CHAPTER 4

RESULTS, DISCUSSION AND ANALYSIS

4.1 Introduction

This chapter discusses the results and findings of the research experiments. There were three different experiments conducted in the research. All three experiments had a different setup such as a table with different working plane height and different window sill height, where the total respondents for this research were 192 for the three experiments. This chapter explains the results and findings according to each method for the three experiments, which were illuminance level measurement, questionnaire, and students' Arabic handwriting performance. The discussion will be based on field measurement on illuminance level, statistical analysis on the questionnaire and findings of the students' performance based on visual eye acuity test. The results and findings of the experiments will define the daylighting simulation parameter to simulate classroom different window sill height that achieves acceptable illuminance levels.

4.2 Field Measurement; Illuminance Level

Each experiment conducted in the research consists of separate sessions in separate classrooms. Illuminance levels for each session were measured and recorded using lux meters located in a grid arrangement of the classroom. Referring to objective one, the measured illuminance level in Experiment One, Two and Three was to identify the range of acceptable illuminance level for students' optimum Arabic handwriting performance for learning *hafazan* measured at the working plane of 900mm and 300mm height. The students were required to occupy the classrooms during the illuminance level measurement process due to the fluctuation of the illuminance level.

The reliability of the lux meters was tested using Statistical Package for Social Sciences (SPSS) through regression analysis. All three lux meter were exposed under adjustable incandescent lamp light at different illuminance level. The actual illuminance level was 50 lx, 100 lx, 150 lx, 200 lx, 500 lx and 900 lx. Illuminance level measured by each of the lux meter were recorded for the SPSS regression analysis, where it shows that the R-value of the regression were 1.000 (100%). This shows that the correlation between actual illuminance level and illuminance level measured by lux meter were very high. The R^2 value of 0.999 shows that the total variation in the illuminance level measured by the lux meters explained by the actual illuminance level at a very large percentage of 99 per cent.

Table 4.1: Regression Model Summary for Lux Meter

Model Summary[b]

R	R Square	Adjusted R Square	R Square Change
1.000[a]	0.999	0.999	0.999

a. Predictors: (Constant), lx

Calibration of the lux meter were established to identify the absolute error value. The percentage of errors for each lux meter is shown in figure 4.1, where the mean absolute error was 12 per cent, 13 per cent and 7 per cent respectively. According to Gutierrez-Martinez (2017), the medium absolute error value is approximately, where the absolute error value for the lux meter used in this research was 11 per cent. The value was slightly lower than the medium value, which explained that the lux meter used were with medium absolute error.

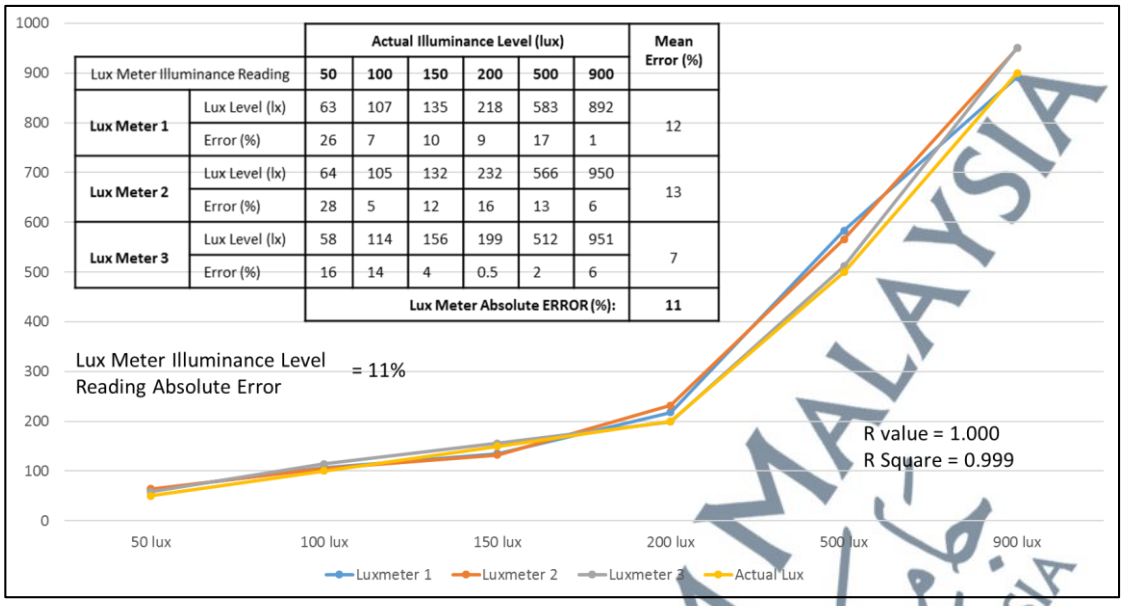


Figure 4.1: Lux Meter Absolute Error and Corellation

4.2.1 Experiment One

Experiment One had been conducted to identify the acceptable illuminance level for *hafazan* task learning performance, which is Arabic handwriting. There were three sessions in this experiment that were conducted in Classroom One, Two and Three respectively. The window sill height of the selected classrooms was at 900mm, while and working plane height was also at 900mm height as shown in figure 4.2.

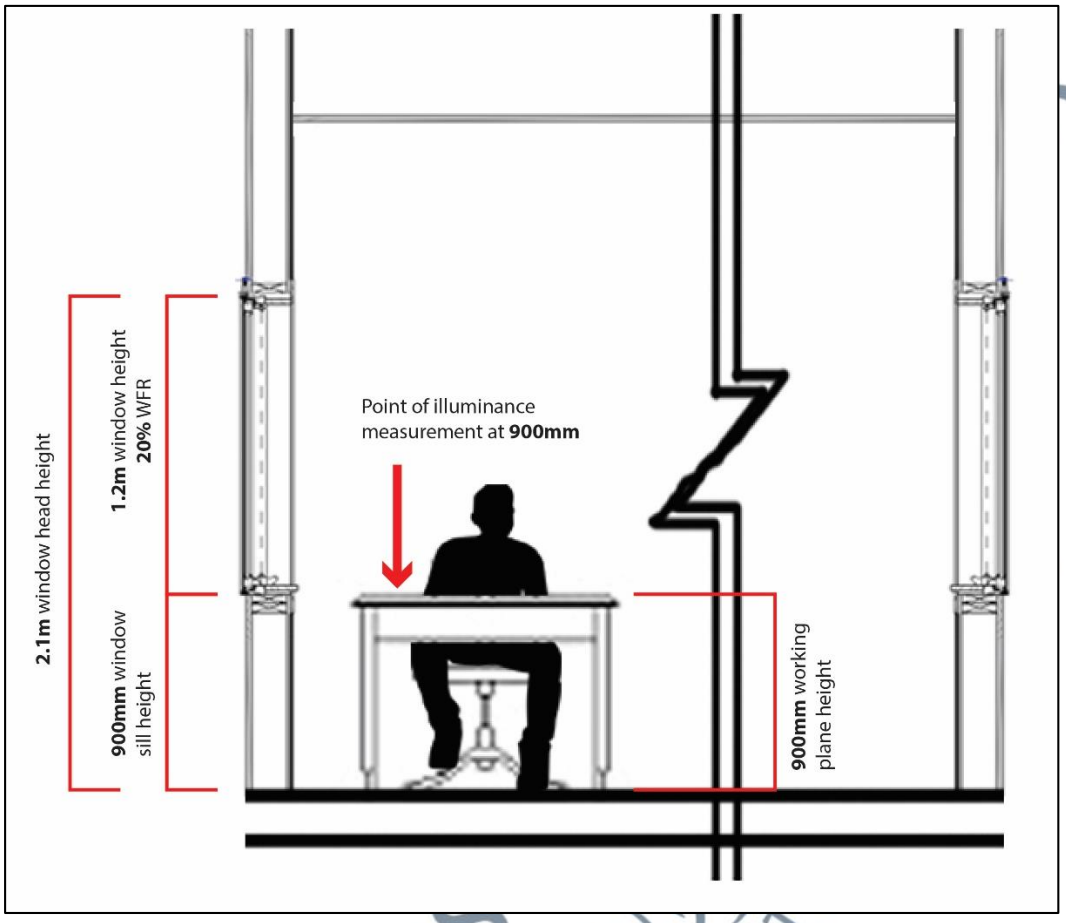


Figure 4.2: Experiment One Classroom Setup

The classroom layout for Session One to Three was with windows and openings on both sides of the classroom, where total of both side windows WFR was 20 per cent based on the recommended standards and guidelines. The floor area of the classrooms was approximately 60m^2 that seated 24 students based on the ratio of 2.5m^2 per student. The illuminance spot measurement, average illuminance level and uniformity ratio for the three session in Experiment One was recorded as shown in figure 4.3.

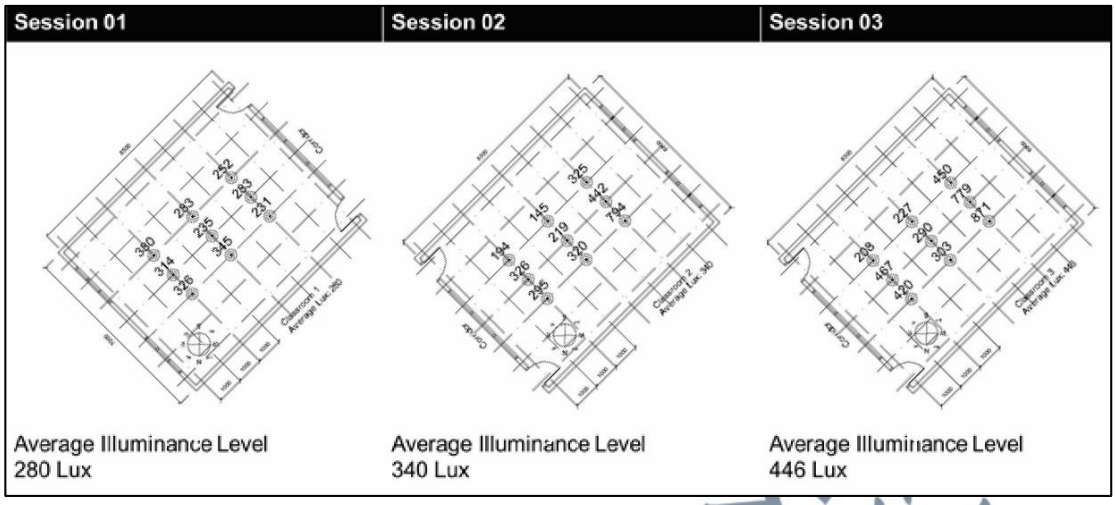


Figure 4.3: Experiment One Average Illuminance Level

The average illuminance level in the first Session One was 280 lx, where the lowest illuminance point measurement was 231 lx. The uniformity ratio for Session One was 0.8, which was too high according to JKR standards. Session Two shows that the average illuminance level was 340 lx with lowest illuminance level measured was 145 lx. The uniformity ratio was 0.4, which makes the daylight quality of the classroom was lower than recommended in JKR standards. The third session average illuminance level was 446 lx, while the lowest illuminance level was 208 lx. The uniformity ratio was at a low value of 0.4. Uniformity ratio for all the session was lower by 0.1, which can be improved by adjusting the amount of daylight penetration in the classroom. One side of each classrooms shows a lower illuminance level due to the corridor of the floor above that created overhang effect, thus reducing the illuminance level and the uniformity ratio. Figure 4.4 shows that Session Two and Three achieve recommended illuminance level range of 300 lx to 500 lx. However, the average illuminance level in Session One was lower than the recommendation of 300 lx.

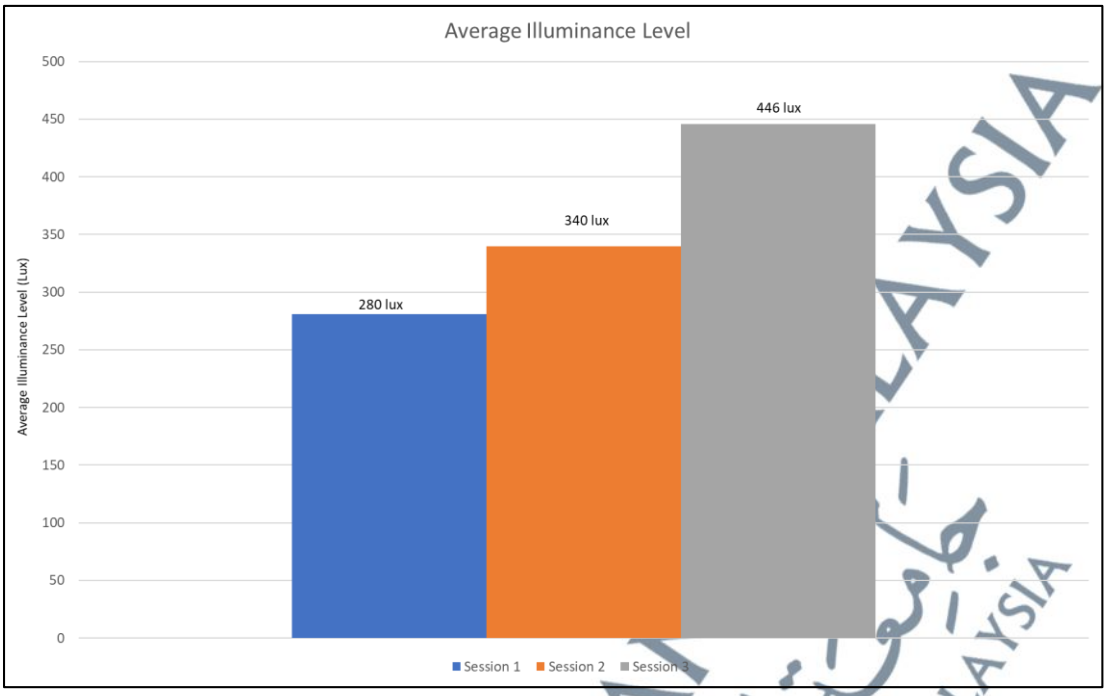


Figure 4.4: Experiment One Average Illuminance Level Graph

Session One average illuminance level was 20 lx (6.7%) lower than the minimum recommended illuminance level of 300 lx. Session Two was 40 lx (13%) higher than 300 lx, while Session Three was 54 lx (10.8%) lower than the maximum recommended illuminance level. In theory, the students' performance in session one will be lower compared to sessions two and three due to insufficient illuminance level. However, the average illuminance level for each classroom was crossed referenced with the students' performance in further discussion. Experiment One shows that the recommended range of illuminance levels between 300 lx to 500 lx can be achieved at 900mm table working plane height in a classroom with 900mm window sill height, in which the range was between 340 lx to 450 lx approximately.

4.2.2 Experiment Two

Experiment Two had been established to identify the illuminance level range at 300mm working plane height in classrooms with 900mm window sill height. There

were four sessions in Experiment Two that were conducted in Classroom Four and Five. The window sill and working plane height for Experiment Two were different, which were 300mm height and 900mm height respectively as shown in figure 4.5.

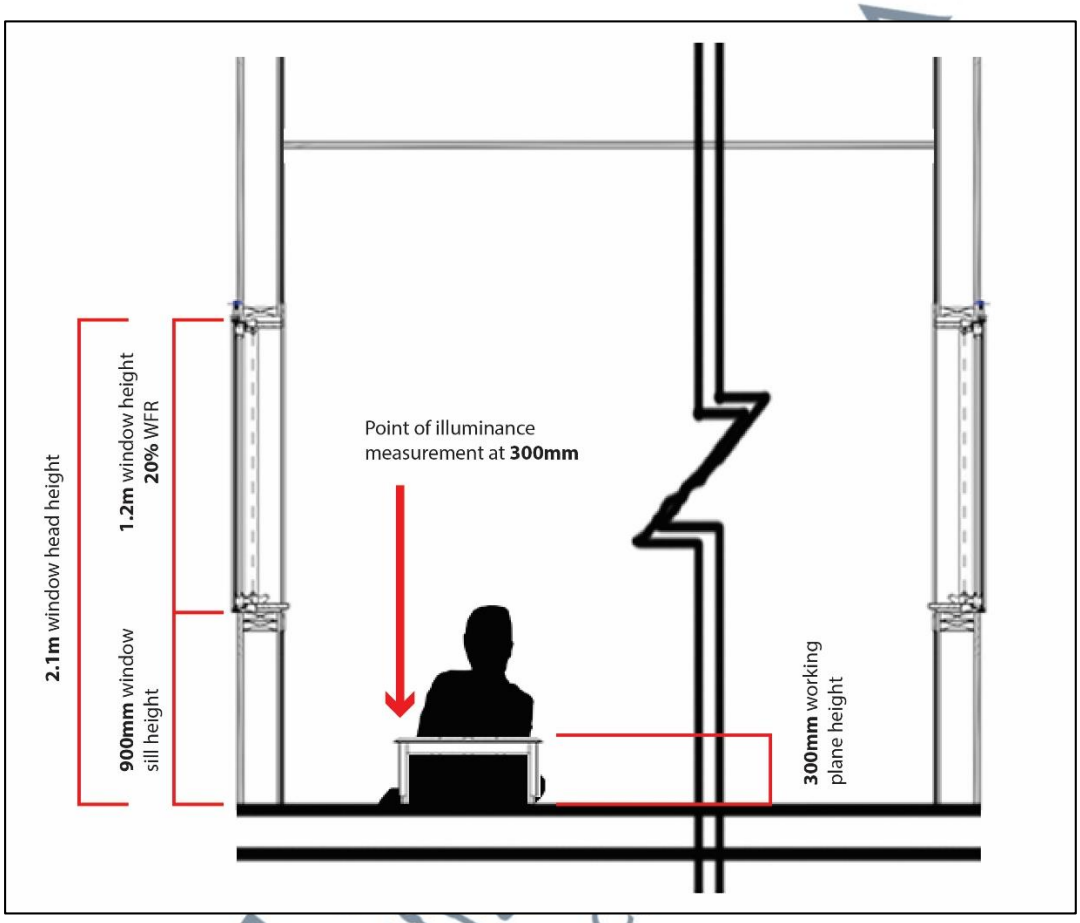


Figure 4.5: Experiment Two Classroom Setup

The classroom layout for Session One to Four was with windows and openings on both sides of the classroom with total of 20 per cent WFR. The floor area of the classrooms was approximately 60m^2 that seated 24 students based on the ratio of 2.5m^2 per student. The data collected in Experiment Two was established to identify the illuminance level range at 300mm working plane height in classrooms with 900mm window sill height. The average illuminance level of each session was recorded as shown in figure 4.6.

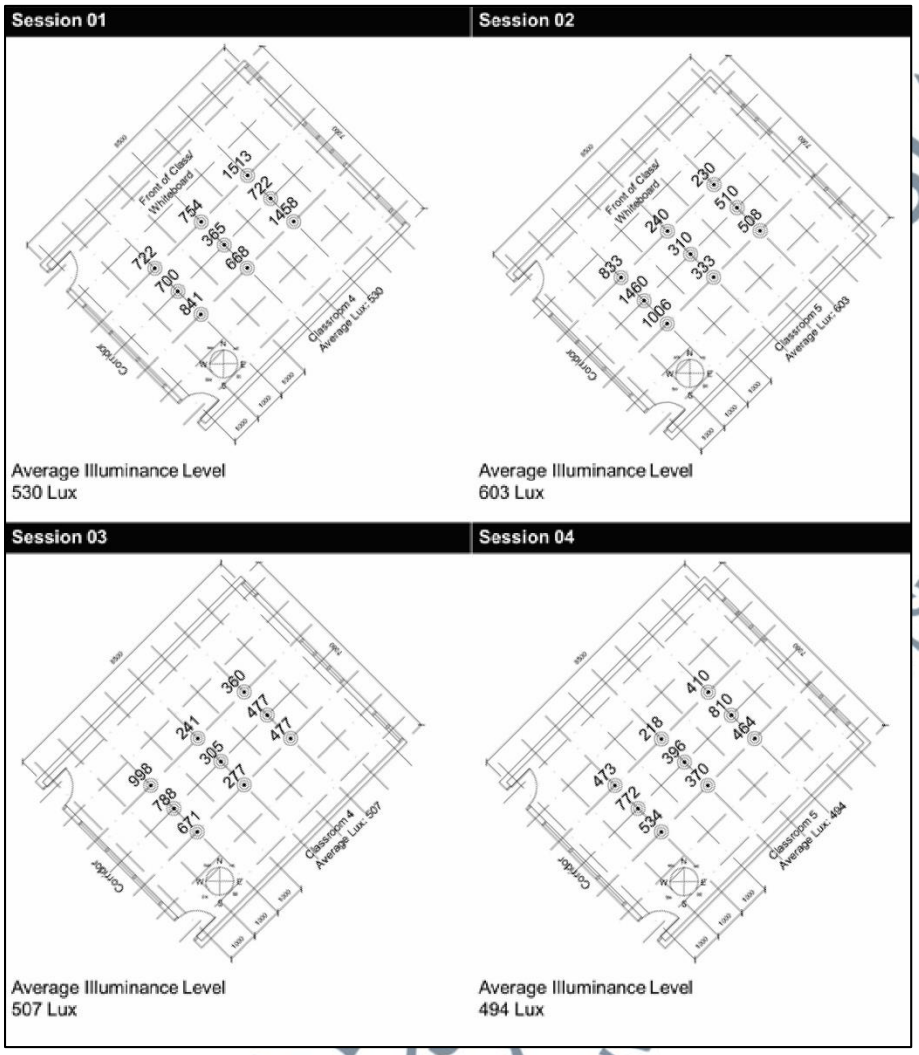


Figure 4.6: Experiment Two Average Illuminance Level

The average illuminance level for each session was 530 lx, 603 lx, 507 lx and 494 lx for each session respectively. The lowest illuminance level in Session One was 365 lx, which makes the uniformity ratio at an acceptable value of 0.7, even though the average illuminance level was higher than recommended in standards and guidelines. Session Two lowest illuminance level was 230 lx with the uniformity value of 0.4, which was lower than recommended value. Session Three lowest illuminance level was 241 lx with acceptable uniformity ratio value of 0.5, while Session Four lowest illuminance level was 218 lx with uniformity ratio at 0.4. Experiment Two results show that slightly

higher than recommended illuminance level measured at 300mm working plane height gives acceptable uniformity ratio values.

Session One and Two was conducted at the same time on the first day, while Session Three and Four was conducted the next day. Illuminance level recorded in Session One and Two shows that the first day had a higher global illuminance level than the second day, where spot illuminance measurement of sessions in the first day exceeds 1000 lx, while sessions in the second day were lower than 1000 lx. Figure 4.7 shows the average illuminance level for comparison between the session in Experiment Two. Session One, Two and Three achieve higher illuminance levels than the recommended level of 300 lx to 500 lx. The session One, two and three average illuminance levels were 530 lx, 603 lx, and 507 lx respectively. However, the average illuminance level in session four achieves the recommended illuminance level between 300 lx to 500 lx.

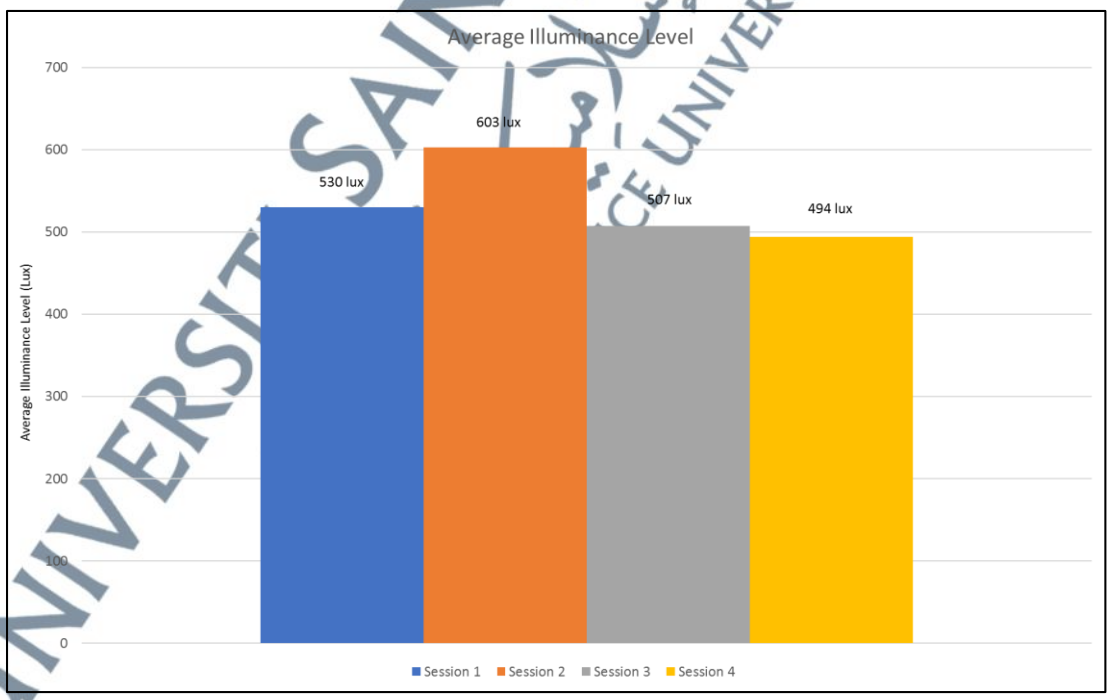


Figure 4.7: Experiment Two Average Illuminance Level Graph

Session One illuminance level exceeds 30 lx (6%) from the maximum recommendation of 500 lx. The illuminance level in Session Two was 103 lx (20.6%) higher than 500 lx. Session Three was only 7 lx (1.4%) higher than 500 lx, while Session Four was only 6 lx (1.2%) lower than 500 lx. In theory, the students' performance in session four will have the highest score compared to sessions two and three due to sufficient illuminance level. However, the average illuminance level for each classroom was crossed referenced with the students' performance in further discussion.

The difference of average illuminance level measured between Experiment One and Two in similar classrooms with 900mm window sill height can be seen as influenced by the difference of working plane height, where the daylight distribution at lower working plane height caused the average illuminance level to increase. Proven that classrooms with 900mm window sill height in Experiment Three had average illuminance level higher than recommended when measured at 300mm working plane height. The average illuminance level recorded at 300mm working plane height in classrooms with 900mm window sill height were at an average of 20 per cent higher than recommended values by standards and guidelines.

4.2.3 Experiment Three

Experiment Three purpose was to identify the illuminance level range for similar working plane height and window sill height of 300mm. Four sessions in Experiment Three were conducted in Classroom *Tasmi'* One and Two. The classroom set up for Experiment Three was as shown in figure 4.8.

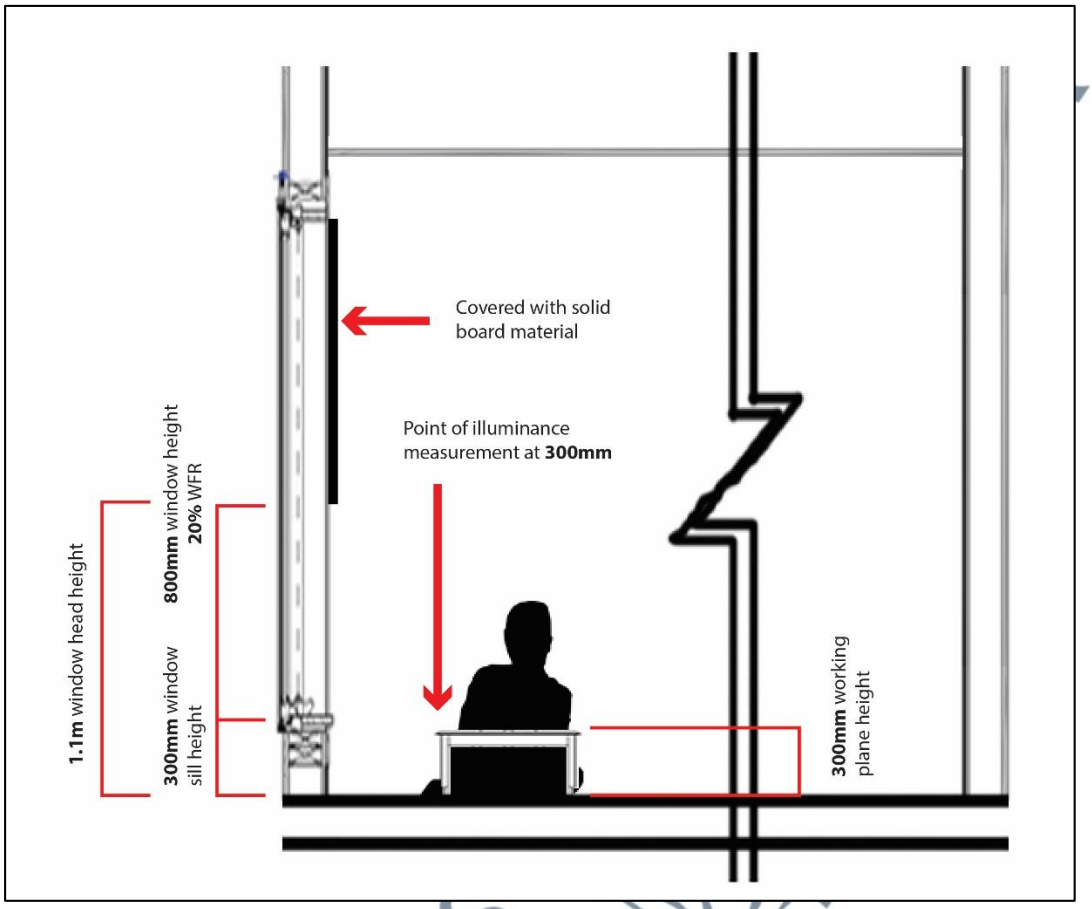


Figure 4.8: Experiment Three Classroom Setup

The classroom layout for Session One to Four was with windows and openings only on one side of the classroom with 59 per cent WFR. The window WFR was controlled by using a solid material such as mounting boards or blinds to keep it at 20 per cent. The floor area of the classrooms was $9m^2$, which according to GRBP ratio of $2.5m^2$ per student can accommodate three students.

The data collected in Experiment Three was to identify the illuminance level range at 300mm working plane height in classrooms with 300mm window sill height. The average illuminance level of each session was recorded as shown in figure 4.9.

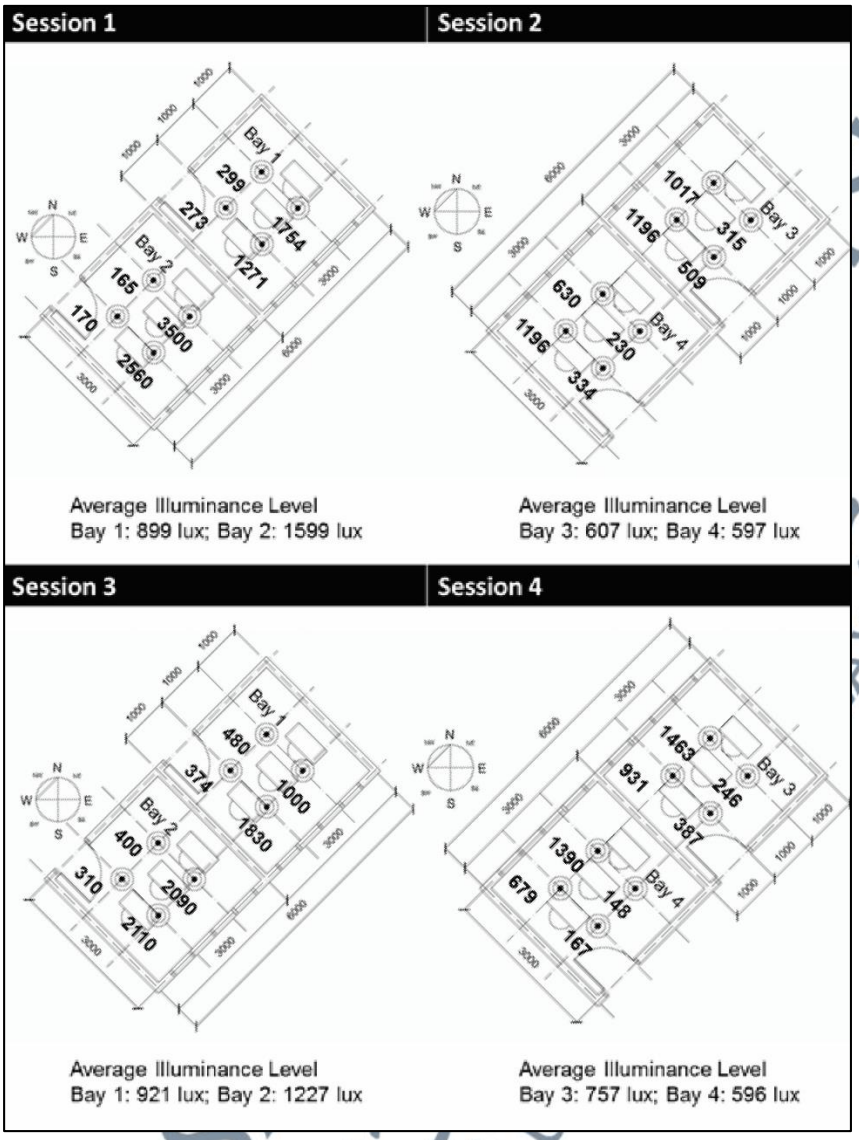


Figure 4.9: Experiment Three Average Illuminance Level

Session One and Two were conducted on the same day and same time, similarly with Session Three and Four. The average illuminance level for each bays in Session One and Two was 899 lx, 1599 lx, 607 lx, and 597 lx respectively. Session Three and Four average illuminance levels were 921 lx, 1227 lx, 757 lx and 596 lx for each respective bay. All of the average illuminance levels were higher than recommended 300 lx. Thus, the performance of the students would be low in theory. This result was due to the distance of the measured point to the windows was only 1 meter apart, closer than as recommended 2 meter.

