



UNIVERSITI PUTRA MALAYSIA

***VISUAL COMFORT UNDER DAYLIGHTING CONDITIONS
IN TWO SCHOOL CLASSROOMS IN MALAYSIA.***

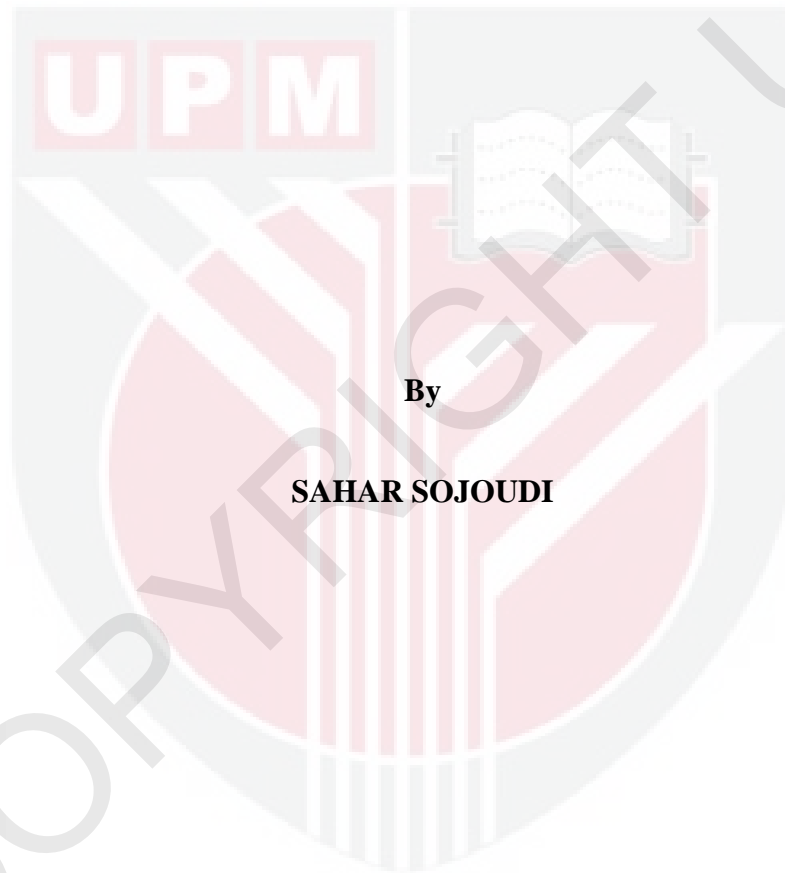
SAHAR SOJUDI

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UNIVERSITI PUTRA MALAYSIA
BERILMU BERBAKTI

**VISUAL COMFORT UNDER DAYLIGHTING CONDITIONS IN TWO
SCHOOL CLASSROOMS IN MALAYSIA.**



By

SAHAR SOJUDI

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfilment of the requirements for the Degree of Master of Science**

March 2014

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the Degree of Master of Science

VISUAL COMFORT UNDER DAYLIGHTING CONDITIONS IN TWO SCHOOL CLASSROOMS IN MALAYSIA.

By

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March 2014

Chair: Mohamad Fakri Zaky Bin Ja'afar, PhD

Faculty: Design and Architecture

Light has important visual and non-visual effects on humans and high-quality light should therefore be supplied inside buildings in sufficient quantities. It is thus important to take into account the visual and non-visual effects of light and energy-efficiency when designing fenestrations for school classrooms. Conventional tropical school building design in Malaysia is experiencing a new paradigm by way of its environmental response to improve the lighting ambiance and a user's comfort by exploiting daylighting. This research was focused on assessing existing visual comfort, illuminance levels, and users' preference of daylighting applied in a tropical country like Malaysia based on their windows by comparing those factors between two schools with different windows.

