CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter reviews the research objectives based on the results of four methods, where the first method of field measurement was referred to the illuminance spot measurement. The total sum of illuminance spot measurement was divided with the total lux meter point to obtain the average illuminance level of each sessions. The second method used was questionnaire survey for daylight condition and performance perception, where the SPSS reliability test shows that the questionnaire had acceptable reliability value. The third method referred to various handwriting assessment tools and the Arabic BAL eye chart that was modified to identify the students' Arabic handwriting task performance. The final method used IESVE daylighting simulation function to evaluate the average illuminance level in classrooms with different window sill height and window head height, where the results leads to the recommendation of suitable window sill height for *hafazan* classroom. The contributions and recommendations of the study were also included in this chapter. Suggestions for any further study will be discussed in this chapter before the conclusion.

5.2 Review of The Research Objectives

Improving the Islamic religious schools' classroom design for better daylighting condition and students' visual performance is the aim of the study. The three objectives derived from the aim and the outcome achieved for the objectives are as shown in table 5.1. The answers for the research questions are also included in the table, where each questions are tabulated accordingly with the respective research objectives.

Table 5.1: Summary of Research Objectives Achieved

Research Objectives	Objectives Achievement	Research Questions	Questions answered
To identify the acceptable illuminance level for students' optimum Arabic handwriting performance for learning *hafazan* in Islamic religious school.	The acceptable average illuminance level for Arabic handwriting tasks was lower than 300 lx. Initial finding at 280 lx.	What is the acceptable illuminance level for students' Arabic handwriting performance?	Lower than recommended 300 lx, with initial finding at 280 lx.
		How do the students perceive the daylight conditions and their task performance in the current classrooms?	Majority of students agreed that the conditions were normal, where they can perform the task clearly.
		How does the performance of the illuminance level at working plane 300mm height affects students' Arabic handwriting performance?	The students had very low Arabic handwriting performance when the average illuminance levels were higher than 280 lx.
To investigate the influence of window design on illuminance level measured at working plane of 300mm height in Islamic religious school.	Identified using IESVE that window sill height and window head height influences the average illuminance level measured at 300mm working plane height, where higher window sill height and window head height resulted in higher average illuminance level, even though the uniformity ratio were acceptable.	What is the range of illuminance level measured at 300mm height working plane from floor level in the classroom with different window sill height?	The range of average illuminance level for window sill height between 300mm to 900mm was between 223 lx to 430 lx.
		Why does the window sill height difference influence the illuminance level measured at 300mm height working plane in the classroom?	The difference in window sill height influenced the window head height, thus influencing the daylight distribution and intensity.
To recommended window sill height for students' optimum Arabic handwriting performance for learning *hafazan* at the working plane of 300mm height.	The recommended optimum window sill height range for Arabic handwriting tasks at 300mm working plane height was between 300mm to 500mm.	What is the suitable window sill height from the floor level that achieves acceptable illuminance level at a 300mm working plane?	The window sill height range for acceptable illuminance level at a 300mm working plane was between 300mm to 500mm.

The first objective achieved shows that the acceptable illuminance level for students' Arabic handwriting performance should be lower than recommended in standards and guidelines. This can be furthered study, where this research suggested that the students required lower average illuminance level for Arabic handwriting performance due to the recursive Arabic alphabets and the difference in font sizes. The other possibility to

be furthered study is the assumption that students in secondary schools aged between 13 to 17 years required lower average illuminance level due to their eye structure's acceptability of certain daylight intensity.

The second objective focused more on the influence of the classrooms window sill height and window head height to the average illuminance level at 300mm working plane height. The simulation results show that the window sill height and head height influenced the average illuminance level significantly, even though the uniformity ratio were at the same acceptable value of 0.7 for each simulation. The simulation results explain that the average illuminance level measured at 300mm working plane height increased when the window sill height and window head height increased, which suggested that further study can be conducted to verify that this caused the daylight intensity and penetration to differ when the height of the daylight sources from windows and openings were at different height than the working plane height.

Thus, objectives one and two leads to the achievement of objective three, which was to recommend the suitable window sill height for acceptable illuminance level at 300mm working plane height for students' optimum Arabic handwriting performance in *hafazan* learning task. The simulation identified that the window sill height should be between 300mm to 500mm, while the window head height should be between 1.5m to 1.7m for classroom layout design that uses *rehal* at 300mm working plane height for Arabic handwriting task. Another scope that can be furthered study is the influence of the window head height towards the students' visual comfort regarding the view to the outside of the classroom.

5.3 Significant Findings

The significant findings of the study are:

i. The acceptable average illuminance level for Arabic handwriting tasks was lower than 300 lx, where results of research suggested at 280 lx.

ii. Students were comfortable and satisfied with the daylight conditions of the classrooms and their Arabic handwriting task performance, even though the results show otherwise. Thus, this shows that students were still unaware of the relationship between the illuminance level and their Arabic handwriting performance.

iii. The influence of window sill height and window head height on the average illuminance level measured at 300mm working plane height, where higher window sill height and window head height increases the average illuminance level.

iv. The window sill height for classroom design that uses *rehal* 300mm working plane height for Arabic handwriting tasks should be within the range of 300mm to 500mm.

v. Classrooms with higher than 500mm window sill height was not suitable for Arabic handwriting tasks at 300mm working plane height.