The uniformity ratio for Session One was 0.3 and 0.1, which was very low. Session Two uniformity ratio was also low, which were at 0.3 and 0.4. Session Three shows a low uniformity ratio for each bay at 0.4 and 0.25. The uniformity ratio in Session Four also showed a low value of 0.3 and 0.25. The low uniformity ratio value for all the sessions can be seen as influenced by the one sided window location, where most of the lowest illuminance point measurement in each bays were located at the windowless corner of the classrooms.

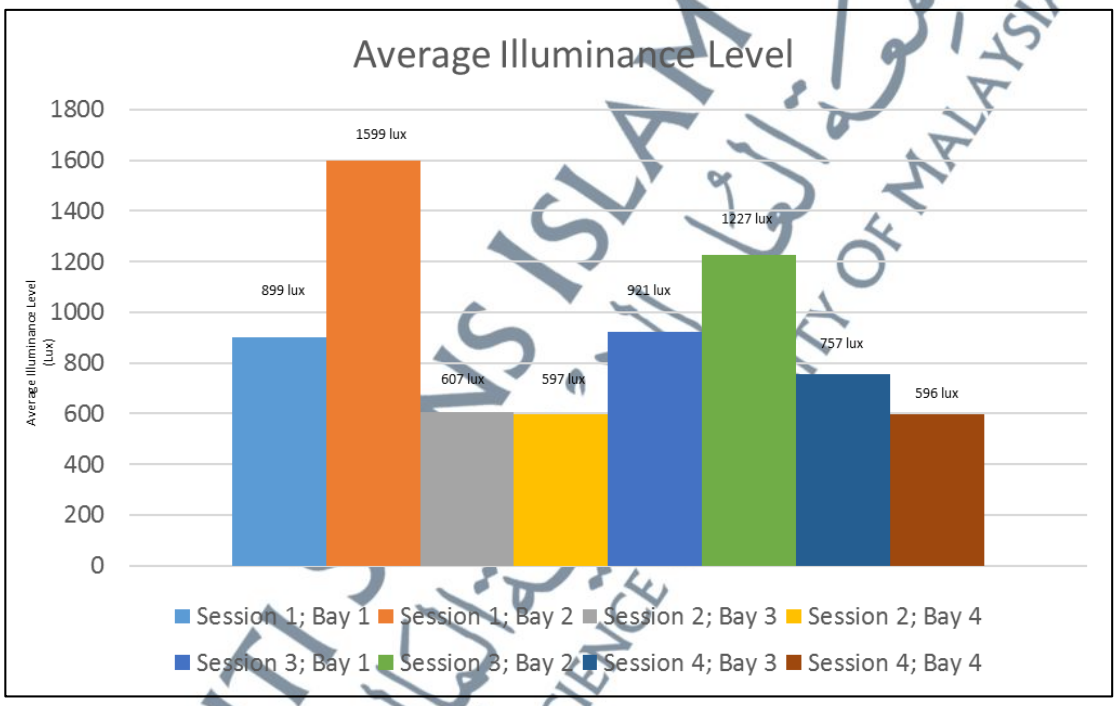


Figure 4.10: Experiment Three Average Illuminance Level Graph

The result in figure 4.10 shows that the daylighting for each bays was consistent within the two days of the experiment. Bay One received an average illuminance level approximately between 900 lx to 920 lx from both days. Bay Two received the highest average illuminance level for the two days of the experiment. The average illuminance level was between 1230 lx to 1600 lx respectively. Bay Three received a higher average illuminance level of 757 lx on the second day compared to 607 lx on the first day. Bay

Four received the lowest and most constant average level of 597 lx and 596 lx for both days respectively.

Session One; Bay One and Two exceeds the maximum recommended illuminance level of 500 lx by 399 lx (80%) and 1099 lx (220%) respectively. Session Two; Bay Three and Four exceeds the maximum recommended illuminance level of 500 lx by 107 lx (21.4%) and 97 lx (19.4%) respectively. Session Three; Bay One and Two exceed the maximum recommended illuminance level of 500 lx by 421 lx (82.4%) and 727 lx (145.4%) respectively. Session Four; Bay Three and Four exceeds the maximum recommended illuminance level of 500 lx by 257 lx (51.4%) and 96 lx (19.2%) respectively. Experiment Three shows that similar height for both working plane and window sill at 300mm received higher illuminance level compared with the recommended 300 lx to 500 lx. The average percentage of illuminance levels exceeding the recommendation was 80 per cent (400 lx).

4.2.4 Field Measurement Discussion and Analysis

Experiment One shows that the average illuminance level measured at a similar 900mm height of window sill was between 280 lx to 446 lx. The lowest average illuminance level measured was 6.7 per cent compared to the recommended value of 300 lx, while the highest measured average illuminance level was 10.8 per cent lower than 500 lx recommended. Two of the three sessions received average illuminance level within the recommended 300 lx to 500 lx for learning tasks, which were Session Two and Three with 340 lx and 446 lx respectively.

Experiment Two that measured the average illuminance level at 300mm working plane height in a classroom with 900mm window sill height shows the range was between

494 lx to 603 lx. The lowest average illuminance level was 1.4 per cent lower than the recommended maximum of 500 lx, while the highest was 20.6 per cent exceeds the value. Only Session Four received average illuminance between 300 lx to 500 lx, which was 494 lx. This shows that the illuminance level measured at 300mm working height in the classroom with 900mm window sill height exceeds the recommended range between 300 lx to 500 lx. Thus, it was not advisable for classrooms with a window sill height of 900mm to be used for *hafazan* learning task that uses 300mm height *rehal* working plane.

Experiment Three shows the highest average illuminance level for each session that ranged approximately between 600 lx to 1600 lx. The illuminance level was measured at 300mm working plane height in smaller classrooms with 300mm window sill height. Even though the smaller *Tasmi'* classrooms specifically used for *hafazan* learning, it was not suitable for learning the task. The small classroom with a $9m^2$ area restricted the 1-meter distance between the position of the table and the window. The highest measure average illuminance level was in Session One; Bay Two, which 220 per cent exceeds the highest recommendation of 500 lx. Meanwhile, the lowest measured average illuminance level exceeds 19.2 per cent in Session Four; Bay Four. This shows a small classroom with window sill height at 300mm and window head height at 1.1m, such as the *Tasmi'* classroom layout design was not suitable for *hafazan* learning tasks even though the WFR was at 20 per cent as recommended in standards and guidelines.

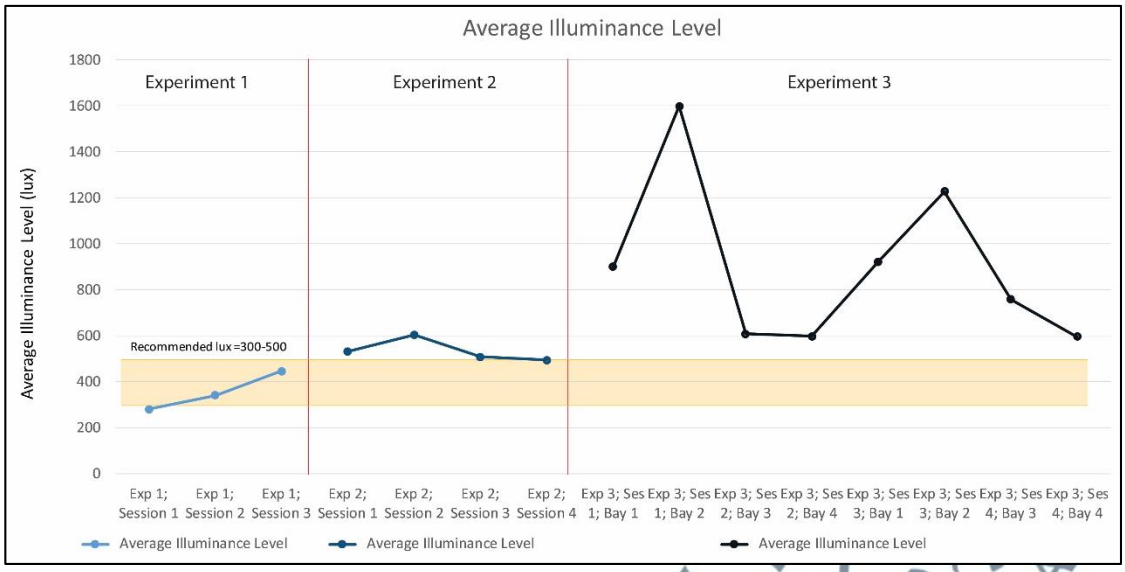


Figure 4.11: Average Illuminance Level Graph

Figure 4.11 shows that the average illuminance level measured at 900mm working plane height in Experiment One was in recommended range of 300 lx to 500 lx, while Experiment Two shows that the average illuminance level measured at 300mm working plane were higher. Both experiments were conducted in classrooms with 900mm window sill height. The highest range average illuminance level at 300mm working plane height recorded was in Experiment Three, ranging from approximately 600 lx to 1600 lx, where the classrooms were 85 per cent smaller and the window sill height were 300mm. This shows that same height of window sill and working plane of 900mm in a standardised classroom layout design achieved the range of recommended average illuminance level by standards and guidelines, where the same classroom layout design with lower working plane height of 300mm received higher average illuminance level. This shows that the measured average illuminance level and daylight distribution was influenced by the difference of working plane height in the classrooms. The distance of the working plane to the windows was also influencing the average illuminance level, where Experiment Three shows that the distance less than 2m causes the average illuminance level to increase significantly.

4.3 Questionnaire Descriptive Statistic Analysis

Each experiment consists of questionnaires that evaluate the students' perceptions of the daylight performance of the classrooms. Five scales Likert Scale was used for the questionnaire which consists of two sections, demographic and daylight condition perception of the classrooms respectively. The data collected from the questionnaire was evaluated through descriptive statistical analysis using Statistical Package for the Social Sciences 25 (SPSS). The questionnaire also evaluates the students' perceptions of their Arabic handwriting performance in the classrooms.

4.3.1 SPSS Questionnaire Reliability Test

The objective of this questionnaire was to identify the students' perception of the daylight condition and their Arabic handwriting performance. A Five scale Likert Scale was developed for this research based on the students' space visual environment perceptions by Hirning (2016), Doulos et al. (2007) and Erell et al. (2014), brightness level of the space by Cauwerts & Bodart (2013) and daylight environment by Bian & Luo (2017). Respondents' perception on the sizes of the windows was based on Doulos et al. (2007) questionnaire. The questionnaire's reliability to use in the research was evaluated in SPSS Reliability Test.

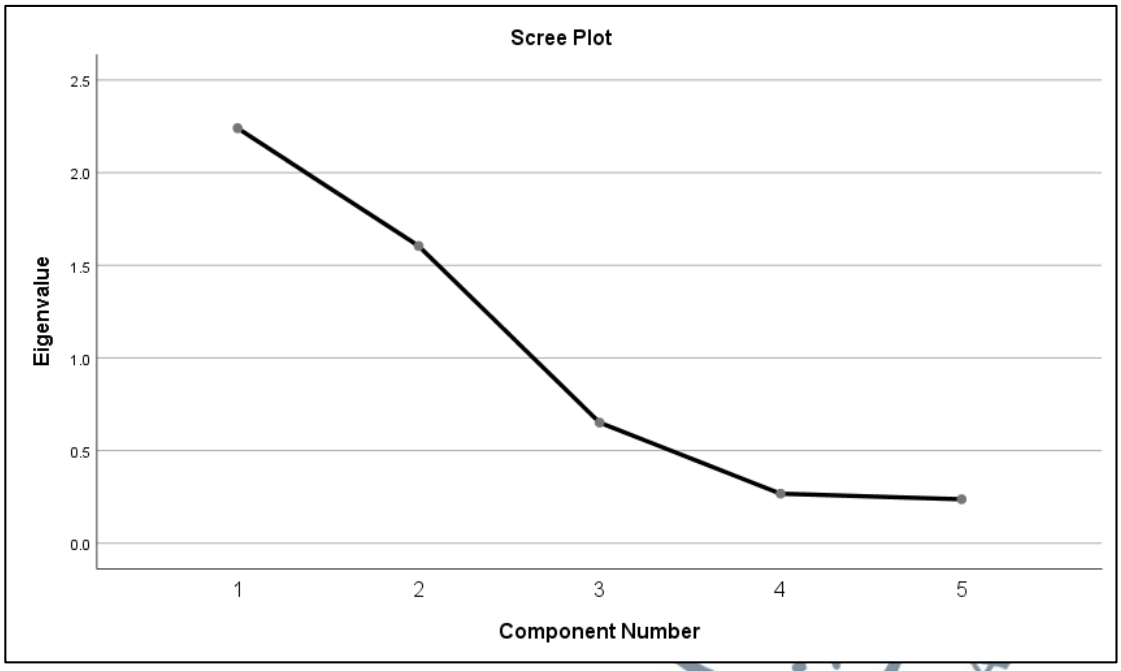


Figure 4.12: Questionnaire Scree Plot

Principal Component Analysis (PCA) reduces the dimensions produced known as components. Figure 4.12 exhibit two components that achieve more than 1.5 Eigenvalue, where will be kept due to its' value were more than 1 (Yong & Pearce, 2013). This explains that there were two reliable components to be analysed in the questionnaire which were students' Daylight Condition Perception and Task Performance Perception respectively.

Table 4.2: Correlation Matrix

Correlation	Factor 1-Daylight Perception			Factor 2-Performance Perception	
	Room Brightness	Size of Window	Amount of Daylight	read eye chart clearly	rewrite eye chart clearly
Room Brightness	1.000				
Size of Window	0.383	1.000			
Amount of Daylight	0.642	0.439	1.000		
read eye chart				1.000	
rewrite eye chart clearly				0.695	1.000
Communality	0.794	0.575	0.772	0.836	0.868

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaizer Normalization.

There was a total of five Likert Scale questions with five scale constructed for the experiment. Table 4.2 shows the questionnaire correlation matrix. Each question from each component had a correlation value lower than 1. Thus, each question was not highly correlated with each other. The communalities for every question were acceptable with values higher than the low-value range of 0.0 to 0.4. Child (2006) recommends removing items or variables that had a commonality score of less than 0.2.

Table 4.3: Rotated Component Matrix[a] and Cronbach's Alpha

	Component	
	1	2
Amount of Daylight	0.878	
Room Brightness	0.772	
Size of Window	0.756	
read eye chart clearly		0.925
rewrite eye chart clearly		0.899
Eigenvalue (% Variance)	44.802	32.087
Eigenvalue Cumulative	44.802	76.889
Cronbach's Alpha	0.732	0.813
	0.674	

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaizer Normalization.

The Rotated Component Matrix[a] for each question was higher than the trivial value of 0.3 or 0.4. The Eigenvalue identifies two underlying components that explain approximately 77 per cent of the variance from the data collected. Cronbach's Alpha value of 0.67 was within a reliable range of 0.6 to 7.0. This reliability test was based on the fourth version of the questionnaire that was used for the experiment based on the statistical analysis.

4.3.2 Experiment One

Experiment One consists of three sessions that evaluates the students' daylight perception and condition while sitting in each classroom using a 900mm height working plane table and window sill. There was no missing data from all 24 respondents for each session with the total number of respondents in Experiment One was 72 students. The function Frequencies was used in the SPSS analysis to evaluate the respondents' questionnaire answers such as the mean, median, and standard deviation.

Demography

The demographic section of the questionnaire consists of two variables which were Gender and Age of the respondents. 100 per cent (n=24) of the questionnaire answered were valid as shown in table 4.4.

Table 4.4: Experiment One Demographic Descriptive Statistical Analysis

Variables		Frequency (N)			Percent (%)			Median (M)			Standard Deviation (SD)			Variance (S^2)		
Valid	24	Session 1	Session 2	Session 3	Session 1	Session 2	Session 3	Session 1	Session 2	Session 3	Session 1	Session 2	Session 3	Session 1	Session 2	Session 3
Gender of Respondents	Male	12	12	12	50	50	50	1.5	1.5	1.5	0.51	0.51	0.51	0.26	0.26	1.26
	Female	12	12	12	50	50	50									
Age of Respondents	12 y/o	0	2	0	0	8.3	0	14	13	13	0.00	0.36	0.28	0.00	0.13	0.08
	13 y/o	0	21	22	0	87.5	91.7									
	14y/o	24	1	2	100	4.2	8.3									

Standard deviation and variance for Gender in all three sessions were SD=0.51 and S^2=0.26 respectively due to the gender for all sessions was 50 per cent male (n=12) and 50 per cent female (n=12) as shown in figure 4.13.

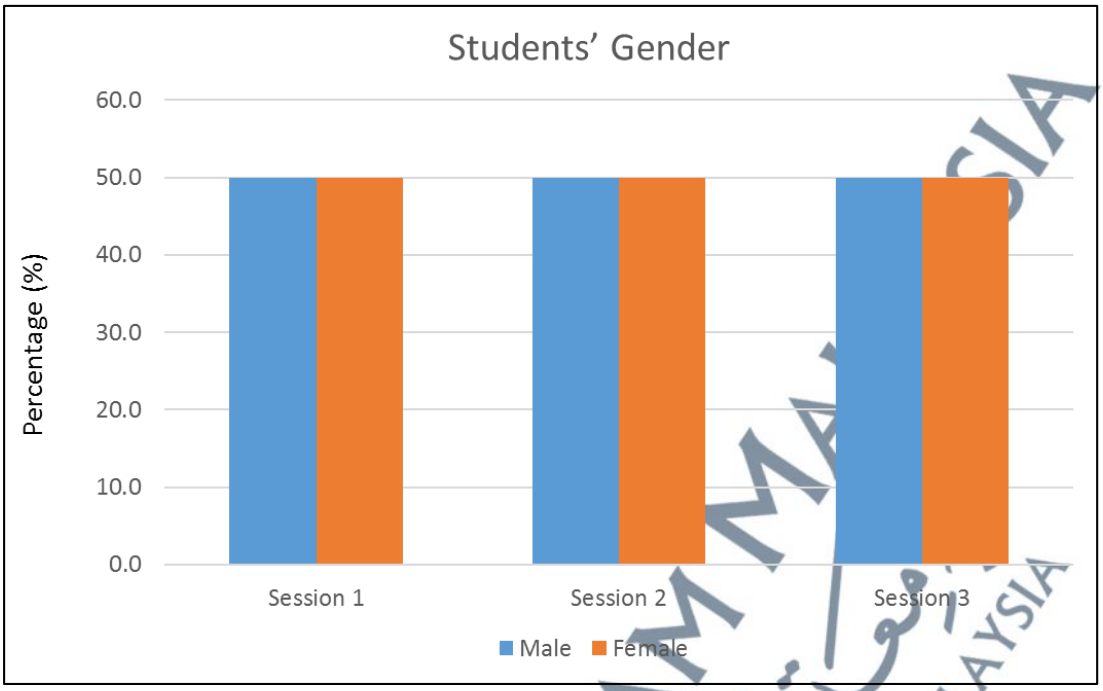


Figure 4.13: Experiement One Students' Gender Percentage Graph

The age of respondents for Experiment One was ranged between 12 to 14 years old. 100 per cent (n=24) of the respondents in Session One was 14 years old. Session Two respondents aged 12 years old was 8.3 per cent (n=2), 13 years old was 87.5 per cent (n=22) and 14 years old was 4.2 per cent (n=1). Session Three respondents were 91.7 per cent (n=22) 13 years old and 8.3 per cent (n=2). The descriptive analysis of students' age was as shown in figure 4.14.

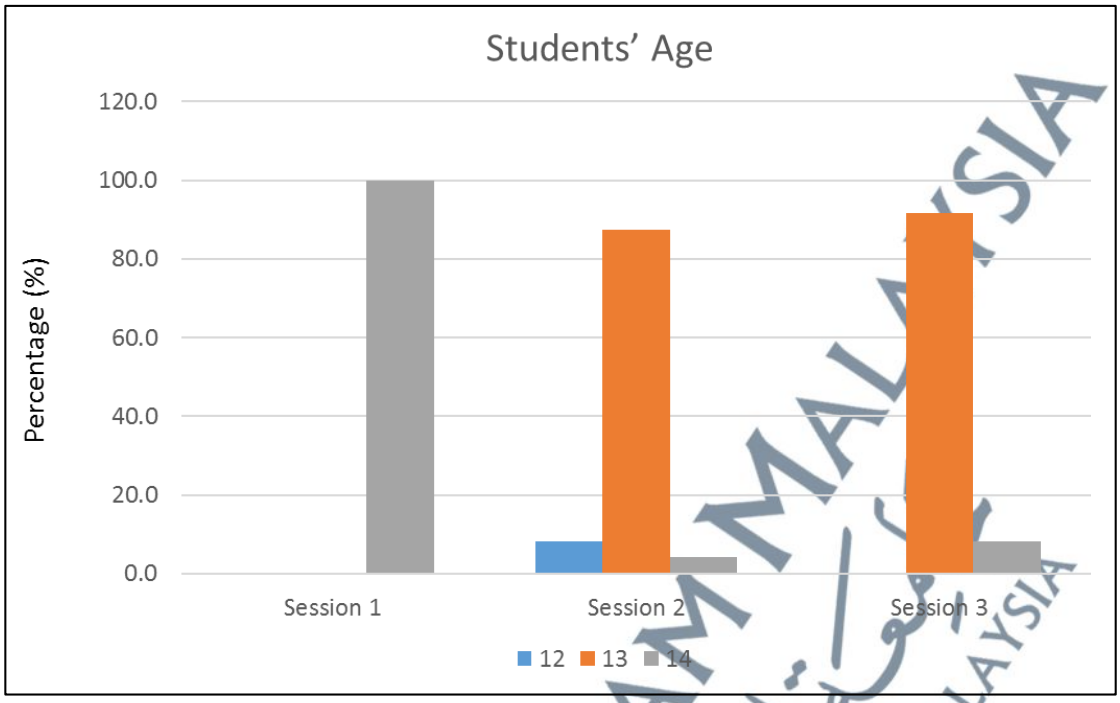


Figure 4.14: Experiment One Students' Age Percentage Graph

The mean age of respondents for Session One was M=14, while for both Session Two and Three was M=13. Since all of the respondents for Session One were the same age, the standard deviation and variance were SD=0 and S^2=0 respectively. The standard deviation for Session Two and Three was SD=0.36 and S^2=0.28 with a variance of S^2=0.13 and S^2=0.08 respectively.

Daylight Condition Perception

This questionnaire section consists of three questions, which were the students' perception of the brightness of the room, the size of the windows and the amount of daylight in the classroom. The total valid respondent for each session in Experiment One was 100 per cent (n=24) as shown in table 4.5.

Table 4.5: Experiment One Daylight Condition Perception Descriptive Statistical Analysis

Statistic		Room brightness			Size of Window			amount of daylight			read eye chart clearly			rewrite eye chart clearly		
		Session 1	Session 2	Session 3	Session 1	Session 2	Session 3	Session 1	Session 2	Session 3	Session 1	Session 2	Session 3	Session 1	Session 2	Session 3
N	Valid	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Median		2.00	3.00	2.50	2.00	2.50	2.00	2.00	3.00	3.00	5.00	4.00	4.00	4.00	4.00	4.00
Mode		2	3	2	2	3	2	2	3	3	5	4	4	4	4	4
Std. Deviation		0.654	0.929	0.924	0.637	0.721	0.702	0.933	0.761	0.806	0.717	0.654	0.721	0.850	0.741	0.690
Variance		0.428	0.862	0.853	0.406	0.520	0.493	0.870	0.580	0.650	0.514	0.428	0.520	0.723	0.549	0.476

The statistics show that the range of standard deviation (SD) for the questionnaire variables in each session was between 0.637 to 0.933. This shows that the SD for every variable in each session was within the positive domain value between -1 to 1. The Mode value shows the scale of answers for each variable in each session.

Table 4.6: Experiment One Room Brightness Descriptive Statistical Analysis

Room brightness	Frequency			Valid Percent		
	Session 1	Session 2	Session 3	Session 1	Session 2	Session 3
Too dim	0	2	2	0	8.3	8.3
Dim	16	4	10	66.7	16.7	41.7
Neutral	6	13	7	25.0	54.2	29.2
Bright	2	4	5	8.3	16.7	20.8
Too Bright	0	1	0	0	4.2	0

Table 4.6 shows the descriptive analysis for the first variable in the first component of the questionnaire which was the students' perception of the brightness of the room. The scale ranged from 1=too dim, 2=dim, 3=neutral or normal, 4=bright and 5=too bright. Students in Session One results show that 66.7 per cent (n=16) perceive the room was dim, 25 per cent (n=6) answered neutral and 8.3 per cent (n=2) agreed that it was bright. 8.3 per cent (n=2) students in Session Two answered the room was too dim, 16.7 per cent (n=4) answered dim, the highest of 54.2 per cent (n=13) were neutral, 16.7 per cent

(n=4) was bright and only 4.2 per cent (n=1) perceive the room too bright. Session Three shows that 8.3 per cent (n=2) of the students perceive the room too dim, the highest percentage of 41.7 per cent (n=10) showcase that the room was dim, 29.2 per cent (n=7) answered neutral and 20.8 per cent (n=5) answered brightly.

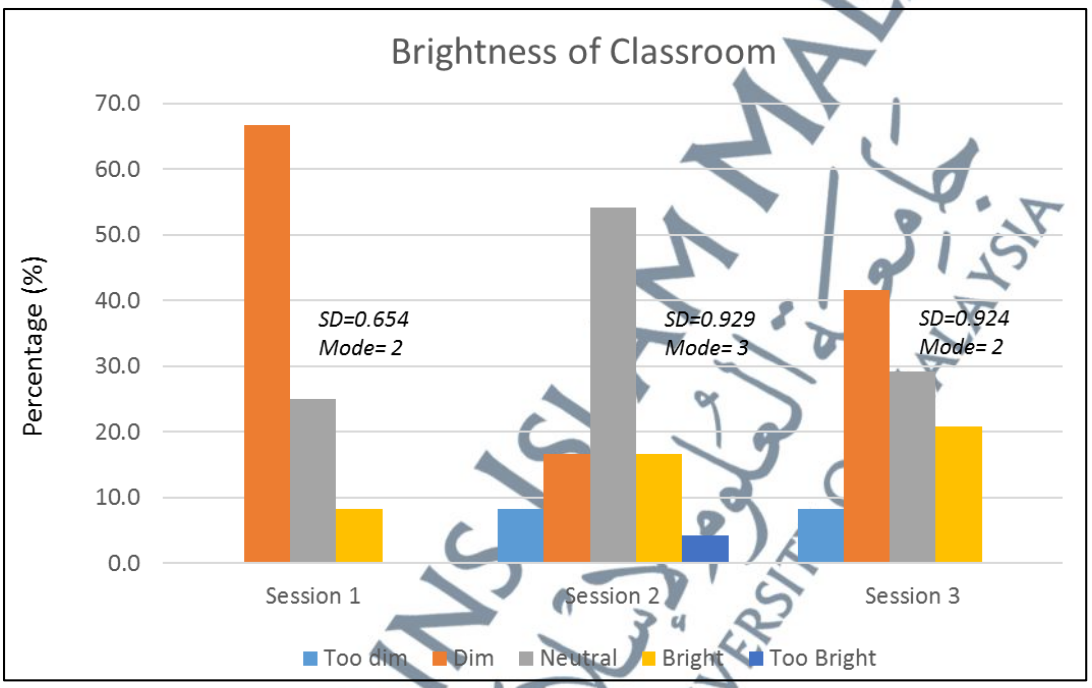


Figure 4.15: Experiment One Students' Brightness Perception Graph

Figure 4.15 shows the graph that explains students' brightness perception. The students' perception in Session One and Three was that the classroom was 2=dim with SD=0.654 and SD=0.924 respectively, where this shows that glare was not interfering with their visual comfort. However, this also shows that students experienced visual discomfort due to inefficient or low daylight distribution and uniformity ratio. Session Two students' perception was 3=neutral or normal with SD=0.929, which explained that the amount of daylight, daylight distribution and uniformity ratio was sufficient for their visual comfort, even though the uniformity ratio value was low as 0.4. This result will be referenced to each average illuminance level respectively in further discussion.

Table 4.7: Experiment One Size of Window Descriptive Statistical Analysis

Size of Window	Frequency			Valid Percent		
	Session 1	Session 2	Session 3	Session 1	Session 2	Session 3
Too small	7	2	4	29.2	8.3	16.7
Small	14	10	12	58.3	41.7	50.0
Neutral	3	11	8	12.5	45.8	33.3
Big	0	1	0	0	4.2	0
Too Big	0	0	0	0	0	0

The descriptive analysis for the second variable in the questionnaire which was the students' perception of the window size of the classroom was as shown in table 4.7. Scale range of 1=too small, 2=small, 3=neutral or normal, 4=big and 5=too big was used for this variable. Students in Session One results show that 29.2 per cent (n=7) perceive the window size was too small, 58.3 per cent (n=14) answered the window was small and 12.5 per cent (n=3) agreed that the window size was normal. 8.3 per cent (n=2) students in Session Two answered the window size was too small, 41.7 per cent (n=10) answered the window was small, the highest of 45.8 per cent (n=11) were neutral and only 4.2 per cent (n=1) perceive the window size was big. Session Three shows that 16.7 per cent (n=4) of the students perceive the window size was too small, the highest percentage of 50 per cent (n=12) showcase that the window size was small, and 33.3 per cent (n=8) answered neutrally.

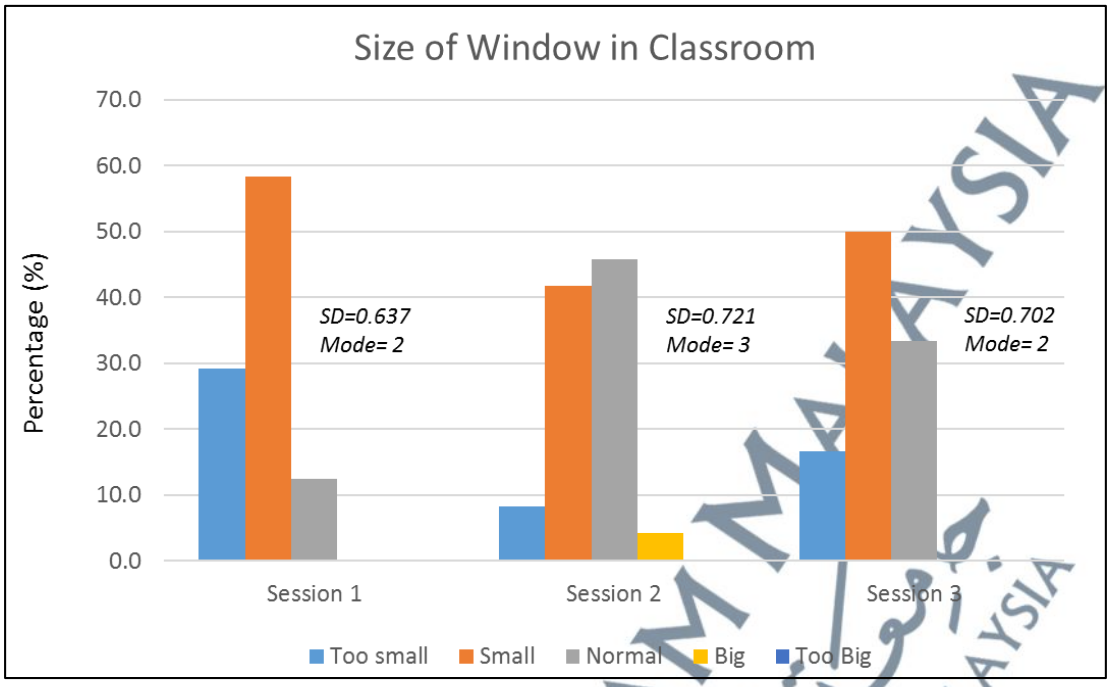


Figure 4.16: Experiment One Students' Size of Window Perception Graph

Figure 4.16 shows the graph that explains the students' perception of the size of the windows in the classroom. The students' perception in Session One and Three was that the window size was 2=small with SD=0.637 and SD=0.702 respectively, even though the WFR for the classrooms in Experiment One was 20 per cent based on the recommended standards and guidelines. However, Session Two students' perception was 3=neutral or normal with SD=0.721, which means that the window size was suitable to provide the students visual comfort. The students' perception correlated between window sizes and brightness of the classroom, where both Session One and Three shows that the brightness was low due to the small window size. Session Two also showed a significant correlation, where the both students' perception on brightness and window size was normal.

