Sciences & Technologie – N°16, Décembre (2001), pp. 109-118.

THE RISKS OF SUNLIGHTING CLASSROOMS. An appraisal method to assess the severity of discomfort due to sunlight penetration in classrooms. Site of study: Primary school classrooms in Constantine (ALGERIA)

Reçu le 05/05/2000 – Accepté le 15/01/2001

Abstract

The westerly orientations for a large number of primary school classrooms in Constantine involved a serious environmental problem provoked by uncontrolled sunlight. Under such circumstances the schoolchildren had no choice than keep sitting under incident sunlight while performing their various school tasks. Evidence of the severity of discomfort experienced by those pupils was investigated using observational methods. The results allowed to reach substantial conclusions about the risks of sunlighting classrooms.

***Key words**: westerly orientation, classrooms, sunlight, discomfort, observational methods.*

Résumé

Un nombre important de salles de classe, dans les écoles primaires à Constantine, sont orientées vers l'Ouest. Ceci est causatif d'un problème d'ensoleillement critique dans les intérieurs où les enfants se retrouvent à exécuter les diverses tâches scolaires sous un soleil incident. Afin de mieux identifier la sévérité d'inconfort enduré par les élèves exposés aux radiations solaires directes, une investigation fut entreprise. Les méthodes d'observation utilisées et les résultats obtenus ont permis des conclusions substantielles sur les risques d'ensoleillement d'une salle de classe.

***Mots clés**: Orientation vers l'Ouest, salle de classe, ensoleillement, inconfort, méthodes d'observation.*

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ملخص

إن الاتجاه الغربي لعدد كبير من أقسام المدارس الابتدائية في قسنطينة أدى إلى مشكل خطير بسبب التشمس – فالتلاميذ كانوا يقومون بأشغالهم المدرسية بدون حماية من أشعة الشمس المباشرة. قمنا بهذه الدراسة لتوضيح مدى التأثير السلبي لهذه الظاهرة على الطفل وهو في القسم، باستخدام الملاحظات المباشرة وغير المباشرة.

***الكلمات المفتاحية:** اتجاه نحو الغرب – قسم – تشمس – عدم الرفاهية - الملاحظات.*

***Foreword:** In Algeria -as in probably a large number of developing countries, for economical, technical or other reasons countries, for economical, technical or other reasons the priority economical, technical or other reasons the priority is still for building enclosures to accommodate people. And yet there is much less concern about the impact of indoor environmental conditions upon users comfort. Therefore perhaps, it is common to see researchers (specially academics) deploying lots of efforts trying to improve conditions in already constructed buildings. However, most research works (in Algeria) are turned towards the thermal aspects and indeed less interest is paid to acoustic and lighting comfort.*

In respect to this latest aspect and because as well expressed by the IENSA group [1] "Adequate lighting for the conduct of human activities is, of course, a necessity in the built environment", the current paper relates an experience -part of a PhD thesis research work [36], tackling broadly the matter of lighting conditions in primary school classrooms in Constantine. Note that challenges to provide for students lighting supportive environments in learning places, are today more and more subjects of concern in developed countries [2-5].

INTRODUCTION

An investigation carried to assess the degree of luminous comfort in primary school classrooms **built during the three last decades in Constantine** –ALGERIA (note 1), revealed a potential environmental problem of solar glare and thermal discomfort particularly in those classrooms with westerly orientations. These were inexplicably found to be the predominant orientations of classrooms (3 out of 4 schools) or more precisely of their external largely glazed facades (Fig.1). This together with the local climatic characteristics –mediterranean continental with sunshine probability above 50% [6-8], resulted in an abundant penetration of afternoon sunlight within the classrooms.

