

**WINDOW DESIGN FOR OPTIMUM
CLASSROOM DAYLIGHT IN ISLAMIC SCHOOL**

RAJA NUR SYAHEEZA RAJA MOHD YAZIT

UNIVERSITI SAINS ISLAM MALAYSIA

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IN ISLAMIC SCHOOL**

RAJA NUR SYAHEEZA RAJA MOHD YAZIT

Thesis submitted in fulfillment for the degree of
**DOCTOR OF PHILOSOPHY
SCIENCE AND TECHNOLOGY**

UNIVERSITI SAINS ISLAM MALAYSIA

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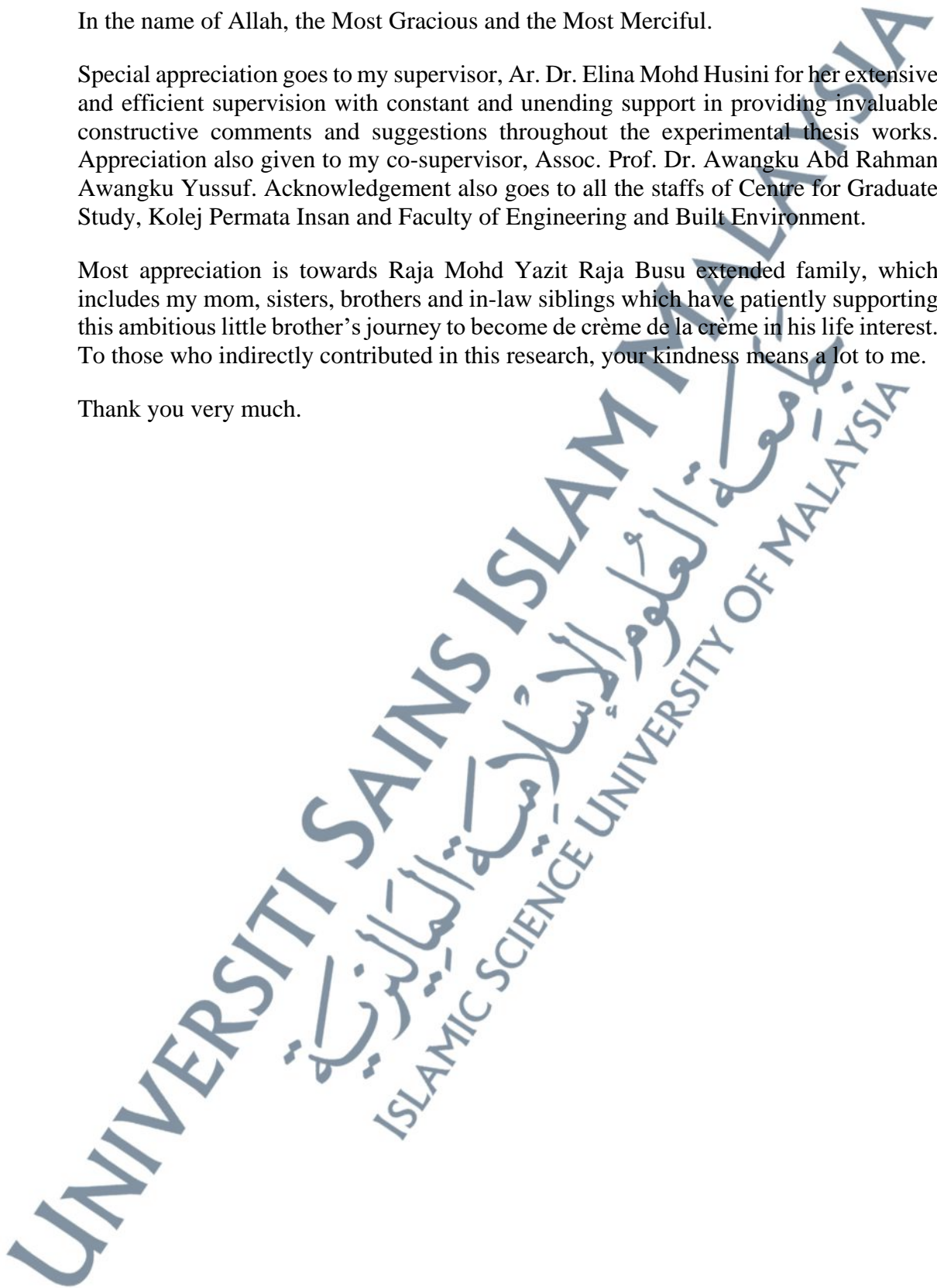
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نبذة مختصرة