Table 4.8: Experiment One Amount of Daylight Descriptive Statistical Analysis

amount of daylight	Frequency			Valid Percent		
	Session 1	Session 2	Session 3	Session 1	Session 2	Session 3
Too low	2	0	1	8.3	0	4.2
Low	13	9	9	54.2	37.5	37.5
Neutral	4	10	10	16.7	41.7	41.7
High	5	5	4	20.8	20.8	16.7
Too high	0	0	0	0	0	0

The third variable was the students' perception of the amount of daylight in the classroom with the questionnaire scale range of 1=too low, 2=low, 3=neutral or normal, 4=high and 5=too high. Students in Session One results shows that 8.3 per cent (n=2) perceive the amount of daylight was too low, highest percentage of 54.2 per cent (n=13) answered the amount of daylight was low, 16.7 per cent (n=4) selected the amount of daylight was normal and 20.8 per cent (n=5) agreed that the amount of daylight was high. 37.5 per cent (n=9) students in Session Two answered the amount of daylight was low, 41.7 per cent (n=10) answered normal and 20.8 per cent (n=5) selected that the amount of daylight was high. Session Three shows that only 4.2 per cent (n=1) of the student perceive the amount of daylight was too low, 37.5 per cent (n=9) showcase that the amount of daylight was low, 41.7 per cent (n=10) answered normal and 16.7 per cent (n=4) answered the amount of daylight was high.

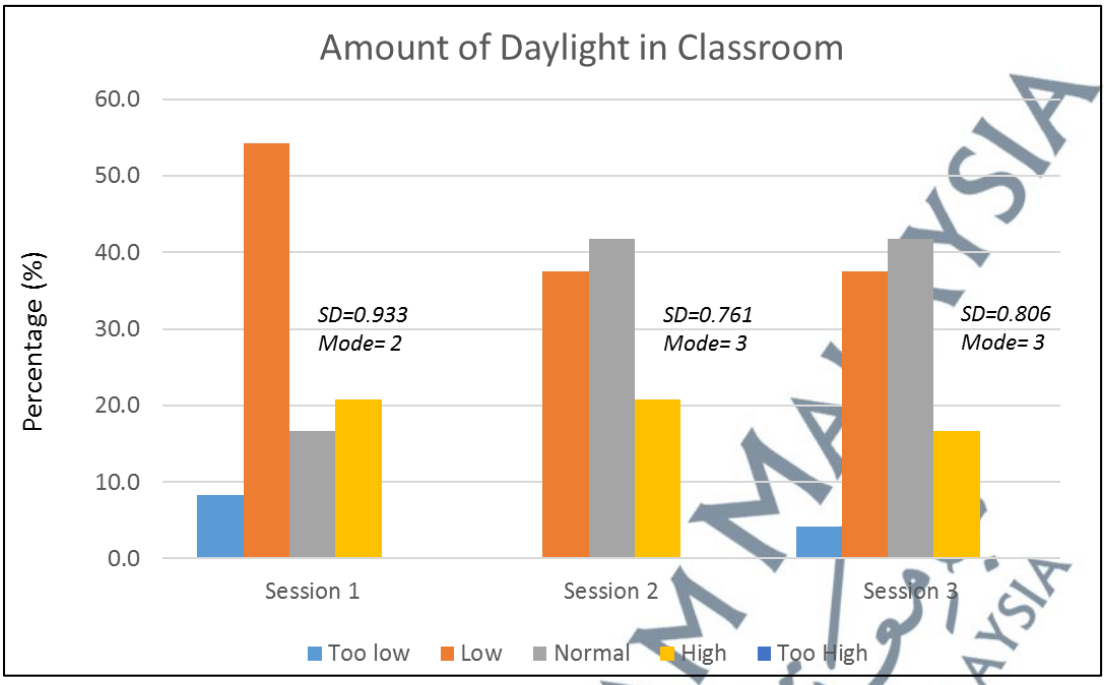


Figure 4.17: Experiment One Students' Amount of Daylight Perception Graph

Figure 4.17 shows the graph that explains the students' perception of the amount of daylight in the classroom. The students' perception in Session One was that the amount of daylight was 2=low with SD=0.933, which correlated with both brightness and window size perceptions. Session Two students' perception on amount of daylight was also correlated with brightness and window size of the classroom, where it was perceived as 3=neutral or normal with SD=0.761. However, students in Session Three perceived that the amount of daylight in their classroom was 3=normal with the standard deviation of SD=0.806 even though the perceptions on brightness and window size were both 2=dim and small. This may due to the visual comfort experienced by the students, where the uniformity ratio of 0.4 seemed to be sufficient for students in Session Three.

Task Performance Perception

Table 4.9 shows the descriptive analysis for the first variable in the second component of the questionnaire which was the students' perception on the reading task

performance in the classroom. The scale ranged from 1=very disagree, 2=disagree, 3=neutral or normal, 4=agree and 5=very agree.

Table 4.9: Experiment One Read Eye Chart Clearly Descriptive Statistical Analysis

read eye chart clearly	Frequency			Valid Percent		
	Session 1	Session 2	Session 3	Session 1	Session 2	Session 3
very disagree	0	0	0	0	0	0
disagree	0	0	0	0	0	0
neutral	3	4	4	12.5	16.7	16.7
agree	8	14	11	33.3	58.3	45.8
very agree	13	6	9	54.2	25.0	37.5

Students in Session One results show that 12.5 per cent (n=3) was neutral in their reading task performance, 33.3 per cent (n=8) answered agree and the highest percentage of 54.2 per cent (n=13) agreed that they can read the provided BAL eye chart clearly. 16.7 per cent (n=4) students in Session Two answered neutral, 58.3 per cent (n=14) answered agree and 25 per cent (n=6) very agree. Session Three shows that 16.7 per cent (n=4) of the students answered neutral, the highest percentage of 45.8 per cent (n=11) answered agree and 37.5 per cent (n=9) answered very agree.

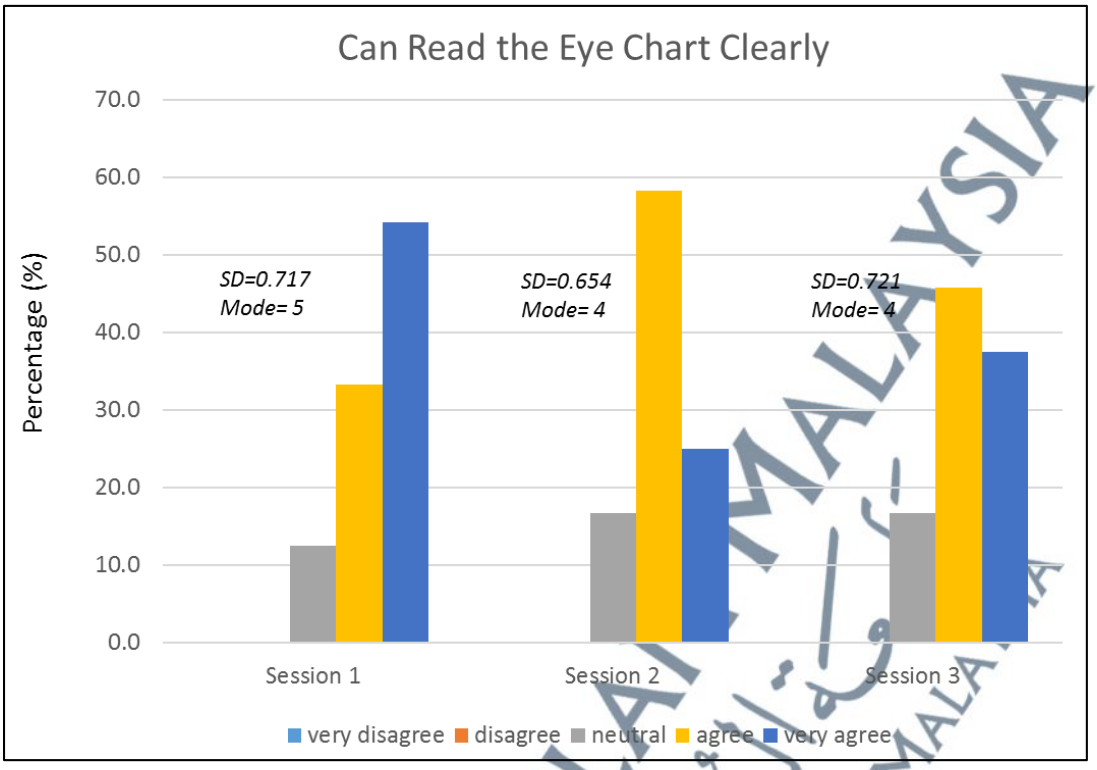


Figure 4.18: Experiment One Students' Arabic Reading Task Perception Graph

Figure 4.18 shows the graph that explains the first variable of students' *hafazan* reading task perception. The students' perception in Session One was that they 5=very agree that they can read the BAL eye chart clearly with standard deviation of SD=0.717, even though the students perceived the classroom's brightness and daylight amount was dim and low. Session Two students' perception was that 4=agree with SD=0.654 that they can read the BAL eye chart clearly, even though the students' perception on the classroom's brightness and daylight amount were normal. Students in Session Three also 4=agree with Session Two that they can perform the *hafazan* reading task with a standard deviation of SD=0.721, where correlated with the students' perception on the brightness of the classroom. The perceptions result also shows that even though the classrooms' brightness was dim, the students still can still read the BAL eye chart clearly. This shows that the daylight condition of the classroom based on brightness and

daylight amount should be restudied for students' visual comfort. This result will be referenced to each average illuminance level respectively in further discussion.

Table 4.10: Experiment One Write Eye Chart Clearly Descriptive Statistical Analysis

rewrite eye chart clearly	Frequency			Valid Percent		
	Session 1	Session 2	Session 3	Session 1	Session 2	Session 3
very disagree	0	0	0	0	0	0
disagree	1	1	0	4.2	4.2	0
neutral	4	5	5	16.7	20.8	20.8
agree	10	14	13	41.7	58.3	54.2
very agree	9	4	6	37.5	16.7	25.0

Table 4.10 shows the descriptive analysis for the second variable in the second component of the questionnaire which was the students' perception of the Arabic handwriting performance. Students in Session One results show that only 4.2 per cent (n=1) disagree that can rewrite the eye chart clearly. Meanwhile, 16.7 per cent (n=5) answered neutral, 41.7 per cent (n=10) and 37.5 per cent (n=9) answered agree and disagree respectively. Similarly, only 4.2 per cent (n=1) disagree that can rewrite the eye chart clearly, with 20.8 per cent (n=5) answered neutral, 58.3 per cent (n=14) agree and 16.7 per cent (n=4) very agree. Session Three shows that 16.7 per cent (n=4) of the students answered neutral, the highest percentage of 20.8 per cent (n=5) answered neutral, 54.2 per cent (n=13) agree and 25 per cent (n=6) answered very agree.

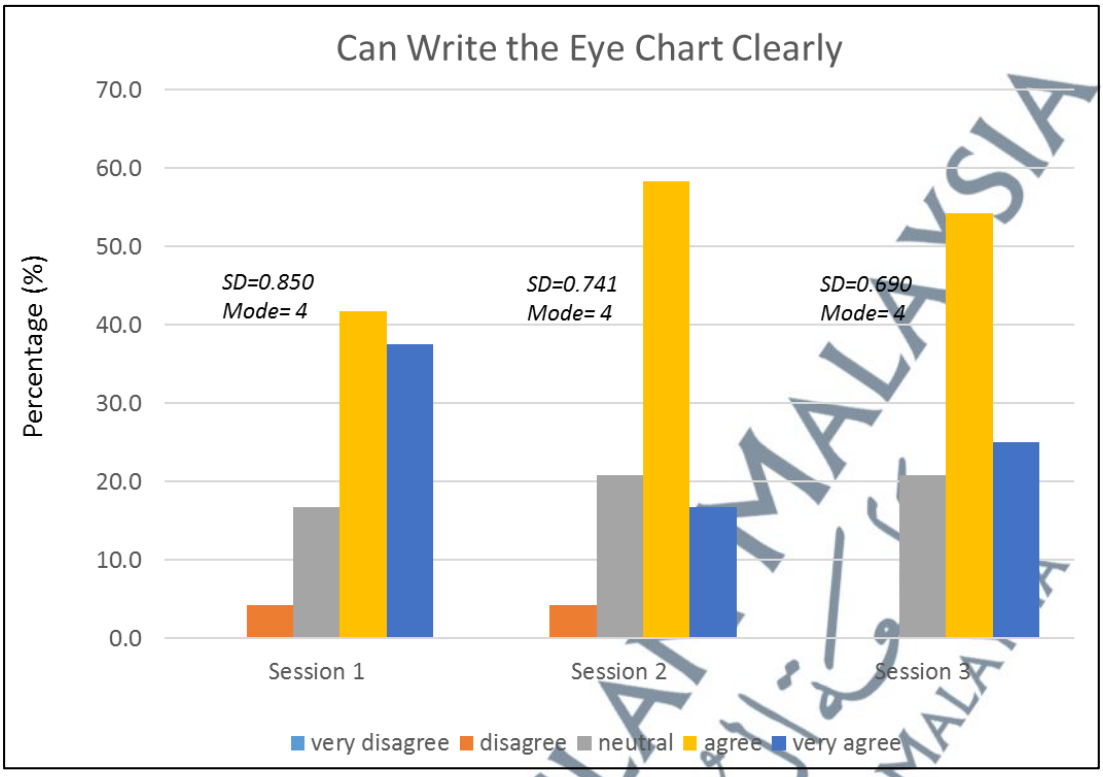


Figure 4.19: Experiment One Students' Arabic Handwriting Task Perception Graph

Figure 4.19 shows the graph that explains the students' perception of their Arabic handwriting performance. The students' perception in Session One was 4=agree with SD=0.850 that they can write the provided BAL eye chart, even though the students perceived that they can read the BAL eye chart very clearly. A correlation can be seen due to the students' perception that the classroom brightness and daylight amount were dim and low, where it was suitable for reading and less suitable for writing.

Session Two and Three students' perception score was higher compared to Session One, where students in both 4=agree with SD=0.741 and SD=0.690 respectively. There was significant correlation between reading and writing the BAL eye chart in both Session Two and Three, where it shows students' perception were that the normal amount of daylight was suitable for both reading and writing the BAL eye chart. This also shows that the students' visual comfort during reading and writing were acceptable based on their perceptions.

Experiment One Results and Findings

Table 4.11 show that the Daylight Condition for Experiment One had a correlation between brightness, amount of daylight and window size, where The students' perception of the daylight conditions was that the windows were too small, thus having low brightness and amount of daylight. Although, the students' Task Performance Perceptions shows that the daylight conditions were suitable for their Arabic reading and writing task performance. This shows that even though the students perceived the classrooms had low brightness and the amount of daylight, they can still perform the learning task clearly.

Table 4.11: Experiment One Questionnaire Results

Experiment		Component 1 - Daylight Condition Perception			Component 2 - Task Performance	
		Brightness of Classroom	Size of Window in Classroom	Amount of Daylight in Classroom	Can Read Eye Chart Clearly	Can Write Eye Chart Clearly
Exp 1	Session 1	2=dim	2=small	2=low	5=very agree	4=agree
	Session 2	3= neutral	3= neutral	3= neutral	4=agree	4=agree
	Session 3	2=dim	2=small	3= neutral	4=agree	4=agree

4.3.3 Experiment Two

Experiment Two consist of four sessions that evaluates the students' daylight perception and condition while sitting in each classrooms using 300mm height working plane table and 900mm classroom window sill height. There was no missing data from all 24 respondents for each session with a total of 96 students.

Demography

Experiment Two shows that 100 per cent (n=24) of the questionnaire answered were valid as shown in table 4.12. The standard deviation in Experiment Two was between -1 to 1.

Table 4.12: Experiment Two Demographic Descriptive Statistical Analysis

Variables		Frequency (N)				Percent (%)				Median (M)				Standard Deviation (SD)				Variance (S^2)			
Valid	24	Session 1	Session 2	Session 3	Session 4	Session 1	Session 2	Session 3	Session 4	Session 1	Session 2	Session 3	Session 4	Session 1	Session 2	Session 3	Session 4	Session 1	Session 2	Session 3	Session 4
Gender of Respondents	Male	0	24	0	24	0	100	0	100	2	1	2	1	0	0	0	0	0	0	0	0
	Female	24	0	24	0	100	0	100	0												
Age of Respondents	12 y/o	0	0	0	0	0	0	0	0												
	13 y/o	23	14	22	18	95.8	58.3	91.7	75	13	13	13	13	0.2	0.5	0.3	0.4	0.04	0.3	0.1	0.2
	14y/o	1	10	2	6	4.2	41.7	8.3	25												

The mean age of respondents for all of Experiment Two sessions were M=13. Session One standard deviation was SD=0.2, Session Two was SD=0.5, Session Three was SD=0.3 and SD=0.4 for Session Four. Variance for each session were S^2=0.04, S^2=0.3, S^2=0.1 and S^2=0.2 respectively.

Standard deviation and variance for Gender in all four sessions were SD=0.00 and S^2=0.00 respectively, showing that there was no variance in each session. This was due to the respondents in each session were divided into male and female as shown in figure 4.20.

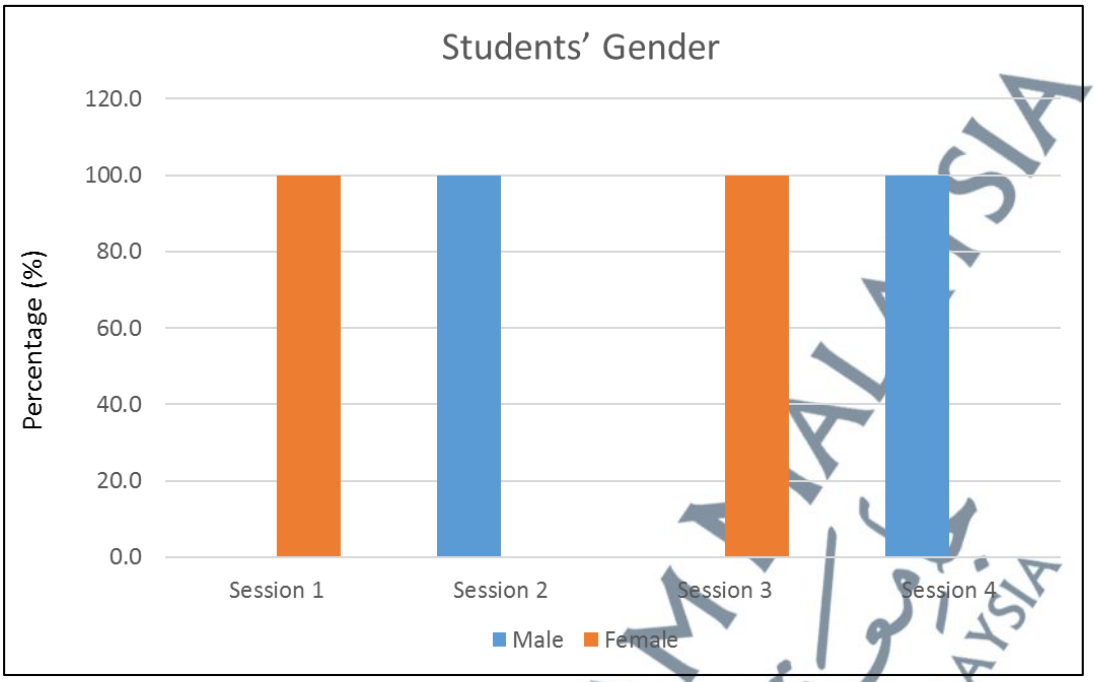


Figure 4.20: Experiment Two Students' Gender Percentage Graph

The age of respondents for Experiment Two was ranged between 13 to 14 years old as shown in figure 4.21. 95.8 per cent (n=23) of the respondents in Session One was 13 years old and only 4.2 per cent (n=1) aged 14 years old. Session Two respondents aged 13 years old was 58.3 per cent (n=14) and aged 14 was 41.7 per cent (n=10). Session Three respondents were 91.7 per cent (n=22) 13 years old and 8.3 per cent (n=2). Students in Session Four aged 13 years old were 75 per cent (n=18) and 25 per cent (n=6) was 14 years old.

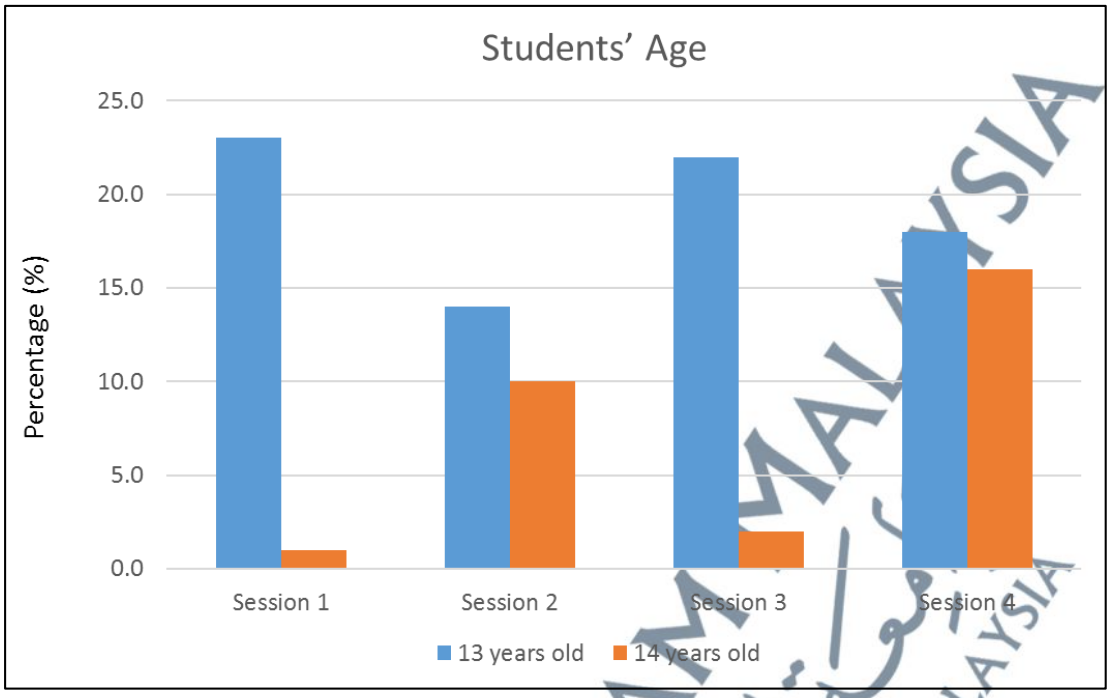


Figure 4.21: Experiment Two Students' Age Percentage Graph

Daylight Condition

The total valid respondent for each session in Experiment Two was 100 per cent (n=24) as shown in table 4.13.

Table 4.13: Experiment Two Daylight Condition Perception Descriptive Statistical Analysis

Statistic		Room brightness				Size of Window				amount of daylight				read eye chart clearly				rewrite eye chart clearly			
		Session 1	Session 2	Session 3	Session 4	Session 1	Session 2	Session 3	Session 4	Session 1	Session 2	Session 3	Session 4	Session 1	Session 2	Session 3	Session 4	Session 1	Session 2	Session 3	Session 4
N	Valid	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Median		3.00	3.00	3.00	3.00	2.00	2.00	2.00	2.00	3.00	2.00	3.00	2.00	4.00	4.00	4.00	4.00	3.00	4.00	4.00	4.00
Mode		3	2	3	3	2	2	2[a]	2	3	2	3	2	4	4	4	4	3	4	4	4
Std. Deviation		0.64	0.75	0.68	0.72	0.68	0.61	0.74	0.59	0.71	0.90	0.58	0.59	0.83	0.83	0.69	0.64	0.93	1.01	0.83	0.72
Variance		0.41	0.56	0.46	0.51	0.46	0.37	0.54	0.35	0.51	0.81	0.33	0.35	0.69	0.69	0.48	0.41	0.87	1.01	0.69	0.51

a. Multiple modes exist. The smallest value is shown

The statistics show that the range of standard deviation (SD) for the questionnaire variables in all four sessions was between 0.58 to 1.01. Only the Read Eye Chart Clearly variable was not within the SD positive domain value between -1 to 1.

Table 4.14: Experiment Two Room Brightness Descriptive Statistical Analysis

Room brightness	Frequency				Valid Percent			
	Session 1	Session 2	Session 3	Session 4	Session 1	Session 2	Session 3	Session 4
Too dim	0	0	0	1	0	0	0	4.2
Dim	10	11	7	10	41.7	45.8	29.2	41.7
Neutral	12	9	13	11	50.0	37.5	54.2	45.8
Bright	2	4	4	2	8.3	16.7	16.7	8.3
Too Bright	0	0	0	0	0	0	0	0

Table 4.14 was the descriptive analysis for the students' perception of the brightness of the room as the first variable in Experiment Two. Students in Session One results show that 41.7 per cent (n=10) sees the room as dim, half of the students (n=12) answered neutral and 8.3 per cent (n=2) agreed that it was bright. The highest value of 45.8 per cent (n=11) students in Session Two answered the room was dim, 37.5 per cent (n=9) answered neutral and 16.7 per cent (n=4) sees the room as bright. Session Three shows that 29.2 per cent (n=7) of the students perceive the room dim, highest percentage of 54.2 per cent (n=13) showcase that the room normal or neutral and 16.7 per cent (n=4) sees the room as bright. There was only 4.2 per cent (n=1) answered the room was too dim in Session Four. Other 41.7 per cent (n=10) sees the room as dim, 45.8 per cent (n=13) answered neutral and 8.3 per cent (n=2) agreed that it was bright.

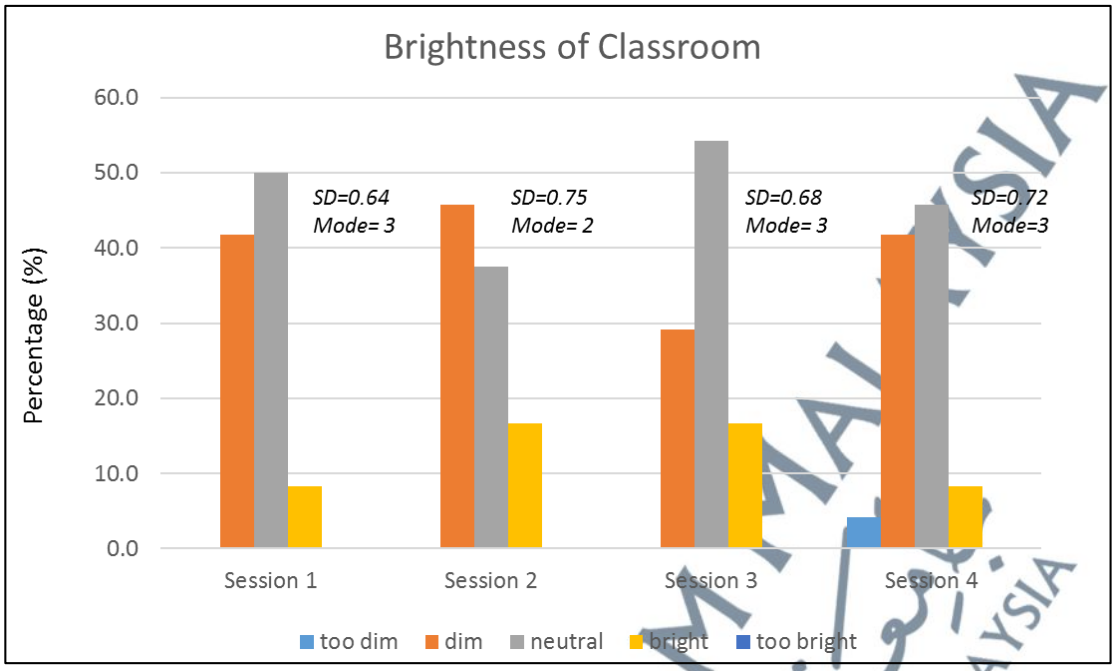


Figure 4.22: Experiment Two Students' Brightness Perception Graph

Figure 4.22 shows the graph that explains the students' brightness perception for Experiment Two. The students' perception in Session One, Three and Four were that the classrooms were 3=normal or neutral with SD=0.64, SD=0.68 and SD=0.72 respectively. This shows that the students perceived the brightness of the classroom as acceptable and visually comfortable. This correlated with the uniformity ratio value, where Session One and Three were within acceptable range of 0.5 to 0.7, although only Session Four was slightly lower at 0.4. In the other hand, even though the uniformity ratio value in Session Two was the same with Session Four, the students perceived the classroom brightness to be 2=dim with SD=0.929, which caused the students to experience slight visual discomfort.

Table 4.15: Experiment Two Size of Window Descriptive Statistical Analysis

Size of Window	Frequency				Valid Percent			
	Session 1	Session 2	Session 3	Session 4	Session 1	Session 2	Session 3	Session 4
Too small	0	1	4	2	0	4.2	16.7	8.3
Small	7	17	10	15	29.2	70.8	41.7	62.5
Neutral	13	5	10	7	54.2	20.8	41.7	29.2
Big	4	1	0	0	16.7	4.2	0	0
Too Big	0	0	0	0	0	0	0	0

The descriptive analysis for the students' perception of window size of the classroom was shown in table 4.15. Session One results show that 29.2 per cent (n=7) answered the window size was small, 54.2 per cent (n=13) perceived the window was neutral or normal and 16.7 per cent (n=4) agreed that the window size was big. Only 4.2 per cent (n=1) sees the window size was too small and big in Session Two. 70.8 per cent (n=17) and 20.8 per cent (n=5) answered the window was small and normal respectively.

Figure 4.23: Experiment Two Students' Size of Window Perception Graph

Figure 4.23 shows the graph for students' perception of the size of the windows in the classroom. The students in Session One and Three perceived the window size was 3=normal with SD=0.68 and SD=0.74 respectively, while the students in other session

perceived the window size to be 2=small, where the Session Two was SD=0.61 and Session Four was SD=0.59. The results show a correlation between students' perception on classroom brightness and size of window, where most of the students perceived the brightness of the classroom to be sufficient with the window size was normal at 20 per cent WFR as recommended in standards and guidelines, except for Session Four. Thus, since that there was correlation between brightness and uniformity ratio, there was a factor of window size that influenced the students' overall perception on the classroom's daylight condition in Session Four.

Table 4.16: Experiment Two Amount of Daylight Descriptive Statistical Analysis

amount of daylight	Frequency				Valid Percent			
	Session 1	Session 2	Session 3	Session 4	Session 1	Session 2	Session 3	Session 4
Too low	1	5	1	0	4.2	20.8	4.2	0
Low	9	14	7	13	37.5	58.3	29.2	54.2
Neutral	12	2	16	10	50.0	8.3	66.7	41.7
High	2	3	0	1	8.3	12.5	0	4.2
Too high	0	0	0	0	0	0	0	0

Students in Session One results shows that only 4.2 per cent (n=1) perceive the amount of daylight was too low, 37.5 per cent (n=9) answered the amount of daylight was low, highest percentage 50 per cent (n=12) selected the amount of daylight was normal and 8.3 per cent (n=2) agreed that the amount of daylight was high. 20.8 per cent (n=5) students in Session Two answered the amount of daylight was too low, 58.3 per cent (n=14) answered low, only 8.3 per cent (n=2) answered neutral and 12.5 per cent (n=3) selected that the amount of daylight was high. Session Three shows that only 4.2 per cent (n=1) of the student perceive the amount of daylight was too low, 29.2 per cent (n=7) showcase that the amount of daylight was low and 66.7 per cent (n=16) answered the amount of daylight was normal. The last session shows that more than half which

was 54.2 per cent (n=13) answered low, 41.7 per cent (n=10) answered normal and only 4.2 per cent (n=1) answered the daylight was high.