Two similar classrooms from two different schools in the same geographic location with different opening provisions were compared. Daylighting evaluation was done through field measurement; computer simulation and user survey. Visual comfort level in one classroom for both schools collected at 8am until 1pm. Light measurements were indicated using 10 data loggers (HOBO devices) were at 9 different locations in the classroom and one outdoor. Computer simulations generated under '10K CIE Overcast Sky' file were used to predict daylighting performance. Furthermore, the survey carried out measured user's comfort and awareness. The response were recorded via questionnaires issued to them at each of the selected classrooms. The survey is performed during operation morning hours of the secondary schools.

In conclusion, findings from the field measurement showed that below minimum recommended illumination for reading (300 Lux) was indicated at 45 percent of the classroom in Taman Desaminium secondary school. Thus more complaints were recorded by an occupational survey at the Taman Desaminium school in terms of high level of contrast and glumness from the users.

As the Seri Serdang secondary school, field measurement showed that below minimum recommended illumination for reading is 33 percent and 55.55 percent of classroom is definitely in the recommended illumination for reading (300 -500 Lux).

Abstrakt tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

**COMFORT VISUAL DI BAWAH SYARAT SIANG DALAM DUA BILIK
DARJAH SEKOLAH DI MALAYSIA.**

Oleh

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Cahaya mempunyai kesan visual dan bukan visual yang penting ke atas manusia dan cahaya yang berkualiti tinggi itu harus dibekalkan di dalam bangunan dalam kuantiti yang mencukupi. Oleh itu, adalah penting untuk mengambil kira pada masa yang sama visual, kesan-kesan bukan visual cahaya dan kecekapan tenaga apabila merekabentuk bukaan cahaya untuk bilik darjah sekolah. Reka bentuk bangunan Konvensional sekolah tropika di Malaysia sedang mengalami satu paradigma baru dalam tindak balas alam sekitar untuk meningkatkan suasana lampu dan keselesaan pengguna dengan mengeksploitasi pencahayaan siang. Kajian ini memberi tumpuan kepada menilai keselesaan visual yang sedia ada, tahap pencahayaan, keutamaan pengguna daripada pencahayaan siang digunakan di negara tropika seperti Malaysia dinilai berdasarkan tingkap mereka dengan membandingkan faktor-faktor antara dua buah sekolah dengan tingkap yang berbeza.

Dua buah bilik darjah dari dua sekolah berbeza tetapi di lokasi geografi yang sama telah dipilih untuk kajian. Bilik darjah telah dipilih mengikut yang sama tinggi dari lantai, kedudukan yang sama di koridor, dan lokasi yang sama di dalam pelan.

Penilaian Pencahayaan siang penilaian dilakukan melalui tiga kaedah, iaitu melalui Pengukuran lapangan; Simulasi Komputer dan soal selidik Pengguna. Bilik darjah di dua buah sekolah menengah dengan dua konfigurasi tingkap yang berbeza telah dikenal pasti sebagai kajian kes.

Tahap keselesaan visual dalam satu kelas dari kedua-dua sekolah dikumpulkan pada pukul 8 pagi sehingga 13. Ukuran ditunjukkan menggunakan 10 pembalok data (peranti batak), pada 9 lokasi yang berbeza di dalam kelas dan satu di luar. Simulasi yang dihasilkan di bawah fail '10K CIE Mendung Sky' digunakan untuk meramal prestasi Pencahayaan siang. Tambahan pula, kajian yang dijalankan mengikut keselesaan dan kesedaran pengguna diukur negara mengikut kesan yang ditunjukkan dalam berhubung dengan dua bilik darjah sekolah menengah. Jawapan yang direkodkan adalah melalui soal selidik yang dikeluarkan kepada mereka pada setiap kelas yang dipilih. Kaji selidik itu dilakukan pada waktu pagi operasi sekolah menengah tersebut.

Kesimpulannya, hasil daripada pengukuran lapangan menunjukkan bahawa di bawah pencahayaan minimum yang dicadangkan untuk bacaan (300 lux) telah ditunjukkan pada 45 peratus daripada kelas di sekolah menengah Taman Desaminium. Oleh itu,

lebih banyak aduan telah direkodkan oleh kajian pekerjaan di Taman Desaminium dari segi tahap kontras dan suram daripada pengguna.