يعمل ضوء النهار الفعال على تحسين أداء الطلاب مثل مهام الكتابة في الفصول الدراسية. يتم تقييم كفاية ضوء النهار في الفصل الدراسي من خلال تصميم النافذة القياسي ، والذي يمثل 20 في المائة من نسبة النافذة إلى يتم قياس مستوى الإنارة عند 800 مم إلى 900 مم بارتفاع سطح العمل مع عتبة النافذة في (WFR) الأرض نفس الارتفاع ، حيث هذه هي المتغيرات التي تركز عليها الأبحاث الأخرى في ضوء النهار في الفصول الدراسية. ومع ذلك ، فإن المدرسة الدينية الإسلامية التي تعطي الأولوية لمهام تحفيظ القرآن (حفزان) من خلال القراءة بارتفاع 300 مم من سطح العمل. نظرًا للممارسة (rehal) والكتابة باللغة العربية تستخدم مكتبًا منخفضًا للقراءة الحالية لدمج المواد الأكاديمية والدينية في الفصول الدراسية ، تتبع المدارس الدينية تصميم النافذة والجدول القياسي بارتفاع سطح العمل من 800 مم إلى 900 مم ، حيث سيؤثر استخدام إعادة التأهيل على مستوى الإضاءة المقيس. أهداف هذا البحث هي تحديد مدى مستويات الإنارة المقبولة لأداء الطلاب العرب الأمتل للكتابة اليدوية ، والتحقيق في متوسط مستوى الإنارة في الفصول الدراسية في المدرسة الدينية الحالية ، وتقييم ارتفاع عتبات النوافذ المختلفة لأداء الطلاب في الكتابة اليدوية العربية الأمتل للتعلم حافظان على سطح العمل بارتفاع 300 ملم. تم اختيار ، حيث أجريت ثلاث تجارب مع ارتفاع عتبة النافذة WFR الفصول الدراسية مع 20 في المائة الموصى بها من المختلفة وارتفاع الطائفة العاملة. كانت طريقة القياس الميداني لتحديد متوسط مستوى الإنارة في الفصول الدراسية هي قياس نقاط شبكة الإنارة ، حيث تم وضع مقياس اللوكس في تخطيط شبكة 1 م × 1 م في الفصل الدراسي تم قياس الاستطلاع حول تصورات الطلاب عن حالة ضوء النهار وأداء المهام من خلال استبيان من نوع مقياس ليكرت من خمسة مستويات ، في حين تم إجراء اختبار أداء الكتابة اليدوية العربية في الفصل الدراسي لقياس كلمة مخطط العين. ثم أشارت النتائج (Leat (BAL) باستخدام تعديل بلسم العبد القادر (wpm) الطلاب في الدقيقة لتقييم ارتفاع عتبة النافذة للفصول (IES) إلى المعلمات لمحاكاة ضوء النهار في برنامج محاكاة البيئة المتكاملة Ix الدراسية التي تستخدم إعادة التأهيل. كان نطاق متوسط قياس مستوى الإضاءة في الفصول الدراسية هو 280 تظهر نتائج الاستبيان أن الطلاب قبلوا الإضاءة بشرط 20٪ من معدل التدفق في الفصل. يُظهر Ix إلى 1600 تقييم الكتابة اليدوية باللغة العربية أن الطلاب حققوا ارتفاعًا في الدققة في الفصل الدراسي الذي حصل على تظهر المحاكاة Ix متوسط مستوى إضاءة أقل من الموصى به في المعايير والمبادئ التوجيهية ، والذي كان 280 ، في حين أن ارتفاع عتبة النافذة Ix أن ارتفاع عتبة النافذة فوق 500 مم يتجاوز متوسط مستوى الإنارة 280 بين 300 مم إلى 500 مم يتلقى متوسط مستوى الإنارة بين 223 لتر إلى 284 لتر. وبالتالي ، فإن ارتفاع عتبة النافذة المقبول الموصى به للمدارس الدينية يتراوح بين 300 مم إلى 500 مم. ستعمل هذه التوصية على تحسين التصميم القياسي للمدارس الإسلامية من قبل المهندسين المعماريين والمصممين ، مما سيؤدي إلى تحسين أداء الطلاب في الكتابة اليدوية بخط اليد لعملية تعلم الحفزان

الكلمات المفتاحية: الإضاءة الطبيعية ، مستويات الإضاءة ، أداء الكتابة العربية ، ارتفاع نافذة الفصل ، مساحة العمل