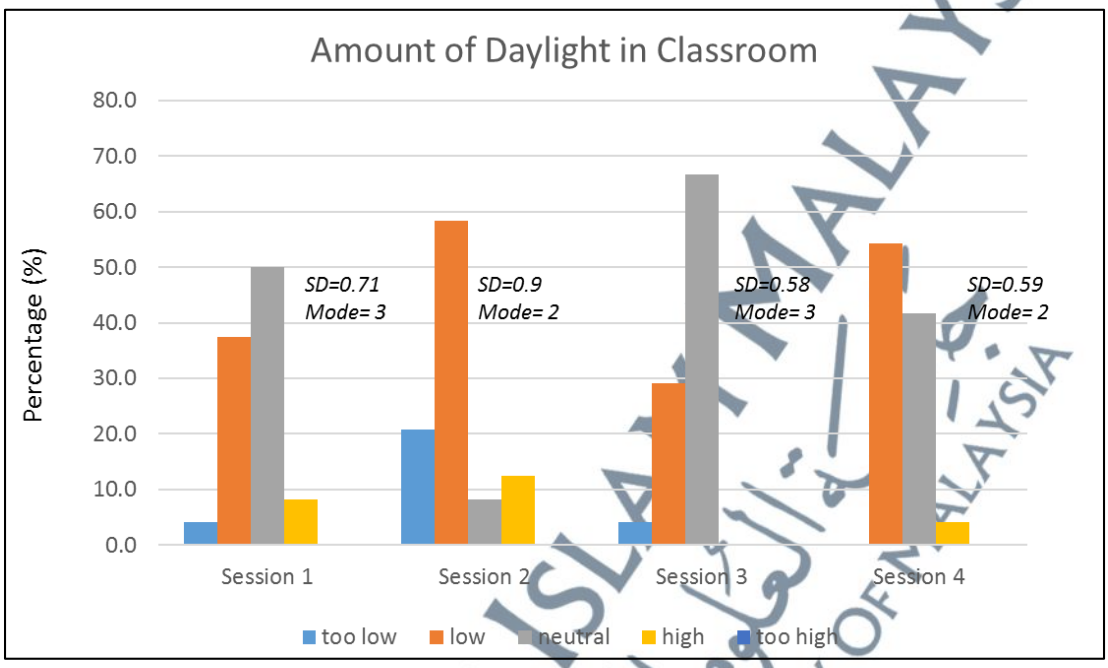


Figure 4.24: Experiment Two Students' Amount of Daylight Perception Graph

The students' perception in Session One and Three was that the amount of daylight was 3=normal with SD=0.71 and SD=0.58 respectively. This highly correlated with the students' perception on brightness and window sizes, where normal amount of daylight and normal brightness in the classroom was due to normal 20 per cent WFR window sizes. The uniformity ratio for both Session One and Three also within acceptable range of 0.5 and 0.7 respectively. Session Two and Four students' perception on amount of daylight was 2=low with SD=0.9 and SD=0.59. It shows a correlation with the previous window size variable, where small window size caused a low amount of daylight and brightness in the classroom. The uniformity ratio for both sessions also showed to be inefficient with 0.4 value. In theory, classroom for Session One and Three was suitable for learning task at 300mm working plane height. However, these results will be referenced with the measured average illuminance level in further discussion.

Task Performance Perception

Table 4.17 shows the descriptive analysis for the second component first variable, which was the students' perception of the reading task performance in the classroom.

Table 4.17: Experiment Two Read Eye Chart Clearly Descriptive Statistical Analysis

read eye chart clearly	Frequency				Valid Percent			
	Session 1	Session 2	Session 3	Session 4	Session 1	Session 2	Session 3	Session 4
very disagree	0	0	0	0	0	0	0	0
disagree	1	2	0	0	4.2	8.3	0	0
neutral	8	3	10	3	33.3	12.5	41.7	12.5
agree	10	14	11	14	41.7	58.3	45.8	58.3
very agree	5	5	3	7	20.8	20.8	12.5	29.2

Students in Session One results shows that only 4.2 per cent (n=1) disagree that they can read the BAL eye chart clearly, 33.3 per cent (n=8) answered neutral, 41.7 per cent (n=14) answered agree and 20.8 per cent (n=5) very agree. 8.3 per cent (n=2) students in Session Two answered disagree, 12.5 per cent (n=3) answered neutral, highest percentage 58.3 per cent (n=14) answered agree and 20.8 per cent (n=5) very agree. Session Three shows that 41.7 per cent (n=10) of the students answered neutral, the highest percentage of 45.8 per cent (n=11) answered agree and 12.5 per cent (n=3) answered very agree. Session Four shows that students answered 12.5 per cent (n=3) neutral, 58.3 per cent (n=14) agree and 29.2 (n=7) very agree.

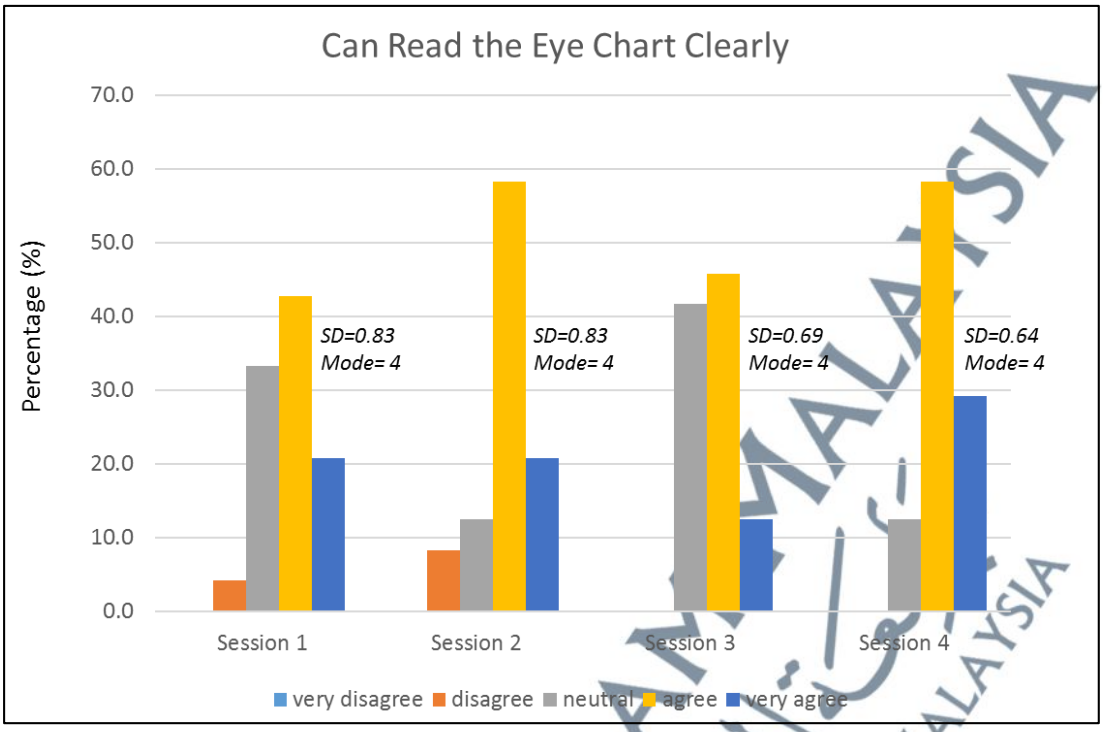


Figure 4.25: Experiment Two Students' Arabic Reading Task Perception Graph

Figure 4.25 shows the graph that explains the students' *hafazan* reading task perception in Experiment Two. The students' perception in all sessions was that they 4= agree that they can read the BAL eye chart clearly. The standard deviation was SD=0.83, SD=0.83, SD=0.69 and SD=0.64 respectively. Since that students' perception in Session One and Three shows the variables were efficient and acceptable, this result was also correlated with the previous variables. However, Session Two and Four also shows that the students can read the BAL eye chart clearly even though the perceptions of the previous variables were low. This result will be referenced to each average illuminance level respectively in further discussion to identify the relationship between the students' perceptions and the actual task performance.

Table 4.18: Experiment Two Write Eye Chart Clearly Descriptive Statistical Analysis

rewrite eye chart clearly	Frequency				Valid Percent			
	Session 1	Session 2	Session 3	Session 4	Session 1	Session 2	Session 3	Session 4
very disagree	0	1	0	0	0	4.2	0	0
disagree	3	2	2	1	12.5	8.3	8.3	4.2
neutral	11	5	9	4	45.8	20.8	37.5	16.7
agree	6	12	10	15	25.0	50.0	41.7	62.5
very agree	4	4	3	4	16.7	16.7	12.5	16.7

Table 4.18 shows the descriptive analysis for the second variable students' perception of the Arabic handwriting performance. Students in Session One result shows that 12.5 per cent (n=3) disagree that they can rewrite the eye chart clearly. Meanwhile, 45.8 per cent (n=11) answered neutral, 25 per cent (n=6) and 16.7 per cent (n=4) answered agree and very agree respectively. Only 4.2 per cent (n=1) very disagree, 8.3 per cent (n=2) answered disagree, 20.8 per cent (n=5) neutral, 50 per cent (n=12) and 16.7 per cent (n=4) very agree. Session Three shows that 8.3 per cent (n=2) of the students answered disagree, 37.5 per cent (n=9) answered neutral, 41.7 per cent (n=10) agree and 12.5 per cent (n=3) answered very agree. The final session students answered 4.2 per cent (n=1) disagree, 16.7 per cent (n=4) neutral, 62.5 per cent (n=15) agree and 16.7 per cent (n=4) very agree.

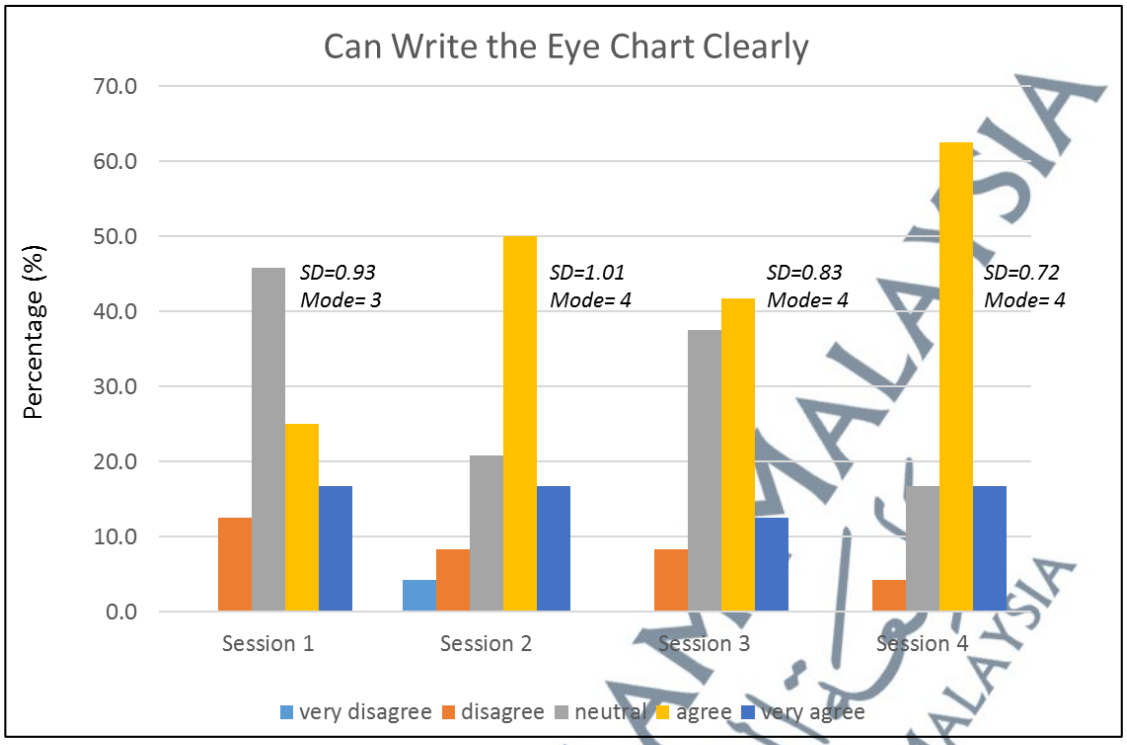


Figure 4.26: Students' Arabic Handwriting Task Perception Graph

Figure 4.26 shows the graph that explains the variable of students' perception of their Arabic handwriting performance, where only Session One students perceived that their Arabic handwriting performance as 3=neutral with SD=0.93, where Session One students' perceptions on the other variables were also normal and neutral. Session Two, Three and Four students' perception was 4=agree with SD=1.01, SD=0.83, and SD=0.72 respectively, which were better even though the other variables shows that the amount of daylight, brightness and window size of the classrooms were inefficient. Thus, further discussion required in identifying the relationship between these variables and the average illuminance level measured at 300mm working plane height.

Experiment Two Results and Findings

Most of the sessions in Experiment Two shows correlations between the variables, where the students perceived the brightness of the classroom was normal due to the perception that the classroom window size was normal. Meanwhile, the daylight

amount was perceived both low and normal when the window size was both small and normal, which shows a correlation between both variables. Since that most of the students perceived that they agreed on clearly reading and writing the BAL eye chart, they can perform the learning task clearly in classrooms that had normal brightness with a low and normal amount of daylight.

Table 4.19: Experiment Two Questionnaire Results

Experiment		Component 1 - Daylight Condition Perception			Component 2 - Task Performance	
		Brightness of Classroom	Size of Window in Classroom	Amount of Daylight in Classroom	Can Read Eye Chart Clearly	Can Write Eye Chart Clearly
Exp 2	Session 1	3= neutral	3= neutral	3= neutral	4=agree	3= neutral
	Session 2	2=dim	2=small	2=low	4=agree	4=agree
	Session 3	3= neutral	2=small, 3= neutral	3= neutral	4=agree	4=agree
	Session 4	3= neutral	2=small	2=low	4=agree	4=agree

4.3.4 Experiment Three

Experiment Three consist of four sessions that evaluates the students' daylight perception and condition while using 300mm height working plane table in each *Tasmi'* bay classrooms with 300mm window sill height. There was no missing data from all 24 respondents for the total sessions with 3 students for each bays.

Demography

100 per cent (n=12) of the questionnaire answered were valid as shown in table 4.20. Standard deviation and variance for Gender in all four sessions were SD=0.00 and S^2=0.00 respectively, showing that there was no variance in each session. This was due to the respondents in each session were divided into male and female group.

Table 4.20: Experiment Three Demographic Descriptive Statistical Analysis

Variables		Frequency (N)				Percent (%)				Median (M)				Standard Deviation (SD)				Variance (S_2)			
Valid	12	Session 1	Session 2	Session 3	Session 4	Session 1	Session 2	Session 3	Session 4	Session 1	Session 2	Session 3	Session 4	Session 1	Session 2	Session 3	Session 4	Session 1	Session 2	Session 3	Session 4
Gender of Respondents	Male	12	0	12	0	100	0	100	0	1	2	1	2	0	0	0	0	0	0	0	0
	Female	0	12	0	12	0	100	0	100												
Age of Respondents	12 y/o	2	0	1	0	33	0	16.7	0												
	13 y/o	4	6	5	6	66.7	100	83.3	100	13	13	13	13	0.52	0	0.41	0	0.27	0	0.17	0
	14y/o	0	0	0	0	0	0	0	0												

The mean age of respondents for all of Experiment Three sessions were M=13. Session One standard deviation was SD=0.52, Session Two and Four was similarly SD=0. Session Three was SD=0.41 with variance for each session were S^2=0.27, S^2=0, S^2=0.17 and S^2=0 respectively.

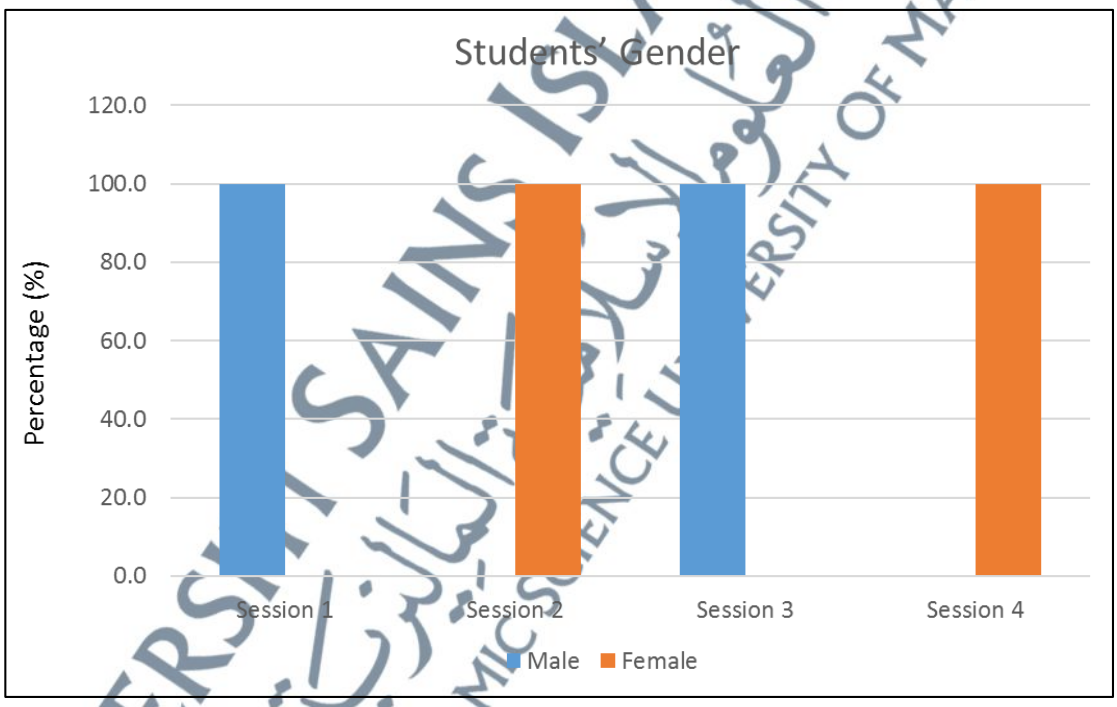


Figure 4.27: Experiment Three Students' Gender Percentage Graph

The age of respondents for Experiment Three was ranged between 12 to 13 years old. Students aged 13 years old in Experiment Three were 66.7 per cent (n=4), 100 per cent (n=6), 83.3 per cent (n=5) and 100 per cent (n=6) for Session One, Two, Three and Four respectively. Only Session One and Three had 33.3 per cent (n=2) and 16.7 per cent

(n=1) students aged 12 years old. The mean age of respondents for each session was M=13 years old since the majority of the respondents for Experiment Three were the same age. The descriptive analysis of students' age was as shown in figure 4.28.

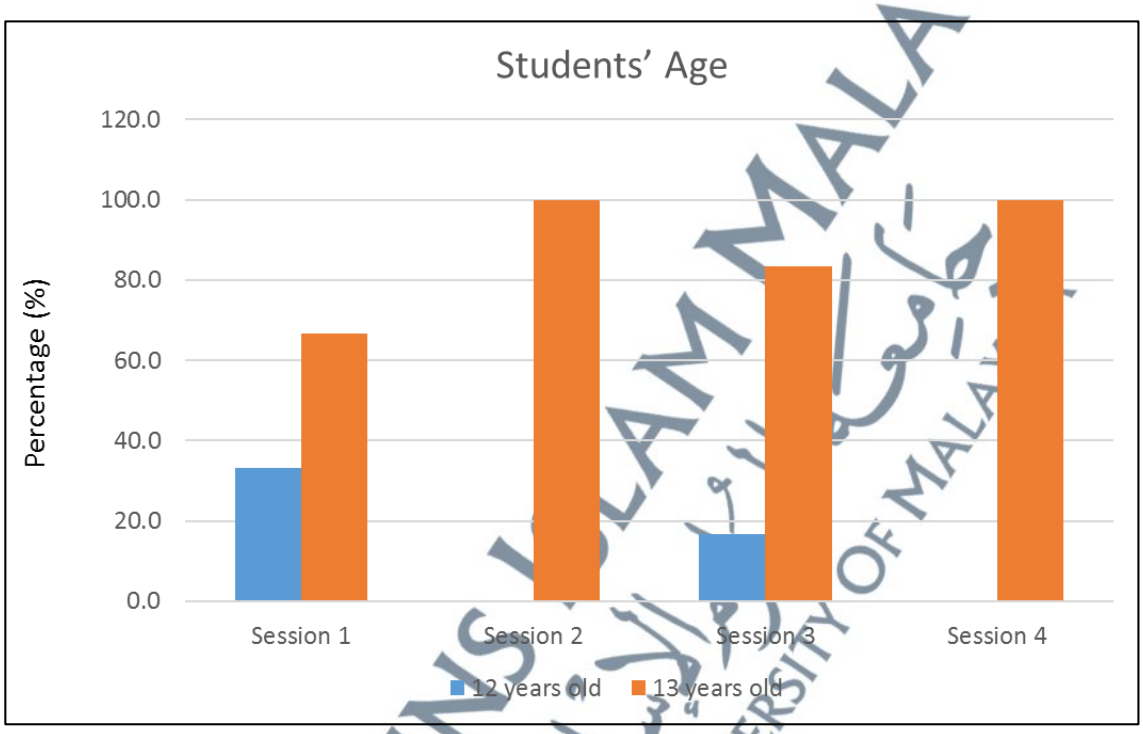


Figure 4.28: Experiment Three Students' Age Percentage Graph

Daylight Condition

The total valid respondent for Experiment Three was 100 per cent (n=24) as shown in table 4.21. The statistics show that the SD for the questionnaire variables in each session were SD=0.00, 0.53, 0.58, 1.00 and 1.15. This shows that the SD for every variable in each session was within the positive domain value. SD=0.00 shows that all students answered the same question.

Table 4.21: Experiment Three Daylight Condition Perception Descriptive Statistical Analysis

Statistic			Valid (N)	Median	Mode	Std. Deviation	Variance
Room brightness	Session 1	Bay 1	3	3.00	3	1.15	1.33
		Bay 2	3	5.00	5	0.58	0.33
	Session 2	Bay 3	3	2.00	2	0.58	0.33
		Bay 4	3	4.00	2[a]	1.53	2.33
	Session 3	Bay 1	3	3.00	3	0.58	0.33
		Bay 2	3	4.00	4	0.58	0.33
	Session 4	Bay 3	3	4.00	3[a]	1.00	1.00
		Bay 4	3	3.00	3	0.58	0.33
Size of Window	Session 1	Bay 1	3	3.00	2[a]	1.00	1.00
		Bay 2	3	2.00	2	0.00	0.00
	Session 2	Bay 3	3	2.00	2	0.00	0.00
		Bay 4	3	2.00	2	0.58	0.33
	Session 3	Bay 1	3	3.00	2[a]	1.00	1.00
		Bay 2	3	4.00	4	0.58	0.33
	Session 4	Bay 3	3	4.00	4	0.58	0.33
		Bay 4	3	2.00	2	1.15	1.33
amount of daylight	Session 1	Bay 1	3	3.00	3	0.00	0.00
		Bay 2	3	4.00	4	0.58	0.33
	Session 2	Bay 3	3	3.00	2[a]	1.53	2.33
		Bay 4	3	5.00	5	0.58	0.33
	Session 3	Bay 1	3	3.00	3	0.58	0.33
		Bay 2	3	4.00	4	0.00	0.00
	Session 4	Bay 3	3	4.00	3[a]	1.00	1.00
		Bay 4	3	3.00	3	0.00	0.00
read eye chart clearly	Session 1	Bay 1	3	5.00	5	0.00	0.00
		Bay 2	3	5.00	5	0.58	0.33
	Session 2	Bay 3	3	5.00	5	0.00	0.00
		Bay 4	3	4.00	4	0.58	0.33
	Session 3	Bay 1	3	4.00	3[a]	1.00	1.00
		Bay 2	3	4.00	4	0.58	0.33
	Session 4	Bay 3	3	5.00	5	0.58	0.33
		Bay 4	3	4.00	4	0.00	0.00
rewrite eye chart clearly	Session 1	Bay 1	3	5.00	5	0.58	0.33
		Bay 2	3	4.00	3[a]	1.00	1.00
	Session 2	Bay 3	3	5.00	5	0.58	0.33
		Bay 4	3	4.00	4	0.58	0.33
	Session 3	Bay 1	3	3.00	3	1.15	1.33
		Bay 2	3	4.00	4	0.58	0.33
	Session 4	Bay 3	3	5.00	5	0.58	0.33
		Bay 4	3	4.00	4	0.58	0.33

a. Multiple modes exist. The smallest value is shown

Table 4.22: Experiment Three Room Brightness Descriptive Statistical Analysis

Room brightness	Frequency								Valid Percent							
	Session 1		Session 2		Session 3		Session 4		Session 1		Session 2		Session 3		Session 4	
	Bay 1	Bay 2	Bay 3	Bay 4	Bay 1	Bay 2	Bay 3	Bay 4	Bay 1	Bay 2	Bay 3	Bay 4	Bay 1	Bay 2	Bay 3	Bay 4
Too dim	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dim	0	0	2	1	0	0	0	0	0	0	66.7	33.3	0	0	0	0
Neutral	2	0	1	0	2	1	1	2	66.7	0	33.3	0	66.7	33.3	33.3	66.7
Bright	0	1	0	1	1	2	1	1	0	33.3	0	33.3	33.3	66.7	33.3	33.3
Too Bright	1	2	0	1	0	0	1	0	33.3	66.7	0	33.3	0	0	33.3	0

Table 4.22 was the descriptive analysis for the students' perception of the brightness of the classroom. Students in Session One results show that 66.7 per cent (n=2) was neutral and 33.3 per cent (n=1) sees the room as too bright in Bay One. Meanwhile, students in Bay Two answered bright and too bright with 33.3 per cent (n=1) and 66.7 per cent (n=2) respectively. Session Two in Bay Three shows that students answered the room being dim and neutral with 66.7 per cent (n=2) and 33.3 per cent (n=1) respectively. Bay Four in Session Two shows that 33.3 per cent (n=1) of the students answered the room was dim, bright and too bright. Session Three in Bay One shows that 66.7 per cent (n=2) and 33.3 per cent (n=1) of the students answered neutral and bright respectively. 33.3 per cent (n=1) and 66.7 per cent (n=2) of the students answered neutral and bright respectively in Bay Two. 33.3 per cent (n=1) in Session Four Bay Three students answered the room brightness was neutral, bright and too bright each. Session Four in Bay Four answers was similar to Session Three Bay One with 66.7 per cent (n=2) and 33.3 per cent (n=1) for neutral and bright respectively.

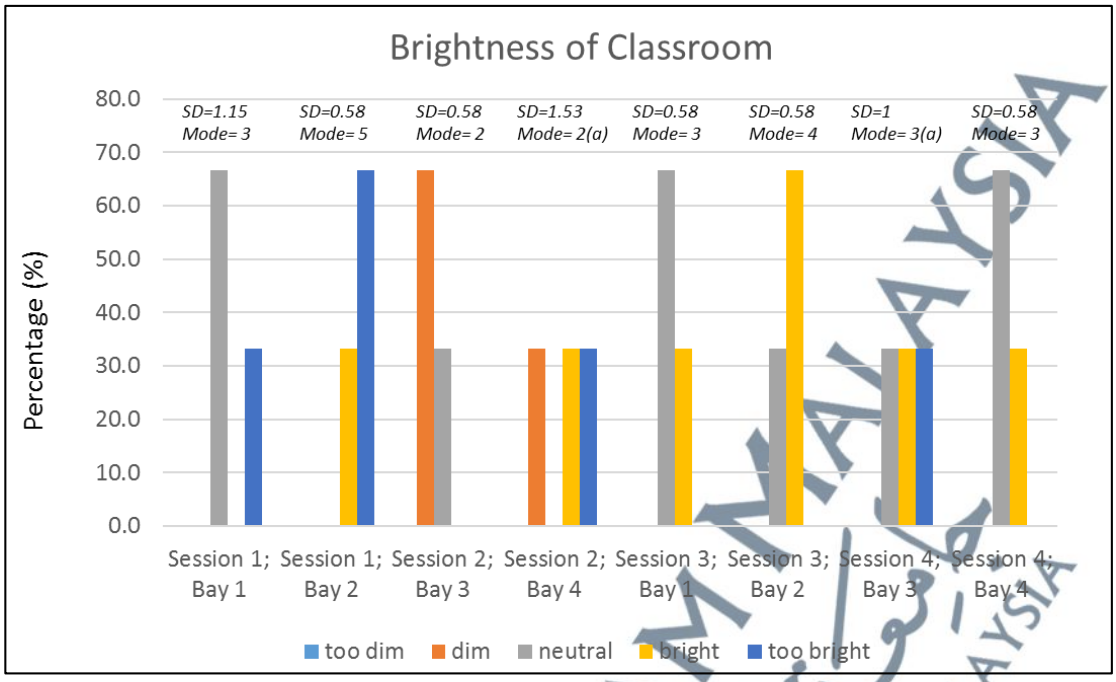


Figure 4.29: Experiment Three Students' Brightness Perception Graph

Figure 4.29 shows the graph that explains the students' brightness perception for Experiment Three in each session and bays. There were only four bays that perceived by the students as 3=normal or neutral, which were Session One Bay One with SD=1.15, Session Three Bay One with SD=0.58, Session Four Bay Three with SD=1 and Session Four Bay Four with SD=0.58. Even though the perception of the brightness was normal, the uniformity ratio was low at between 0.25 to 0.3, where this was influenced by the layout design of the classrooms. Session One Bay Two perception was 5=too bright with SD=0.58 and Session Three Bay Two as 4=bright with SD=0.58, which were the most possible result since the window of the classrooms were too close to the sitting area due to the layout design, where the uniformity ratio was very low at 0.1 and 0.4. Session Two Bay Three students' perception was 2=dim with SD=0.58 and 2a=dim with SD=1.53 for Bay Four, where the uniformity ratio was 0.3 and 0.4. These results may be influenced by the students' sitting location near to the windowless corner of the classroom during the experiment, where the uniformity ratio was also low.

Table 4.23: Experiment Three Window Size Descriptive Statistical Analysis

Size of Window	Frequency								Valid Percent							
	Session 1		Session 2		Session 3		Session 4		Session 1		Session 2		Session 3		Session 4	
	Bay 1	Bay 2	Bay 3	Bay 4	Bay 1	Bay 2	Bay 3	Bay 4	Bay 1	Bay 2	Bay 3	Bay 4	Bay 1	Bay 2	Bay 3	Bay 4
Too small	0	0	0	1	0	0	0	0	0	0	0	33.3	0	0	0	0
Small	1	3	3	2	1	0	0	2	33.3	100	100	66.7	33.3	0	0	66.7
Neutral	1	0	0	0	1	0	1	0	33.3	0	0	0	33.3	0	33.3	0.0
Big	1	0	0	0	1	2	2	1	33.3	0	0	0	33.3	66.7	66.7	33.3
Too Big	0	0	0	0	0	1	0	0	0	0	0	0	0	33.3	0	0

The descriptive analysis for the second variable was as shown in table 4.23. Students in Session One Bay One results show that the same value of 33.3 per cent (n=1) perceives the window size was small, neutral or normal and big. Students in Session One Bay Two and Session Two Bay Three 100 per cent (n=3) agree that the window size in the classrooms was small. 33.3 per cent (n=1) and 66.7 per cent (n=2) students in Session Two Bay Four answered the window was too small and small respectively. Session Three Bay One students' perception of the window size was the same as Session One Bay One. Bay Two in Session Three shows that the students' perception of the classroom windows was 66.7 per cent (n=2) big and 33.3 per cent (n=1) too big. 33.3 per cent (n=1) responded neutral and 66.7 per cent (n=2) responded that the window size was big in Session Four Bay One. 66.7 per cent (n=2) responded small and 33.3 per cent (n=1) responded that the window size was big in Session Four Bay One.

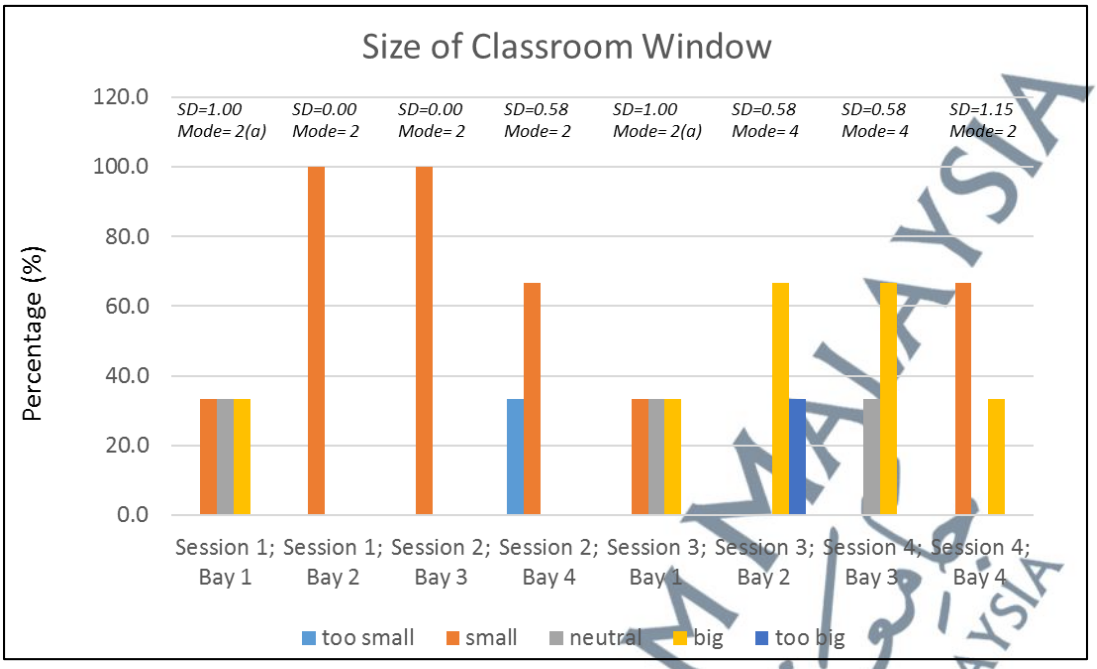


Figure 4.30: Experiment Three Students' Size of Window Perception Graph

Figure 4.30 shows the graph that explains the variable of students' perception of the size of the windows, where most of the sessions perceived the window to be 2=small, where the Standard Deviation for Session One were SD=1.00 and SD=0.00, Session Two were SD=0.00 and SD=0.58, Session Three Bay One was SD=0.00, and Session Four Bay Four was 1.15. These results shows that students' perception of the window was influenced by the low window head height at 1.1m, even though the WFR were controlled at recommended 20 per cent. Only two sessions perceived the classroom window size as 4=big, which were Session Three Bay Two and Session Four Bay Three with both SD=0.58. The students' perception that the classroom was bright influenced the students' perceptions on the window size as well.