Bagi Seri Serdang, sekolah ukuran bidang menengah menunjukkan bahawa penerangan di bawah minimum disyorkan untuk membaca adalah 33 peratus dan 55.55 peratus daripada kelas pasti dalam pencahayaan disyorkan untuk membaca (300 -500 lux).



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Last but not the least, I would like to thank my family: my parents Mojtaba Sojoudi and Ashraf Alsadat Saghirzadeh, for supporting me spiritually throughout my life.

I certify that a Thesis Examination Committee has met on 28 March 2014 to conduct the final examination of Sahar Sojoudi on her thesis entitled "Visual Comfort Under Daylighting Conditions in Two School Classrooms in Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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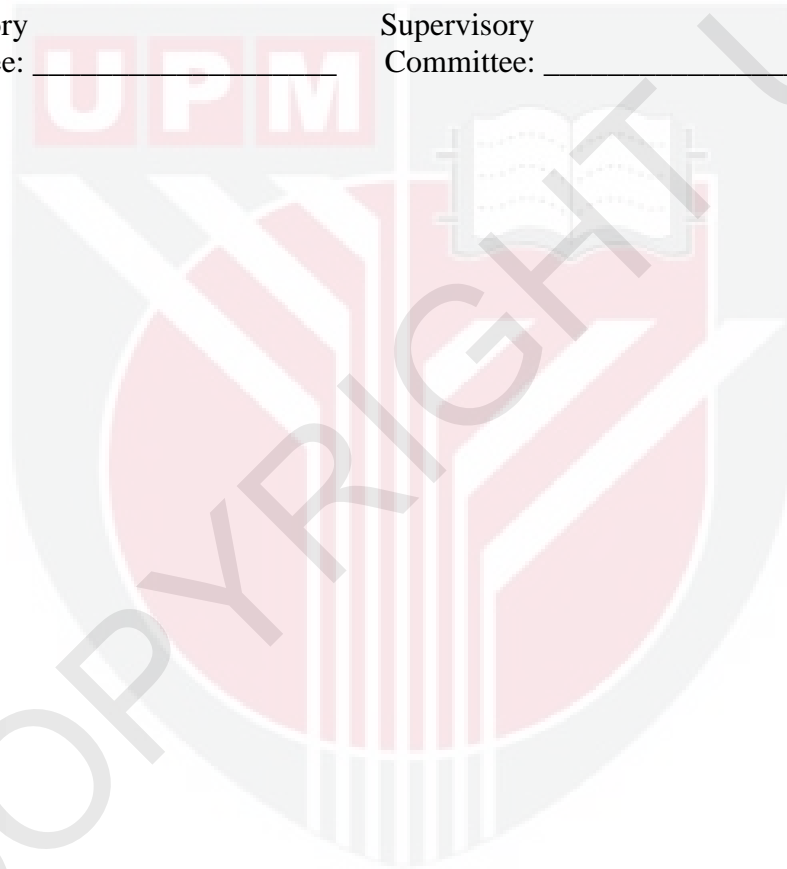


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LIST OF ABBREVIATIONS

BRS	Building Research Station
DF	Daylight Factor
E	illuminance (Lux)
E_{over}	upper limit of the visual comfort range (Lux)
E_{under}	lower limit of the visual comfort range (Lux)
FVC	Frequency of Visual Comfort conditions (%)
IESve	Integrated Environmental Solutions ‘Virtual Environment’
PWD	Public Works Department
SMK SS	Seri Serdang Secondary School
SMK TD	Taman Desaminium Secondary School
UDI	Useful Daylight Illuminance



CHAPTER 1

INTRODUCTION

This study explores the effect of entry lighting characteristics in new design secondary schools with tropical school design. The focus of study is narrowed to compare the level of pupils' visual comfort in the new design plan secondary school and the typical plan secondary schools. Although the design of the school complies with the requirement of Uniform Building by-Laws (UBBL) (UBBL: 1984) with regards to lighting, unfortunately, no requirement was made for daylighting. Researchers (Ahmad & Yeoman, 1997; N. Dahlan, Jones, Alexander, Salleh, & Alias, 2009a; Fadzil & Sia, 2003) have investigated that daylighting implementation in tropical buildings could optimize the lighting ambiance and reduce glare and discomfort. In theory, daylight design criteria for Malaysia shows sky illuminance approximately 10,000 Lux of diffused illuminance during working hours (from 9am to 4pm) (Zain-Ahmed, 2000). Thus, the high availability of daylight should be fully exploited as one of a building design strategy in this country. Therefore the investigation to promote and upgrade the daylighting performance of school should be carried out.

