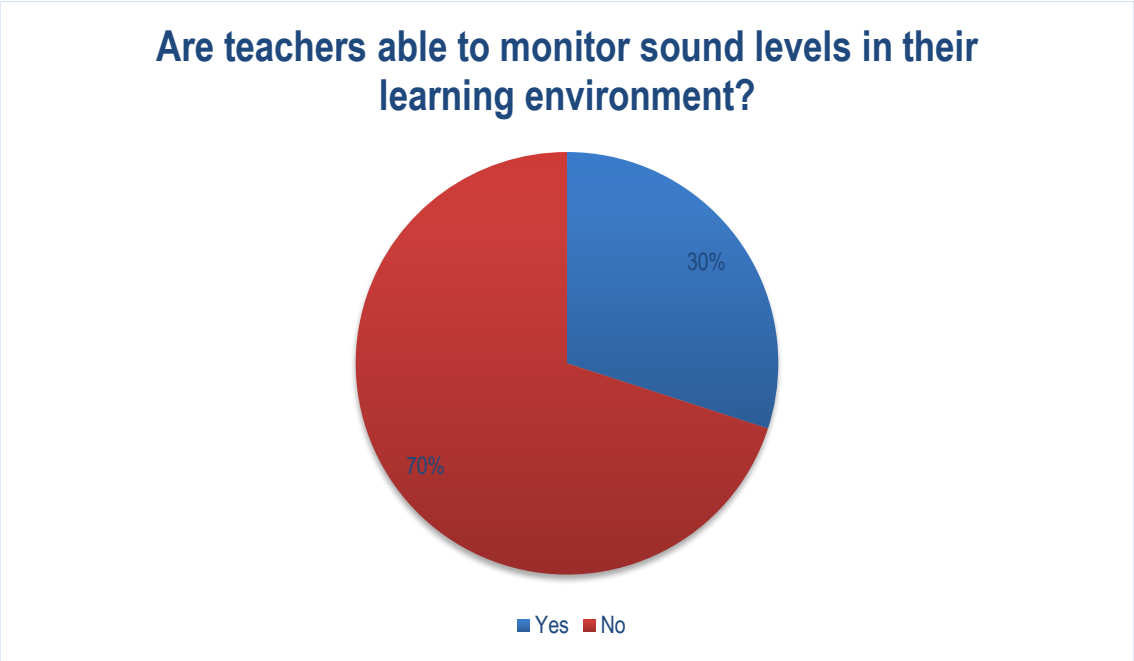


*Figure 33: Ability of teachers to monitor sound levels in learning environments*

Despite the apparent seriousness of the issue, the majority of teachers (28 out of 40) do not report being able to monitor their learning environment for sound. 70% of teachers reported that they are unable to monitor sound levels in their learning environment, suggesting that whilst they are aware of the severity of the issue, they are unable to judge the level of the problem. It may also imply that teachers are unaware of what constitutes a problem with regards to sound.