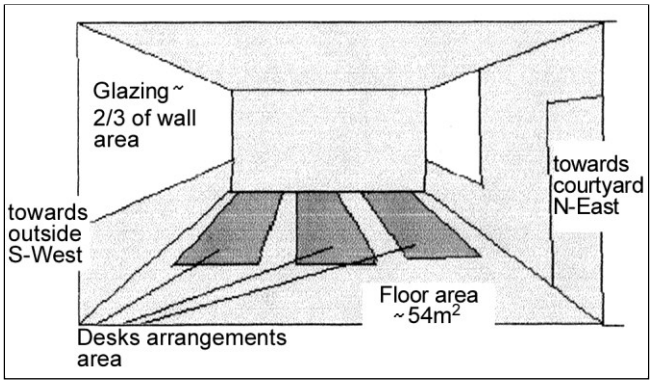

Figure 1: A sketch of a stereotype classroom [10].

Added to that the general features of classrooms (Appendix 1), the seats arrangement and also the rate of occupancy (an average of 40 pupils per classroom [9]) obliged the children to remain seated under direct solar radiation [10]. This, occurring during the afternoon class sessions -2 hours for at least 5 days a week throughout the academic year; provoked an excessive exposure of children to incident sunlight. The extent of discomfort was not only inherent to children seating under hot sunrays but to the tremendous efforts they were deploying to carry their various school tasks.

An initial criticism could be that such a situation should not even be because as confirmed by Marietta S. Millet [11] "*the perils of daylighting are very real but through careful planning and common sense, readily avoidable*". Of course a likewise working conditions are no more or scarcely encountered in countries where recommendations and regulations are remarkably developed (e.g. CIBSE [12], BSI code [13], IESNA [14] and others [15,16]) and their application firmly respected. However, in the herein circumstances, texts related to lighting design in schools are merely non existent or too superficial [17,18].

Thus on one hand it became important to inform practitioners about the kind of scholastic environment they were providing because of mistaken conception (Fig.2). On the other hand it was strongly hoped to raise among the concerned authorities constructive disputes about the effective inefficiency of those lame local design regulations.

Figure 2: A view of working conditions during afternoon class sessions (photo taken on a sunny day at 15.20).

At the best, this may give thoughts to the establishment of some exhaustive lighting design standards in accordance with the characteristics of the local climate and schooling conditions.

The non availability of light level meters was not believed a reason sufficient enough to stop this search study. It was instead decided to have recourse to qualitative assessments of indoor lighting. Emotions and behaviours were previously used as dimensions to assess the quality of light within schools [4, 19] and in offices [20].

Because of the age group involved in the experiments a number of possible surveying methods –including time delay photographs [29], questionnaires [30,31], interviewing [32] and laboratory work [7,33,36], were reviewed. Nevertheless it was decided that observational methods [28] (appendix 2) were more liable to provide valuable information to show the extent of distress and distraction experienced by pupils performing their school tasks under direct sunlight.

The results gave clear evidence of the usefulness of indirect observation using video-taping as a means of documenting reactions to an environmental factor which in this case is the uncontrolled sunlight within classrooms. More, the behavioural reactions of children allowed to reach substantial conclusions about the severity of distress caused by uncontrolled sunlight.

The herein paper summarises this personal experimental work and discusses in particular the merits of the observational method that is video recording in qualitative lighting studies, and explains how subjects behavioural reactions might be used as a gauge to identify a potential qualitative lighting problem.

BACKGROUND AND SELECTION OF VIDEOTAPING AS THE APPRAISAL METHOD ISSUE

Because, the actual research objective was to assess behavioural reactions while performing school tasks under incident sunlight it could have been hypothesised some reactions such as blinking the eyes, shading with hands and

turning the back to the sun. However, if common sense or 'naive psychology' may allow predicting behaviour in a variety of circumstances [21], in science the matter is different. No researcher should pretend that he understands people scientifically or even satisfactory with no supportive experiments [22]. These may be carried in laboratories or on site (if field correlation studies are involved as in the current search) in order to achieve valid, reliable and objective conclusions.

Throughout investigation of research studies inherent to the general matter of classroom lighting and schoolchildren [2-5, 19, 23, 24] it was found that for the assessments of lighting effects upon pupils general attitudes a recourse to observational methods was fairly frequent. Yet, a number of other appraisal methods were used varying in accordance to the specific objectives of the study subject.