Table 4.24: Experiment Three Amount of Daylight Descriptive Statistical Analysis

amount of daylight	Frequency								Valid Percent							
	Session 1		Session 2		Session 3		Session 4		Session 1		Session 2		Session 3		Session 4	
	Bay 1	Bay 2	Bay 3	Bay 4	Bay 1	Bay 2	Bay 3	Bay 4	Bay 1	Bay 2	Bay 3	Bay 4	Bay 1	Bay 2	Bay 3	Bay 4
Too low	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Low	0	0	3	0	0	0	1	0	0	0	100	0	0	0	33.3	0
Neutral	3	0	0	0	2	0	1	0	100	0	0	0	66.7	0	33.3	0
High	0	2	0	1	1	3	1	3	0	66.7	0	33.3	33.3	100	33.3	100
Too high	0	1	0	2	0	0	0	0	0	33.3	0	66.7	0	0	0	0

The third variable was the students' perception of the amount of daylight. Students in Session One Bay One results show that 100 per cent (n=3) perceive the amount of daylight was neutral. 66.7 per cent (n=2) students in Session One Bay answered the amount of daylight was high, 33.3 per cent (n=1) answered too high. 100 per cent (n=3) answered low in Session Two Bay Three. Session Two Bay Four students answered 33.3 per cent (n=1) and 66.7 per cent (n=2) high and too high respectively. Session Three Bay One answers were 66.7 per cent (n=2) neutral and 33.3 per cent (n=1) high. 100 per cent (n=3) answers the daylight was high in Session Three Bay Two and Session Four Bay Four. Students in Session Four Bay Three answers 33.3 per cent (n=1) low, neutral and high respectively.

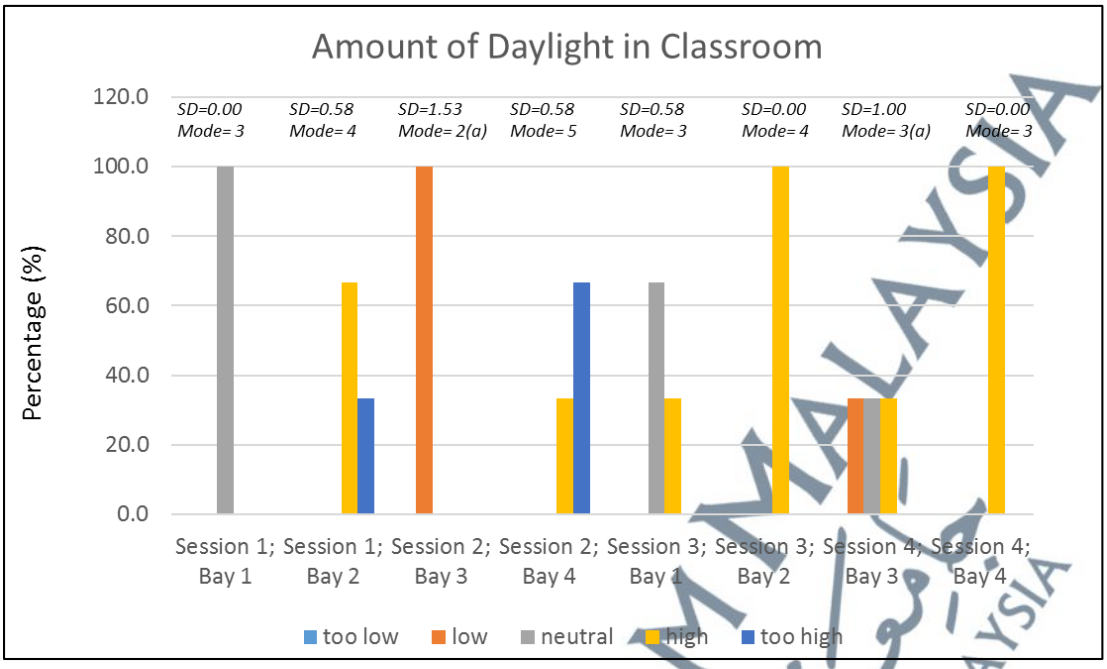


Figure 4.31: Experiment Three Students' Amount of Daylight Perception Graph

Figure 4.31 shows the graph that explains the students' perception of the amount of daylight in the classroom. The students' perception in Session One Bay One, Session Three Bay One and Session Four Bay Three on the amount of daylight were 3=normal with SD=0.00, SD=0.58 and SD=1.00 respectively, while Session Two Bay Three was the only one that perceived it as 2=low, even though the average illuminance level were very high and the uniformity ratio were low at between 0.25 to 0.3. Three of the sessions perceived the daylight amount as 4=high, which related to the high average illuminance level in the classrooms. The sessions were Session One Bay Two with SD=0.58, Session Three Bay Two and Session Four Bay Four with SD=0.00. Session Two Bay Four was the only one that perceived the amount of daylight as 5=too high, even though the students perceived the brightness of the classroom as dim and the window size was small. This may due to the location of the students in the classroom, where the sitting area was too closed to the windows.

Task Performance Perception

Table 4.25 shows the descriptive analysis for the second component first variable the students' perception of the reading task performance in the classroom.

Table 4.25: Experiment Three Read Eye Chart Clearly Descriptive Statistical Analysis

read eye chart clearly	Frequency								Valid Percent							
	Session 1		Session 2		Session 3		Session 4		Session 1		Session 2		Session 3		Session 4	
	Bay 1	Bay 2	Bay 3	Bay 4	Bay 1	Bay 2	Bay 3	Bay 4	Bay 1	Bay 2	Bay 3	Bay 4	Bay 1	Bay 2	Bay 3	Bay 4
very disagree	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
disagree	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
neutral	0	0	0	0	1	1	0	0	0	0	0	0	33.3	33.3	0	0
agree	0	1	0	2	1	2	1	3	0	33.3	0	66.7	33.3	66.7	33.3	100
very agree	3	2	3	1	1	0	2	0	100	66.7	100	33.3	33.3	0	66.7	0

Students in Session One Bay One results show that all students 100 per cent (n=3) very agree that they can read the BAL eye chart clearly. Session One Bay Two shows that 33.3 per cent (n=1) of the students answered agree and 66.7 per cent (n=2) very agree. Percentage of 100 per cent (n=3) answered very agree in Session Two Bay Three. Session Two Bay Four shows that students answered 66.7 per cent (n=2) agree and 33.3 (n=1) very agree. 33.3 per cent (n=1) of the students' answers neutral, agree and very agree respectively in Session Three Bay One. 33.3 per cent (n=1) and 66.7 per cent (n=2) answers neutral and agree respectively in Session Three Bay Two. 33.3 per cent (n=1) and 66.7 per cent (n=2) answers agree and very agree respectively in Session Four Bay Three. 100 per cent (n=3) of the students in Session Four Bay Four agree that they can read the BAL eye chart clearly.

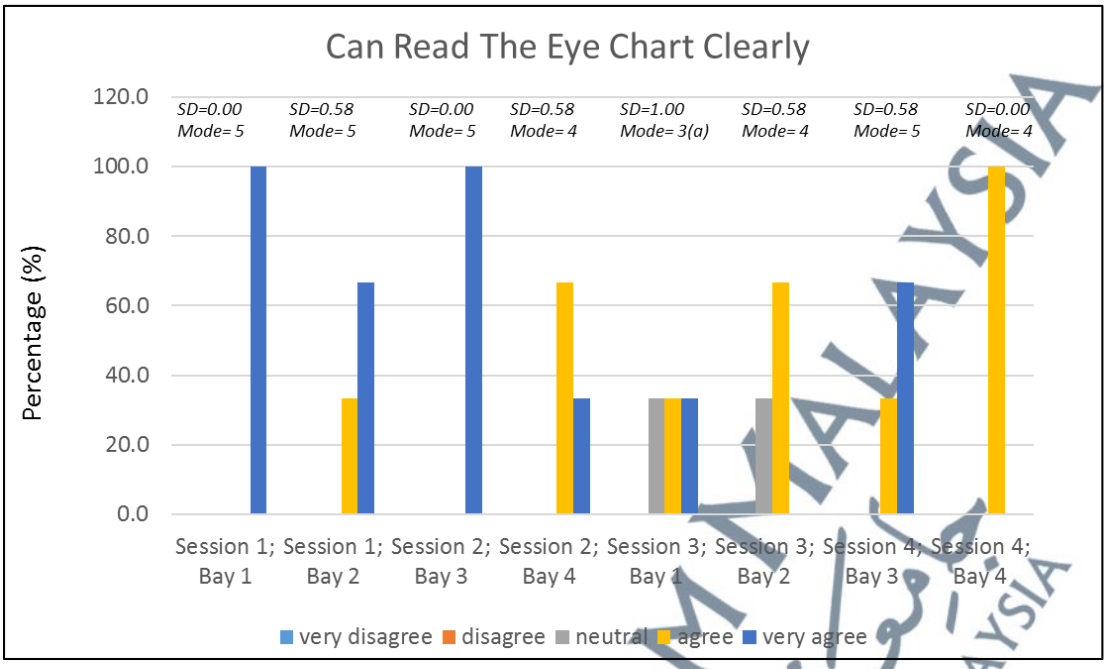


Figure 4.32: Experiment Three Students' Arabic Reading Task Perception Graph

The students' perception in Session One Bay One, Bay Two, Session Two Bay Three and Session Four Bay Three were that they 5=very agree that they can read the BAL eye chart clearly with SD=0.00 and SD=0.58 as shown in figure 4.32. These results in general correlated with normal amount of daylight and brightness of the classrooms, where the uniformity ratio were between 0.1 to 0.3, which were very low based on the recommended value. This also shows that students perceived that higher amount of daylight and brightness of the classrooms allowed them to read the BAL eye chart clearly, even though they experienced glare due to high intensity of daylight received. In other sessions shows that the students' perception 4=agree that they their read the BAL eye chart clearly, due to the glare they had experienced during the experiment. The sessions were Session Two Bay Four, Session Three Bay Two and Session Four Bay Four with SD=0.00 and SD=0.58. There was only one session that was 3=neutral, which were Session Three Bay One with SD=1.00. The results explained that even though the amount of daylight and brightness were perceived as high, the students can still perform Arabic reading task at 300mm working plane height in the classroom.

Table 4.26: Experiment Three Write Eye Chart Clearly Descriptive Statistical Analysis

rewrite eye chart clearly	Frequency								Valid Percent							
	Session 1		Session 2		Session 3		Session 4		Session 1		Session 2		Session 3		Session 4	
	Bay 1	Bay 2	Bay 3	Bay 4	Bay 1	Bay 2	Bay 3	Bay 4	Bay 1	Bay 2	Bay 3	Bay 4	Bay 1	Bay 2	Bay 3	Bay 4
very disagree	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
disagree	0	1	0	0	0	0	0	0	0	33.3	0	0	0	0	0	0
neutral	0	1	0	0	2	1	0	0	0	33.3	0	0	66.7	33.3	0	0
agree	1	1	1	2	0	2	1	2	33.3	33.3	33.3	66.7	0	66.7	33.3	66.7
very agree	2	0	2	1	1	0	2	1	66.7	0	66.7	33.3	33.3	0	66.7	33.3

Table 4.26 shows the descriptive analysis the students' perception on the Arabic handwriting performance, where students in Session One Bay One, Session Two Bay Three and Session Four Bay Three results show that 33.3 per cent (n=1) agree and 66.7 per cent (n=2) very agree that they were able to rewrite the eye chart clearly. Meanwhile, 33.3 per cent (n=1) each answered disagree, neutral and agree in Session One Bay Two. 66.7 per cent (n=2) and33.3 per cent (n=1) answered agree and very agree respectively in Session Two Bay Four and Session Four Bay Four. Session Three Bay One shows that students were 66.7 per cent (n=2) neutral and 33.3 per cent (n=1) very agree. Students in Session Three Bay Two answers 33.3 per cent (n=1) neutral and 66.7 per cent (n=2) agree.

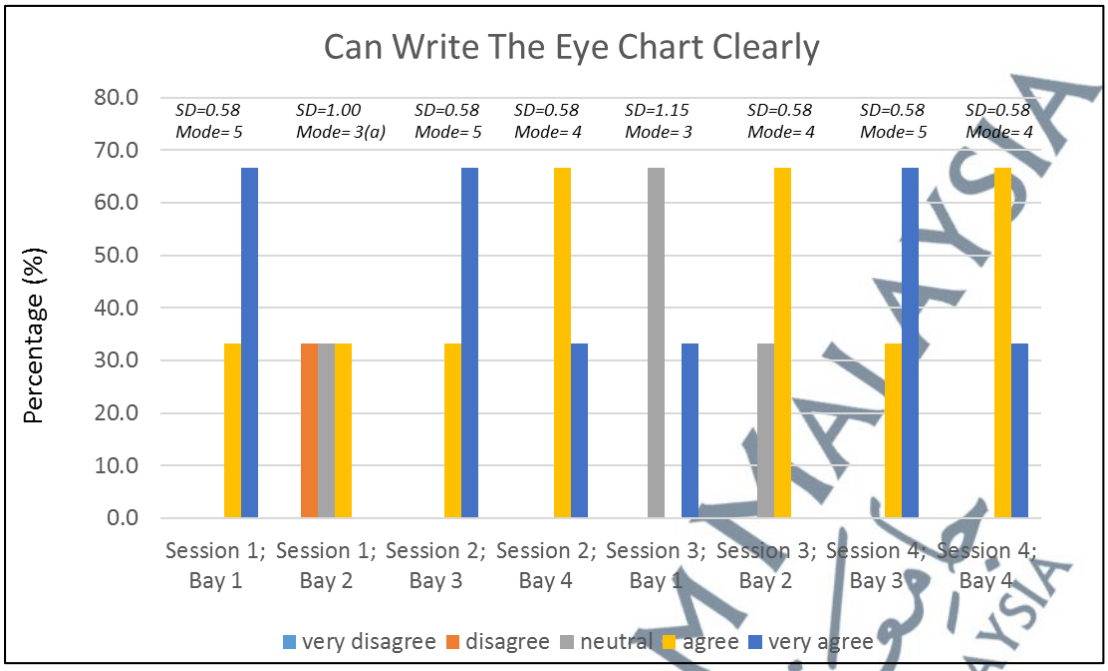


Figure 4.33: Experiment Three Students' Arabic Handwriting Task Perception Graph

Figure 4.33 shows the graph that explains the students' perception of their Arabic handwriting performance. Session One Bay One, Session Two Bay Three and Session Four Bay Three students 5=very agree with them writing the eye chart clearly with SD=0.58 each. This shows that the students' visual comfort in reading the BAL eye chart influenced the visual comfort for writing, where students in both also very agreed with their reading performance. Session One Bay Two and Session Three Bay One students were 3=neutral with their performance, where the standard deviations were SD=1.00 and SD=1.15. Only Session Three Bay One results correlated with the reading performance perception by students. Students' results for Session Two Bay Four, Session Three Bay Two and Session Four Bay Four were 4= agree, where the standards deviation were the same at SD=0.58. All three sessions show significant correlation between reading and writing performance perception. The overall results show that the students' perception on writing performance influenced by the reading performance as well, where if the visual comfort for reading was high, the writing visual comfort were the same.

Experiment Three Results and Findings

The results of the questionnaire show the students perceived that there was less relationship between the brightness of the classroom with the window size. However, a higher relationship can be seen between brightness of classroom and amount of daylight, where this can be related with the high daylight intensity and average illuminance level for each classroom. This shows that students perceived the amount of daylight increased or decreased when the brightness of the classroom increased or decreased respectively.

Table 4.27: Experiment Three Questionnaire Results

Experiment			Component 1 - Daylight Condition Perception			Component 2 - Task Performance	
			Brightness of Classroom	Size of Window in Classroom	Amount of Daylight in Classroom	Can Read Eye Chart Clearly	Can Write Eye Chart Clearly
Exp 3	Session 1	Bay 1	3= neutral	2, 3, 4	3= neutral	5=very agree	5=very agree
		Bay 2	5=too bright	2=small	4=high	5=very agree	2, 3, 4
	Session 2	Bay 3	2=dim	2=small	2=low	5=very agree	5=very agree
		Bay 4	2, 4, 5	2=small	5=too high	4=agree	4=agree
	Session 3	Bay 1	3= neutral	2, 3, 4	3= neutral	3, 4, 5	3= neutral
		Bay 2	4=bright	4=big	4=high	4=agree	4=agree
	Session 4	Bay 3	2, 3, 4	4=big	2, 3, 4	5=very agree	5=very agree
		Bay 4	3= neutral	2=small	4=high	4=agree	4=agree

Results for the student's Task Performance Perception on reading the BAL chart shows that most of the sessions agree and very agreed that they can read it clearly. This shows that students in these classrooms can still read the BAL chart even though the they perceived the brightness and daylight amount were inefficient. However, results for the students' perception of their writing performance shows that brightness and amount of daylight influenced their answers. Most of the sessions that had students highly agreed that they can write the BAL chart clearly were also the sessions that had mostly answered low and neutral for brightness and amount of daylight in the classroom. This shows that students perceived that their writing tasks can be performed clearly in a classroom with a lower amount of daylight and brightness.

4.3.5 Questionnaire Discussion and Analysis

The overall perception of brightness was low, size of the window was small and daylight was low in Experiment One, assumed that the students experienced visual discomfort. However, the students agreed that they can read and write the eye chart clearly, which shows that the classroom layout design in Experiment One was insufficient in providing daylight condition suitable for students' visual comfort, even though the perception on task performance were otherwise. Experiment Two shows that the students perceived the daylight condition as neutral or normal, while the task performance perception were good in those daylight conditions. This shows that the classrooms in Experiment Two were suitable in providing good daylight conditions for students' visual comfort. The daylight condition perception results for Experiment Three shows a high dissatisfaction from the students even though they perceived their task performance as very good. This can be assumed that the students perceived that they can perform better in a highly day-lighted classroom even though they experienced high visual discomfort.

Table 4.28: Questionnaire Descriptive Statistical Analysis

Experiment			Component 1 - Daylight Condition Perception			Component 2 - Task Performance	
			Brightness of Classroom	Size of Window in Classroom	Amount of Daylight in Classroom	Can Read Eye Chart Clearly	Can Write Eye Chart Clearly
Exp 1	Session 1		2=dim	2=small	2=low	5=very agree	4=agree
	Session 2		3= neutral	3= neutral	3= neutral	4=agree	4=agree
	Session 3		2=dim	2=small	3= neutral	4=agree	4=agree
Exp 2	Session 1		3= neutral	3= neutral	3= neutral	4=agree	3= neutral
	Session 2		2=dim	2=small	2=low	4=agree	4=agree
	Session 3		3= neutral	2=small, 3= neutral	3= neutral	4=agree	4=agree
	Session 4		3= neutral	2=small	2=low	4=agree	4=agree
Exp 3	Session 1	Bay 1	3= neutral	2, 3, 4	3= neutral	5=very agree	5=very agree
		Bay 2	5=too bright	2=small	4=high	5=very agree	2, 3, 4
	Session 2	Bay 3	2=dim	2=small	2=low	5=very agree	5=very agree
		Bay 4	2, 4, 5	2=small	5=too high	4=agree	4=agree
	Session 3	Bay 1	3= neutral	2, 3, 4	3= neutral	3, 4, 5	3= neutral
		Bay 2	4=bright	4=big	4=high	4=agree	4=agree
	Session 4	Bay 3	2, 3, 4	4=big	2, 3, 4	5=very agree	5=very agree
		Bay 4	3= neutral	2=small	4=high	4=agree	4=agree

Results of the questionnaire in table 4.28 shows that 49 per cent of the students in overall were satisfied with the daylight condition of the classrooms, while 36 per cent responded neutral or normal, with another 15 per cent were dissatisfied. 74 per cent of the students were satisfied with their Arabic reading and handwriting task performance, while 22 per cent and 4 per cent perceived their performance as normal and poor respectively. Even though the percentage for daylight condition perception was the highest, it was still less than 50 per cent of the total respondent. This shows that the classroom layout design for Arabic reading and writing task requires further study especially in providing acceptable and efficient daylight conditions. The results of the questionnaire will be discussed with relation to the students' Arabic handwriting performance assessment further in this study.

4.4 Students' Arabic Handwriting Performance

The students' performance was measured by evaluating the students' word per minute (wpm) score for the Arabic handwriting task. The students were required to rewrite the BAL eye chart provided with the questionnaire in the space provided, where students also required to record the time taken for them to finish the Arabic handwriting task. The average Arabic handwriting task speed was recorded to evaluate the students' performance, where the average wpm for students aged 13 to 14 years old was 14.3 wpm to 15.6 wpm. Each session was provided with a stopwatch at the front area of the classroom. The average word per minute for each experiment was cross-referenced with the classroom's average illuminance level.

4.4.1 Experiment One

Table 4.29: Experiment One Students' Arabic Handwriting Speed and Performance

Task Performance	Speed/Time			Word per Minute		
	Session 1	Session 2	Session 3	Session 1	Session 2	Session 3
Valid (N)	24	24	24	24	24	24
Mean	590.0	657.7	773.8	15.7	13.7	11.7
Median	577.5	658.0	766.5	14.6	12.8	11.0

a. Multiple modes exist. The smallest value is shown

Table 4.29 shows the students' average Arabic handwriting speed and performance based on the provided BAL eye chart for Experiment One. Students in Session One shows a significantly high average word per minute (wpm) or Arabic handwriting performance and fastest average speed (sec) for the Arabic handwriting task. However, the results in Session One and Two shows low average Arabic handwriting performance compared to the first session.

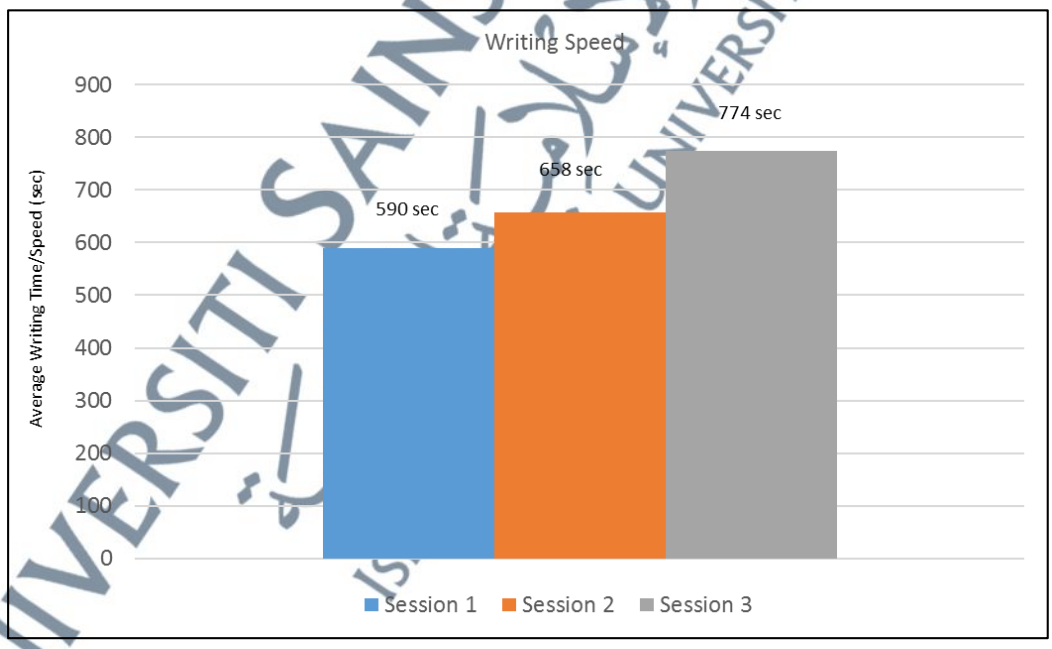


Figure 4.34: Experiment One Average Arabic Handwriting Speed Graph

Figure 4.34 shows the average Arabic handwriting task speed taken for each session. Session One student in Classroom average time speed taken for the Arabic handwriting performance was M=590 seconds (9 min 50 sec), which was the fastest in Experiment One. The average time speed for Session Two and Three was M=658 seconds (10 min 58 sec) and M=774 seconds (12 min 54 sec) respectively.

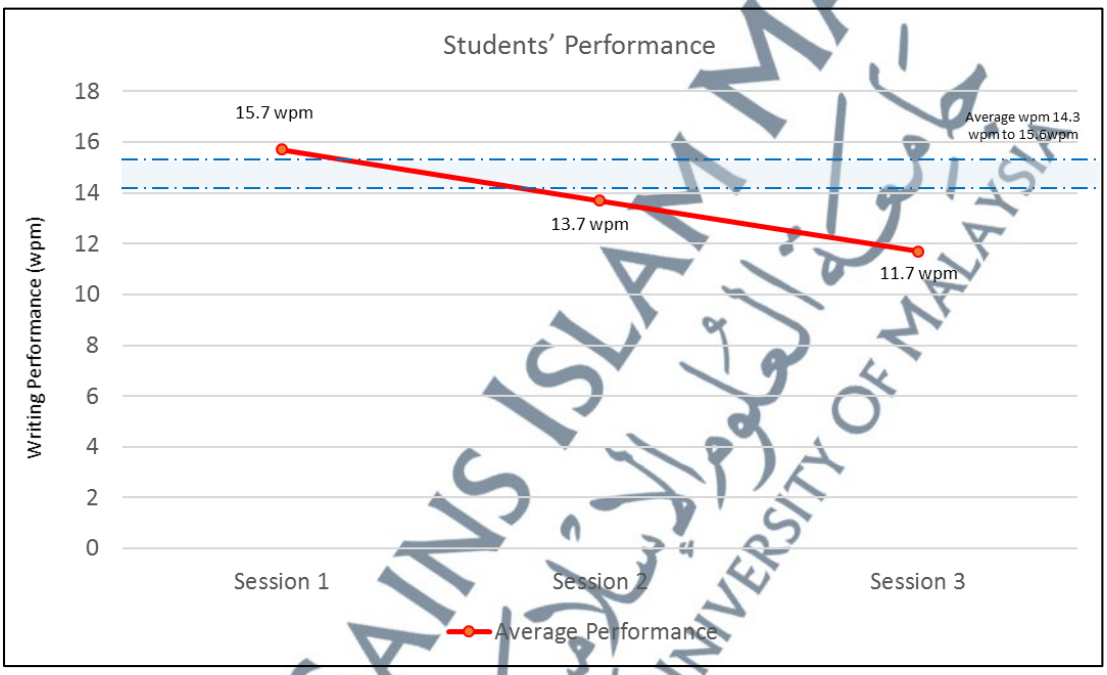


Figure 4.35: Experiment One Average Arabic Handwriting Speed Graph

Session One in Classroom One had the highest average performance of M=15.7 wpm as shown in figure 4.35, where the score was higher than average word per minute for students of the same age group. Students in Session Two and Three performed lower, which were M=13.7 wpm and M=11.7 wpm respectively. In theory, Session One received an acceptable illuminance level for the students to perform 'Arabic handwriting tasks at 900mm working plane height, where wpm scores will be compared with the average illuminance level measured in field measurement to confirmed the theoretical statement.

4.4.2 Experiment Two

Table 4.30: Experiment Two Students' Arabic Handwriting Speed and Performance

Task Performance	Speed/Time (sec)				Word per Minute (wpm)			
	Session 1	Session 2	Session 3	Session 4	Session 1	Session 2	Session 3	Session 4
Valid (N)	24	24	24	24	24	24	24	24
Mean	838.3	920.8	691.1	841.5	10.4	9.4	12.6	10.5
Median	798.5	908.0	687.0	796.5	10.5	9.3	12.2	10.5

a. Multiple modes exist. The smallest value is shown

Table 4.30 shows that the students in Experiment Two Arabic handwriting performance scored lower than the average wpm for the same age group. The overall results suggested that the daylight condition in Experiment Two was not suitable for Arabic handwriting tasks for *hafazan* at 300mm working plane height due to the high intensity of daylight, thus creating glare and visual discomfort to the students.

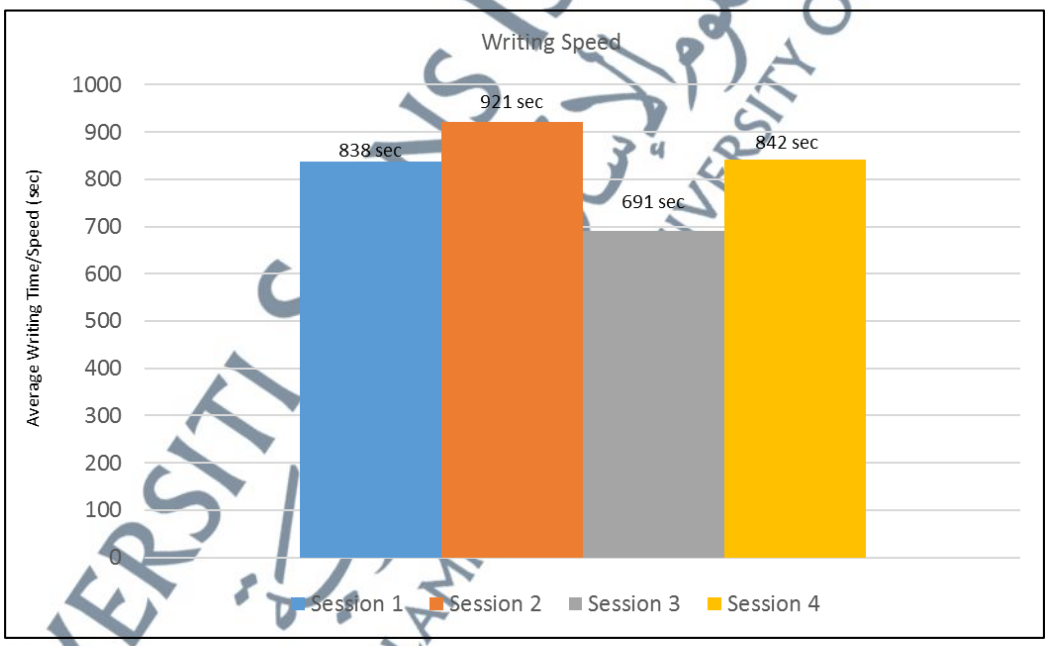


Figure 4.36: Experiment Two Average Arabic Handwriting Speed Graph

The recorded average time speed taken for the students in all four sessions to rewrite the BAL chart in each session was as shown in figure 4.36. Session Three had the fastest average time speed taken for Arabic handwriting task performance in M=691 seconds (11 min 31 sec). The average time speed for Session One, Two and Four was M=838

seconds (13 min 58 sec), M=921 seconds (15 min 21 sec) and M=842 seconds (14 min 2 sec) respectively.

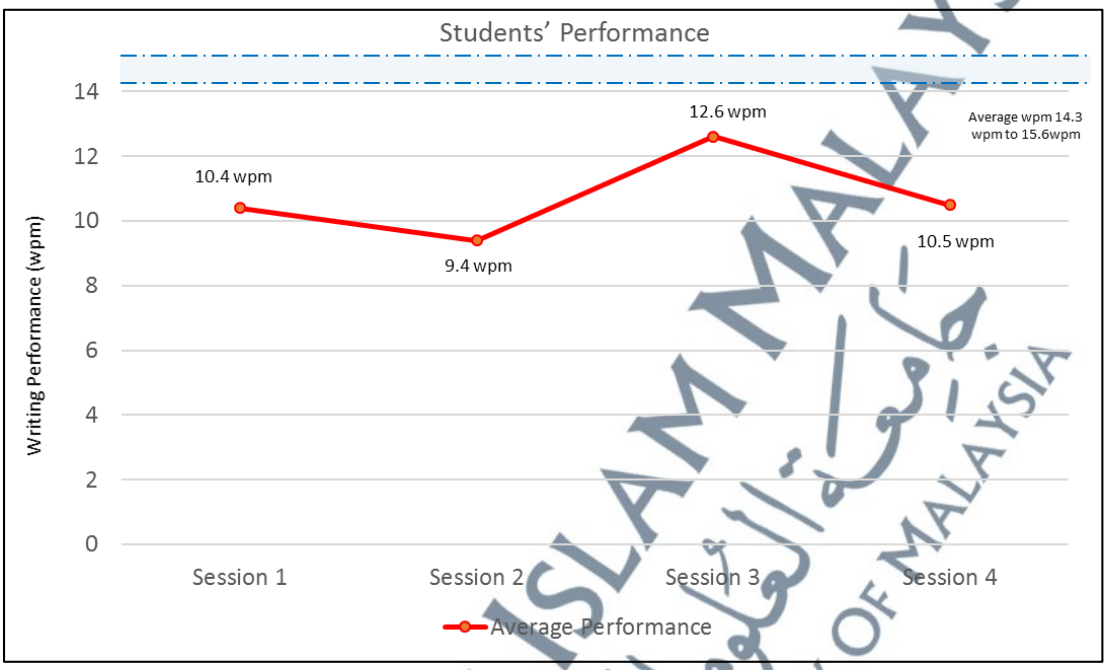


Figure 4.37: Experiment Two Average Arabic Handwriting Speed Graph

The students located in Classroom Four during Session Three had the highest average performance with M=12.6 wpm as shown in figure 4.37. The students in Session One, Two and Four had low Arabic handwriting performance results, which were M=10.4 wpm, M=9.4 wpm, and 10.5 wpm respectively. However, the performance result for all sessions in Experiment Two was still lower than the average for the students' age group.