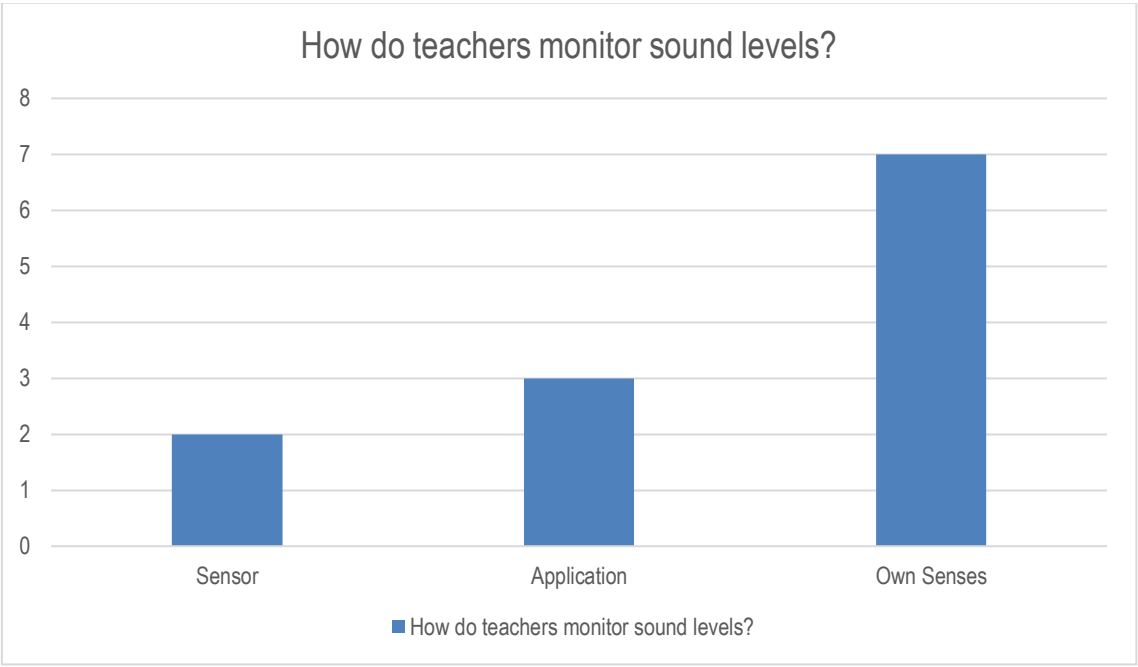


*Figure 34: Mechanisms by which teachers monitor sound levels*

As is the case with light levels, sound levels are predominantly measured through one's senses – seven out of 12 respondents reported this as the primary mechanism for measuring sound. Very few schools use specialised solutions to this issue. As is the case for light, all teachers have the same tools available for their use, yet they do not actively monitor the environment with their senses – either this implies that they do not actively monitor the environment for sound levels, or that they do not feel their own senses are an appropriate mechanism for evaluating the levels of this variable.

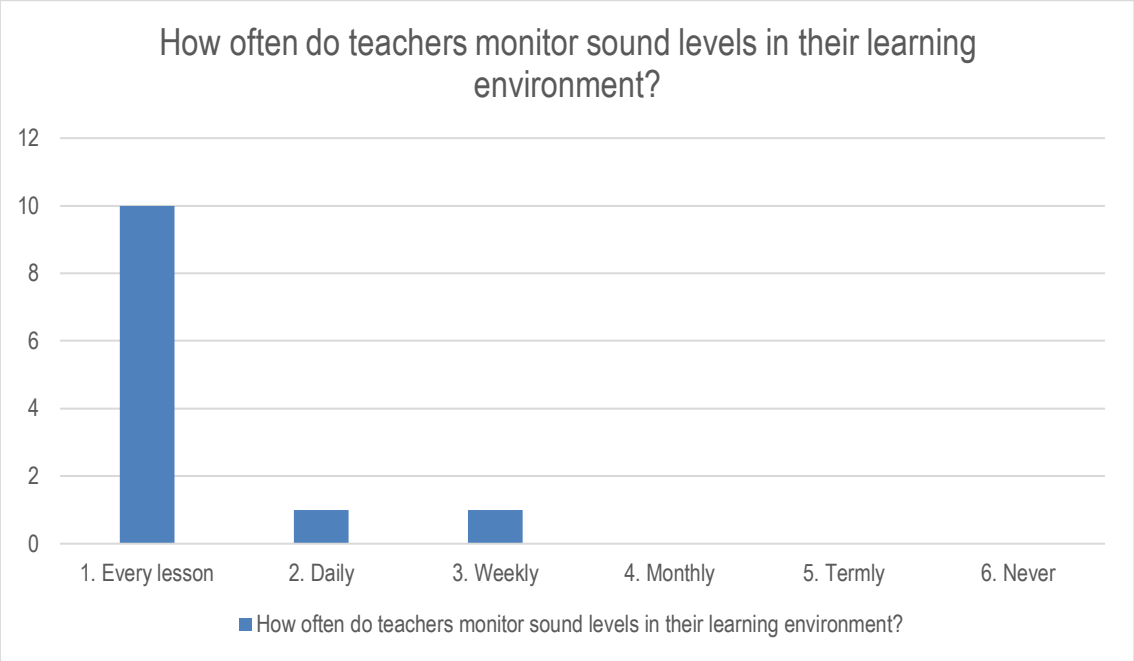


*Figure35: Frequency of monitoring sound levels in learning environment*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 1.25 Every lesson | 1 Every lesson | 1 Every lesson |

As one may expect, sound is seen as a frequent issue and is therefore monitored on a frequent basis. As is the case for light, the two highest rated issues are monitored the most frequently – and these two are the ones that are most frequently observed through one's senses. This implies that the ready

availability of information (in this case through one's senses) influences the frequency of monitoring of the learning environment.