For instance, some of the here above authors (e.g. Hathaway, Wohlfarth, Mike Nicklas & Henshong Mahone Group) used *Scoring Tests* to record the effects of light quantity and quality upon pupils/students academics records. Whereas, in his field study upon five Swedish schools, Tikkanen used a ***'Feeling State'*** questionnaire making hence 16 year old students emotions as medium levels to collect information upon the relationship between the quality of light and the pleasantness of indoor environments in four observed classrooms. Also, in some cases where the major interest was to check the effects of light upon children health [23], the assessment methods took the form of checking growth (weight &height) [25] or vision (visual acuity and fatigue) [26].

Out of the available methods for recording schoolchildren behaviour inherent to classroom lighting impact, observational methods were strongly felt most appropriate to assess the effect of incident sunlight upon pupils in the observed classrooms. Yet, among the various categories of observational methods, videotaping was found most advantageous for identifying the extent of exacerbating effects of direct sunlight upon pupils during the performance of their various school-tasks.

The permanent visual record of all activities meant that there had to be no definite prior judgement of particular pupils actions indicators of severe distress for the normal course of scholastic tasks. Added to that, the sight of live pictures was believed a better vehicle than any high light level figures, to allow drawing attention of the concerned authorities (who were not bound to be lighting experts) to the severity of the matter.

Last but not least, indirect observation using video recording, was believed to satisfy a number of important criteria that would help achieve an acceptable degree of research objectivity. The criteria in question were:

- Children natural reactions should recorded free of bias.
- There should be no disruption of the lessons.
- The children should remain unaware of the objective the survey.

METHOD OF WORK

Videotaping as a surveying method is one issue that would allow the gathering of maximum information in the shortest time possible. It might be used alone or with combination to other methods -such as direct observation [4,36]. Its application necessitates to set a clear program of action. But prior to that, it is essential to first make an inventory of the available suitable equipment and second get permission from the appropriate authorities and persons to observe. In this sense, a summary of the actual procedure followed in this personal work is evoked in the here below section.

Availability of equipment and permissions

The equipment available from the CNAV Centre (note 2) was quite bulky and the Centre had restrictions on the use of the equipment such as:

- There had to be a fixed timetable which was a complex task as the experiments were to be carried on sunny days which were not always easily predictable.
- It was not possible to monopolise the use of the equipment for an extended period of time because of the necessity to leave it available to others.

Finally, a personal cam-recorder (Sony Handy-cam Video 8) was retained to carry most surveys.

An initial concern about the reactions of staff in the schools, was quickly forgotten when staff members (teachers and head of school) in schools A and B (note 3), showed genuine willingness to accept the videotaping method as a way of investigating the effects of sunlight.

It was then explained to those teachers volunteering for the experiments, that it was not intended to let the children suspect that they were being videotaped and that one idea was to hide the cam-recorder in a box. There, the teachers agreed and even confirmed that the use of a box should not rise children suspicion, as it was not uncommon to see teachers bring boxes for some specific lessons.

The idea was later improved by the use of a file box to house the camera which was to be kept concealed as much as possible whilst maximising its field of view. Throughout a number of tests run in a classroom within the CNAV centre, details were refined and the file box housing the camera was then covered with black paper to minimise the contrast between the sides of the box and the camera lens.

Permission was not granted from the children but the parent's associations and school directors approved the video recording in the classroom. It would not have been possible to consult the parents individually and beside this would have weaken the insurance to keep the objective unknown to the children. Therefore permission taken from parents association and other authorities was considered sufficient to proceed to the experiment.

The experiment procedure

Selection of subjects

A sample of 160 pupils taken from the primary schools A and B were subject to observation. In other words two classrooms from each school were field of investigation. Note that because -as mentioned earlier, the study school plans and functioning were stereotyped, there was no real

justification for carrying the experiments in more than four classrooms. Added to that the total group of children was believed fairly representative if compared with the number of subjects involved in the reviewed relevant case studies [2, 4, 23, 24].