ABSTRAK

Cahaya semulajadi yang efisien meningkatkan prestasi pelajar seperti tugas menulis di kelas. Kesesuaian cahaya di dalam kelas dinilai melalui reka bentuk piawai tingkap, iaitu 20 peratus daripada Nisbah Tingkap-ke-Lantai (WFR). Tahap pencahayaan diukur pada ketinggian satah kerja 800mm hingga 900mm dengan sil tingkap pada ketinggian yang sama, di mana ia menjadi fokus di dalam penyelidikan cahaya semulajadi di dalam kelas. Namun, sekolah aliran agama Islam yang mengutamakan tugas menghafaz al-Quran melalui pembacaan dan penulisan bahasa Arab menggunakan meja rendah (rehal) dengan ketinggian satah kerja 300mm. Oleh kerana integrasi mata pelajaran akademik dan agama di kelas, sekolah aliran agama mengikuti reka bentuk tingkap piawai dan meja dengan ketinggian satah kerja 800mm hingga 900mm, di mana menggunakan rehal akan mempengaruhi tahap pencahayaan yang diukur. Objektif penyelidikan ini adalah untuk mengenal pasti tahap pencahayaan semulajadi yang boleh diterima untuk prestasi penulisan bahasa Arab pelajar, menyelidik tahap pencahayaan purata di kelas sekolah aliran agama sedia ada, dan untuk menilai pelbagai ketinggian tingkap untuk prestasi penulisan bahasa Arab pelajar yang optimum untuk pelajaran hafazan pada satah kerja ketinggian 300mm. Kelas dengan 20 peratus WFR dipilih, di mana tiga eksperimen dengan ketinggian sil tingkap dan ketinggian satah kerja berbeza telah dijalankan. Kaedah pengukuran cahaya untuk mengenal pasti tahap pencahayaan purata kelas yang digunakan adalah pengukuran titik grid pencahayaan, di mana meter lux diletakkan dalam susunan grid 1m x 1m. Tinjauan mengenai persepsi pelajar terhadap keadaan cahaya dan prestasi tugas diukur melalui soal selidik jenis skala Likert dengan lima tahap, sementara ujian prestasi penulisan bahasa Arab dilakukan di dalam kelas untuk mengukur perkataan per minit (ppm) pelajar menggunakan carta mata Balsam Alabdulkader (BAL) yang diubah suai. Hasilnya kemudian dirujuk sebagai parameter untuk simulasi cahaya dalam perisian Integrated Environment Simulation (IES) untuk menilai ketinggian sil tingkap untuk kelas yang menggunakan rehal. Julat ukuran tahap pencahayaan purata di kelas adalah 280 lx hingga 1600 lx. Hasil soal selidik menunjukkan bahawa pelajar setuju dengan pencahayaan dengan 20 peratus WFR di dalam kelas. Penilaian penulisan bahasa Arab menunjukkan bahawa pelajar memperoleh wpm lebih tinggi di kelas yang mendapat tahap pencahayaan purata yang lebih rendah daripada yang disyorkan dalam piawaian dan garis panduan, iaitu 280 lx. Simulasi menunjukkan bahawa ketinggian sil tingkap 500mm ke atas melebihi tahap pencahayaan purata 280 lx, sementara ketinggian sil tingkap antara 300mm hingga 500mm menerima tahap pencahayaan purata antara 223 lx hingga 284 lx. Oleh itu, ketinggian sil tingkap yang disyorkan untuk sekolah aliran agama adalah antara 300mm hingga 500mm. Cadangan dapat meningkatkan pengamatan rekabentuk piawaian sekolah aliran agama oleh arkitek dan perekabentuk dalam meningkatkan kualiti proses pembelajaran hafazan menggunakan kaedah penulisan bahasa Arab.