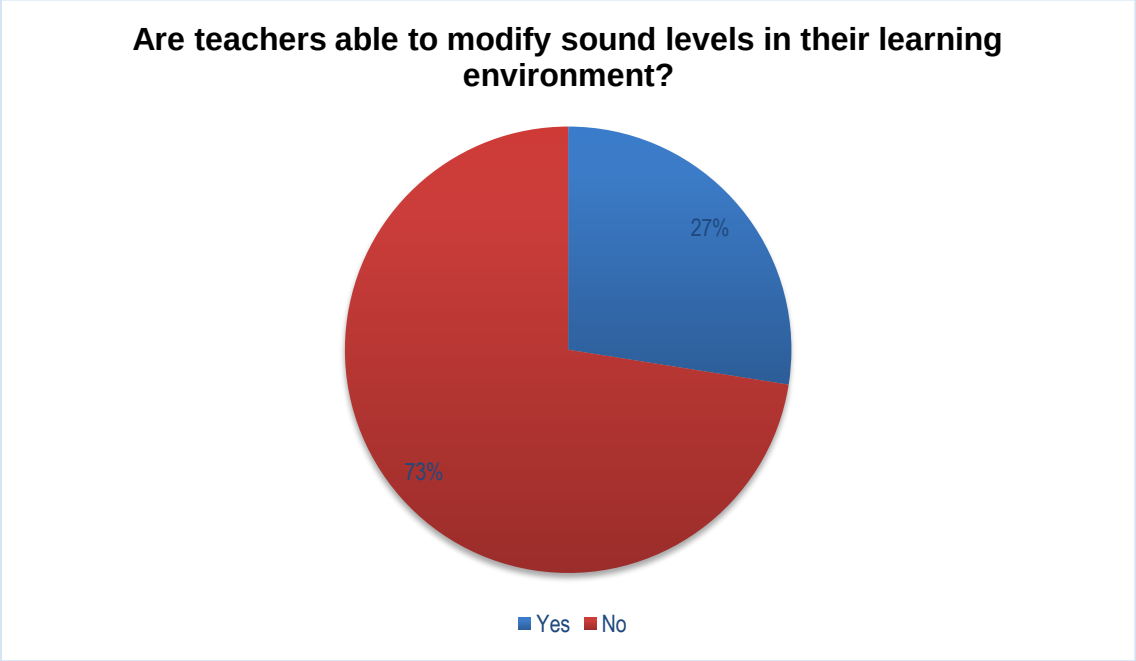


*Figure36 Ability of teachers to modify sound levels*

The vast majority of teachers (73% - 29 out of 40 respondents) report being unable to modify sound levels. This is of concern as teachers see sound as a problem yet report to being unable to do anything about it.

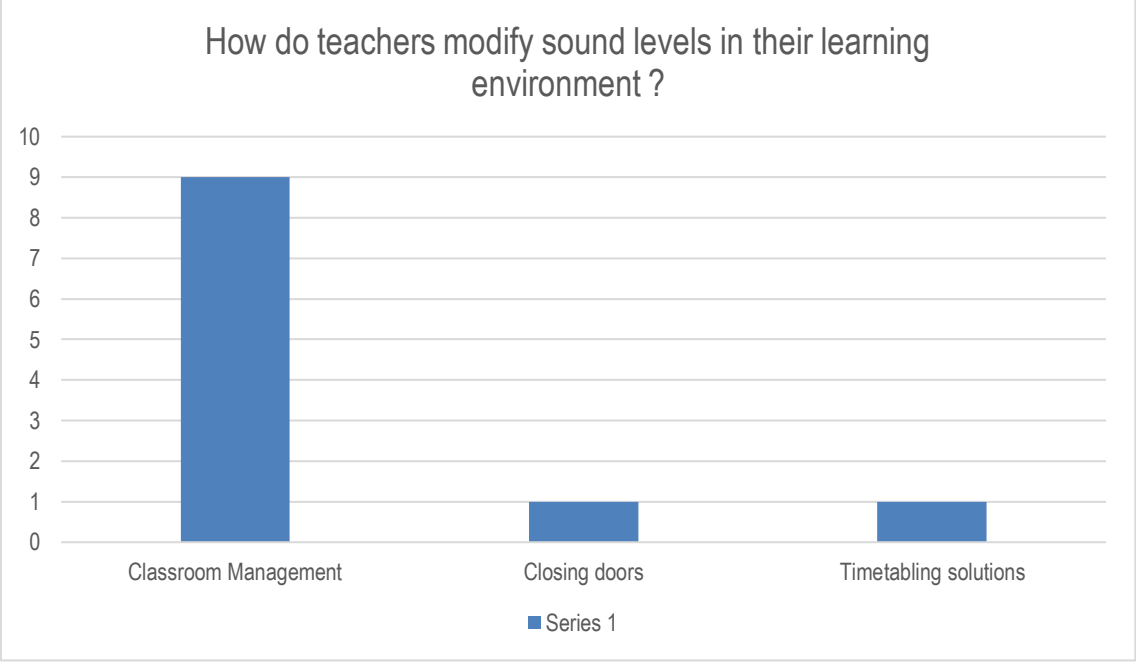


*Figure 27: Mechanism for modifying sound levels in learning environments*

As might be expected, sound levels are a predominantly as a result of human activity – therefore the solutions tend to be human focused as well. 10 of the 11 responses utilise behavioural modifications – either via classroom management or via scheduling. As they are human centred solutions, it is not beyond reasonable assumption that this would be an option for all teachers in all schools.