The observed pupils who were averaging between nine and 11 years of age, might be said randomly selected by being respective pupils of the teachers who volunteered to collaborate. At the start of the experiments the children were from fourth and sixth grade in school A and from only fourth grade in school B. Actually the age range of all subjects was found in keeping with the age group patterns in other studies -from 6 to 16 years [4, 19].

Remark: Around 30 pupils from one class in school B, became permanent subjects to observation throughout the three following years i.e. until the total completion of the thesis search work. Also, as often the case with the local educational system, the pupils remained with the same teacher, which was considered as a bonus for the plausibility of the survey.

Observational sessions

Within the scope of this specific section of the research where the major concern was to confirm the severity of distraction and distress of children performing their scholastic tasks under incident sunlight, two observational sessions were carried. The first one took place in autumn 1997 while the second set of observation was carried during the following winter 1998. The former observation program is the one discussed in this paper as believed most important because of the total time duration, size of sample surveyed and different classroom conditions (unshaded and shaded by the means of internal curtains).

The second set of observations was not least significant but restricted to observation of subjects in only unshaded classrooms in school B. It was carried exactly like the first survey and provided exactly the same conclusions with in addition an extra information that the number of pupils distracted by incident sunlight is independent from the season or the outdoor temperature. In fact it is directly proportional to the amount of sunlight entering the room.

The video-recording program

Prior to any recording session four file boxes were modified as explained above and were equally dispatched between the schools in question. There, each one of the teachers volunteering for the experiments was asked to put the file box on the desk throughout the two weeks that preceded the recording. This aimed to get the children familiar with the sight of the file box and thus avoid the arousal of their suspicion or curiosity on the days where the recording sessions were scheduled.

From the 30th of September till the 18th of October it was run a whole series of recording sessions which duration time was around 7 hours and half hours. Simultaneously with some videotaping sessions, it was also carried direct observation run by the first author herself. This did not appear to cause any great change in the children's behaviour and this was assumed to be due to the experimenter deliberate visits to the study classes before launching the video recording sessions. Then she was introduced to the children as a class inspector which is fairly common in primary schools.

Although four classes were to be observed, only one single cam-recorder was used -alternately put into one box and then the other. The experimenter transported the cam-recorder and ensured that fresh tape and spare batteries were available and also that the box was positioned correctly for recording. For most sessions the camera was set on teacher's desk and this allowed a favourable view of the children's responses to sunlight.

It is important to specify that most observations were taken principally under clear sunny skies. During one observational session in school B, the teacher (B. Sana) was asked -on the third recording session in her classroom, to exchange children short and distant from the external windows. This made the children usually seated under direct sunlight be in the shade and vice-versa. This done, it was expected to collect more frequent reactions but not really spontaneous, direct and loud arguing about exacerbating sunshine. The teacher tried to stop the complaints but the experimenter asked discretely that she allows the pupils outspoken feelings.

Nevertheless, one recording was carried during a cloudy day in order to provide a comparison with sunny days. More precise but concise information about the recording sessions framework is enclosed in Table 1 together with a description of the children main reactions as extracted from a meticulous viewing of the tapes and also from personal assessment while acting as an observer.

THE RESULTS

Children main behavioural reactions which are believed indicative of adverse reactions to sunlight (Table 2), were extracted from videotaping and also direct observation. Yet, most of these reactions were essentially defined from indirect observation of the videotaped sessions. This because, during direct observations some of the reactions were indeed watched live, while others were missed out because it is difficult to keep watching every detail for an extended period of time.

A number of photographs –retaken from videorecorded films, are presented to provide a clearer picture of the kind of actions assessed inhibitory of the scholastic tasks normal course (Fig. 3-5). Picking up the finest details was possible only by the means of videotaping method. This emphasised further the usefulness of such a surveying method in assessing subjects. It was also found that it was possible to film glare as it occurs within classrooms (Fig. 6).