5.4 Contributions of the Research

This research shows significant contributions such as:

i. The adaptation of Design Science Research concept and method in daylighting study theoretical framework.

ii. The acceptable average illuminance level required for students' Arabic handwriting task performance for Islamic religious schools in Malaysia.

iii. Arabic handwriting assessment prototype based on modified Arabic BAL eye chart that can be used in other countries for similar research.

iv. Suitable Daylighting Rule of Thumb (DRT) for Islamic religious schools in Malaysia.

v. Recommendation of suitable window sill height range for Arabic handwriting tasks at 300mm working plane height.

vi. Reference to architects and designers for Islamic religious school classroom layout design that are suitable for *hafazan* learning.

vii. Awareness on the importance of sufficient daylight and illuminance level in Islamic religious schools learning spaces for *hafazan* learning.

viii. The findings of this research can be further studied and developed as an insertion to the existing standards and guidelines.

5.5 Recommendations

The results and findings of this research suggested a few recommendations regarding the Islamic school classroom layout design and the acceptable illuminance level for Arabic handwriting task such as:

i. The acceptable average illuminance level for students' optimum Arabic handwriting tasks was recommended in the study at 280 lx.

ii. The margin between the seating area and internal walls with windows and openings at 2m away, where the margin can be utilised as low cupboard or shelves area.

iii. Adaptation of the modified BAL eye chart as Arabic handwriting task performance evaluation method for similar studies around the world.

iv. Existing classrooms with window sill height higher than 500mm and window head height higher than 1.7m should not be used for *hafazan* learning process based on Arabic handwriting tasks.

v. The range of window sill height for Arabic handwriting tasks at 300m working plane was between 300mm to 500mm, while the window head height was between 1.5m to 1.7m.

vi. Recommended that the standards and guidelines should include an insertion on acceptable illuminance level, window sill height and window head height for learning tasks at lower working plane height.

5.6 Further Study

Other researchers may address various inter-correlation of other factors influencing the average illuminance level measured at lower working plane height such as the environmental and human factors, design strategies, passive and active strategies, artificial lighting and many more. Other further studies include:

i. The applicability and adaptability of Design Science Research concept and method in daylighting studies.

ii. The acceptable average illuminance level required in learning spaces for Arabic handwriting tasks should be evaluated and improved, which can be an insertion for the existing standards and guidelines.

iii. The acceptable average illuminance level measured at a lower working plane height, such as *rehal* for Arabic handwriting tasks in Islamic religious schools should be further evaluated for improvement.

iv. Inclusion of other internal and external factors such as loose furniture, colours, and different materials of structural components and finishes.

v. Evaluation based on other design variables such as the position and sizes of the windows, different Wall-to-Floor Ratio (WFR) and Wall-to-Window Ratio (WWR).

vi. Evaluation based on passive design strategies such as building envelope, glazing transmittance percentage, shading devices, light tubes, light shelves and many more.

vii. Evaluation based on active design strategies such as artificial lighting, sensors, automated shading devices, and other innovations.

viii. The daylight and illuminance level uniformity distribution at a lower working plane.

ix. Comparative studies of same research principal in other region or country with the same or different climatic conditions.

x. Comparative studies of same research principal based on other daylight conditions such as Daylight Factors or Glare Index.

xi. Improvement of the Arabic handwriting performance assessment method used in this research.

xii. Further development and improvement of the evaluated data due to the restriction of time limitation, limited government and authority cooperation, limited resources and equipment to accommodate additional demands.

xiii. The energy consumption of the classroom can be furthered studied based on the research parameter.

5.7 Conclusion

The research findings and results of this study indicates that the daylight condition in Islamic religious school classrooms for *hafazan* learning differs from standards and guidelines recommended in Malaysia. Since that the daylight conditions such as luminance area, average illuminance level and uniformity ratio influenced by the classroom layout design and parameters, this study suggest classroom design parameter suitable for Islamic religious schools should be different. The classroom caters for 24 students according to the range of optimum student's number per classroom, which requires 59.5m^2 floor area per classroom. The suggested parameters based on the simulation as shown in table 5.2 can be referred as Syaheeza's Daylighting

Rule of Thumb (DRT) for Islamic religious schools in Malaysia, where the DRT can be an additional insertion to JKR and UBBL standards for illuminance level and window design for learning spaces. The DRT also requires more study for improvement.

Table 5.2: Syaheeza's DRT for Islamic Religious School in Malaysia

Parameter	Value/Detail
Daylight condition	
Average illuminance level	220 lx to 280 lx
Uniformity ratio	0.7
Reflectance	
Walls	0.5 (50%)
Floor	0.3 (30%)
Ceiling	0.7 (70%)
Window glazing	
Transmittance	0.81 (81%).
Orientation	North/south
Classroom layout (max. 24 students)	
Classroom width	8.5m
Classroom depth	7m
Classroom height (ceiling)	3.5m
Classroom floor area	59.5m^2
Window design	
Window-to-Floor Ratio (WFR)	20%
Window height	1.2m
Window width	5m
Window area (total)	12m^2
Window sill height/window head height	300mm/1.5m
	400mm/1.6m
	500mm/1.7m

A range between 300mm to 500mm is the suitable classrooms window sill height for Arabic handwriting tasks at 300mm working plane height, where the recommended average illuminance level is between 220 lx to 280 lx. This contributes to the improvement of classroom learning environment based on students' visual comfort and acceptable illuminance level. Finally, this study urges designers, architects, and authority to emphasize the studies on Malaysian Islamic religious schools' daylight conditions at different working plane height for specific tasks such as *hafazan* learning.