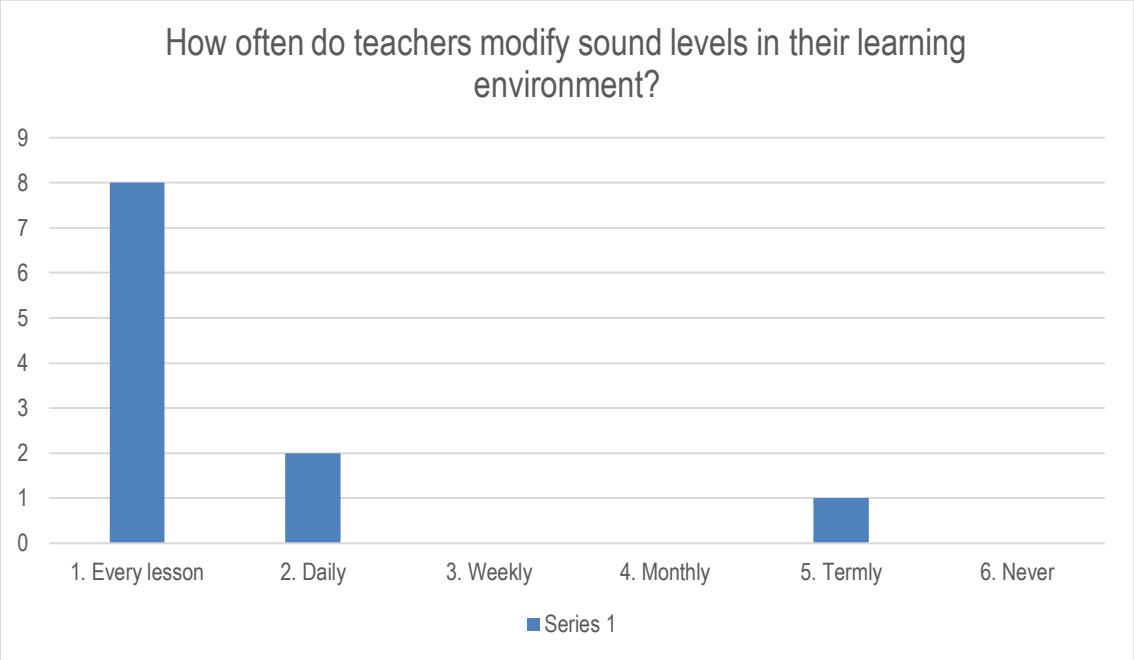


*Figure 28: How frequently teachers modify sound levels in learning environments*

| MEAN | MODE | MEDIAN |
|---|---|---|
| 1.55 Daily | 1 Every lesson | 1 Every lesson |

As is to be expected; sound is seen as a significant issue and where it is modified, it is modified on a frequent basis. As mentioned earlier, sound levels are a predominantly human-created issue, and as a result rectification occurs when there is human to human interaction.

# 5 STATISTICAL ANALYSIS

## 5.1 Analysis of potential correlations between data sets

1. Perceived impact vs perceived frequency of issue

In order to ascertain if teachers' opinions of the severity of the problem were related to frequency, a Pearson test was applied.

Pearson tests range from -1 to 1 – the value of -1 indicating a perfect negative correlation, and a value of 1 representing a perfect positive correlation.

*Temperature*

With these two variables, a score of 0.182 is indicative of a very weak to almost no correlation between these two factors. Therefore, it is highly unlikely that these two factors are linked.

*Humidity*

When the variables are analysed, the Pearson Correlation test gave an output of 0.342. The correlation is weak, and it is unlikely that these two factors are linked in any way

*Air Quality*

Of all of the environmental variables, air quality gave the lowest Pearson Tests score of 0.082. There is almost certainly no correlation between the two variables.

*Light*

Light also had a very low Pearson test score of 0.210. This suggests that any relationship between impact and frequency is very weak.

*Sound*

The Pearson Test score for sound is 0.339. This shows that there is a very weak link between the two variables, and that correlation is almost non-existent.

Overall

For all five environmental variables, there is no clear correlation between the perceived seriousness of the issue and the perceived frequency of the issue.

2. <u>The relationship between monitoring and modification</u>

| VARIABLE | Number able to monitor variable | Number able to modify variable | Number able to monitor and modify variable | % modification linked to potential monitoring |
|---|---|---|---|---|
| Temperature | 19 | 21 | 16 | 76.2 |
| Humidity | 4 | 4 | 2 | 50 |
| Air Quality | 3 | 7 | 2 | 28.6 |
| Light | 12 | 29 | 10 | 34.5 |
| Sound | 12 | 11 | 6 | 54.5 |

The data gives varying viewpoints to be considered:

1. When monitoring devices are present, there is also usually the ability to change the environmental variable – no lower than 50% of monitoring cases also have the ability to modify conditions too.