Although initially, the experimenter intention was not to intervene during the direct observation sessions, there has been an exception during the children initiation of a discussion to express their feelings about the unwelcome sunlight. Initially the teacher tried to stop the complaints but the experimenter discretely asked that she allows the pupils to voice their feelings. This provided an unexpected

Observation / Details / school	Length of Recording & sky condition	Observation of children's responses (extracted from videotapes)	Direct observation (made by experimenter)	General comment	Technical details
School A Group1	30/9/1997 at 11.30 35 mns. Mainly clear sky.	-Curtains drawing initiated by the children at the beginning of the class. - Rubbing eyes. - Putting hands on the forehead to shade. - Writing and reading tasks performed under sunlight. - Avoiding the seats in the sunshine.	Observer not present	Because only 28 pupils were attending the class, it was easier to chose seats away from the sun. - Children were sitting in the shaded places & no disturbance was noted.	Handycam Video 8, Sony Angle of view too narrow. -The teacher didn't move the camera as she was asked.
School A Group2	30/9/1997 at 13.00 45 mns. Mainly clear sky.	- First the children sit with their back to the sun then they initiated the drawing of the curtains after verbal complaints about sunlight. - Eyes rubbing. - Hiding face and eyes. - Wiping sweat. - Keep adjusting the curtains.	Observer not present.	-"The children reactions are not different from the usual ones," said the teacher. - The children keep adjusting the curtains at a rate of 9 times in 12 mns.	Handycam Video 8, Sony. Angle of view still narrow but covers all the children in the sun.
School B Group1	30/9/1997 at 15..00 65 mns. Clear sky.	- Twisting in their seats trying to hide from the sun. - Sleeping on the table. - Hiding from the sunshine - Rubbing eyes. - Wiping neck from the sweat. - Leaning on their arms.	Observer not present.	- In this school where no curtains are provided disturbance and exhaustion are continuously observed.	Handycam Video 8, Sony. Angle of view still narrow but covers all the children in the sun.
School B Group2	4/10/1997 at 15.00 45 mns. Clear sky.	- Twisting in their seats trying to hide from the sun. - Shading while writing and reading with one leaf of the book or blotter paper. - Rubbing eyes. - Verbal complains. - Leaning on their arms. - Drinking water.	Observer not present.	Same as above.	Handycam Video 8, Sony. Another view angle was chosen which showed a clearer evidence of glare effects.
School A Group 2	11/10/ 1997 at 13.00 - 30mns. Clear sky.	Similar as the ones cited here above.	Observer present during recording time.	Usual reactions as cited above for the same school.	Handycam Video 8, Sony.
School B Group2	11 / 10/1997 at 15.00 85 mns. Clear sky.	- Verbal complaints more openly made, and discussion initiated by children about sunlight disagreement. The reactions were as cited above.	Observer present during the whole class.	Exchange of children short and distant from external windows. Signs of discomfort.	Handycam Video 8, Sony. Camera moved by observer during the recording.
School B Group2	14/10/1997 at 15.00 -60 mns spread over the 2 hrs. Cloudy sky.	- No twisting on the tables. - Evenly calm throughout the classroom. - No drinking of water.	Observer present during the whole class session.	- General atmosphere much calmer. - Children adopting proper postures. - No signs of irritation or exhaustion.	Handycam Video 8, Sony.
School B Group2	18/10/1997 at 15.00 -85mns. Clear sky.	Similar responses are observed as the ones cited above for the same school.	Observer present during recording time.		Hi 8 Handycam Pro. CCD. UX Pal, Sony with fish eye lens, angle of 220°.

School A = School El Moutannabi // School B = School Ibn Abitaleb.

Table 1: Observational sessions and general observed children reactions.

School A - curtains available	School B - no shading
- Curtains drawing initiated by the children at the beginning of the class. - Putting hands on the forehead to shade. - Avoiding the seats in the sunshine when a smaller group allows to do so. - Expressing verbally their feeling of discomfort because of sunlight. - Eyes rubbing. - Hiding face and eyes. - Wiping sweat away. - Keep adjusting the curtains.	- Twisting in their seats trying to hide from the sun. - Shading while writing and reading with one leaf of the book or blotter paper . - Rubbing eyes. - Frequent verbal complains. - Leaning on their arms. - Drinking water. - Sleeping on the table. - Hiding from the sunshine by turning their back to the window or using hands to shade. -Wiping sweat from neck.

