# PROBE Conference 2005

## The Second Scottish Conference for POSTGRADUATE RESEARCHERS OF the BUILT and NATURAL ENVIRONMENT

16th - 17th November
Glasgow Caledonian University
City Campus, Glasgow
Scotland, UK

Edited by
Prof. Charles O. Egbu
Michael K.L. Tong

ISBN 1-903661-82-X 

GLASGOW CALEDONIAN UNIVERSITY · In partnership with Scottish Enterprise GLASGOW · CIOB · Blackwell Publishing · apm · ARCOM

# THE ENVIRONMENTAL PERFORMANCE OF CLASSROOMS: A CASE STUDY FROM EL-MINYA GOVERNORATE, EGYPT

**T. Gado***, **M. Mohamed***, **S. Unwin***

* *School of Architecture, University of Dundee, 13 Perth Road, Dundee, DD1 4HT, Scotland, UK*

E-mail: T.gado@dundee.ac.uk

**Abstract:** The provision of primary schools in Egypt is one of the demanding issues facing the Egyptian government since the earthquake of 1992. In the aftermath of the quake the government has designed a substantial number of primary schools around the country in an attempt to replace schools lost in the disaster. This paper presents the results of an investigation into the environmental performance of classrooms inside eighteen government schools from the El-Minya Governorate. Interviews were conducted with the pupils and the staff of the schools. The authors of the present paper believe that the environmental performance of these classrooms could be better addressed than at present. Accordingly, this investigation was essentially to establish the roots of the problems and to identify approaches for further investigation. One problem is that schools of typical design have been built in varying climatic regions of the country. The results suggest that the majority of pupils and teachers in all case studies suffer from thermal and visual discomfort during much of the academic year inside the classrooms.

**Keywords:** Egypt, Environmental performance, Schools

## 1. INTRODUCTION

This paper presents the findings of a pilot study which is part of an extend research project running at Dundee School of Architecture investigating the environmental performance of government schools in Egypt. The main aim of this pilot study was to identify environmental problems inside classrooms of government primary schools. This study focused on problem identification. Proposal for addressing the environmental problems found will be the focus of the next part of the research; it is not covered here. Schools investigated in this work are those designed and built by the Egyptian General Authority of Educational Buildings (GAEB) after the earthquake of 1992. Eighteen case studies from El-Minya Governorate were surveyed. A total number of 108 classroom occupants were interviewed to assess their subjective response.

## 2. BACKGROUND

### 2.1 Location of the study

Egypt occupies the Northern corner of Africa. It is bounded by the Mediterranean Sea from the North, the Red Sea from the East, Libya from the West and Sudan from the South as shown in Figure 1. The total area of the land is just over one million $Km^2$, only 4% of this area is inhabited. Egypt is divided into 26 administrative units called 'Governorates'; each is divided into several towns. Each town includes one city and several villages. Egypt lies in the dry equatorial region except its northern areas which lies in the moderate warm region with a climate similar to that of the Mediterranean. On average the climate is warm and dry in summer and moderate with limited rain fall that increases at the coast in the winter. The climate in Egypt is influenced by several factors including its geographical location, topography, general system of atmospheric pressure and the water surfaces surrounding it. The country is divided into seven climatic design regions; the largest is the desert region. El-Minya Governorate is indicated on the map.


**Figure 1:** Egypt boarders and El-Minya Governorate location

All the case studies are located in El-Minya Governorate, which lies in the heart of Egypt and is bounded by Bani-Suef Governorate from the north, the Eastern Desert from the east, the Western Desert from the west and Assuit Governorate from the south (Figure 1). Its total area is 56,587 $Km^2$ and consists of nine towns, each has a centre called city. Each town is divided into several administrative sectors; each includes a number of villages and has its council. The total number of villages in the governorate is 346 (IDSC; 1999).