2. For some variables, it appears that when there is a modification device there is also the ability to monitor the conditions – this is particularly useful for feedback and further responses to conditions
3. Not all variables are readily monitored and modified.

# 6 DISCUSSION

## 6.1 Key points to consider

1. Are teachers aware of the potential impact of environmental conditions?
2. Are the issues frequent enough to merit monitoring?
3. Are teachers currently able to monitor environmental conditions?
4. Are teachers able to modify environmental conditions?

If these issues are significant, are not monitored regularly and can be rectified, it stands to reason that an IoT device that alerts teachers to issues and suggests rectification would be of value.

For each variable, and for each question the answer is somewhat different.

### 6.1.1 *Are teachers aware of the potential impact of environmental conditions?*

In general teachers believe that all five variables impact upon learning to a moderate to significant degree

| Variable | Mean | Rank | Mode | Rank |
|---|---|---|---|---|
| Temperature | 3.875 | 3 | 4 | 2 |
| Humidity | 3.65 | 5 | 4 | 2 |
| Air Quality | 3.675 | 4 | 3 | 3 |
| Light | 4.425 | 1 | 5 | 1 |
| Sound | 4.25 | 2 | 5 | 1 |

Cross referencing this against the work of Barrett offers insight since Barrett et al (year?) tested a number of these parameters in their work as well. They found light to be the most significant environmental factor, which corroborates with the data above. However, it should be noted that Barrett's work stated that

air quality (including humidity) was the second largest factor, followed by temperature. Due to the cumulative nature of what defines air quality in Barrett's work, it is somewhat challenging to say that these findings completely corroborate the data obtained during this study.

One of the key questions that should be asked is why teachers believe that this order is an accurate perception of the issues of environmental conditions. The two variables that are significantly higher than the others are light and sound. One hypothesis for these results can be that as human beings we have two distinct senses for these two variables – sight and hearing. The other variables can be detected, but do not have such sophisticated physiology behind them. Teachers tend to have a gut reaction to what is happening – for example feeling drowsy or sleepy when air quality is sub-optimal, but it is not as definitive as hearing or seeing an issue. Alternatively, it could be proposed that these two variables are integral to teaching and learning – they form a central component of communication within the classroom, so therefore it is inevitable that teachers will notice issues with these areas much more markedly than other variables.

### 6.1.2 *Are the issues frequent enough to merit monitoring?*

| Variable | Mean | Rank | Mode | Rank |
|---|---|---|---|---|
| Temperature | 4.25 Monthly | 3 | 5 Termly/Seasonally | 2 |
| Humidity | 4.775 Monthly | 5 | 5 Termly/Seasonally | 2 |
| Air Quality | 4.525 Monthly | 4 | 5 Termly/Seasonally | 2 |
| Light | 3.775 Monthly | 2 | 5 Termly Seasonally | 2 |
| Sound | 3.05 Weekly | 1 | 1 Every Lesson | 1 |

The majority of the variables are very similarly rated – however one variable is significantly different to the others. Sound is seen as the most frequent issue affecting teachers, albeit the second most serious one after light. This could be due to the fact that sound is the variable that is most markedly changed merely by the presence of human beings in the classroom. Hodgson et al (1994) noted

that a typical background noise level of 35 dB(A) in an empty classroom increased to 56 dB(A) when students were present. The work of Shield and Dockrell (2003) found that the ambient noise level in an occupied primary school classroom was closely related to the pupil activity. The measured activity levels ranged from 56 dB (silent activity) to 77 dB when the pupils were engaged in noisier activities involving group work or movement within the learning environment. This is a significant shift from 35dB in an empty classroom and demonstrates the human element of sound. Other variables that demonstrate an element of human input are not felt as sharply as that of sound – for example air quality and temperature can have a significant element attached to them.

However, the period for an environmental factor to develop into a negative issue is significantly different – in the case of air quality, it takes some time for an issue to become apparent. Satish et al (2012) showed that CO2 levels of 1000ppm influenced attainment negatively and statistically significantly, and levels of 2500ppm resulted in exceptionally reduced performance. As CO2 is a by-product of human respiration, it takes time for levels to build. Hence, it can be inferred that the frequency of this issue may not well be noticed until significantly later – or even not at all.