Two types of classrooms with regard to daylight provisions are compared. First is the conventional design where corridor are single loaded, allowing daylighting from two sides of the classroom. The other, newly designed classroom, is double loaded corridor with daylighting coming from one side of the wall. Other parameters such as plan, size of windows, geographic location, materials for walls and windows, and floors level are of similar characteristics. These were the important reasons why I selected the two schools for this research.

anecdotal evidence suggests students' dissatisfaction with the daylighting in new school, the decision was made to examine the factors influencing the level of visual comfort of daylighting in new secondary schools and compare them with the visual comfort level in a typical secondary school classroom at the same position with the new school.

In order to ascertain this, measurement were taken to compare the level of Lux in a newly designed classroom and a typical designed classroom. Next, simulations were done on both classrooms to investigating the level of illuminance. The survey investigates the level of human comfort from daylighting in both classrooms.

1.1 Background of Study

Using daylight as a primary light source has been widely recognized as an important strategy to reduce building energy demand and enhance indoor environmental quality. However, to design and operate a building to make full use of daylight, which is a dynamic light source, remains a challenge (Hua, Oswald, & Yang, 2011). Daylighting has been considered as the most favourite and important lighting source in schools. Many literatures have stated that daylighting appears to be generally desirable for students in schools. In addition, good quality of daylighting has been shown to be closely associated with improving student performance and promoting better health. It also contributes significantly to the aesthetics and physical character of the learning space (Dunn, Krinsky, Murray, & Quinn, 1985; Küller & Lindsten,

1992). In addition, Datin Fatimah Abdullah Minister in the Chief Minister (Responsible for Early Education Child, Family Development as well as being in charge Training) emphasized to make school classrooms safe in Malaysia. However daylighting should be on standards to make visual comfort for students (saai, 2011).

Daylighting has often been recognized as a useful source of energy savings in buildings. For daylight spaces, daylight-linked automatic lighting control can give excellent energy savings (Li & Lam, 2001, 2003). Many studies have indicated that proper lighting controls integrated with daylighting have a strong potential for reducing energy demand in non-domestic building by exploiting daylight more effectively (Crisp, 1978; Li & Lam, 2001, 2003) In order to change this situation, besides relying on improving lighting fixture efficiency and introducing sophisticated controls, using daylight as primary light source has been widely recognized as an important strategy to reduce lighting energy demand in buildings. Many green buildings adopted daylighting design strategies for the superior luminous efficiency of daylight (Hua, et al., 2011) and the resulted energy and environmental benefits. In addition, the financial benefits do not stop at energy savings but carry over to even larger gains because of the effect of daylight on the health, comfort, satisfaction, well-being, and productivity of occupants (J. A. Veitch & Gifford, 1996).

This thesis only focuses on comparing the level of pupil's visual comfort from a natural lighting classroom in secondary school SMK SS as a standard school plan that was designed by Public Works Department (PWD) in Malaysia, since all of them followed the same plan, materials and rules. SMK TD on the other hand is a new school with a completely different plan which was built by developers.

1.2 Problem Statement

In a tropical country such as Malaysia, there are limited data available for measured illumination which is the case of several regions (Djamila, Ming, & Kumaresan, 2011) in Malaysia, especially for schools. The understanding of qualitative effects of lighting has been sporadic and lacks a shared agenda to guide investigators (Wu & Ng, 2003). Although there have been little research on how lighting influences, or can be used to influence the occupants of an environment, the absence of a common definition has been one impediment to the progress of lighting quality. Moreover, few students have reported about good quality of daylighting in schools.