### 2.2 Primary schools in Egypt

Figure 2 illustrates the growth of public school numbers in Egypt. It can be seen from this figure that the number of schools has jumped twice since the 1950s. The first time was at the end of 1952 when the Revolution brought about - at that time what was considered - a host of achievements that included an increase in the number of schools (IDSC; 2005). The second was after the 1992; the government had to build many

schools to replace those destroyed by the major earthquake of that year (GAEB; 1994).

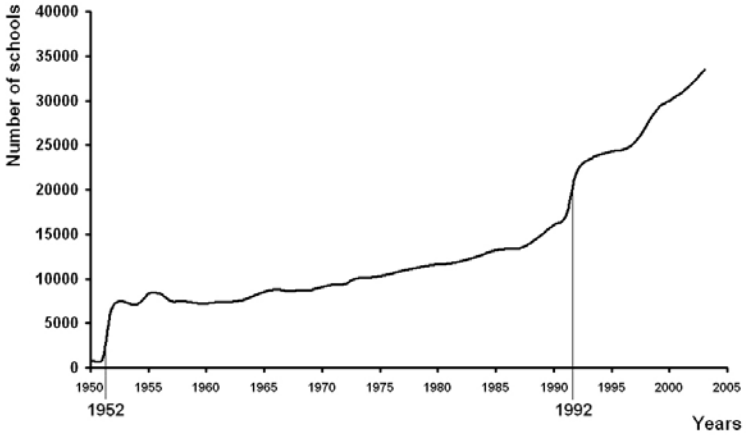


**Figure 2:** Schools number in Egypt from the year 1951 to 2005, after the Egyptian Ministry of Education (Ministry of Education; 2005)

### 2.3 Research problem

In 1992 Egypt was hit by an earthquake that registered 4.7 on the Richter scale and was followed shortly by an aftershock measuring 3.8 (Farag; 2002). This disaster affected 3964 buildings including a considerable number of schools increasing the demand for primary schools which was already high pre 1992.

Another factor that contributed to the increase in this demand was the changes that took place in the education system. Primary education in Egypt has traditionally had six levels. In the academic year 1988/1989 this was reduced to five levels (Fergany; 1994), but in 2004/2005 the sixth level was reintroduced. In 1999 the policy was to build bigger primary schools to cope with the increased numbers of pupils expected by the academic year 2004/2005. Until the academic year 2004/2005 this problem was not solved completely; 14% of the primary schools in Egypt did not have enough classrooms to accommodate the pupils in the sixth level who started school at 1999. Accordingly pupils had to use the classrooms of nearby preparatory schools (Ebrahim; 2004). This greatly affected the educational process.

The government established the Egyptian General Authority of Educational Buildings (GAEB) to be responsible for designing, building and maintaining new schools around the country to deal with the new demands before and after the earthquake. The authority designed several prototypes for all the education stages including primary schools. The number of classrooms in each prototype varied from six classes to forty three classes per school (GAEB; 2004).

The problem at the heart of the present research is that the same basic school designs were repeated all over the country without taking into consideration the varying effects of climate on the environmental behaviour of such schools. In previous work Gado (Gado; 2001) proved that the implementation of this design policy using the same design in different parts of Egypt in the housing sector produced climatically problematic dwellings. It is expected that the same will be true for the school buildings. Investigating this problem is very important. The majority of children up to the age of twelve in Egypt spend from 15% to 22% of their time in mainstream schooling.