Table 2: Children actions that may be regarded as indicative of an adverse reaction to sunlight.

opportunity for the experimenter to hear the children express their views without inhibitions in non confrontational exchange.

Figures 3: Children having to shade while writing and in the mean time to adopt a bad body posture.

The comments made by the children were the usual ones but just expressed more clearly and at a same time by a larger group. Verbal complaints were believed to correspond to the extreme tolerance of an unbearable but unavoidable situation. The comments repeated by most children are summarised in Table 3.

- The sun is hurting my eyes.
- The sun is upsetting me.
- The sun does not let me read on the book/ on the textbook.
- Sunshine is making me feel too hot.
- The sun does not let me work.

Table 3: Typical comments made by children when they described their feelings.

Figure 4: Children succumbing to tiredness after prolonged exposure to sunlight.

Figure 5: Even when curtains are provided they became a source of distraction.

Remark: During the recording under cloudy skies conditions none of the reactions adopted when sunny days were directly or indirectly observed. In fact the pupils were sitting correctly and their books and textbooks were also set flat open on their desks.

Figure 6: Evidence of strong glare from direct sunlight.

DISCUSSION OF RESULTS

In this study, the behavioural reactions indicative of the problem involved by uncontrolled sunlight within classrooms were viewed from a different angle than the ones defined in other studies case studies [2-5, 23-27]. For instance in Grangaard research work [4], schoolchildren behavioural reactions were named off-task behaviour every time they were believed disruptive such as when:

- The child is not visually following the lesson being presented.
- The child appears to be attending, but is playing with objects.
- The child is moving the chair or his body in a way, which precludes his being able to concentrate on the lesson.
- The child is covertly bothering the children around him while appearing to be involved in the lesson.

Actually, in the herein work it was mainly sought for a correlation between effects of sunlight and children behavioural reactions while performing the learning tasks. The registered reactions, which vary from verbal complaints about disturbing sunlight to putting hand on the forehead to shade (table2), would be the actual off tasks behaviour for this particular study and were believed by the authors and confirmed by the teachers to genuinely inhibit a primary schoolchild from performing normally most of his schooltasks.

It might be argued that disagreement caused by striking sun radiation is a well-known phenomenon and yet those pupils behavioural reactions could have been speculated upon without even having recourse to an observational method. However, as said previously it would not be a scientific attitude to establish results upon the basis of personal assumption with no idea of the real dimension of the facts. Indeed, until the observational work took place, some reactions could not have been guessed or foreseen such as for instance the verbal complaints or the initiative to manipulate curtains to properly shade.

The discomfort which was experienced by children because of direct sunlight was both visual and thermal. However, discriminating between the two types of discomfort from the reactions of the children is not always possible with a high degree of certainty without further tests such as for instance carrying vision tests [26]. Yet, there were some behavioural reactions that could clearly be attributed to visual discomfort provoked by sunlight glare effects (e.g. eyes rubbing) while others were most obviously the result of thermal discomfort (e.g. wiping sweat from neck). But, there were other reactions that were difficult to attribute to any one of those two feelings as they might also be attributed to illness, after-meal or boredom (e.g. sleeping on the table).

Indeed, one of the general problems with behavioural studies is that it is difficult to attribute actions to particular feelings or causes without there being additional evidence of some sort. In this study the spontaneous complaints of the children confirmed clearly that the source of their discomfort was the unwelcome presence of sunlight including its heating and glaring effects . They also separately commented about visual and thermal discomfort.

Originally there had been the intention to measure numerically the incidence of particular actions. However, it proved difficult to extract accurate measures because of the varied nature of the responses and the large number of individual actions throughout the class. The overall level of activity was so overwhelming that the discomfort of the children appeared obvious with no resort to numerical description. A further evidence of this fact was the observations in a non-shaded classroom under completely overcast (cloudy) sky. There, although the same children were observed at the same time in the same classroom, and also with the same teacher, none of the reactions associated with sunlit periods was registered. The pupils maintained a good posture and left their books open flat on the desks and did not use their textbooks as improvised shading devices. They also remained calmer through the whole class session, which did never occur during sunny days. It was also noted that during this particular session none of the pupils resorted to drinking from their water flasks.