Kata kunci: pencahayaan semulajadi, tahap pencahayaan, prestasi penulisan Bahasa Arab, ketinggian tingkap kelas, ketinggian satah kerja

ABSTRACT

Efficient daylighting improves students' performance such as writing tasks in classrooms. Daylighting adequacy in the classroom is assessed through the standardized window design, which is 20 per cent of the Window-to-Floor Ratio (WFR). The illuminance level is measured at 800mm to 900mm working plane height with the window sill at the same height, where these are the variables focused by other researches on classroom daylight. However, the Islamic religious school that prioritizes the Quran memorization (*hafazan*) tasks through reading and writing Arabic language uses a low reading desk (*rehal*) with 300mm working plane height. Due to the current practice of integrating academic and religious subjects in classrooms, religious schools follows the standardised window design and table with 800mm to 900mm working plane height, where using a *rehal* will influence the illuminance level measured. The objectives of this research are to identify the acceptable illuminance level for students' optimum Arabic handwriting performance, to investigate the influence of window design on illuminance level measured at working plane of 300mm height, and to recommended window sill height for students' optimum Arabic handwriting performance for learning *hafazan* at the working plane of 300mm height in Islamic religious school. Classrooms with recommended 20 per cent of WFR were selected, where three experiments with different window sill height and working plane height were conducted. The field measurement method to identify the average illuminance level of the classrooms was illuminance grid points measurement, where the lux meter was placed in a 1m x 1m grid layout of the classroom. The survey on students' perceptions of the daylight condition and task performances were measured through a five level Likert scale type questionnaire, while the Arabic handwriting performance test was conducted in the classroom to measure the students' word per minute (wpm) using modified Balsam Alabdulkader-Leat (BAL) eye chart. The results then referred as the parameters for daylight simulation in Integrated Environment Simulation (IES) software to evaluate the window sill height for classrooms that uses *rehal*. The range of average illuminance level measure in the classrooms was 280 lx to 1600 lx. The questionnaire results show that the students accepted the illumination at the condition of 20 per cent WFR in the classroom. The Arabic handwriting assessment shows that students scored higher wpm in a classroom that received lower average illuminance level than recommended in standards and guidelines, which was 280 lx. The simulation shows that window sill height above 500mm exceeds the 280 lx average illuminance level, while window sill height between 300mm to 500mm received average illuminance level between 223 lx to 284 lx. Thus, the acceptable window sill height recommended for religious schools is between 300mm to 500mm. This recommendation will improve the standard design of Islamic schools by architects and designers, which will improve the students' Arabic handwriting performance for *hafazan* learning process.

Keywords: daylighting, illuminance level, Arabic handwriting performance, classroom window sill height, working plane height

TABLE OF CONTENT

AUTHOR DECLARATION	i
BIODATA OF AUTHOR	ii
ACKNOWLEDGEMENT	iii
نبذة مختصرة	iv
ABSTRAK	v
ABSTRACT	vi
TABLE OF CONTENT	vii
LIST OF TABLES	xi
LIST OF FIGURES	xiv
LIST OF APPENDICES	xix
GLOSSARY	xx
TRANSLITERATION	xxii
ABBREVIATION	xxiii

CHAPTER 1 INTRODUCTION	1
1.1 Background Study	2
1.2 Problem Statement	7
1.3 Research Gap	8
1.4 Research Aim and Objectives	10
1.5 Research Questions	11
1.6 Scope of Study	12
1.7 Limitations	14
1.8 Thesis Structure	15
1.9 Significant of Study	20