### 2.4 Previous work

Many attempts had been made in the past to approach government schools in Egypt. However, the majority of these researches approached this issue from social, educational, economical or theoretical points of view and very few looked into their environmental design. Toulan (Toulan; 1982, Toulan; 1989) focused on the conceptual design of primary schools. Abdalla (Abdalla; 1994) studied the impact of new educational tools on both conceptual design and human dimensions. Shalabi (Shalabi; 1996) and El-Mola (El-Mola; 1999) investigated the integration of the educational process with the architectural design process. El-Nashar (El-Nashar; 1998) studied the physical setup of the educational spaces and its impact on children's behaviour. Noufal (Noufal; 1998) studied factors affecting schools built in overcrowded districts of Cairo. El-Hefnawy (El-Hefnawy; 2002) investigated health and safety issues in educational buildings especially in primary and preparatory schools (fundamental schools). The Housing Building and Urban Planning Research Centre (HBUPRC) under the supervision of Ministry of Education conducted a research aiming to formulate guidelines for designing fundamental schools in Egypt (HBURC; 1987). The study looked into the quality of educational spaces, their occupants' responses and their environmental performance. A survey was conducted that included twenty fundamental schools in Greater Cairo and a questionnaire was distributed to teachers the head teachers. The most recent research that was found (IERS; 1992) during this review looked into the conceptual design of fundamental schools, landscape design, materiality, and solar shading.

From previous notes, it can be seen that only a few studies have touched on the environmental performance of primary schools in Egypt. The majority of work has been oriented towards other aspects of primary schools design. This gap in the body of knowledge was identified and is being approached in this extended research project.

## 3. RESEARCH METHODOLOGY

Egypt is divided into seven climatic design regions the largest is the desert region. The climate of El-Minya Governorate represents the typical climate of this region. Accordingly it was decided to choose all the cases studies from this governorate.

### 3.1 Case studies

The study chose to investigate primary schools as these represents just over 44% of all the governmental schools in Egypt (Education; 2005). In this work three prototypes

designed by GAEB were investigated; the six classes prototype (T6), the twelve classes prototype (T12) and the eighteen classes prototype (T18). These three prototypes represent 80% of the primary schools built after the earthquake of 1992 (GAEB; 2004). A total number of eighteen primary schools were used in the survey; five T6, seven T12, and six T18 schools. These case studies are located in seven different towns of El-Minya Governorate. Out of the eighteen schools twelve were built in rural contexts (villages) and six were built in urban areas (city).

### 3.2 Method of data collection

The present study has used semi-structured interviews to collect data from the occupants of the case studies. This method of data collection is very flexible, suitable for gathering information and people's opinions and motivations (Drever; 1995). More importantly it guaranteed a higher response rate when compared to questionnaires distributed by post. A mixture of closed and open ended questions was used in the interviews. The open ended questions explored the occupants' subjective response to the buildings; while the closed ended questions were used to allow the application of statistical analysis on the results later on in future work. A total number of one hundred and eight occupants were interviewed, 29% of whom were females. Six occupants were chosen randomly from each school, three pupils and three teachers from each.

The aim of the interview with the pupils was to collect data related to their state of comfort inside the classrooms. This work was concerned with thermal, visual and acoustic performance of the classrooms. The interview with the teachers and head teachers aimed to collect data from them regarding both the classrooms and their office rooms. Only the results relating to the classrooms are presented in this paper.

The following three closed ended questions were asked in the interviews:

Q1: Do you feel warm during summer and cold during winter inside the classroom?
Q2: Do you experience any kind of visual discomfort?
Q3: Do you have problem hearing the speaker regardless your location in the classroom?

The interviewees had to choose one answer for each question; either yes, no or not sure. Any difficult expression such as 'visual discomfort' was explained prior to the interviews. The results are presented in the following section.

## 4. RESULTS AND DISCUSSION

On analyzing the data collected from the interviews it has been found that the majority of occupants of all case studies are not thermally or visually comfortable for most of the academic year. Figure 3 presents this data. 78% of the occupants involved in the interviews were thermally uncomfortable, 58% of them were visually uncomfortable however only 21% reported that the acoustics of the classroom is poor.

83% of the occupants inside T6, 74% inside T12 and 82.35% inside T18 were thermally uncomfortable for most of the time. This could be due to the use of large (2.5m x 1.4m) unshaded south facing single glazed windows. This led to almost half of the children inside the classroom receiving direct solar radiation on their bodies most of the time as shown in the example in Figure 5.