Temperature and humidity are also influenced by human action, as water vapour is a by-product of human respiration, as well as heat. Like air quality, this will not significantly influence the environment for some time – it takes time for sufficient water vapour to be exhaled to influence the surrounding conditions. Therefore, this is probably reflected in the statistics stating that this is a predominantly seasonal or termly issue – the by-products of respiration will probably only accumulate in a classroom where ventilation is not of the highest level. In Northern hemisphere countries, this is likely to be in winter, as the windows will be closed, and the heating will be switched on – resulting in a lack of new, fresh air entering the learning space. This is particularly evident in Finland, where mold is a significant issue (YLE. 2013; Taskinen 1999, Korppi, 2003) – mold growth is dependent upon high levels of humidity, and lack of air circulation exacerbates this issue. In hot countries such as the United Arab

Emirates and Malaysia, there is usually air conditioning to continually recirculate air in learning environments - this would inevitably affect the process of accumulation in these environments. Wargocki and Wyon (2007) found that when air supply rate was increased from 5.2 to 9.6 L/s (11.0 to 20.3 cfm) per person, student performance on four numerical exercises improved significantly, so it stands to reason that when it is possible to ventilate a learning environment it is less likely that respiratory by-product will accumulate to a highly detrimental level.

In the case of light being of concern, the data suggests that there is a significant relationship to the time of year. Rautkylä et al (2010) showed that there is a significant difference in student alertness in autumn, in comparison to spring. This would reinforce the idea that teachers note that light is a seasonal factor. Rautkylä also found that exposure to bright light during autumnal periods drastically improved alertness – further showing that there is a significant seasonal component.

### *6.1.3 Are the issues frequent enough to merit monitoring?*

| Variable | Yes | Rank | No |
|---|---|---|---|
| Temperature | 48% | 1 | 52% |
| Humidity | 10% | 4 | 90% |
| Air Quality | 7% | 5 | 93% |
| Light | 30% | 2 | 70% |
| Sound | 30% | 2 | 70% |

At first glance, it should be noted that in all cases teachers have a limited ability to monitor environmental factors. No variable recorded over 50% monitoring capacity. The most monitored environmental variable was temperature – with the vast majority of cases being monitored via thermostats on heating or air-conditioning installations. This is not linked to any geographical factor – heating and air-conditioning are ubiquitous to all geographical regions. The other

variables are substantially different. The next ranked variables are light and sound. The mechanisms of monitoring these variables were very different to the others – these variables relied on the use of senses, as opposed to any kind of hardware. Subsequently, it is somewhat surprising that these variables do not report 100% monitoring as teachers can usually utilise these senses. If human senses were to be removed from these variables, the level of monitoring significantly drops – 7.5% for light, and 12.5% for sound. As there have not been studies on teachers monitoring environmental conditions, it is somewhat challenging to draw clear inferences from this observation.

With regards to humidity and air quality, it is relatively rare for schools to monitor these variables. Devoted air quality sensors, such as CO2 meters cost around 150Euro (https://www.dataloggers.shop/CO2-Meter-AIRCO2NTROL-5000?Lng=en) , and humidity sensors cost around 100 Euro (https://www.fishersci.com/shop/products/fisher-scientific-traceable-relative-humidity-temperature-meters-3/p-191574) so this is a potential reason as to why these are measured relatively infrequently. The need to purchase devoted hardware is a clear disincentive, as it eats into already limited school budgets. With regards to prior research, it would be prudent for schools to change tack and invest in sensors, as air quality is the third most negatively impacting environmental factor, according to the work of Barrett et al.

#### *6.1.4 Are teachers able to modify environmental conditions?*

| Variable | Yes | Rank | No |
|---|---|---|---|
| Temperature | 53% | 2 | 47% |
| Humidity | 10% | 5 | 90% |
| Air Quality | 17% | 4 | 83% |
| Light | 72% | 1 | 28% |
| Sound | 27% | 3 | 73% |

Whilst monitoring levels were always below 50%, modification levels are highly variable, and in two cases exceed 50%. This is somewhat understandable –

temperature and sound modifications are often standard elements of the design of a room. In the case of light, having a light switch is usually a standard part of the fixtures and fittings of a learning environment. In the case of temperature, many classrooms have thermostats to control heating or air-conditioning systems respectively. With the other three variables, the situation is markedly less clear. Humidity and air quality are more challenging to modify, however as illustrated by the work of Wargocki (2007), high levels of air circulation reduce issues of air quality and would also mitigate for atmospheric humidity. The figure may be under-reported as it may be that teachers are relatively unaware of how to modify these variables easily, and see air-conditioning as a primarily temperature-related mechanism – when comparing the data of the 8 cases who reported air-conditioning as the mechanism to modify temperature, only 2 remarked that this was a mechanism to address issues of humidity. Wargocki's work has commented that a continual flow of air through a learning environment has marked impact upon learning outcomes – and this may well be due to the continual refreshment of the atmosphere of the classroom in question.