4.4.3 Experiment Three

Experiment Three consists of four sessions, with each session, had two separated bays that were suitable for three students to occupy during the learning process.

Table 4.31: Experiment Three Students' Arabic Handwriting Speed and Performance

Task performance	Speed/Time (sec)								Word per minute (wpm)							
	Session 1		Session 2		Session 3		Session 4		Session 1		Session 2		Session 3		Session 4	
	Bay 1	Bay 2	Bay 3	Bay 4	Bay 1	Bay 2	Bay 3	Bay 4	Bay 1	Bay 2	Bay 3	Bay 4	Bay 1	Bay 2	Bay 3	Bay 4
Valid (N)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Mean	1142.7	1397.7	1122	822.3	823.3	1038.0	1084.3	723.0	7.7	6.8	7.7	10.4	10.3	8.1	8.0	11.8
Median	1201.0	1619.0	1054	812.0	820.0	1046.0	970.0	697.0	7.0	5.2	8.0	10.3	10.2	8.0	8.7	12.1

Table 4.31 shows all average performance in Experiment Three scores were very low compared to the average performance for students of same age group. Overall results suggested that the *Tasmi'* classroom were not suitable for Arabic handwriting task at 300mm working plane height.

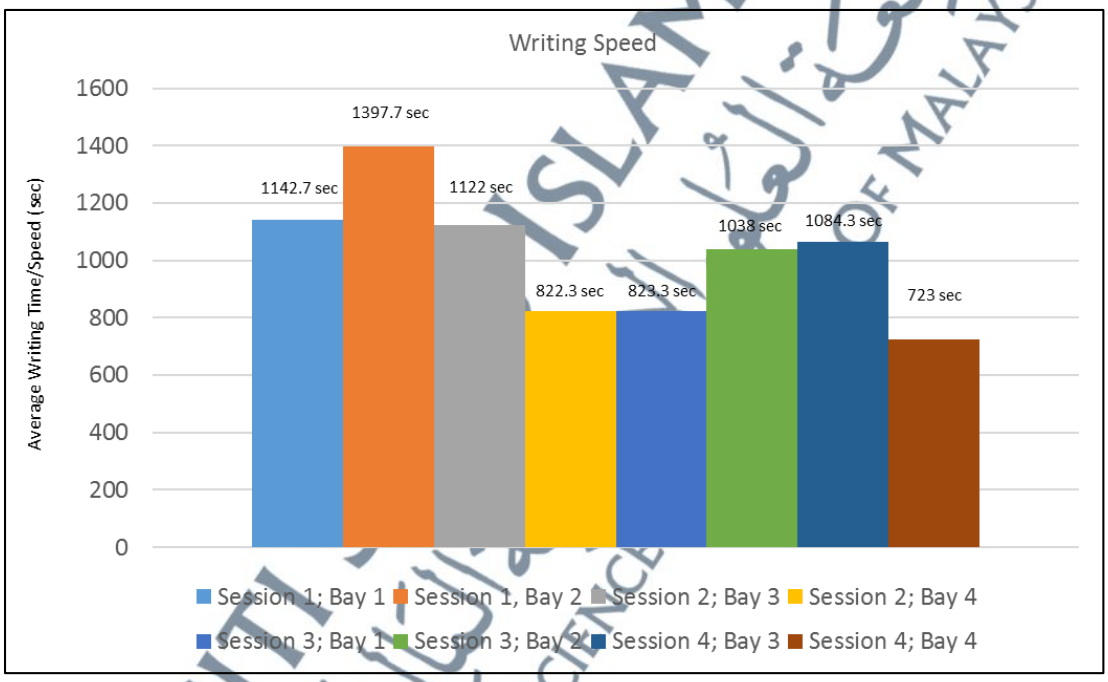


Figure 4.38: Experiment Three Average Arabic Handwriting Speed Graph

Session One Bay Two shows the highest recorded average Arabic handwriting speed, which was M=1398 sec (23 min 18 sec). This shows that students in that session perform poorly in the given Arabic handwriting task. Students in Session Two Bay Four and Session Three Bay One had the approximately same value of M=823 secs (13 min 43 sec). However, the fastest average Arabic handwriting speed in Experiment Three was Session Four Bay Four with M=723 secs (12 minutes 3 sec).

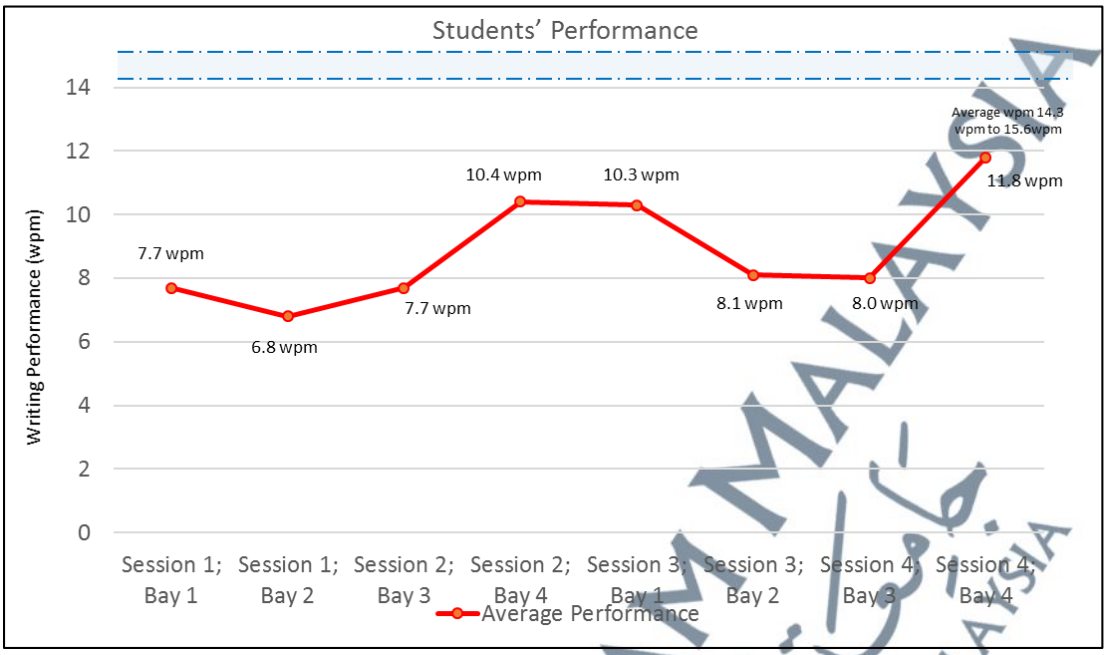


Figure 4.39: Experiment Three Average Arabic Handwriting Speed Graph

The students located in Session One Bay One and Session Two Bay Three shows that the average performance was M=7.7 wpm. Session Two Bay Four and Session Three Bay One were closely similar to having an average performance of M=10.4 wpm and M=10.3 wpm respectively. The average performance in Session Three Bay One and Session Four Bay Three were approximately the same with M=8.1 wpm and M=8.0 wpm respectively. The lowest average performance was in Session One Bay Two with M=6.8 wpm. The highest average performance was in Session Four Bay Four, with M=11.8 wpm. However, all students average performance was lower than the same age group average word per minute.

4.4.4 Students' Performance Discussion and Analysis

Experiment One shows that only students in Session One Average Arabic handwriting performance for *hafazan* learning that surpassed the average word per minute based on the same group age. The other two sessions had wpm lower than the

average performance based on the same age group, which suggested that the difference in average illuminance level measured for each session at 900mm working plane height in classrooms with 900mm window sill height influenced the students' students' Arabic handwriting performance. Thus, the average illuminance level for each session was evaluated to identify the acceptable illuminance level for Arabic handwriting performance in *hafazan* learning.

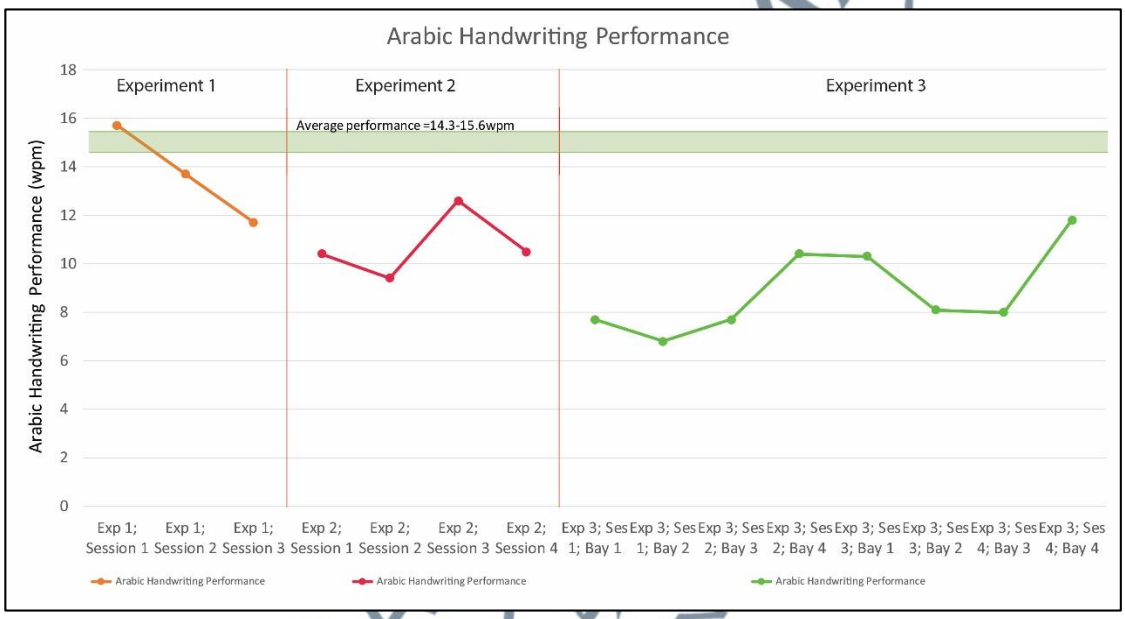


Figure 4.40: Average Arabic Handwriting Speed Graph

Each session in Experiment Two indicated that students' average Arabic handwriting performance was low. Students in Session Three had the highest average Arabic handwriting performance, although it was still lower than the average performance compared with the same age group. This shows that the students' Arabic handwriting performance at 300mm working plane height in classrooms with 900mm window sill height was lower due to the high daylight intensity and average illuminance level that caused glare and visual discomfort to students. Thus, classrooms with a window sill height of 900mm were not suitable for Arabic handwriting task at *rehal* 300mm working plane height.

All of the students' average Arabic handwriting performance in Experiment Three students was very low compared to the average performance score by students of the same age group. The design layout of the *Tasmi'* classrooms that were smaller and had lower window sill height and window head height received very high daylight intensity and average illuminance level, which caused glare and visual discomfort to the students during the Arabic handwriting task performed. Since that the average Arabic handwriting performance scores was the lowest in Experiment Three, it was suggested that the classroom design layout was not suitable for Arabic handwriting task at 300mm working plane of *rehal.*

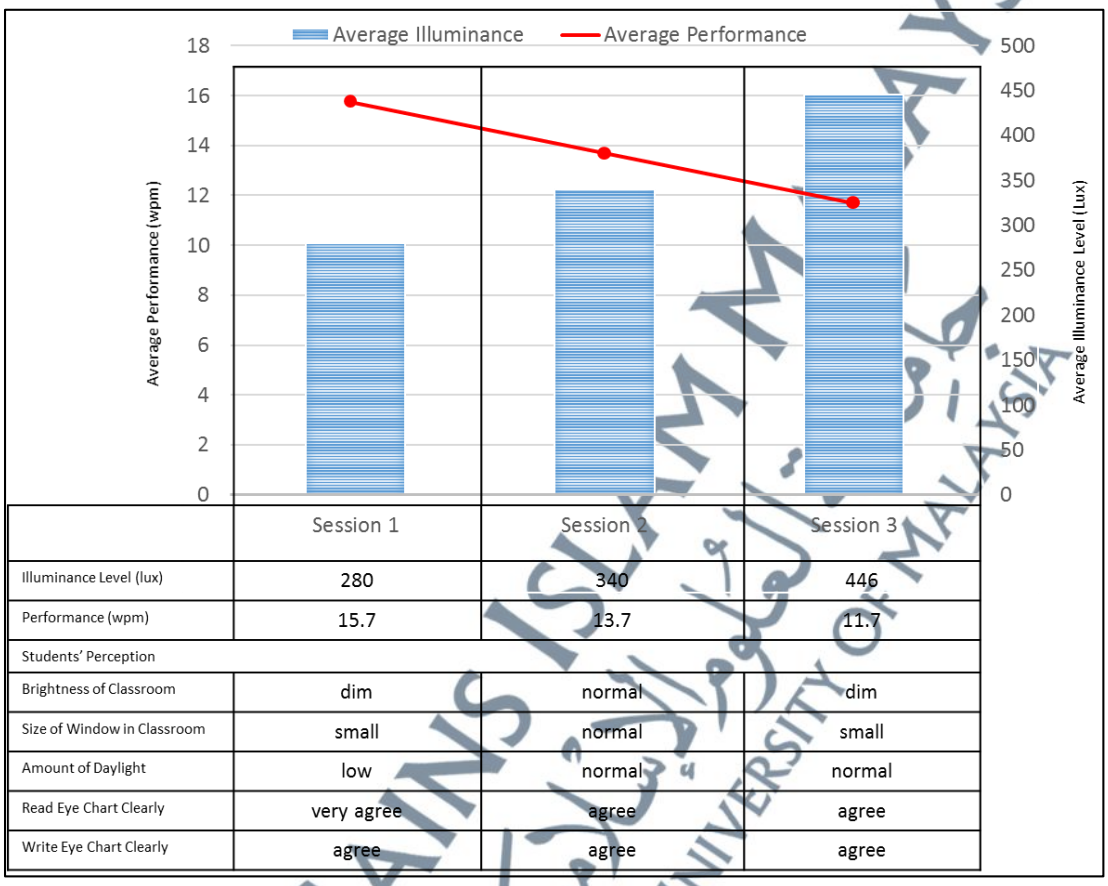
4.5 Experimental Analysis and Discussion

The average illuminance level measured in the field measurement was cross-referenced with the students' average performance for each experiment to identify the correlation between both results and findings. However, the experiments conducted for this research had different classroom layout and setups. Thus, each experiment of the research had different correlation results between illuminance level and students' performance. The results and findings based on the variables for field measurement, questionnaire and students' Arabic handwriting performance will be used as parameter setup and reference for the computer simulation.

4.5.1 Experiment One

Data collection sessions conducted in Experiment One was to identify the acceptable illuminance level for *hafazan* learning task performance. The illuminance level measured for Experiment One was at the working plane of a table of 900mm height. The window sill height of the classrooms was similar at 900mm height. The

cross-referenced results of illuminance level and students' performance will identify the acceptable illuminance level for optimum *hafazan* learning task performance.



	Session 1	Session 2	Session 3
Illuminance Level (lux)	280	340	446
Performance (wpm)	15.7	13.7	11.7
Students' Perception			
Brightness of Classroom	dim	normal	dim
Size of Window in Classroom	small	normal	small
Amount of Daylight	low	normal	normal
Read Eye Chart Clearly	very agree	agree	agree
Write Eye Chart Clearly	agree	agree	agree

Figure 4.41: Experiment One; Data Analysis

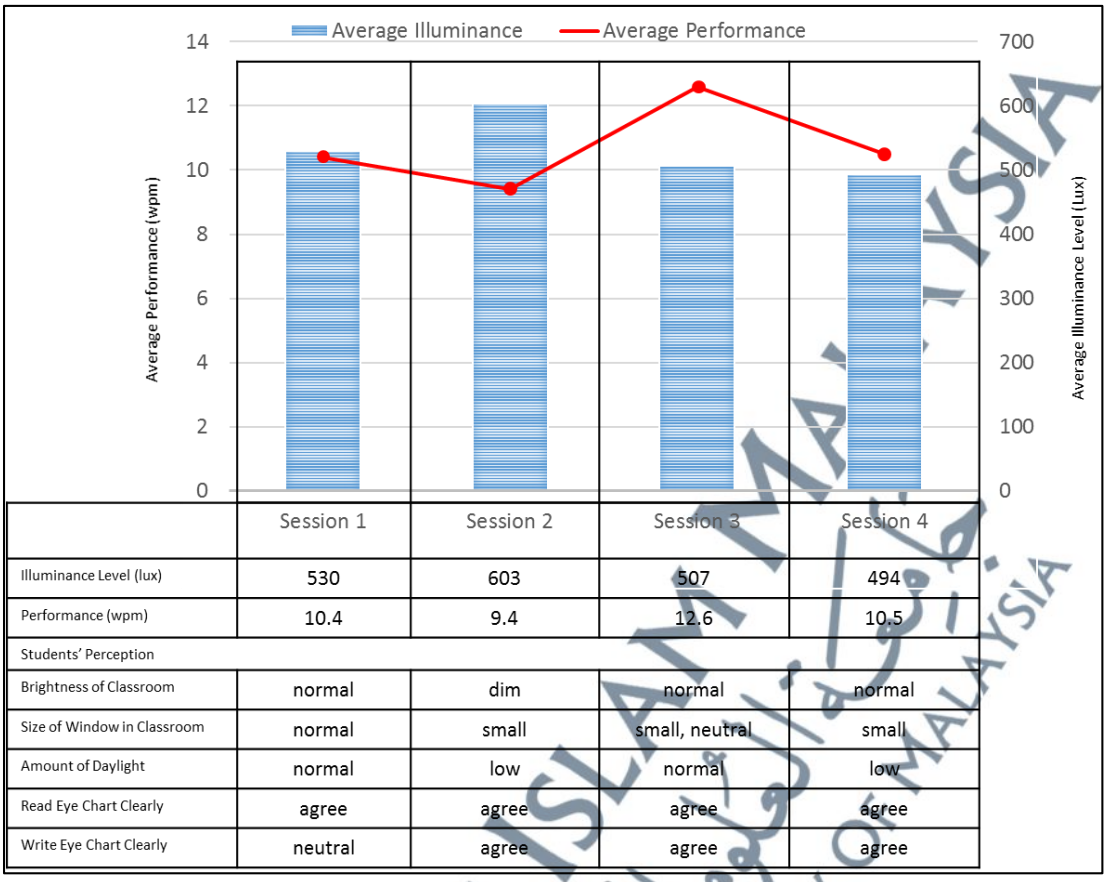
Figure 4.41 shows the average illuminance level measured at 900mm working plane height, students' perceptions and average students' performance of each session conducted in Experiment One. Session One conducted in Classroom One shows that the students' performance was higher than the average performance of the same age group, even though the average illuminance level was lower than recommended, which correlated with the students' perception of low daylight condition in the classroom. Although, the students' perception of the reading and Arabic handwriting performance was high, where the students very agree and agree for both task performances

respectively. This shows that the acceptable average illuminance level for students' optimum Arabic handwriting performance should be lower than standards and guidelines recommendation.

Other sessions in Experiment One shows that the average illuminance level were within the range of standards and guideline recommendation, which correlated with the students' perception of normal daylight condition in the classrooms. However, the students' performance was low, even though the students agreed that they can read and write the eye chart clearly. This result shows clearly that a higher illuminance level in the classroom decreases the students' performance and a lower than recommended illuminance level increases the students' performance significantly.

4.5.2 Experiment Two

Experiment Two session was conducted to identify the suitable average illuminance level for Arabic handwriting performance at working plane height at 300mm in classrooms with window sill height of 900mm.



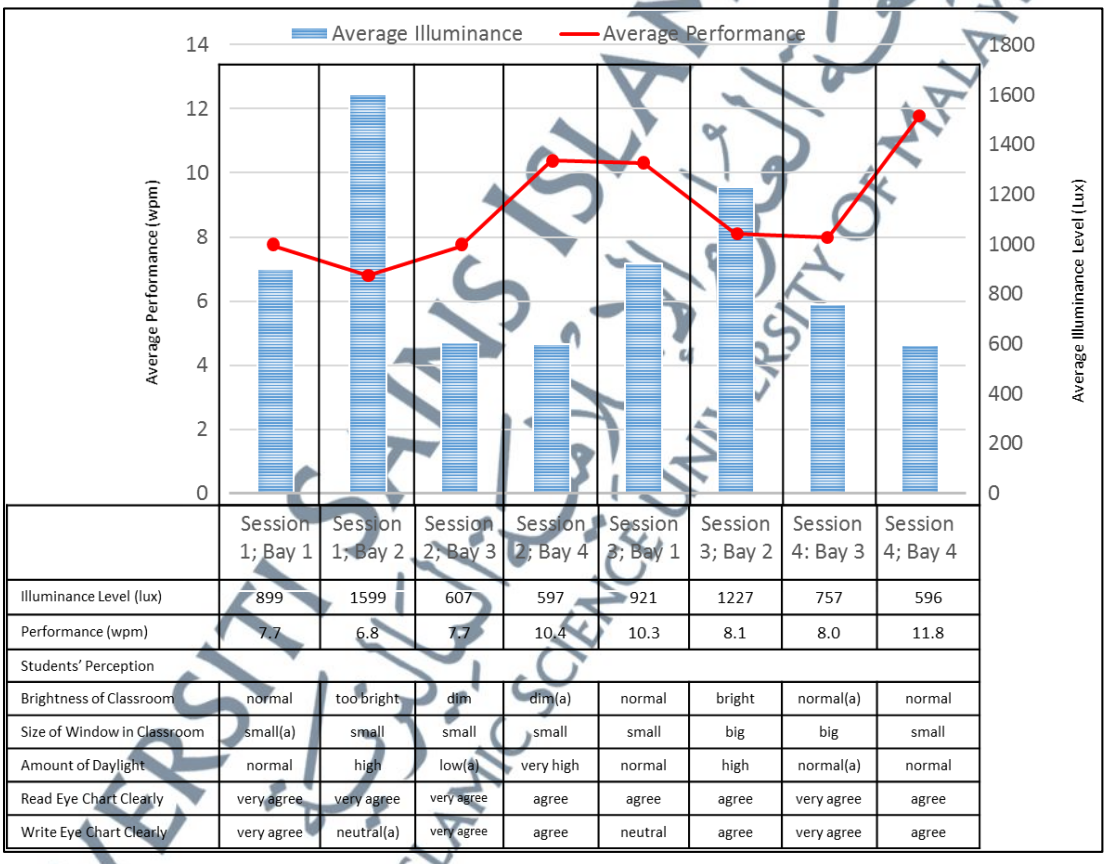
	Session 1	Session 2	Session 3	Session 4
Illuminance Level (lux)	530	603	507	494
Performance (wpm)	10.4	9.4	12.6	10.5
Students' Perception				
Brightness of Classroom	normal	dim	normal	normal
Size of Window in Classroom	normal	small	small, neutral	small
Amount of Daylight	normal	low	normal	low
Read Eye Chart Clearly	agree	agree	agree	agree
Write Eye Chart Clearly	neutral	agree	agree	agree

Figure 4.42: Experiment Two; Data Analysis

Figure 4.42 shows the average illuminance level, students' perceptions and average students' performance correlation in each session conducted in Experiment Two. All sessions conducted shows that the students' performance was low, which related to the high average illuminance level that exceeds the recommended value measured at 300mm working plane. Although the average illuminance level in Session Four was in the recommended range, the students' performance was still low. The factors correlated in this experiment was the height of the working plane and the window sill. Different height between the working plane and window sill influences the average illuminance level. Therefore, suggested that classrooms with 900mm window sill height were not suitable for Arabic handwriting task at 300mm working plane height of a *rehal*.

4.5.3 Experiment Three

Experiment Three sessions were to identify the illuminance level at *hafazan* learning task working plane of 300mm height in a classroom layout with a window sill height of 300mm and 1.1m window head height from the floor level. The cross-referenced results of illuminance level and students' performance will identify the acceptable illuminance level for Arabic handwriting task in this particular classroom layout design.



	Session 1; Bay 1	Session 1; Bay 2	Session 2; Bay 3	Session 2; Bay 4	Session 3; Bay 1	Session 3; Bay 2	Session 4: Bay 3	Session 4; Bay 4
Illuminance Level (lux)	899	1599	607	597	921	1227	757	596
Performance (wpm)	7.7	6.8	7.7	10.4	10.3	8.1	8.0	11.8
Students' Perception								
Brightness of Classroom	normal	too bright	dim	dim(a)	normal	bright	normal(a)	normal
Size of Window in Classroom	small(a)	small	small	small	small	big	big	small
Amount of Daylight	normal	high	low(a)	very high	normal	high	normal(a)	normal
Read Eye Chart Clearly	very agree	very agree	very agree	agree	agree	agree	very agree	agree
Write Eye Chart Clearly	very agree	neutral(a)	very agree	agree	neutral	agree	very agree	agree

Figure 4.43: Experiment Three; Data Analysis

Figure 4.43 shows the average illuminance level, students' perceptions and average students' performance of this experiment. The range of average illuminance level was very high, which was not acceptable in any standards and guidelines. Proven that higher average illuminance level negatively influenced the students' performance due to glare

and visual discomfort, where the highest students' performance was in classroom with the lowest average illuminance level, and the lowest students' performance was in classroom with the highest average illuminance level. This shows a clear relationship between average illuminance level and students' average performance in classrooms with 300mm window sill height using *rehal* 300mm working plane height. Thus, the *Tasmi'* classroom layout design was not recommended for Arabic handwriting task at 300mm working plane height.

4.5.4 Discussion and Analysis

Figure 4.44 shows that the students' Arabic handwriting performance was higher when the average illuminance level was lower. The only acceptable Arabic handwriting performance score was in a classroom that had low average illuminance level of 280 lx. The classroom window sill height was 900mm, while illuminance level and Arabic handwriting performance were measured at 900mm working plane height.

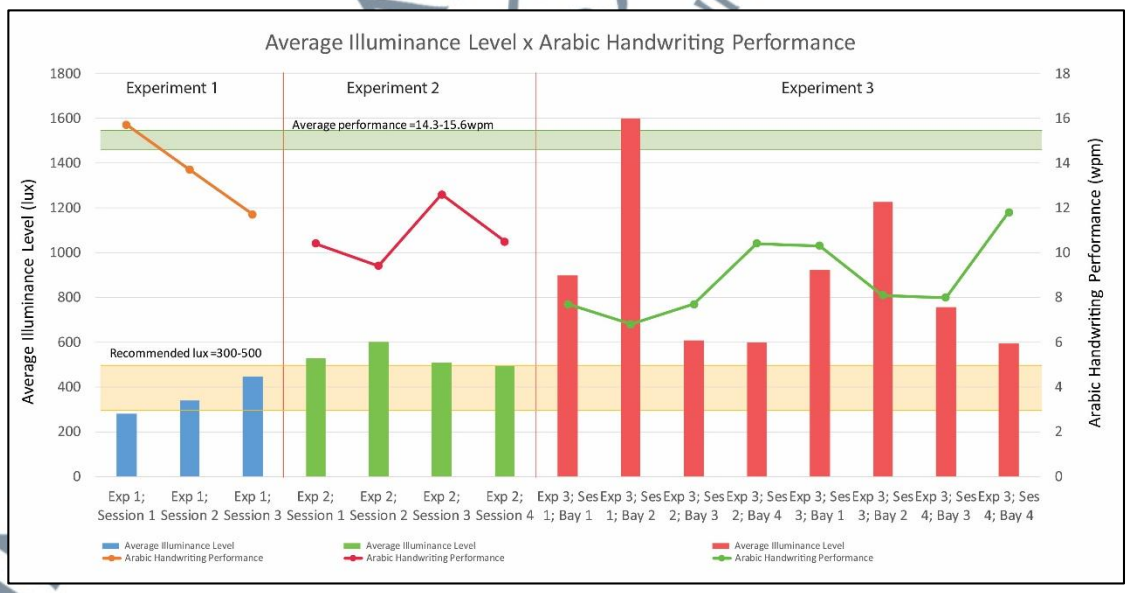


Figure 4.44: Experiment Average Illuminance Level and Arabic Handwriting Performance

The results of Arabic handwriting performance at 300mm working plane height in classrooms with 900mm and 300mm window sill height were low due to high average illuminance level, which created glare and visual discomfort to the students during the Arabic handwriting task.

Different classroom parameter such as smaller floor area and lower window head height in Experiment Three was not suitable for Arabic handwriting task since that the average illuminance level measured at 300mm working plane height was too high, which significantly decreases the students' Arabic handwriting performance to be very low. Therefore, the next phase of the research was to require the suitable window sill and head height in a classroom that catered for Arabic handwriting task using *rehal* with 300mm working plane height through computer simulation.

4.6 Daylighting Simulation

The daylight simulation using IESVE evaluates various window sill height for students' optimum *hafazan* learning task performance at a working plane of 300mm height, which refers to objective two of the research. The parameter of the variables identified in the experiments such as the size of classrooms and acceptable illuminance levels for Arabic handwriting were used in the simulation process. The model setup requires the material internal reflectance (%) to simulate the illuminance level of the space. The reflectance values for each internal material and components were 0.7 (70%) for ceiling, 0.3 (30%) for floor and 0.5 (50%) for walls, as shown in figure 4.45. The transmittance value was 0.81 (81%) from a single glazed unit with clear glass panels windows located on both sides of the classroom.

Construction/Material ID	External area (m²)	External reflectance (%)	Internal area (m²)	Internal reflectance (%)
STD_CEIL	119.00	70	119.00	70
STD_FLO1	297.50	0	59.50	30
STD_ROOF	297.50	10	59.50	70
STD_WAL1	675.45	50	225.15	50

Figure 4.45: Simulation Parameter Setup

The simulated classrooms had the same parameter set up except for the window sill height, as shown in table 4.32. The window sill height range for each model was set at between 300mm to 900mm. Since that the window size and WFR were constant, the window sill height influenced the window head height, where range were between 1.5m to 2.1m. Each model's average illuminance level was only within the students' seating area, where the area was 2m margin from the walls, especially walls that had windows. The date for every simulation was 21 March at 10.00am, where the sky condition selected was intermediate according to CIE standard for Malaysia with global illuminance level of 60,000 lx.

Table 4.32: Classroom Simulation Parameter

Parameter	Detail
Dimension	7m x 8.5m x 3.5m
Floor area	59.5m^2
Window dimension	1.2m x 5m
Window to Floor Ratio (WFR)/Window area	20% / 12m^2
Window sill/head height	300mm/1.5m 400mm/1.6m 500mm/1.7m 600mm/1.8m 700mm/1.9m 800mm/2.0m 900mm/2.1m
Window orientation	North/south

Regression analysis using SPSS based on the field measurement and the simulation identify the reliability of the daylighting simulation parameter setup, as shown in table 4.33, where both Experiment One and Experiment Two were combined. Experiment

Three was not included since the regression result was invalid due to different classroom design and condition.

Table 4.33: Regression Model Summary

Model Summary[b]

R	R Square	Adjusted R Square	R Square Change
0.883a	0.780	0.736	0.780

a. Predictors: (Constant), lx
b. Dependent Variable: lx

The regression analyses the average illuminance level measured in classrooms as an independent or explanatory variable and average illuminance level simulation as a dependent variable. The R-value shown above explains a simple correlation between average illuminance level measured and average illuminance level simulation. R-value of 0.833 (83.3%) indicates that the correlation between the two variables was high. The R^2 value of 0.780 shows that the total variation in the average illuminance level simulation explained by the average illuminance level measured at a very large percentage of 78 per cent.