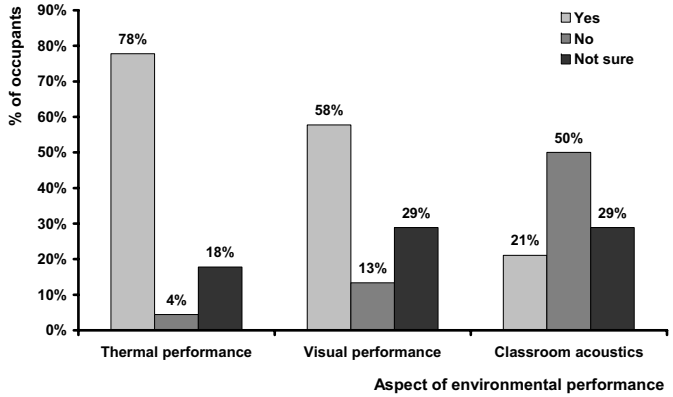


**Figure 3:** Percentages of occupants feeling discomfort, neutral and who could not answer

This together with air temperatures that range between 35°c and 42°c in summer will lead to thermal discomfort or even sunstroke in severe cases. The children reacted to this by moving around the classroom, disturbing the educational process and crowding into shaded areas of the room, which made their thermal discomfort worse. In other cases the children and teachers reacted to this situation by sticking sheets of paper on the windows or by painting the windows using dark opaque emulsion as shown in Figure 6 and Figure 7. This led to a severe drop in natural light levels and led to the use of artificial lighting during the day.

**Figure 5:** Direct solar radiation on the children

**Figure 6:** The use of artificial lighting systems during the day

61% of the occupants inside T6 reported that they experience visual discomfort and cannot clearly see the blackboard as shown in Figure 8. 63% of T12 occupants and 47% of T18 occupants reported the same. This is due to the presence of many sources of glare inside the visual field of the children such as; reflections on the blackboard and high levels of light on the working surfaces. This led the occupants to close the windows most of the time leading to stuffy and smelly classrooms due to low levels of

air change. It also led as mentioned earlier to low natural light levels and thus artificial lights were being used during the day.

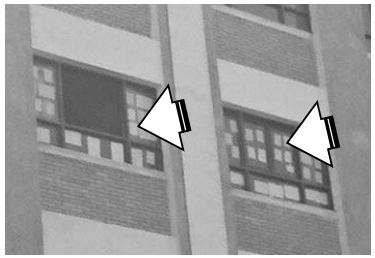

**Figure 7:** Transformation done by the occupants

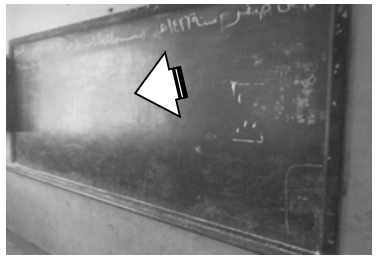

**Figure 8:** The reflections on the blackboard

As for the acoustic performance it was found that 48% of T6 occupants reported that the acoustics inside the classrooms were poor as they could not normally hear the speaker regardless of their location inside the room. However, only 11% of T12 occupants and 12% of T18 occupants reported the same. This could be due to the large number of pupils inside the same classroom that can reach from 60 to 70 pupils as shown in Figure 9. Another reason could be the high levels of noise coming from external sources especially in overcrowded areas (Figure 10). This can explain why the highest percentage of dissatisfaction was noted in T6 schools since four out of five T6 cases were located in urban contexts while 10 out of the 13 T12 and T18 schools were located in rural contexts where sources of noise are minimal.