With regards to sound, the low reporting is probably due to the fact that there is no specific hardware that can reduce sound levels – the majority of interventions are related to behaviour modification with students. This coincides with the work of Shield and Dockrell (2003) which looked at ambient noise levels in classrooms. The causative factor of noise levels rising is directly down to the presence of people – ergo any remedying factor should also be related to human beings. Based on this, it is somewhat surprising that the figures are so low – technically any teacher is able to apply behaviour management techniques, so the figure could potentially reach 100%.

### *6.2 Conclusions*

### 6.2.1 Conclusions relating to research question

The research question posed was “are teachers aware of the impact of environmental factors upon learning in their classrooms and are they able to monitor or modify them?”. The research very clearly shows that environmental conditions are of moderate to serious concern in all cases. In addition, these conditions manifest as problems on a regular basis. The ability of teachers to monitor conditions is varied, with responses as low as 7.5% up to 48% - this suggests that monitoring is relatively rare and should be highlighted to teachers due to its impact upon learning (Barrett 2015, Cheryan, 2014). The ability to modify environmental conditions is even more variable, with reponses being as low as 10%, and being as high as 72% - this implies that limited attention has been given to the need to adjust conditions in classrooms. As the background research has shown, there is a need for teachers to be able to monitor and modify conditions as they are negatively impacting upon learning.

*Does the research suggest that an IoT monitoring device would be of value?*

Overall, the research suggests some potential value in having a monitoring device in classrooms.

Teacher responses indicate that environmental conditions are of moderate to high significance in terms of their impact on teaching and learning. On average, no environmental condition scored below 3.5/5 in terms of significant impact upon teaching and learning. No environmental condition was seen as insignificant, and teachers understand the importance they play. This would suggest that from this angle, the monitoring device would be of value

In terms of the frequency of issues occurring, teachers generally report that environmental issues impact upon them periodically – with modal responses varying from every lesson to termly/seasonally. In the case of light and sound, teachers seem to pick up on these issues relatively easily – this is likely due to the fact that teachers have senses that identify these issues with relative ease. For other variables, teachers would rely on a device or a non-specific sense to

identify if there is an issue – this may go some way to explaining the disparities in frequency of issues occurring. Based on this, it may be of value to have a monitoring device

With regards to the amount of monitoring that occurs, all variables were monitored in less than half of all classrooms. This implies that there is a lack of monitoring occurring, and that this contradicts the first point that all environmental factors are of moderate to significant impact upon learning. It would be expected that if something is serious enough to impact on learning, it would be monitored. Based on this, it gives credence to the suggestion that a monitoring device would be useful.

Finally, modification of issues should be considered. Modification of temperature and light are possible in most classrooms to at least at a basic level. Sound modification is a predominantly behavioural solution, as suggested by Shield and Dockrell (2007) – therefore modification is technically possible in every classroom. In the case of humidity and air quality, more complex solutions need to be considered – but it is possible. Identification of issues is the first step in rectifying any problem. Therefore, in essence it is possible to resolve most environmental issues – and identifying them becomes much easier with a monitoring device.

### *6.2.2 Potential Concerns or Matters to Consider*

Whilst the above points suggest that there is some potential in having a monitoring device in every classroom, there are some matters that need to be taken into account before such a device is taken into use. One issue is the nature and frequency of notifications – when would a teacher be told their learning environment is sub-optimal? Another question to consider is what teachers do with the information. In many cases, teachers may be unable to act upon the information in question – especially if they do not know what an appropriate response is. This would probably be the basis of further research and product testing. Other issues relate to architectural and infrastructural

issues – this could also be subject to further research, although the works of Barrett (2015), Wargocki (2007), Satish (2012) and Rautkylä (2010) already give comprehensive research and impetus to act upon any negative conditions in the classroom

Whilst there are some potential issues, there is a clear case for having a device to monitor and warn teachers of issues with their learning environment. The research clearly shows that there are significant issues in terms of measuring issues caused by environmental factors and being able to act on them; and the data infers that teachers often relay on their own reactions rather than using a data informed approach. By providing access to a device that is providing real-time data about classrooms, teachers would inevitably be better informed about their learning environments and probably be more able to respond to the issues at hand. In turn, this should have a positive impact upon teaching and learning.

### *6.2.3 Potential Dissemination Targets*

The primary audiences for dissemination of this study are school leaders and operators, as it is imperative that they have the information to make changes in their institutes. The mechanism for achieving this will be via local education journals and online communities–and potentially the media based on the outcomes of the trial. A secondary community will be other stakeholders of the education systems, such as parents and governments. This will be achieved through schools sharing the outcome of the study through their social media and standard communications channels.