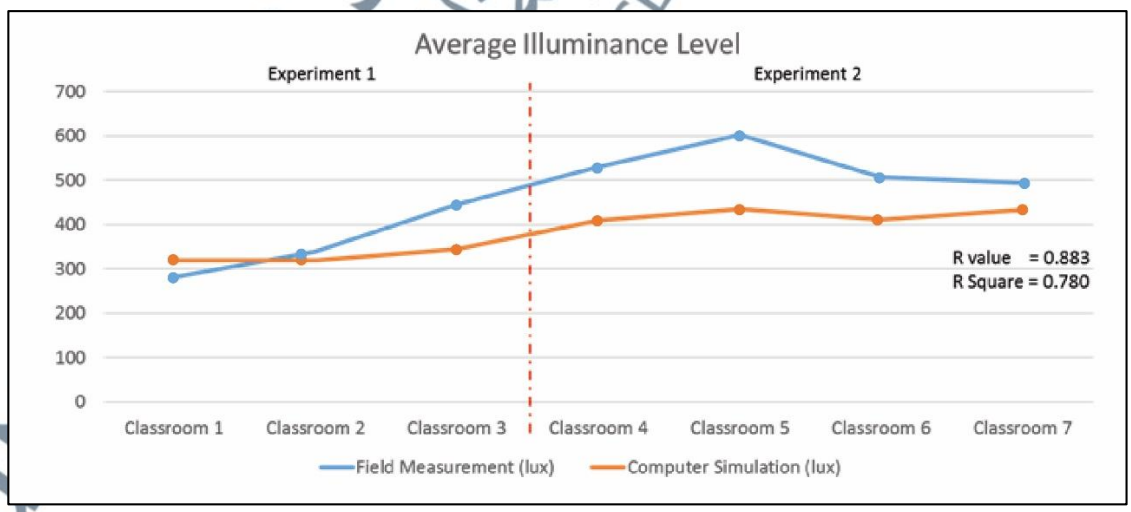


Figure 4.46: Average Illuminance Level Regression Graph

Figure 4.46 shows the regression graph for average illuminance level measured and average illuminance level simulation with a high R-value and a very large R^2 value. Thus, the daylighting simulation parameter set up for the regression analysis was reliable to simulate the average illuminance level for classrooms with a various window sill height.

4.6.1 Window Sill Height Simulation

The simulation result of each model shows the minimum, maximum and average values of daylight factor and daylight illuminance level. The grid or point illuminance measurement result shows the back-coloured numeric grid point values graphs that identify the daylight distribution and uniformity. However, only illuminance grid point values within the 2m margin away from the walls. This area was also the students' seating area. Therefore, the seating area average illuminance level was considered and emphasized in this study.

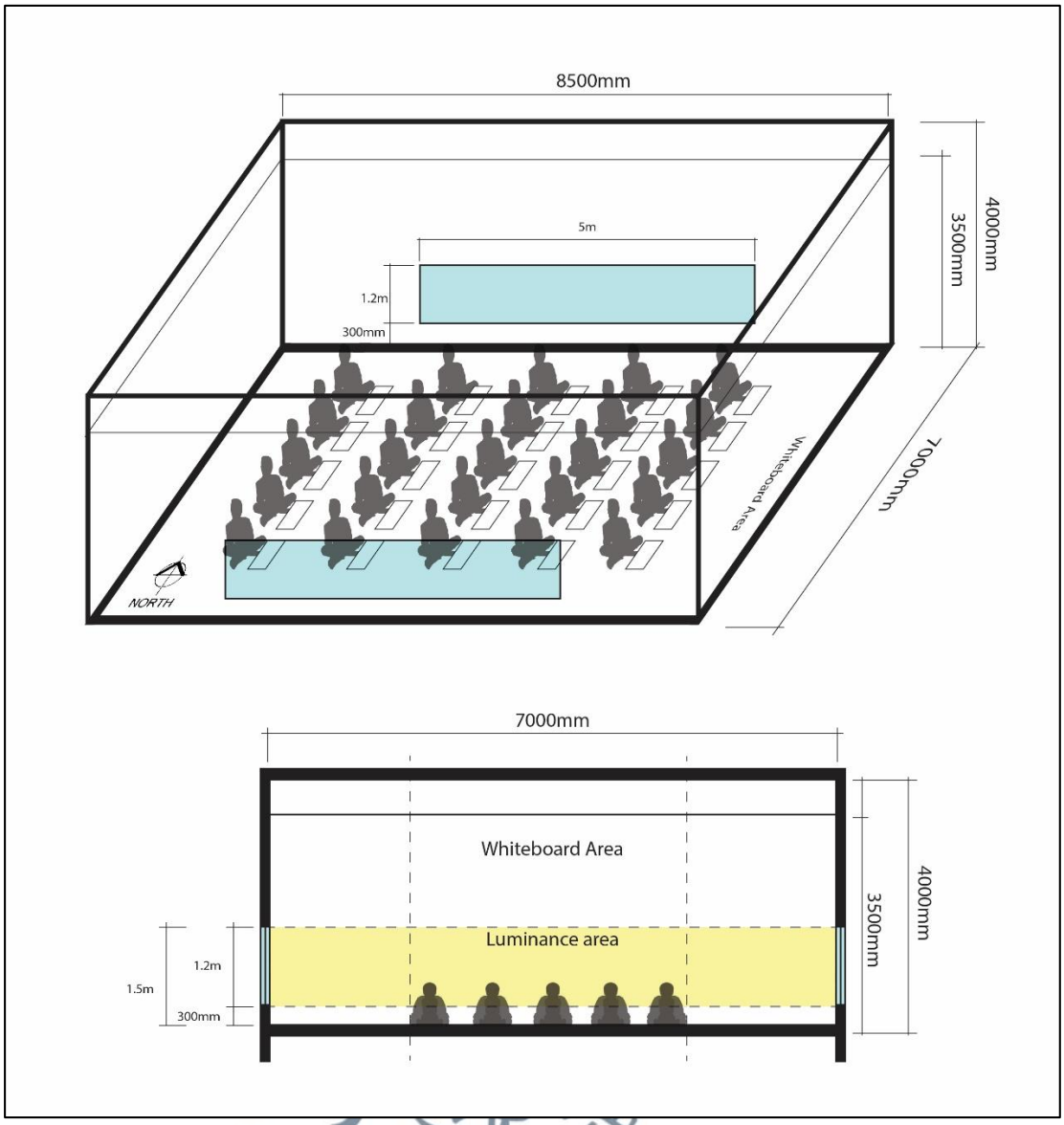


Figure 4.47: Simulation Model; Window Sill Height 300mm

Figure 4.47 shows the simulation model for the classroom with a 300mm window sill height and 1.5m window head height. The students' sitting area was 2m margin away from the walls with windows, while the front of the classroom with a 2m margin was allocated for whiteboard and the back of the classroom was for cupboards and shelves. The simulation model section shows the luminance area between the window head height and the working plane. The luminance area was 1.2m above the 300mm working plane height.

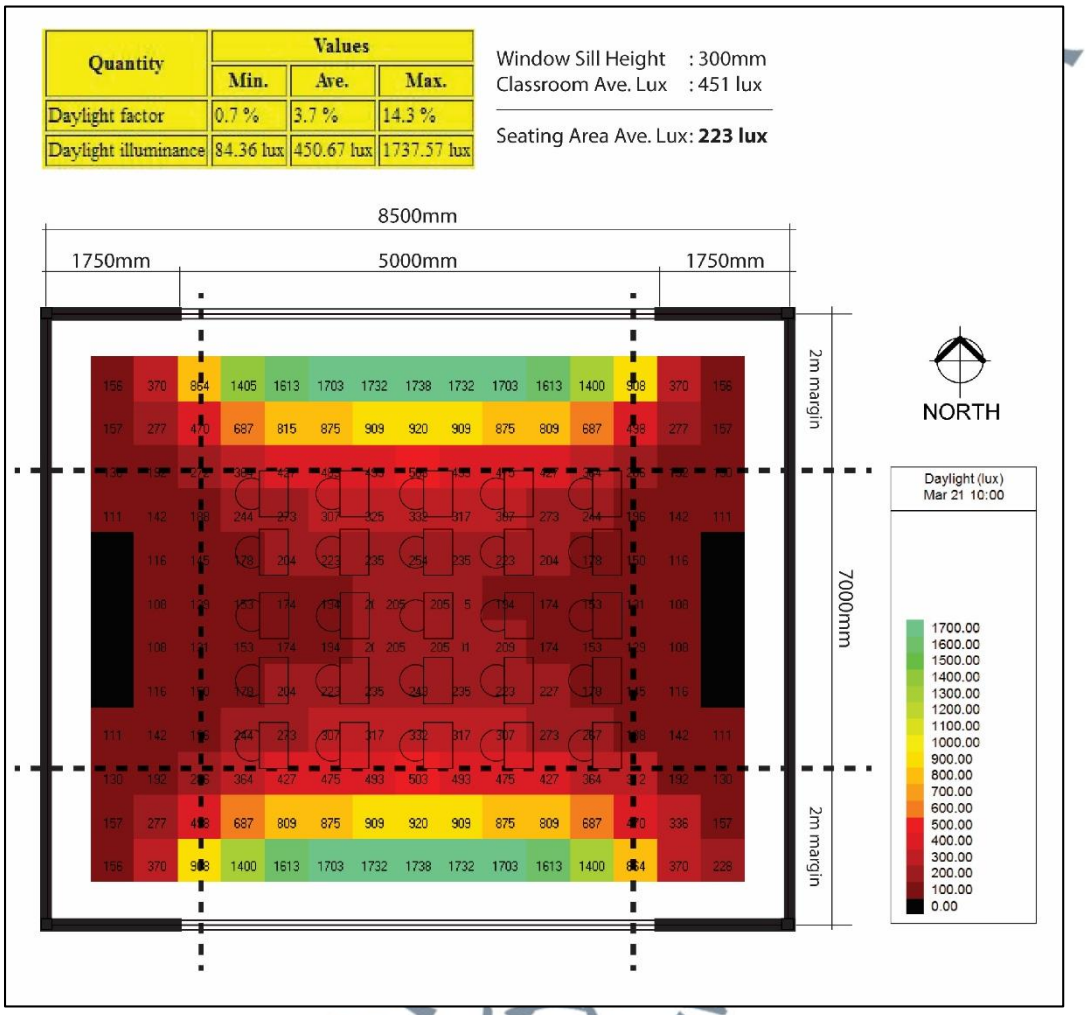


Figure 4.48: Illuminance Level Simulation; Window Sill Height 300mm

The illuminance level simulation result for 300mm window sill height in figure 4.48 shows that the classroom's average illuminance level was 451 lx. Meanwhile, the average illuminance level within the students' seating area located within the 2m margin was 223 lx. The uniformity ratio of the simulation was acceptable based on standards and guidelines by JKR, which was 0.7. The students' seating area achieved an average illuminance level which was acceptable for Arabic handwriting tasks as identified in Experiment One.

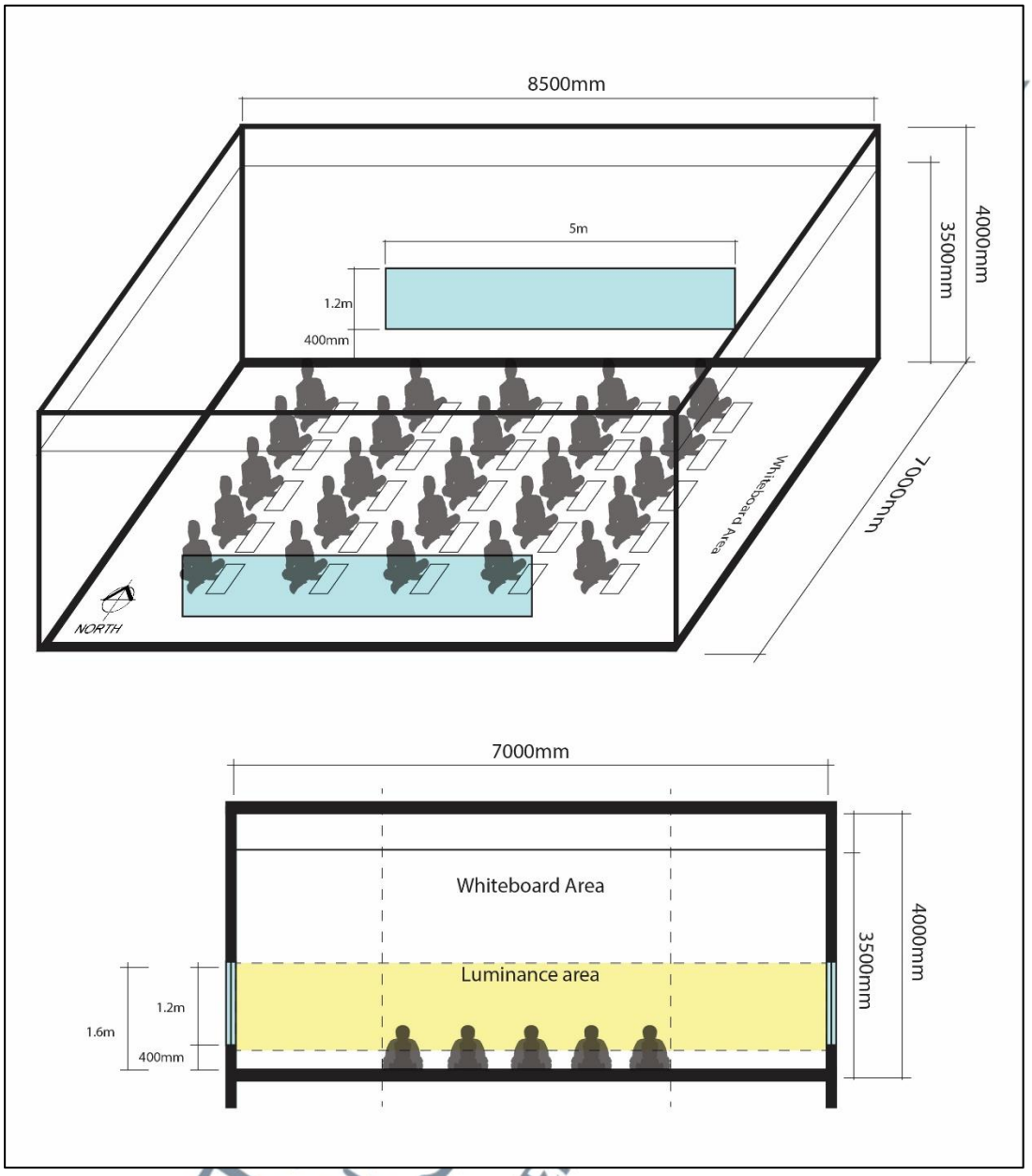


Figure 4.49: Simulation Model; Window Sill Height 400mm

Figure 4.49 shows the simulation model for the classroom with a 400mm window sill height. The window head height of the simulation was 1.6m. The luminance area was 1.3m above the 300mm working plane height as shown in the simulation model section.

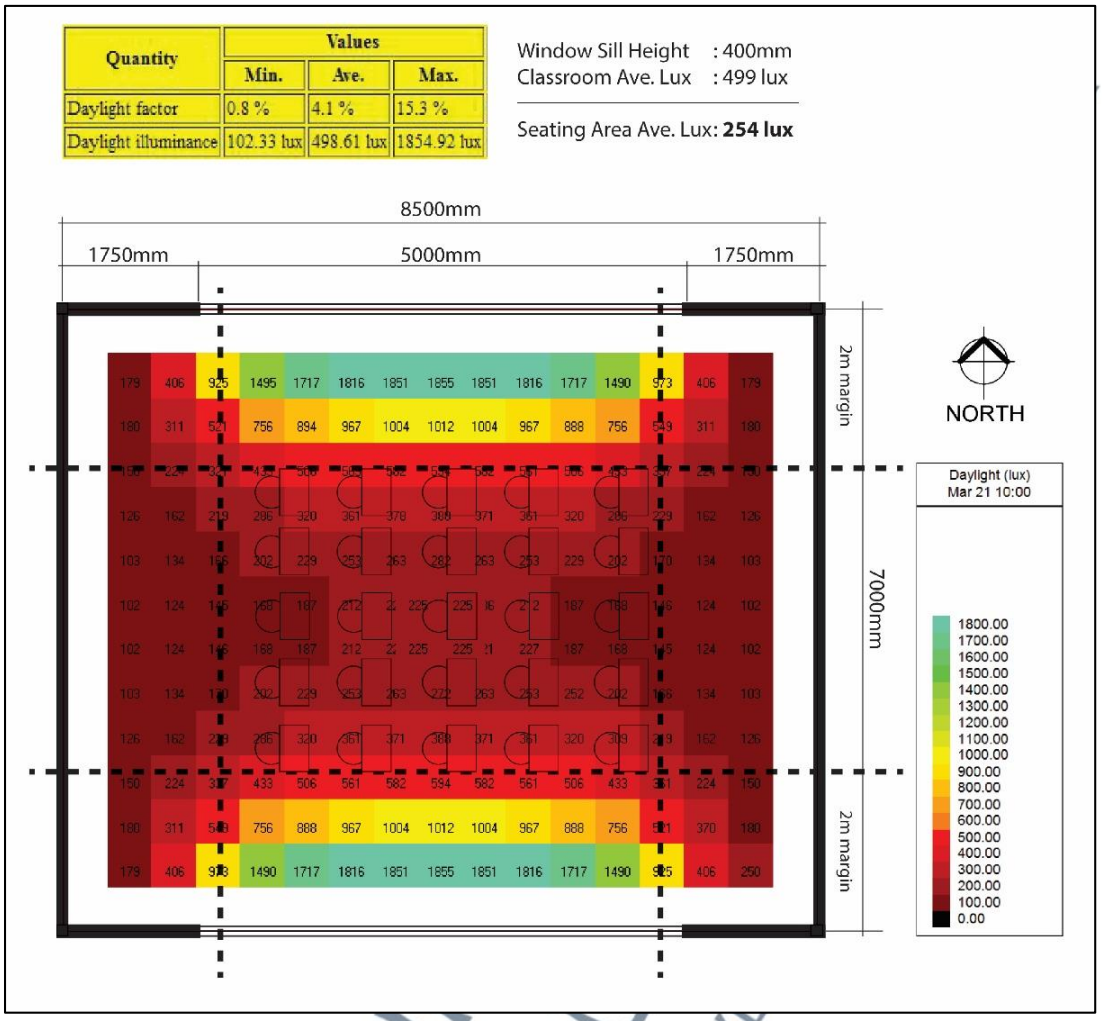


Figure 4.50: Illuminance Level Simulation; Window Sill Height 400mm

The illuminance level simulation result in figure 4.50 shows that the classroom's average illuminance level was 499 lx. Meanwhile, the average illuminance level within the students' seating area located within the 2m margin was 254 lx, where the uniformity ratio of the simulation was acceptable at 0.7. The students' seating area achieved the average illuminance level acceptable for Arabic handwriting tasks, similarly with simulation for window sill height of 300mm.

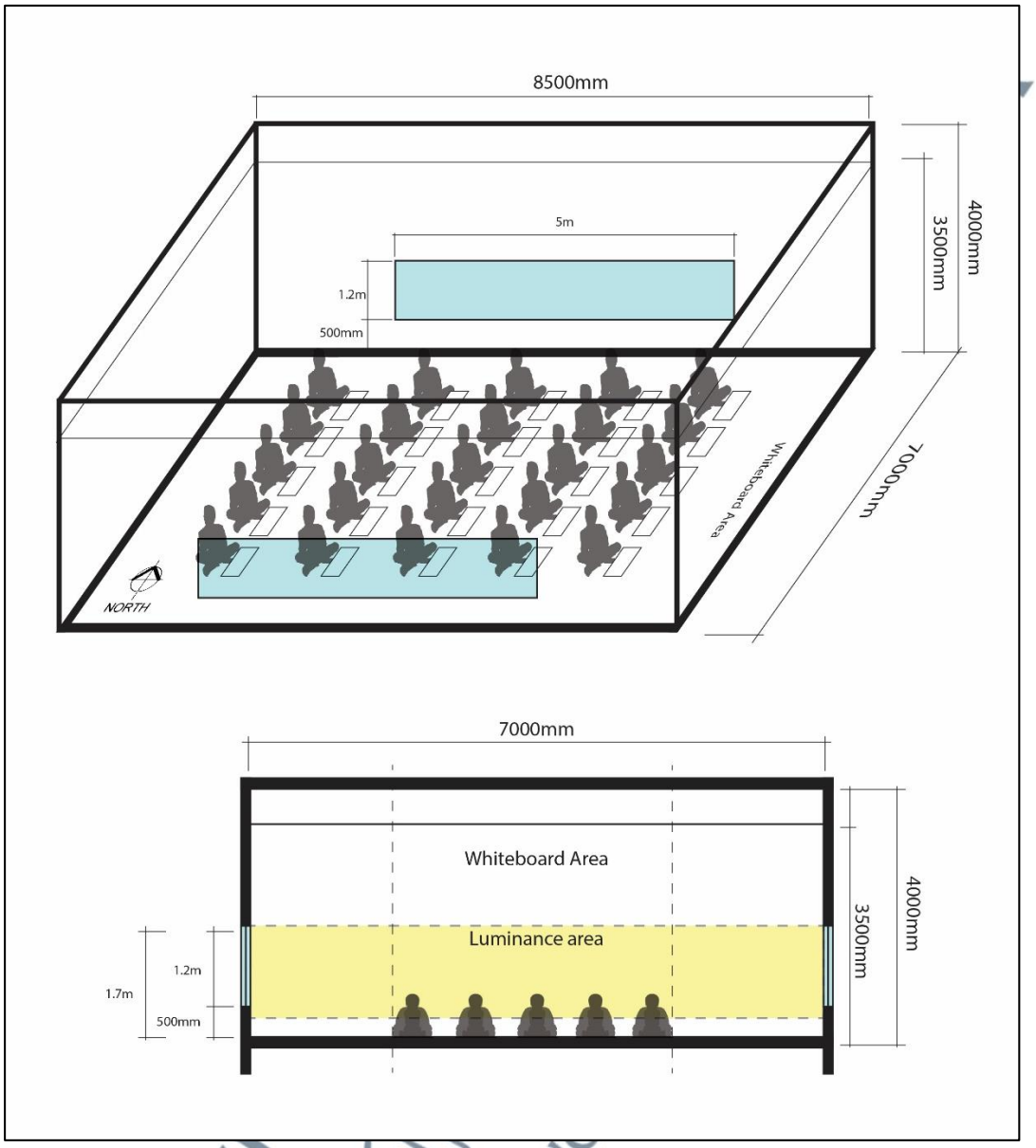


Figure 4.51: Simulation Model; Window Sill Height 500mm

Figure 4.51 shows the simulation model for the classroom with a 500mm window sill height and 1.7m window head height. The simulation model section shows the luminance area between the window height and the working plane. The luminance area was 1.4m above the 300mm working plane height.

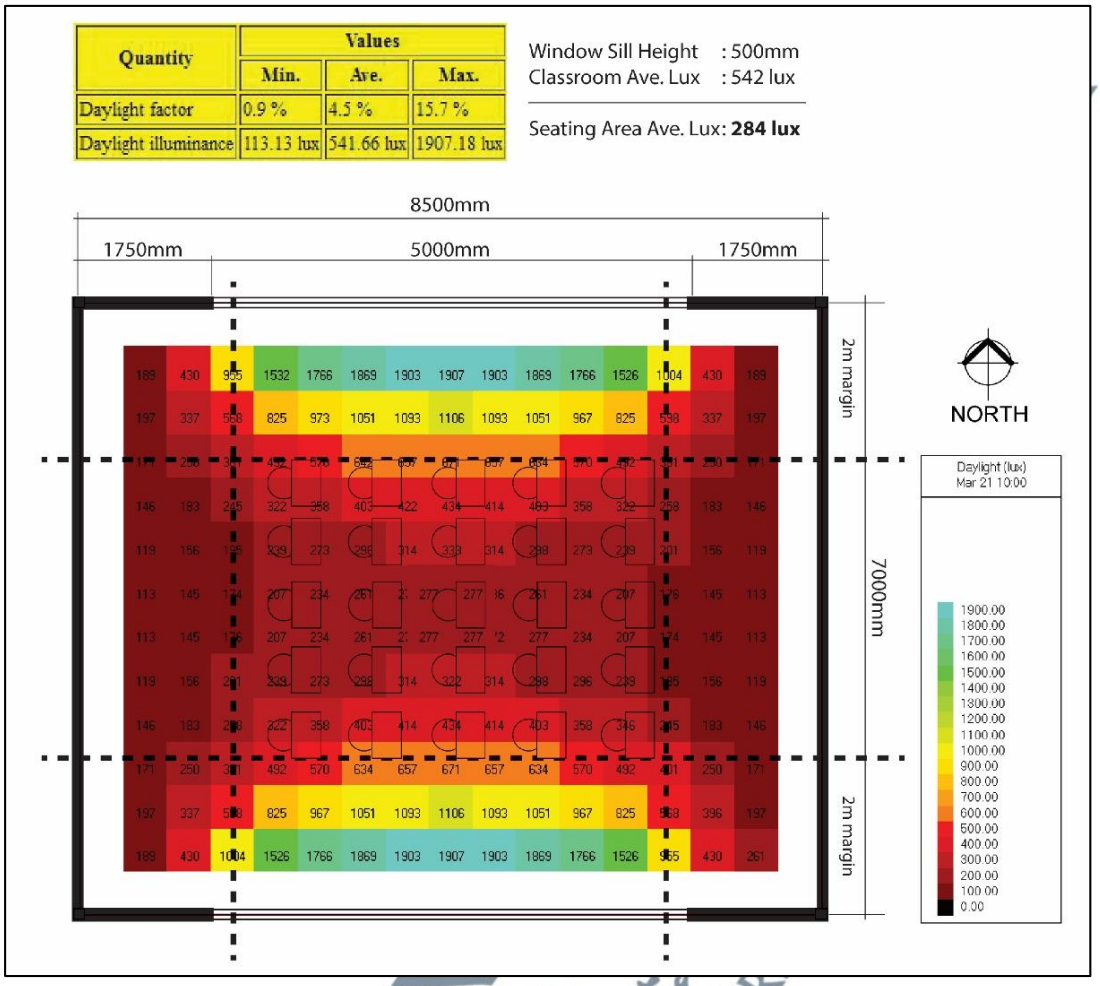


Figure 4.52: Illuminance Level Simulation; Window Sill Height 500mm

The illuminance level simulation result for 500mm window sill height in figure 4.52 shows that the classroom's average illuminance level was 542 lx, while the average illuminance level within the students' seating area was 284 lx. The students' seating area achieved an average illuminance level of 284 lx, where the uniformity ratio was within the acceptable range at 0.7. This shows that the classroom setup was acceptable for Arabic handwriting tasks.

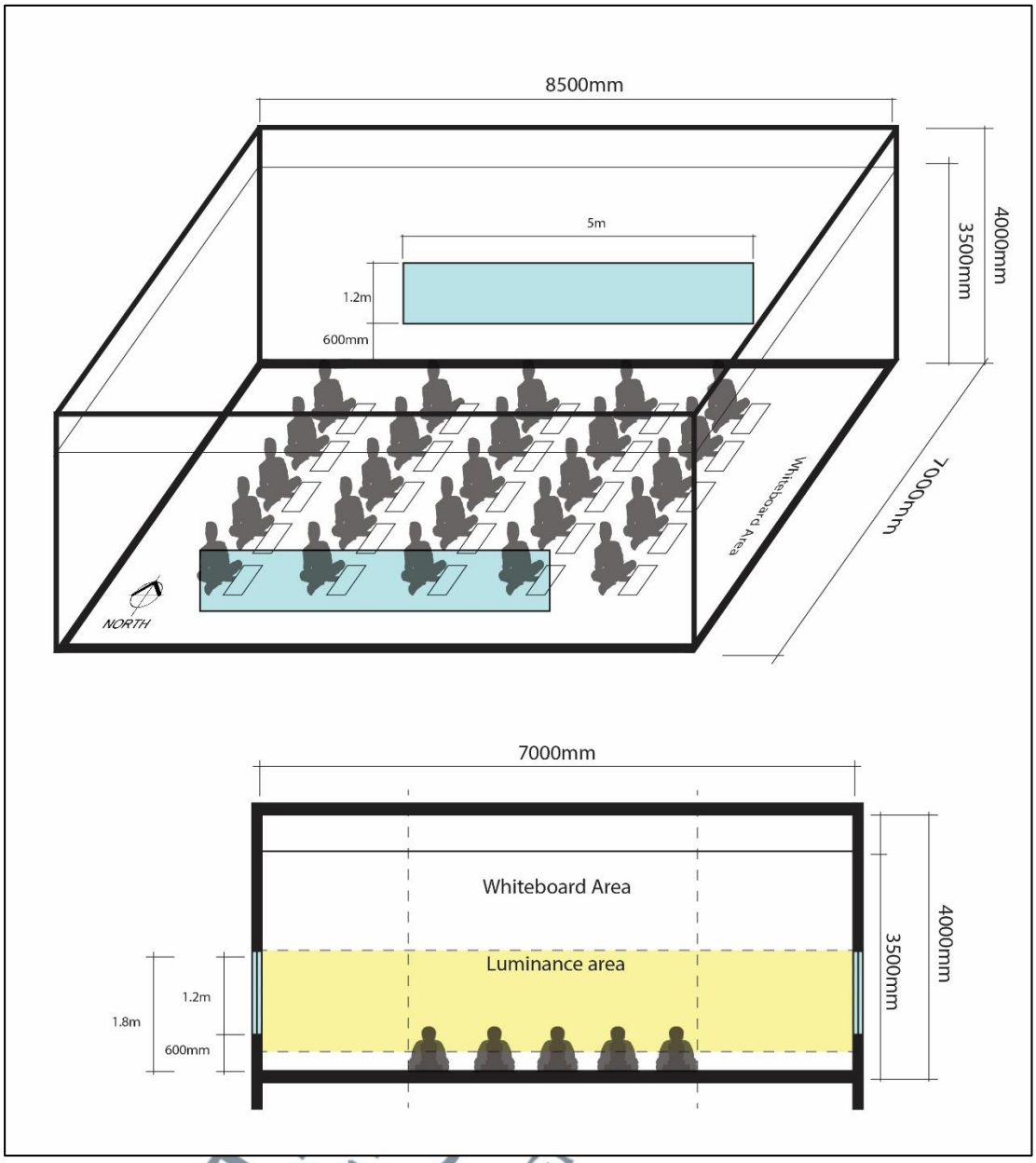


Figure 4.53: Simulation Model; Window Sill Height 600mm

Figure 4.53 shows the simulation model for the classroom with 600mm window sill height and 1.8m window head height, where the simulation model section shows the luminance area between the window height and the working plane was 1.5m above the 300mm working plane height.

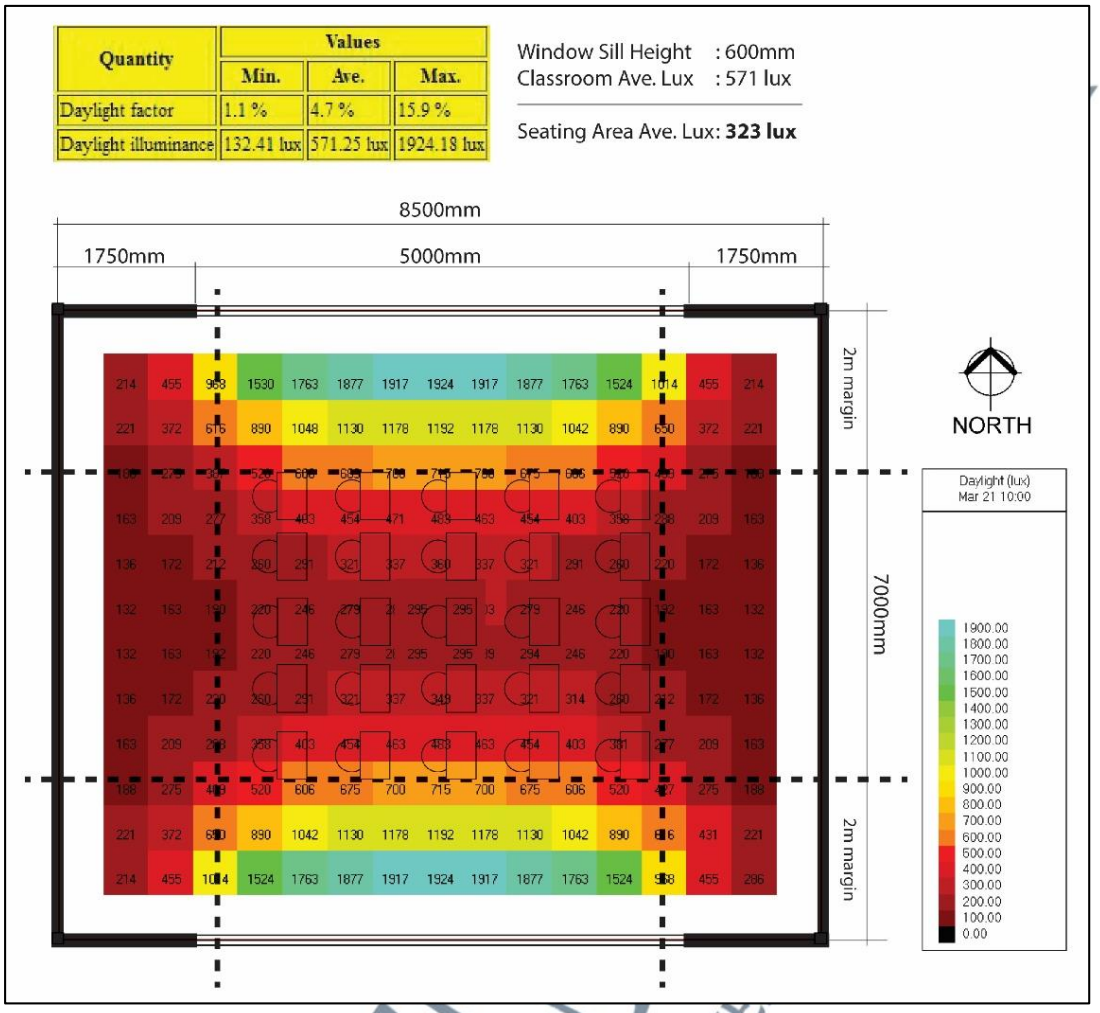


Figure 4.54: Illuminance Level Simulation; Window Sill Height 600mm

The illuminance level simulation result for 600mm window sill height in figure 4.54 shows that the classroom's average illuminance level was 571 lx with the average illuminance level within the students' seating area at 323 lx. Even though the uniformity ratio was 0.7, the students' seating area average illuminance level was higher than 280 lx, which was not acceptable for Arabic handwriting tasks as identified in Experiment One, Two and Three. Suggested that even though the uniformity ratio was acceptable, the daylight intensity was high due to higher window sill and window head height.