1.10	Summary	21
------	---------	----

CHAPTER 2 LITERATURE REVIEW 22

2.1	Introduction	22
-----	--------------	----

2.2	Daylight Theory	22
-----	-----------------	----

2.2.1	Sky Condition and Global Illuminance in Malaysia	26
-------	--	----

2.2.2	Daylight Factor and Illuminance Level	28
-------	---------------------------------------	----

2.2.3	Daylighting Measurement	30
-------	-------------------------	----

2.3	Daylight Effects	39
-----	------------------	----

2.3.1	Daylight Affects the Human Conditions	40
-------	---------------------------------------	----

2.3.2	Daylighting and Student's Performance	44
-------	---------------------------------------	----

2.3.3	Handwriting Performance	48
-------	-------------------------	----

2.4	Educational and Learning Space	55
-----	--------------------------------	----

2.4.1	Daylighting Design for Classrooms	57
-------	-----------------------------------	----

2.4.2	Regulations, Standards and Guidelines for Daylighting Design	61
-------	--	----

2.5	Islamic Religious Schools and Education	67
-----	---	----

2.5.1	Islamic Religious Schools in Malaysia	68
-------	---------------------------------------	----

2.5.2	Method of Quran Memorization (<i>Hafazan</i>)	71
-------	---	----

2.6	Design Science Research	73
-----	-------------------------	----

2.7	Summary	76
-----	---------	----

CHAPTER 3 RESEARCH METHODOLOGY 78

3.1	Introduction	78
-----	--------------	----

3.2	Research Phases	79
-----	-----------------	----

3.3	Research Procedure	82
3.3.1	Experiment Field Measurement	85
3.3.2	Questionnaire	121
3.3.3	Arabic Handwriting Performance Procedure	125
3.3.4	Daylight Simulation	130
3.4	Summary	134
CHAPTER 4 RESULTS, DISCUSSION AND ANALYSIS		135
4.1	Introduction	135
4.2	Field Measurement; Illuminance Level	135
4.2.1	Experiment One	137
4.2.2	Experiment Two	140
4.2.3	Experiment Three	144
4.2.4	Field Measurement Discussion and Analysis	148
4.3	Questionnaire Descriptive Statistic Analysis	151
4.3.1	SPSS Questionnaire Reliability Test	151
4.3.2	Experiment One	154
4.3.3	Experiment Two	167
4.3.4	Experiment Three	180
4.3.5	Questionnaire Discussion and Analysis	195
4.4	Students' Arabic Handwriting Performance	196
4.4.1	Experiment One	197
4.4.2	Experiment Two	199
4.4.3	Experiment Three	200
4.4.4	Students' Performance Discussion and Analysis	202
4.5	Experimental Analysis and Discussion	204
4.5.1	Experiment One	204

4.5.2	Experiment Two	206
4.5.3	Experiment Three	208
4.5.4	Discussion and Analysis	209
4.6	Daylighting Simulation	210
4.6.1	Window Sill Height Simulation	213
4.6.2	Simulation Discussion and Analysis	228
4.7	Summary	230
CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS		231
5.1	Introduction	231
5.2	Review of The Research Objectives	231
5.3	Significant Findings	234
5.4	Contributions of the Research	234
5.5	Recommendations	235
5.6	Further Study	236
5.7	Conclusion	238
BIBLIOGRAPHY		240
APPENDIX A		261
APPENDIX B		269
APPENDIX C		285
APPENDIX D		288
APPENDIX E		289
APPENDIX F		294

LIST OF TABLES

Table 1.1: Summary of previous daylighting and student's performance studies	10
Table 1.2: Research questions	11
Table 2.1: Illuminance Level Based on Space Type (Zumtobel, 2018)	66
Table 2.2: Standards and Guidelines Recommended Lx Level (Syaheeza, et al., 2018)	67
Table 3.1: Corresponding methods with research objectives and questions	79
Table 3.2: Classrooms for Experiments	93
Table 3.3: Summary for simulation parameter	133
Table 4.1: Regression Model Summary for Lux Meter	136
Table 4.2: Correlation Matrix	152
Table 4.3: Rotated Component Matrix ^a and Cronbach's Alpha	153
Table 4.4: Experiment One Demographic Descriptive Statistical Analysis	154
Table 4.5: Experiment One Daylight Condition Perception Descriptive Statistical Analysis	157
Table 4.6: Experiment One Room Brightness Descriptive Statistical Analysis	157
Table 4.7: Experiment One Size of Window Descriptive Statistical Analysis	159
Table 4.8: Experiment One Amount of Daylight Descriptive Statistical Analysis	161
Table 4.9: Experiment One Read Eye Chart Clearly Descriptive Statistical Analysis	163
Table 4.10: Experiment One Write Eye Chart Clearly Descriptive Statistical Analysis	165
Table 4.11: Experiment One Questionnaire Results	167
Table 4.12: Experiment Two Demographic Descriptive Statistical Analysis	168
Table 4.13: Experiment Two Daylight Condition Perception Descriptive Statistical Analysis	170

Table 4.14: Experiment Two Room Brightness Descriptive Statistical Analysis	171
Table 4.15: Experiment Two Size of Window Descriptive Statistical Analysis	173
Table 4.16: Experiment Two Amount of Daylight Descriptive Statistical Analysis	174
Table 4.17: Experiment Two Read Eye Chart Clearly Descriptive Statistical Analysis	176
Table 4.18: Experiment Two Write Eye Chart Clearly Descriptive Statistical Analysis	178
Table 4.19: Experiment Two Questionnaire Results	180
Table 4.20: Experiment Three Demographic Descriptive Statistical Analysis	181
Table 4.21: Experiment Three Daylight Condition Perception Descriptive Statistical Analysis	183
Table 4.22: Experiment Three Room Brightness Descriptive Statistical Analysis	184
Table 4.23: Experiment Three Window Size Descriptive Statistical Analysis	186
Table 4.24: Experiment Three Amount of Daylight Descriptive Statistical Analysis	188
Table 4.25: Experiment Three Read Eye Chart Clearly Descriptive Statistical Analysis	190
Table 4.26: Experiment Three Write Eye Chart Clearly Descriptive Statistical Analysis	192
Table 4.27: Experiment Three Questionnaire Results	194
Table 4.28: Questionnaire Descriptive Statistical Analysis	195
Table 4.29: Experiment One Students' Arabic Handwriting Speed and Performance	197
Table 4.30: Experiment Two Students' Arabic Handwriting Speed and Performance	199
Table 4.31: Experiment Three Students' Arabic Handwriting Speed and Performance	201
Table 4.32: Classroom Simulation Parameter	211
Table 4.33: Regression Model Summary	212