Another subset of interested parties would be academic researchers and IoT developers –and the project would be shared via online PLNs to ensure a maximum audience is reached

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# 8 APPENDIX

**Master's Questionnaire**

*As part of my research towards my Masters Degree in Education Entrepreneurship, I am researching the perception of the effect of environmental factors upon Teaching and Learning, and the ability of staff to observe and measure these variables in learning environments. The data will be used to ascertain if there is a significant issue, and if there are appropriate measures to address this*

*The questionnaire is anonymous, and data will be used solely for the purposes of this Masters Thesis, and will not be shared further. The questionnaire will take around 10-15 minutes to complete. All responses are anonymised to ensure confidentiality*

*By submitting this survey, you consent to this data being used for the above purpose.*

*Many thanks for your time*

*Andrew Nolan*

Focus: Ascertaining the perception of the effect of environmental factors upon Teaching and Learning, and the ability of staff to observe and measure these variables:

1. Temperature
2. Humidity
3. Air quality
4. Light
5. Sound level

QUESTIONS

Which country are you based in?

Temperature:

1. Score the above environmental factor (1 negligible – 5 hugely significant) as to its potential impact upon teaching and learning:

2. How often is this factor an issue (negatively impacting?) in your teaching environment
    1. Every lesson
    2. Daily

3. Weekly
4. Monthly
5. Termly /Seasonally
6. Never

3. Do you have an opportunity to observe the level of temperature in your teaching environment
    1. If yes, How?
    2. If yes, How often do you measure it:
        1. Every lesson
        2. Daily
    2. Weekly
    3. Monthly
    4. Termly
    5. Never

4. Do you have the ability to personally modify temperature in your space?
    1. If yes, How?
    2. If yes, How often do you measure it:
        1. Every lesson
        2. Daily
        3. Weekly
        4. Monthly
        5. Termly
        6. Never

Humidity

1. Score the above environmental factor (1 negligible – 5 hugely significant) as to its potential impact upon teaching and learning:

2. How often is this factor an issue (negatively impacting?) in your teaching environment ?

    1. Every lesson
    2. Daily
    3. Weekly
    4. Monthly
    5. Termly /Seasonally
    6. Never

3. Do you have an opportunity to observe the level of humidity in your teaching environment
    1. If yes, How?

2. If yes, How often do you measure it:
    1. Every lesson
    2. Daily
    3. Weekly
    4. Monthly
    5. Termly
    6. Never

4. Do you have the ability to personally modify humidity in your space?
    3. If yes, How?
    4. If yes, How often do you measure it:
        1. Every lesson
        2. Daily
        3. Weekly
        4. Monthly
        5. Termly
        6. Never

Air Quality

1. Score the above environmental factor (1 negligible – 5 hugely significant) as to its potential impact upon teaching and learning:

2. How often is this factor an issue (negatively impacting?) in your teaching environment ?
        1. Every lesson
        2. Daily
        3. Weekly
        4. Monthly
        5. Termly /Seasonally
        6. Never

3. Do you have an opportunity to observe the level of air quality in your teaching environment
        1. If yes, How?
        2. If yes, How often do you measure it:
            1. Every lesson
            2. Daily
            3. Weekly
            4. Monthly
            5. Termly
            6. Never

4. Do you have the ability to personally modify air quality in your space?
    1. If yes, How?
    2. If yes, How often do you measure it:
        1. Every lesson
        2. Daily
        3. Weekly
        4. Monthly
        5. Termly
        6. Never

Light Levels

1. Score the above environmental factor (1 negligible – 5 hugely significant) as to its potential impact upon teaching and learning:

2. How often is this factor an issue (negatively impacting?) in your teaching environment
        1. Every lesson
        2. Daily
        3. Weekly
        4. Monthly
        5. Termly /Seasonally
        6. Never

3. Do you have an opportunity to observe the level of light in your teaching environment
        1. If yes, How?
        2. If yes, How often do you measure it:
            1. Every lesson
            2. Daily
            3. Weekly
            4. Monthly
            5. Termly
            6. Never

4. Do you have the ability to personally modify light in your space?
    1. If yes, How?
    2. If yes, How often do you measure it:
        1. Every lesson
        2. Daily
        3. Weekly
        4. Monthly
        5. Termly
        6. Never

Sound Levels

1. Score the above environmental factor (1 negligible – 5 hugely significant) as to their potential impact upon teaching and learning:

2. How often is this factor an issue (negatively impacting?) in your teaching environment ?
    1. Every lesson
    2. Daily
    3. Weekly
    4. Monthly
    5. Termly /Seasonally
    6. Never

3. Do you have an opportunity to observe the level of sound in your teaching environment ?
    1. If yes, How?
    2. If yes, How often do you measure it:
        1. Every lesson
        2. Daily
        3. Weekly
        4. Monthly
        5. Termly
        6. Never

4. Do you have the ability to personally modify sound in your space?
    1. If yes, How?
    2. If yes, How often do you measure it:
        1. Every lesson
        2. Daily
        3. Weekly
        4. Monthly
        5. Termly
        6. Never

Thank you for your time.