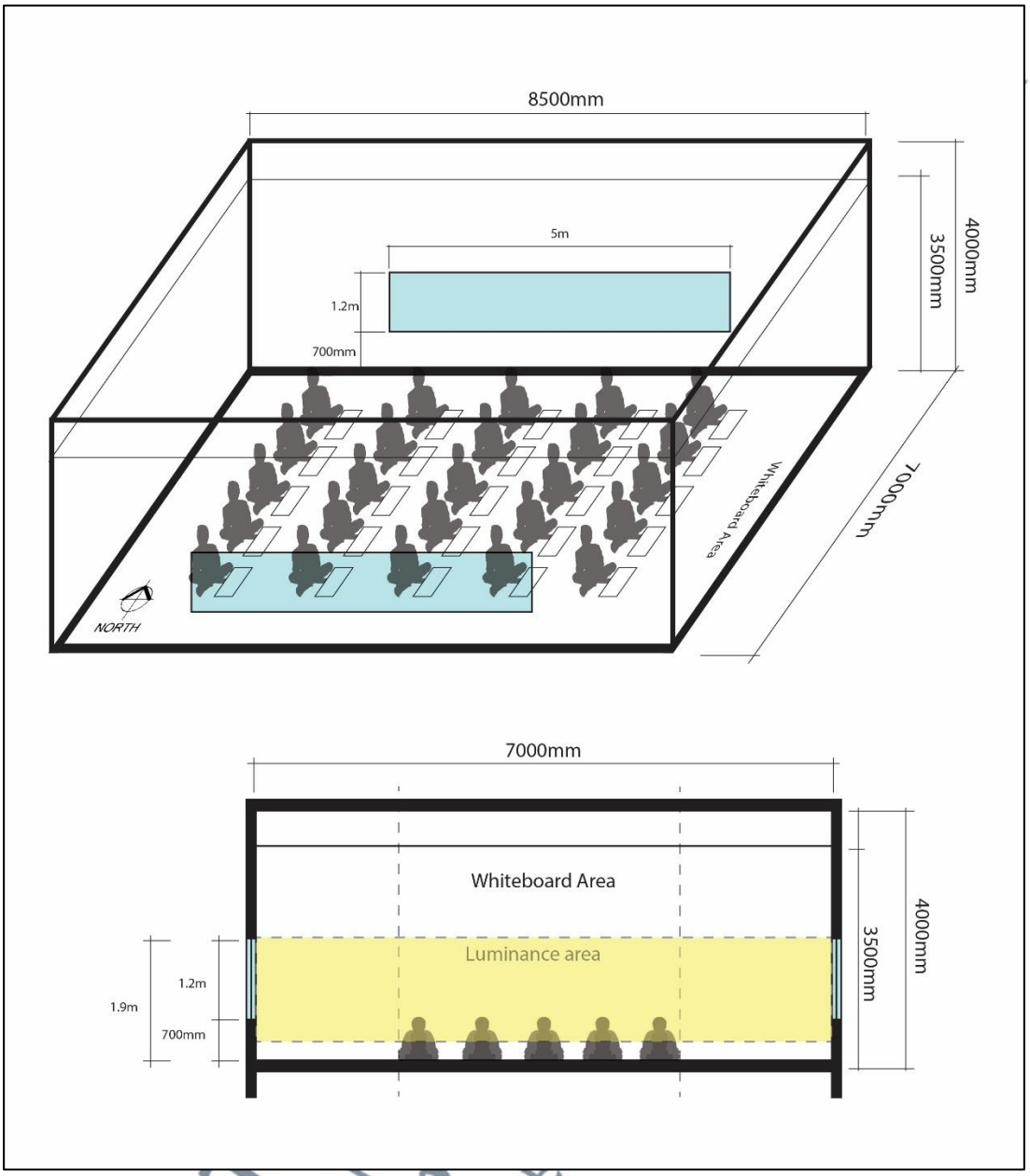


Figure 4.55: Simulation Model; Window Sill Height 600mm

Figure 4.55 shows the simulation model for the classroom with 700mm window sill height. The window head height was at 1.9m, where the simulation model section shows the luminance area was 1.6m above the 300mm working plane height.

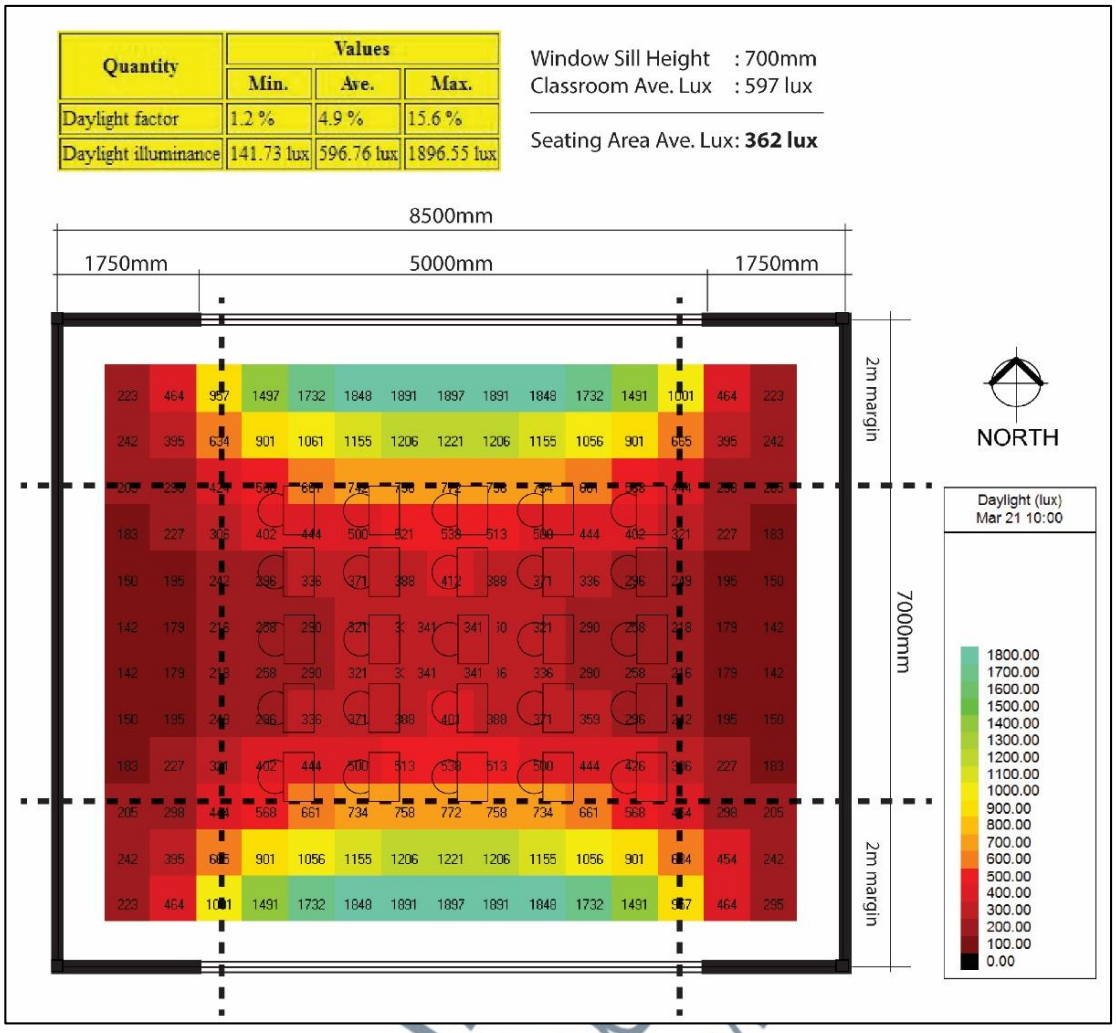


Figure 4.56: Illuminance Level Simulation; Window Sill Height 700mm

The illuminance level simulation result for 700mm window sill height in figure 4.56 shows that the classroom's average illuminance level was 597 lx. Meanwhile, the average illuminance level within the students' seating area located within the 2m margin was 362 lx. The uniformity ratio was the same with previous simulation with lower window sill height, which was 0.7. However, the students' seating area achieved an average illuminance level higher than 280 lx, which was not acceptable for Arabic handwriting tasks. The assumption was similar with simulation for window sill height at 600mm, where the window sill and window head height influenced the daylight intensity at working plane 300mm.

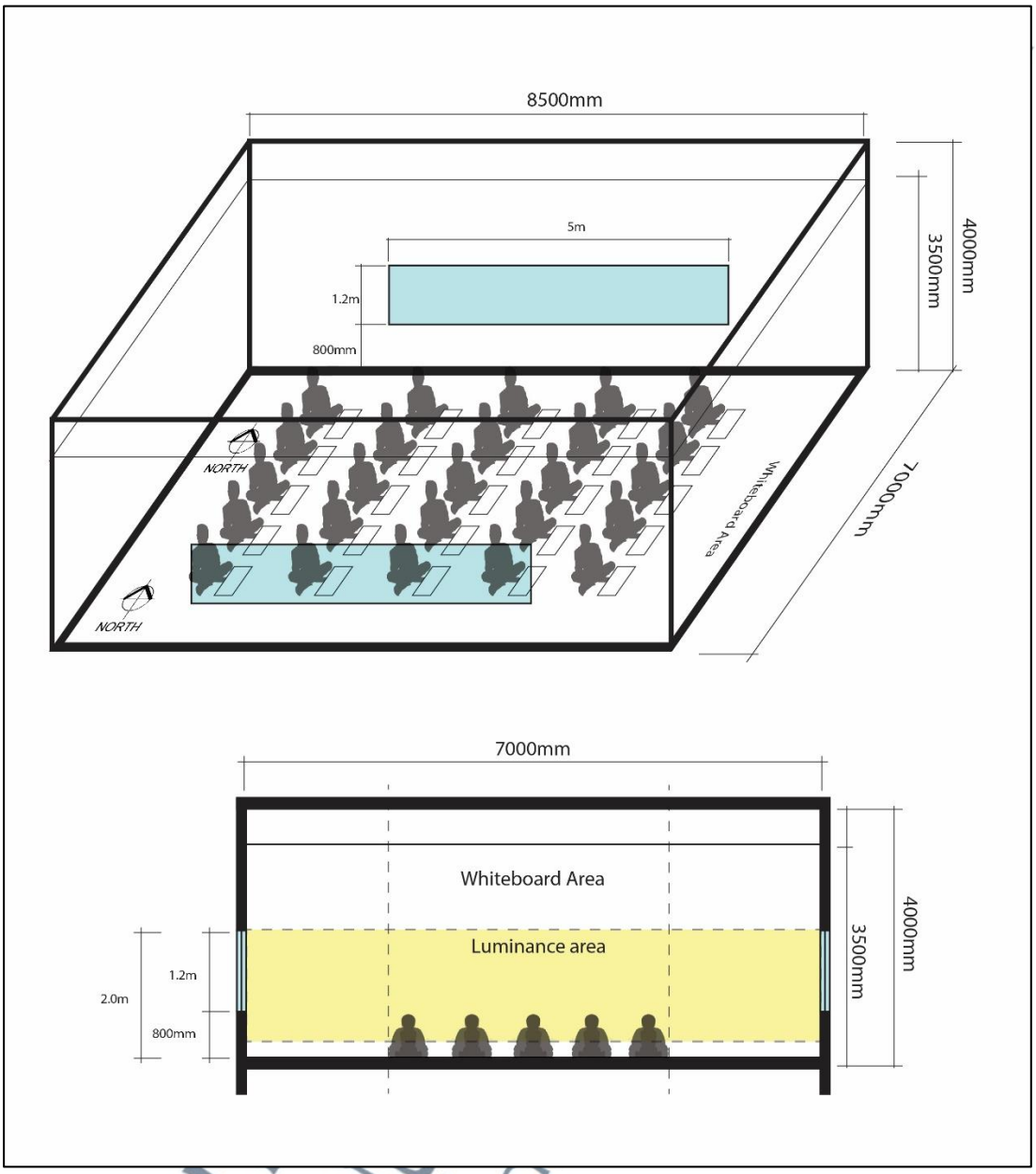


Figure 4.57: Simulation Model; Window Sill Height 800mm

Figure 4.57 shows the simulation model for the classroom with 800mm window sill height, while the window head height was 2m. The simulation model section shows the luminance area between the window height and the working plane 1.7m above the 300mm working plane height.

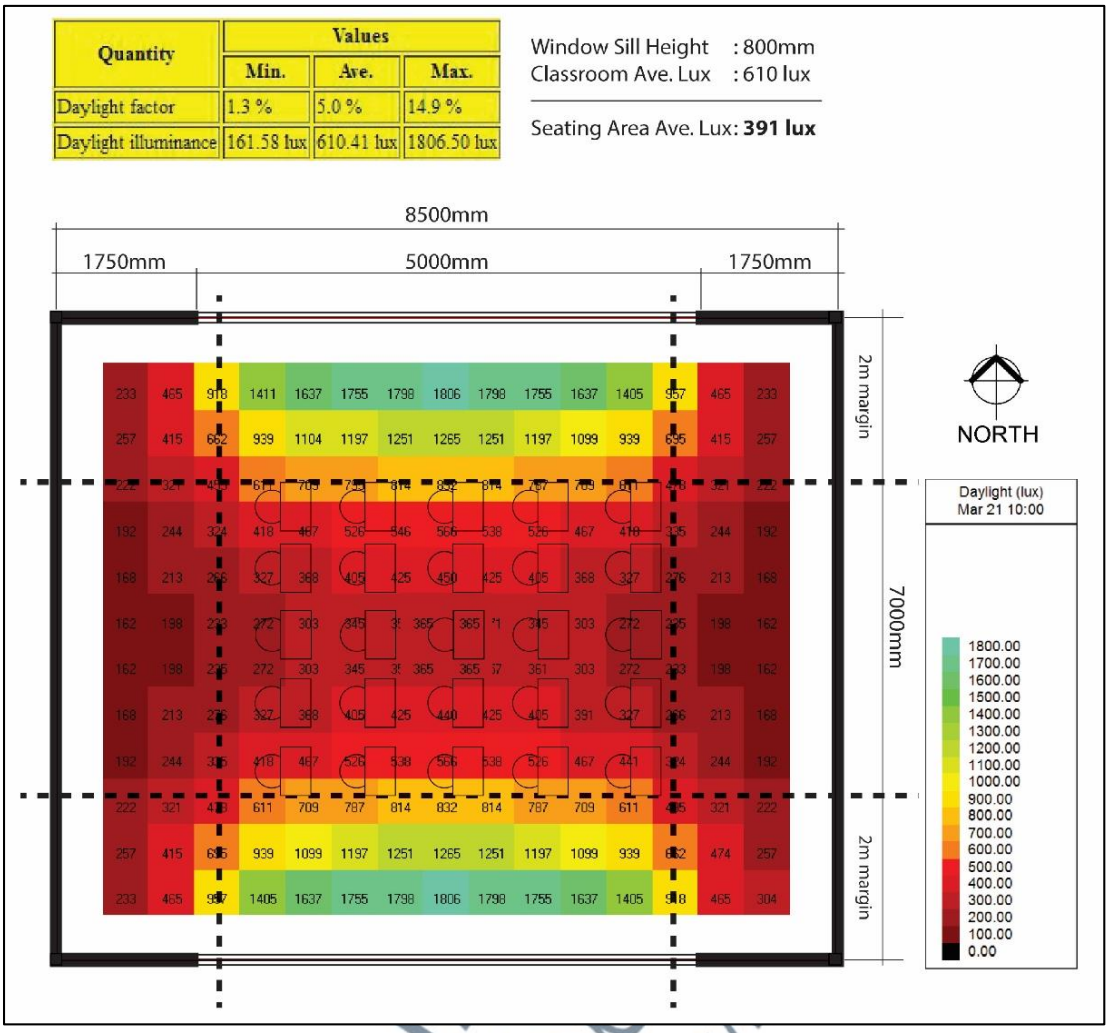


Figure 4.58: Illuminance Level Simulation; Window Sill Height 800mm

The illuminance level simulation result for 800mm window sill height in figure 4.58 shows that the classroom's average illuminance level was 610 lx. Meanwhile, the average illuminance level within the students' seating area was 391 lx. The students' seating area achieved an average illuminance level higher than 280 lx with uniformity ratio at 0.7, which the average illuminance level was still not acceptable for Arabic handwriting tasks. This also shows that higher window sill height and window head height increases the average illuminance level in the classroom.

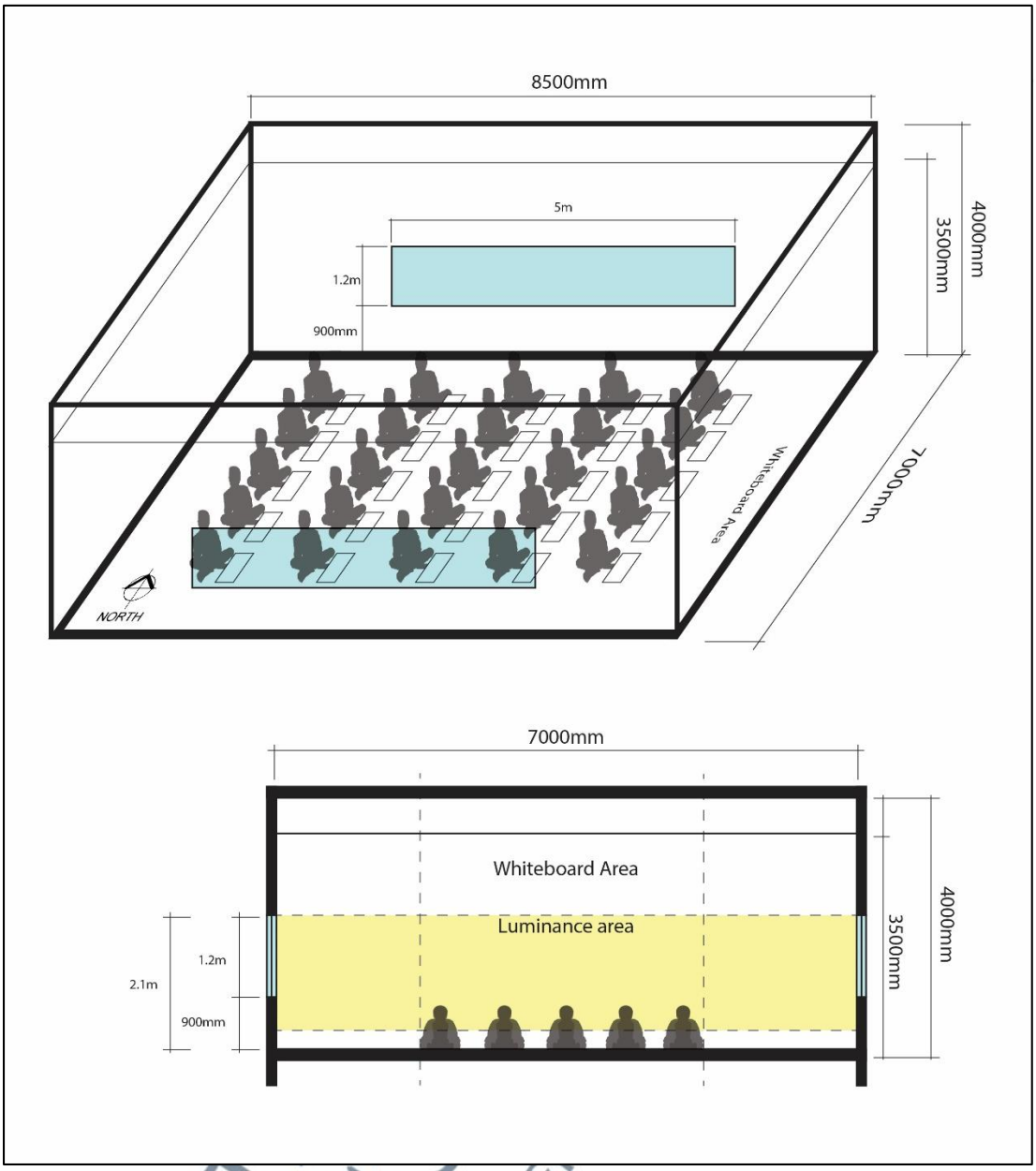


Figure 4.59: Simulation Model; Window Sill Height 900mm

Figure 4.59 shows the simulation model for the classroom with 900mm window sill height. The luminance area was 1.8m above the 300mm working plane height as shown in the simulation model section.

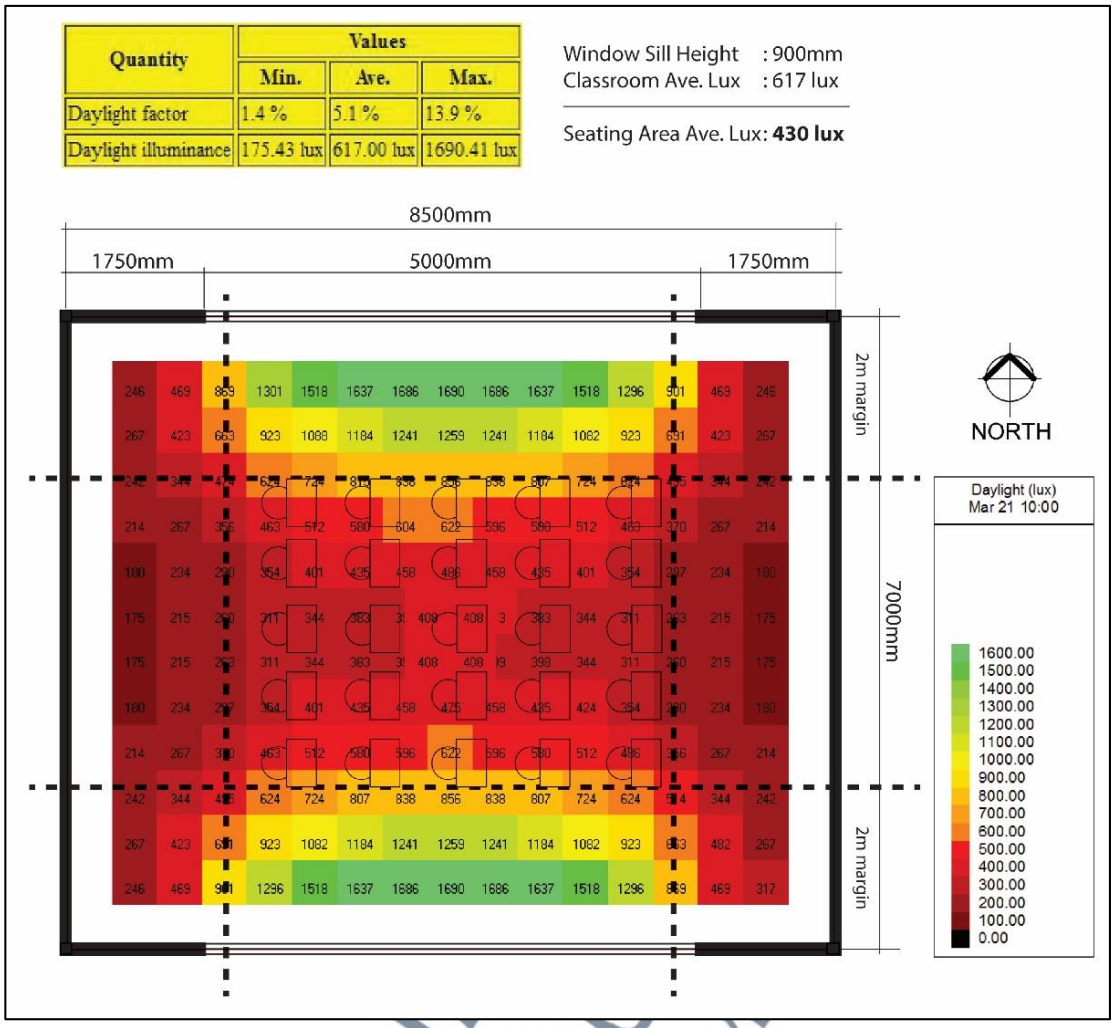


Figure 4.60: Illuminance Level Simulation; Window Sill Height 900mm

The illuminance level simulation result for 900mm window sill height in figure 4.60 shows that the classroom's average illuminance level was 617 lx, where the average illuminance level within the students' seating area was 430 lx with 0.7 uniformity ratio. Since the average illuminance was higher than the identified 280 lx, the classroom layout design was also not acceptable for Arabic handwriting tasks. This strengthen the suggestion that higher window sill height and window head height increases the average illuminance level of the classrooms when the working plane height was at 300mm.

4.6.2 Simulation Discussion and Analysis

The illuminance level simulation results for different window sill height shows a significant relationship between the window sill height, window head height and the average illuminance level measured at 300mm working plane height, where higher window sill increases the average illuminance level as shown in figure 4.61 and table 4.34. The results and findings of the computer simulation verified objective three of the research, which was to recommend the optimum window sill height from floor level that achieved acceptable illuminance level at 300mm height working plane.

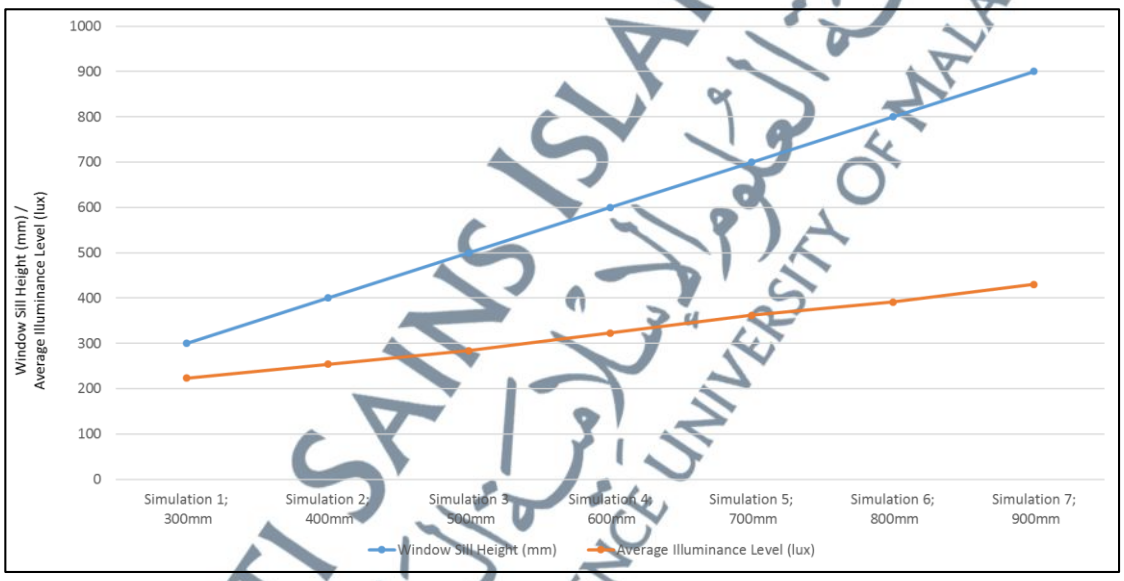
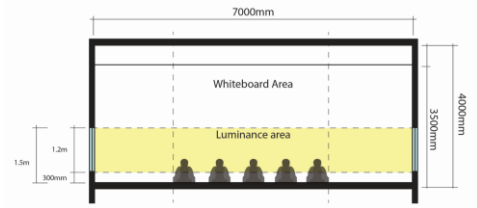
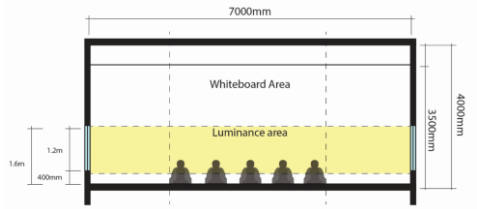
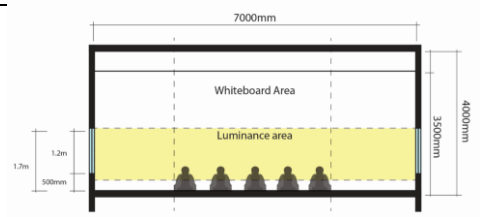
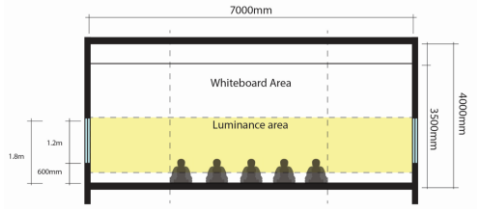
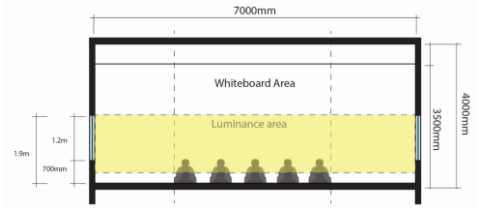
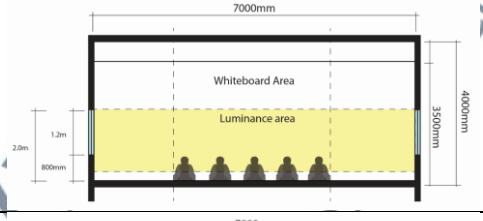
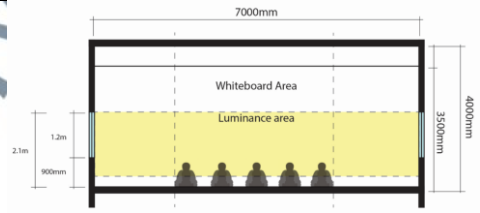


Figure 4.61: Window Sill Height Relation with Average Illuminance Level

The figure and table also shows the suitable window sill height that received average illuminance level within the seating area below 300 lx, which were 300mm, 400mm and 500mm with an average illuminance level of 223 lx, 254 lx and 284 lx respectively. The respective window head height of the simulations was also taken into consideration, where it was 1.5m, 1.6m and 1.7m. Thus, the recommended window sill height for classrooms that requires the students to perform Arabic handwriting tasks at 300mm working plane height ranged from 300mm to 500mm.

Table 4.34: Computer Simulation Results

No.	Window Sill Height (illustration)	Window Sill Height (mm)	Window Head Height (mm)	Average Lux Level (lx)
1		300	1.5	223
2		400	1.6	254
3		500	1.7	284
4		600	1.8	323
5		700	1.9	362
6		800	2.0	391
7		900	2.1	430

4.7 Summary

Experiment One result shows that very high students' average Arabic handwriting performance of 15.7 wpm was in a classroom with average illuminance level of 280 lx, which was 6.7 per cent lower than 300 lx recommended in standards and guidelines. This explains that the average illuminance level for optimum Arabic handwriting performance was lower than 300 lx. Experiment Two shows that average illuminance level measured at 300mm working plane height in classrooms with 900mm window sill height received higher than 300 lx. Thus, similarly suggested in the simulation, window sill height of 900mm was not suitable for Arabic handwriting tasks at 300mm working plane height. Experiment Three that had window sill height at 300mm as recommended in the simulation shows that it was still not suitable for Arabic handwriting tasks at 300mm working plane height. The small classroom size and smaller margin gap between the seating area and the window caused the average illuminance level to be very high at approximately 1600 lx.

The simulation results show that the average illuminance level received with a window sill height of 300mm, 400mm and 500mm were 223 lx, 254 lx, and 284 lx respectively. Classroom with 300mm window sill height received 20.4 per cent lower average illuminance compared to the suggested 280 lx from the experiment, while classroom with 400mm window sill height received 9.3 per cent lower average illuminance level. However, a classroom with 500mm window sill height received the closest value to 280 lx, which was only 1.4 per cent higher than suggested 280 lx. Therefore, the range of suitable window sill height was between 300mm to 500mm for Arabic handwriting tasks at 300mm working plane height.