Table 4.34: Computer Simulation Results	229
Table 5.1: Summary of Research Objectives Achieved	232
Table 5.2: Syaheeza's DRT for Islamic Religious School in Malaysia	239



LIST OF FIGURES

Figure 1.1: Thesis Structure	17
Figure 1.2: Design Science Research Concept for the research	18
Figure 1.3: Theoretical Framework	19
Figure 2.1: Daylight quality design process in the sustainable development context, adapted from Vitruvius (Cauwerts & Bodart, 2013)	25
Figure 2.2: Stereographic Sun Path for Malaysia (Gaisma, 2019)	27
Figure 2.3: illuminance level as a sum of three components (Szokolay, 2004)	29
Figure 2.4: Illuminance in photometry and photography	30
Figure 2.5: Layout of grid points to measure illuminance outdoor.	33
Figure 2.6: Illuminance measurement network grid (Lingfors & Volotinen, 2013)	34
Figure 2.7: Layout of grid points to measure illuminance indoor (Esse-ci, 2019).	35
Figure 2.8: Grid for measuring work plane illuminance (Subramaniam, 2013)	36
Figure 2.9: IES illuminance level simulation result (Syaheeza, et al., 2018)	38
Figure 2.10: Human Visual Path (Maghami, et al., 2012)	41
Figure 2.11: Human Circadian System (Adhikari, 2014)	42
Figure 2.12: Modified LogMAR Eye Chart (Husini, et al., 2017)	53
Figure 2.13: Horace Mann, One-Room Schoolhouse, 1838, Plan (Weisser, 2006)	56
Figure 2.14: Clearance Height for Crossed-leg Maintenance (left) and Squatting (right). (Adler, 2007; Neufert, et al., 2012)	69
Figure 2.15: Design Science Research Framework adapted from Venable and Travis, 1999 after Nunamaker, 1991 (Venable, 2006a)	74
Figure 2.16: Thesis Scope Relationship Figure	77
Figure 3.1: Research Flow	82
Figure 3.2: Methodology Flow	84
Figure 3.3: Stereographic Sun Path; Altitude Angle (www.harvestingrainwater.com)	86

Figure 3.4: Amprobe LED Light Meter	87
Figure 3.5: Amprobe LED Light Meter detector-based calibration	88
Figure 3.6: Kolej Genius Insan Site Plan	89
Figure 3.7: Kolej Genius Insan Second Level Floor Plan and Selected Classrooms	90
Figure 3.8: Kolej Genius Insan Second Level Section	91
Figure 3.9: Laser Distance Meter Fluke 414D (left) and Kennedy 50 m/165 ft tape measurement (right)	91
Figure 3.10: Plan 1; Classroom 1	97
Figure 3.11: Classroom 1 Left and Right Elevation	98
Figure 3.12: Classroom 2 Floor Plan	99
Figure 3.13: Classroom 2 Left and Right Elevation	100
Figure 3.14: Classroom 3 Floor Plan	101
Figure 3.15: Classroom 3 Left and Right Elevation	102
Figure 3.16: Classroom 4 Floor Plan	103
Figure 3.17: Classroom 4 Left and Right Elevation	104
Figure 3.18: Classroom 5 Floor Plan	105
Figure 3.19: Classroom 5 Left and Right Elevation	106
Figure 3.20: Classroom <i>Tasmi</i> ' 1 Floor Plan	107
Figure 3.21: Classroom <i>Tasmi</i> ' 1 Left and Right Elevation	107
Figure 3.22: Classroom <i>Tasmi</i> ' 2 Floor Plan	109
Figure 3.23: Classroom <i>Tasmi</i> ' 2 Left and Right Elevation	109
Figure 3.24: Classroom <i>Tasmi</i> ' 1 and 2 Elevation with 20 per cent WFR	110
Figure 3.25: Students' Seating Position.	111
Figure 3.26: Experiment One Students Seating Arrangement	112
Figure 3.27: Students' Seating Arrangement in Experiment 1	113
Figure 3.28: Experiment Two Students Seating Arrangement	114
Figure 3.29: Students' Seating Arrangement in Experiment 2	115
Figure 3.30: Experiment Three Students' Seating Position	115
Figure 3.31: Students' Seating Arrangement in <i>Tasmi</i> ' Classrooms	116