It would seem that since daylighting is more important for student learning in classrooms and healthy for their bodies also enhances suitable class a more room atmosphere and it is useful for the country and world economy as energy saving. In addition, Malaysia is a developing country and the politics of politicians and positive approach of architectures for sustainability and green building resulted in this thesis analysis on daylight distribution in a traditional Malaysian school classroom with in the context of the Malaysian sky. All schools in Malaysia are built by MOE supervised by the PWD or developer, yet both have to follow the guidelines of the Economic Planning Unit (EPU) for space and material and UBBL for architectural design. Furthermore, the budget given is according to the number of classes, determined and paid by MOE (Fig. 2.35)

However, work on the new schools started since January/2011. Earlier, the dissatisfaction from parents on classroom lighting, such as from Afif PLC blog (PLC, 2011) who wrote in his blog “I remember my old classroom had those huge *naco* windows on both sides of the wall. The newly finished SMK Desaminium has only one of those and the other side has these smaller windows which made the class looked like a bat cave.” (PLC, 2011)

1.3 Questions, Aim and Objectives of Research

1.3.1 Aim of Research

The aim of this study was to compare the daylighting provisions between the old secondary school design building and the new secondary school design building in Malaysia.

1.3.2 Research Questions

The main research question was:

What is the impact of different classrooms design on the level of daylighting in Malaysian secondary schools?

It is further divided into several sub-research questions as follows:

Sub-Research Question 1:

What are the different classroom designs with regard to daylighting provision?

Sub Research Question 2:

What is the level of student’s visual comfort between the two designs?

1.3.3 Objectives of Research

To achieve the aim of this research, the following objectives are formulated:

- To verify the daylighting in the classrooms.
- To determine the level of daylighting in the classroom.
- To investigate the students’ visual comfort in school classrooms.

1.4 Scope and Limitation of Study

This thesis only focused on comparing the level of pupil’s visual comfort from a natural lighting classroom in secondary school SMK SS as a standard school plan that was designed by PWD and SMK TD as a new school with a completely different plan for windows location that was designed by consultants. However, the same materials and geography location were built by the consultants.

From two types of school design in Malaysia, one by PWD and the other one by consultant, the sample selected one school for each type.

The classroom was selected in the top floor (in both schools 3rd floor) which can use the sun light.

Both classrooms are in the middle of the corridor. The walls and window material in both classrooms are the same. Both sample schools are in the same geographical positions.

Since in new school all classrooms are located on the 3rd floor, the classrooms which are in the corner have more windows than the other classrooms that were in the middle of the corridor. In addition, the lighting problem is more acute in the middle classroom than the classroom at the end of the corridor. Therefore, the second classroom in the corridor on the 3rd floor were selected for this project in both schools.

1.5 The Research Framework

In answering the research questions and achieving the research aims, the following tasks were identified and carried out. The research framework is divided into four phases (fig1.1) as follows:

1. In the first phase, the basic understanding of the daylighting parameters affecting in pupils visual comfort was covered. Fundamental understandings on daylighting had also been covered, namely, through the source of daylighting and sky luminance discussed in this phase.
2. The second phase of the research framework focuses on the research methodology which consists of field measurement, survey and simulations. These methodologies are constructed based on specific limitations that will be discussed further in the next chapter.
3. The third phase is a prerequisite from the second phase which is the empirical measurement. In this phase, the field measurement and survey are conducted at the case study bays and applying the limitations constructed earlier. Meanwhile computer simulation will simulate models according to old and new plans of secondary schools. All three methodologies should produce a valid result or else the procedures were revised.
4. In the fourth phase, the overall research is to summarise suggestions as which is the most appropriate design to promote daylight. In the end, recommendations for future research are also included.