In School A where curtains were provided, even when drawn the pupils by the windows complained about the sunshine and tried to draw the curtains fully together in order to totally shade themselves. Although their reactions were less pronounced than those of pupils in non shaded classrooms, they were showing that they were affected. The typical response in the shaded classroom was for pupils to shade their faces with their hands, rub their eyes, or become preoccupied with their attempts to adjust the curtains (Fig.5).

In the second school B where no curtains were provided, all the reactions cited in table 2 were resorted to frequently throughout the whole afternoon class session. A serious

problem was the poor body posture adopted by the children for an extended period of time in their attempts to shade themselves and their work from direct sunlight. However even the actions undertaken to provide improvised shading were restricted because there was a continuous need to find a compromise to avoid sunlight coming from the right and being able to properly view the blackboard in the front.

Remark: Sunlight penetration inside classrooms was found to distract and exacerbate children during their studies. It is interesting to see how sunlight penetration into a work space was taken as a third dimension beside sunlight quantity and quality in Boubekri research work [20]. There this third dimension was argued particularly important for the well being of occupants (office workers) seated in shade. Actually it was found that "the highest feeling of relaxation in the office module occurs when sunlight penetration – or sunlit area, ranges between 15 to 25 % of the floor area" [20].

If such was the case and the children were seated protected from direct solar radiation, this search subject would have appeared the least realistic as it is not yet the era of concern about people feelings in working places in our country. But, the matter was more critical and making a child perform his schoolwork under incident sunlight is merely unthinkable but yet true. One useful argument is M. Millet saying "Complaints about daylight in buildings arise from *improper design causes physiological and psychological problems. Physiologically daylight can cause visual and thermal discomfort. Psychologically, daylight can exacerbate people feelings" [11]*.

CONCLUSIONS

From the run experiments some important conclusions were reached. On one hand, observational methods and precisely videotaping proved to be a successful way of recording reactions to environmental factors. The ability to review actions as they occur a number of times allows an experimenter to observe closely the precise responses of individuals.

The method does not overcome the general problem of interpreting actions, which in some cases might still require additional substantiation before presenting plausible explanations. In addition, in circumstances where there is an overwhelming response, the quantitative measurement of actions may still prove to be difficult even though observations are available for an extended time. If such is the case limiting and clearly defining the variables of investigation at an early design stage may well alleviate the difficulty.

Indirect observation method by the means of video-recording, may also become one most convincing tool to eventually raise disputes for the remodelling of inadequate environments. In this specific case study such a method incited for an attempt to establish more exhaustive lighting design recommendations (36). Note that in the investigated schools the shading methods when provided took the form of curtains. These did may be reduce the problem but did not eliminate it entirely. Curtains are certainly ideal for temporary measures as in temperate climates where sunlight is an exception rather than a rule and they may be recommended for dwellings [35], but they are certainly not the appropriate sunlight control for classrooms. In fact daylighting controls should be figured out at an early design stage of a school project and not implemented to it once completed [35].

The concern is not simply that children are distracted from their studies or exacerbated by incident sunlight, but also that in trying to alleviate the discomfort they are adopting body postures which if repeatedly adopted may well prove detrimental to their physical development. The problem of poor body posture in growing children has been already identified [27] as one of the principal faults of poor lighting.

As a matter of fact, lighting is only one factors among many others that require proper attention in a classroom. A learning environment physical features (such as size, noise level, climate, rate of occupancy and design) do interact with personal characteristics (such as past school experience, age, attitudes towards learning and competitiveness) to produce a higher or lower performance, satisfaction and stress [22, 34].

Notes

Note 1- Constantine is one of the most important Algerian cities which is located in the north-east of the country at a Latitude of 36.17°North, a Longitude of +6.37 and an Altitude of 687m.