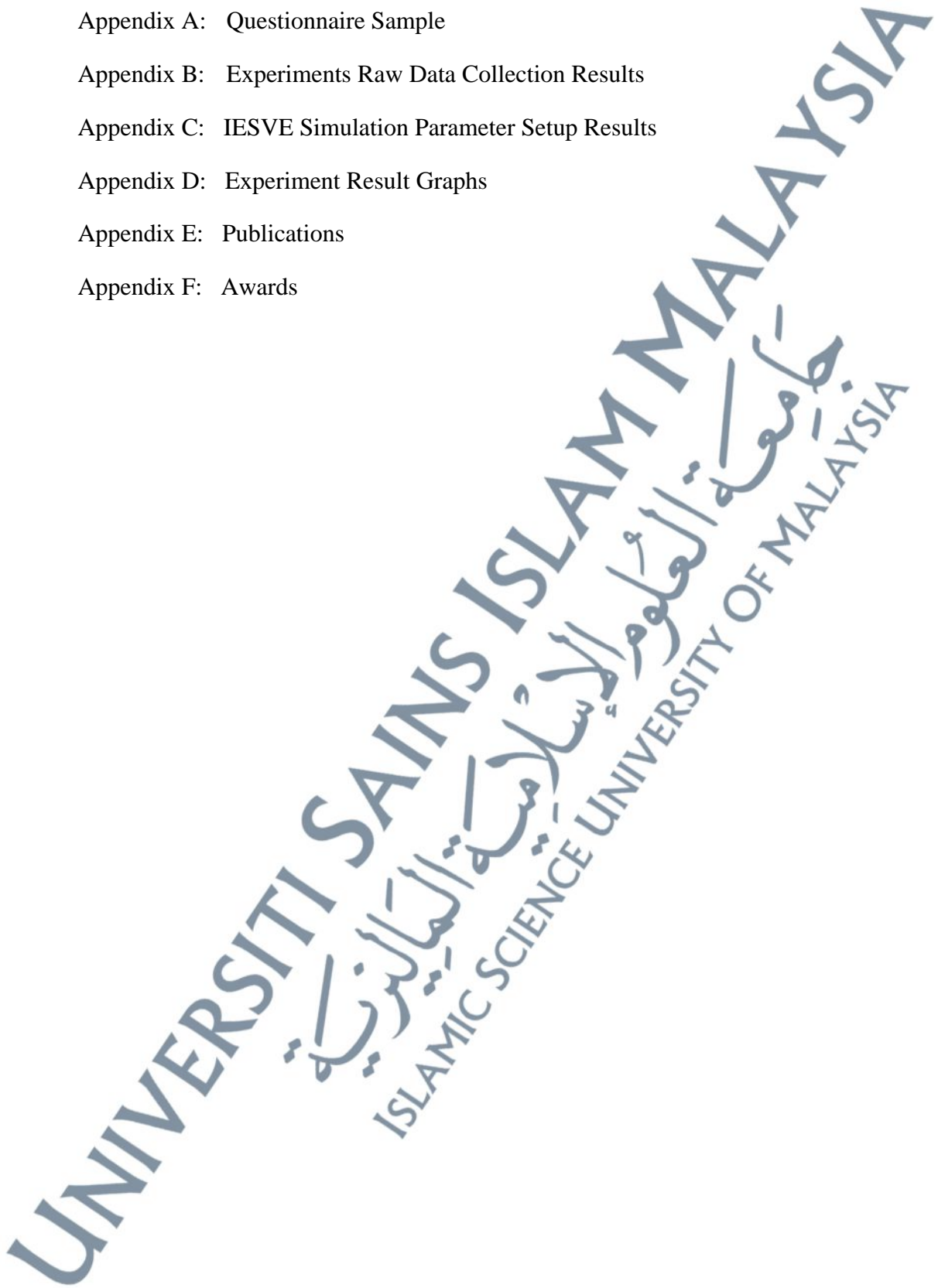
Figure 3.32: Experiment Framework	117
Figure 3.33: Experiment One Illuminance Level Lux Meter Position	119
Figure 3.34: Experiment Two Illuminance Level Lux Meter Position	120
Figure 3.35: Experiment Three Illuminance Level Lux Meter Position	121
Figure 3.36: Sample of Questionnaire Part One; Section One	123
Figure 3.37: Questionnaire Part One; Section Two	124
Figure 3.38: Approval to use the patented BAL eye chart	126
Figure 3.39: Modified Balsam Alabdulkader-Leat (BAL) chart	127
Figure 3.40: Modified BAL chart and Rewriting Space	128
Figure 3.41: Questionnaire – Learning Task Performance	129
Figure 3.42: Classroom Modelling Setup and Layout	132
Figure 4.1: Lux Meter Absolute Error and Corellation	137
Figure 4.2: Experiment One Classroom Setup	138
Figure 4.3: Experiment One Average Illuminance Level	139
Figure 4.4: Experiment One Average Illuminance Level Graph	140
Figure 4.5: Experiment Two Classroom Setup	141
Figure 4.6: Experiment Two Average Illuminance Level	142
Figure 4.7: Experiment Two Average Illuminance Level Graph	143
Figure 4.8: Experiment Three Classroom Setup	145
Figure 4.9: Experiment Three Average Illuminance Level	146
Figure 4.10: Experiment Three Average Illuminance Level Graph	147
Figure 4.11: Average Illuminance Level Graph	150
Figure 4.12: Questionnaire Scree Plot	152
Figure 4.13: Experiment One Students' Gender Percentage Graph	155
Figure 4.14: Experiment One Students' Age Percentage Graph	156
Figure 4.15: Experiment One Students' Brightness Perception Graph	158
Figure 4.16: Experiment One Students' Size of Window Perception Graph	160
Figure 4.17: Experiment One Students' Amount of Daylight Perception Graph	162