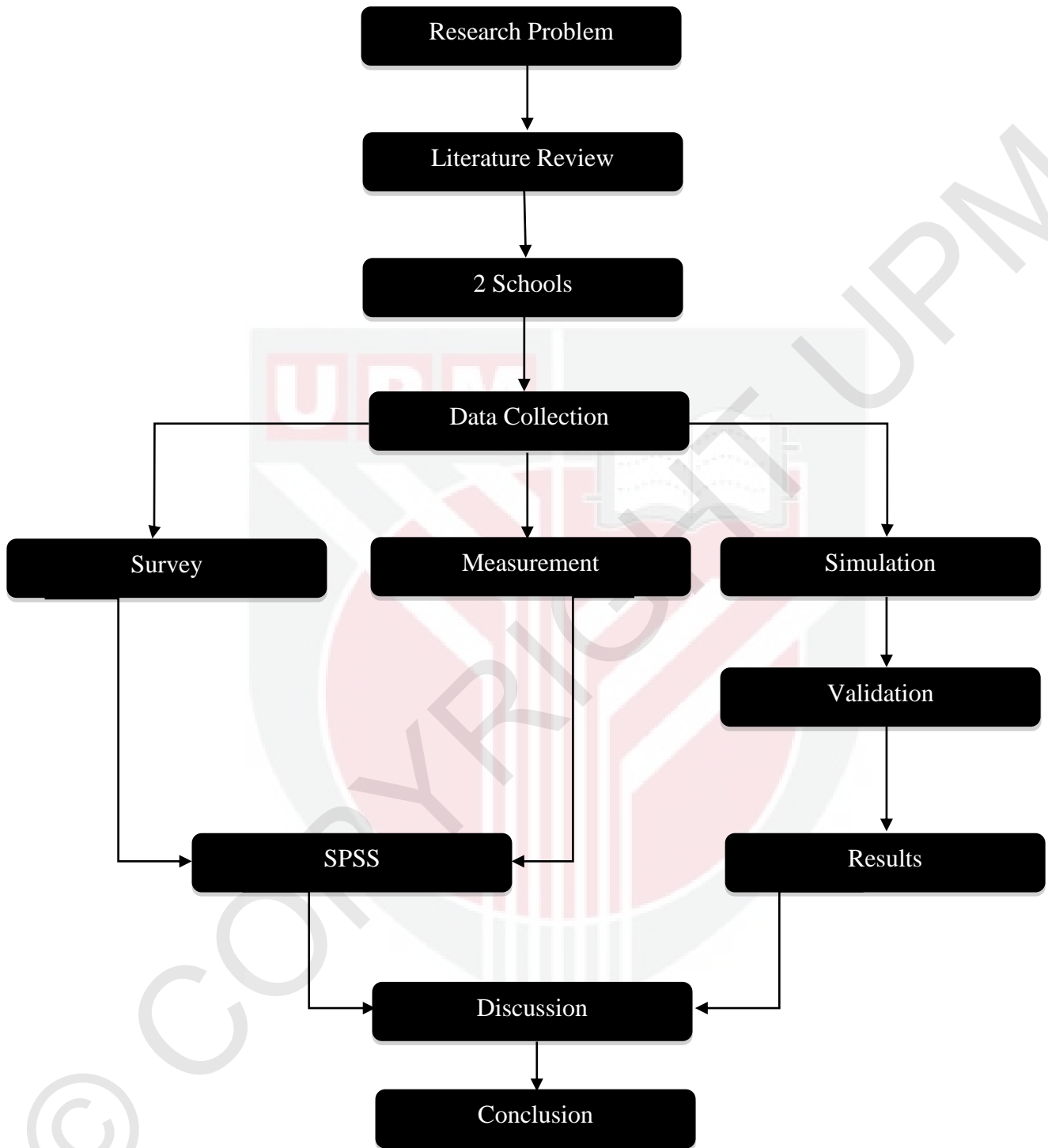


Figure 1.1 Research Framework

1.6 The Importance of the Research

The issues of users' performance and visual comfort as summarized in the background justifies the importance to conduct this research. Thus, they highlight the following outcomes as the advantages of daylighting in secondary school classrooms:

- i. Find the important point of interior lighting characteristic which is useful for future design and especially for future school design.
- ii. By finding the best school classroom design, we can build many useful and comfortable schools which focuses on lighting.



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