Note 2- The CNAV (National Audio Visual Centre at the Constantine University) is a department serving the whole audio visual needs (photographs, slides, films and so on) of all the university staff members.

Note 3- School A is the primary school El Moutannabi located in Cité Ziadia (Constantine). School B is the primary school Ibn Abi Taleb located in Sakiet Sidi Youcef (Constantine).

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Appendix 1: INVESTIGATED CLASSROOMS MAIN FEATURES.

Physical plant / ***Space characteristics***	INVESTIGATED CLASSROOMS (belong to schools built in the three last decades, currently named new schools in reference to the old schools built before 1962, i.e. French colonial period)
Form	Rectangular (29x6 m^2), stereotyped, ceilings height ~ 3.00 m
Glazing/ Orientation	– Windows in bilateral rows occupy most of the eastern and western length walls. These latter form the external facades. - Excessive glazed areas (~ 2/3rd of the wall). - Except from the wall recess (30 cm) no structural shading devices are provided. - In cases where curtains are implemented they are internal and are kept closed every time it is either clear sky or partly cloudy sky conditions outside.
Colours	- Walls are of an off-white yellowish colour. - Tables with non- reflective areas. - Chalkboards are dark green. - Curtains where provided, they are cut in heavy material (canvas, velvet) and of various colours (blue, brown, beige, red).
Electric light	Fluorescent light (6 tubular lamps) fixed perpendicular to windows. Electric light was observed to be on every time the curtains are drawn.
Occupancy mode	Double shiftof classes where the occupancy rate averages 40 pupils per class group. 1st shift; 8 to 10.30 am & 1 to 3.00 p.m. // 2nd shift; 10.30 to 1 p.m. & 10.30 to 5.00 p.m.

Appendix 2: OBSERVATIONAL METHODS.

Observational methods may be classified as either direct I observer based assessment-, or indirect I technical based assessment [26]. The potential advantage of observational methods is that they reveal the real actions of people under particular circumstances.

Regardless to the form of observational method adopted, a well designed one should show how individuals actually perform rather than how they would like to perform, think they should perform or they think they have to perform [22]. It is important prior to the observational sessions to define broadly about the variables indicative of an effective problem. As it is also often necessary to define the possible rating and ranking methods that would present conclusive results for the plausibility of the study.

Direct observations refer to live recording of individuals responses/reactions by an observer often present in the place of investigation. The observer might act alone (the surveyor himself) or in a team with other qualified person as for instance in Grangaard study [4].

Direct observations may introduce two potential difficulties. First, the presence of the observer might itself alter the situation. Knowing that someone is watching can certainly influence the behaviour of the children when performing for the teacher. It might very well be that specific actions in relation to sunlight would be less affected, but it is impossible for the experimenter to definitely confirm this. Secondly, it is necessary for the observer to note and register the behaviour. This may leave a great deal to the judgement of the observer about what actions of the pupils can be regarded as demonstrating a particular behavioural trait.

Indirect observations require mechanical monitoring equipment so to register a retrospective reading of facts and effects. Thus equipment for data recording is necessary.

These kind of observations may take a number of forms such as automatically recording the number of times a particular action is performed. For instance, the number of times a window was opened might be recorded by automatic means such as a counter. This method has great potential but it needs to be recognised that the success of such applications depends upon the significance of the action being recorded. It must first be known that a particular action is the one critically descriptive of a person's response to a given situation.

In respect to indirect observations by the means of visually recording the behaviour of people, there would be an ethical question as to whether it is acceptable to record people without their knowledge. If the experimenters obtain permission beforehand they clearly inform people that they are going to be observed and therefore loose the advantage of unbiased behaviour. One type of this kind of indirect observation is time lapse photography as adopted in Humphreys work [28] inherent to thermal comfort in classrooms. There is also the use of video recording which offers the opportunity to be less prescriptive about a definite list of the actions caused by given effects [4,8,21]. Precise and prevailing actions might be identified throughout a repeated and thorough viewing of the registered scenes.