**Figure 9:** Overcrowded classroom

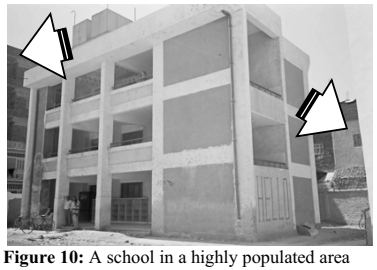

**Figure 10:** A school in a highly populated area

## 5. CONCLUSIONS

An interview with 108 occupants inside eighteen government primary schools in El-Minya Governorate was conducted. Three conclusions can be drawn from this work:

1. The majority of the occupants are thermally uncomfortable for most of the time
2. The majority of the occupants are visually uncomfortable for most of the time
3. Less than 25% of the occupants reported that the classrooms acoustics are poor

## 6. FURTHER WORK

This work will be further developed. A questionnaire will be used to collect data from a larger number of occupants in larger number of case studies. This is important to further confirm the results of this pilot study and identify the most significant environmental problem inside the government primary schools. This will help directing future work in this project. In addition, a number of cases will be monitored during the hottest and the coldest months of the academic year; May and January respectively. This objective measure will confirm the subjective opinion of the occupants. Several passive measures will then be tested using computer modeling in an attempt to enhance the environmental performance of the classrooms. Monitored data will be used to validate the simulations.

## 7. ACKNOWLEDGMENTS

The authors would like to thank all those who participated in this survey especially the pupils and the teachers. In addition they would like to thank all of the head teachers for their co-operation. They also would like to express their thanks to the Egyptian Ministry of Higher Education for its financial support.

## 8. REFERENCES

Abdalla, S. (1994). The philosophy of the new technological aspects on the development of the design of basic education schools and its influence on the human dimensions of the student Unpublished MSc. Architecture Engineering Department, Cairo University, Giza.

Drever, E. (1995) Using semi-structured interviews in small-scale research, Scottish Council For Research In Education.

Ebrahim, O. (2004) Al-Ahram newspaper, 42911.

Education, M. o. (2005), Vol. 2005 The Egyptian Cabinet IDSC, A.R.E., Cairo, Egypt.

El-Hefnawy, M. (2002). Safety and security in Educational buildings, using computer to evaluate and verify the level of safety for basic educational schools Unpublished PhD. Architectural Engineering Department, Cairo University, Giza.

El-Mola, N. (1999). Utilizing architectural spaces for the development of children culture awareness a case study in low income communities Unpublished MSc. Architecture Engineering Department, Ain Shams University, Cairo.

El-Nashar, E. (1998). The impact of spatial form on children Unpublished PhD. Architecture Engineering Department, Helwan University, Cairo.

Farag, F. (2002) Al-Ahram.

Fergany, N. (1994) Survey of access to primary education and acquisition of basic literacy skills in three governorates in Egypt, Almishkat center for research and training, Cairo.

Gado, T. (2001). A parametric analysis of thermal comfort and cooling in walk-up housing blocks in the Arab Republic of Egypt Unpublished MSc. Welsh school of architecture, University Cardiff, Cardiff.

GAEB (1994) School buildings in Egypt the present and the future, General Authority of Educational Buildings - Architectural design department - Researches and studies administration, Cairo.
GAEB (2004) Authority prototypes after the earthquake, General Authority of Educational Buildings - Architectural design department - Researches and studies administration, Cairo.
HBURC (1987) Design standards for the fundamental education stage for great Cairo region, Cairo.
IDSC (1999) Description of El-Minya Governorate, Information and Decision Support Centre in El-Minya Governorate, El-Minya.
IDSC (2005) Information and Decision Support Centre, Cairo, Egypt.
IERS (1992) Basics Environmental design of fundamental schools Guide, Institute of Environmental Researches and Studies, Cairo.
Ministry of Education (2005), Vol. 2005 IDSC, Cairo, Egypt.
Noufal, M. (1998). Development of environmental planning techniques for school buildings in overcrowded districts Unpublished MSc. Architectural Engineering Department, Ain Shams University, Cairo.
Shalabi, E. (1996). The integration between the educational program and the architectural program Unpublished MSc. Architecture Engineering Department, Ain Shams University, Cairo.
Toulan, N. (1982). The design methods of primary schools in Egypt Unpublished MSc. Architecture Engineering Department, Cairo University, Giza.
Toulan, N. (1989). Basic education schools in Egypt - an integrated design approach Unpublished PhD. Architecture Engineering Department, Cairo University, Giza.