Figure 4.18: Experiment One Students' Arabic Reading Task Perception Graph	164
Figure 4.19: Experiment One Students' Arabic Handwriting Task Perception Graph	166
Figure 4.20: Experiment Two Students' Gender Percentage Graph	169
Figure 4.21: Experiment Two Students' Age Percentage Graph	170
Figure 4.22: Experiment Two Students' Brightness Perception Graph	172
Figure 4.23: Experiment Two Students' Size of Window Perception Graph	173
Figure 4.24: Experiment Two Students' Amount of Daylight Perception Graph	175
Figure 4.25: Experiment Two Students' Arabic Reading Task Perception Graph	177
Figure 4.26: Students' Arabic Handwriting Task Perception Graph	179
Figure 4.27: Experiment Three Students' Gender Percentage Graph	181
Figure 4.28: Experiment Three Students' Age Percentage Graph	182
Figure 4.29: Experiment Three Students' Brightness Perception Graph	185
Figure 4.30: Experiment Three Students' Size of Window Perception Graph	187
Figure 4.31: Experiment Three Students' Amount of Daylight Perception Graph	189
Figure 4.32: Experiment Three Students' Arabic Reading Task Perception Graph	191
Figure 4.33: Experiment Three Students' Arabic Handwriting Task Perception Graph	193
Figure 4.34: Experiment One Average Arabic Handwriting Speed Graph	197
Figure 4.35: Experiment One Average Arabic Handwriting Speed Graph	198
Figure 4.36: Experiment Two Average Arabic Handwriting Speed Graph	199
Figure 4.37: Experiment Two Average Arabic Handwriting Speed Graph	200
Figure 4.38: Experiment Three Average Arabic Handwriting Speed Graph	201
Figure 4.39: Experiment Three Average Arabic Handwriting Speed Graph	202
Figure 4.40: Average Arabic Handwriting Speed Graph	203
Figure 4.41: Experiment One; Data Analysis	205

Figure 4.42: Experiment Two; Data Analysis	207
Figure 4.43: Experiment Three; Data Analysis	208
Figure 4.44: Experiment Average Illuminance Level and Arabic Handwriting Performance	209
Figure 4.45: Simulation Parameter Setup	211
Figure 4.46: Average Illuminance Level Regression Graph	212
Figure 4.47: Simulation Model; Window Sill Height 300mm	214
Figure 4.48: Illuminance Level Simulation; Window Sill Height 300mm	215
Figure 4.49: Simulation Model; Window Sill Height 400mm	216
Figure 4.50: Illuminance Level Simulation; Window Sill Height 400mm	217
Figure 4.51: Simulation Model; Window Sill Height 500mm	218
Figure 4.52: Illuminance Level Simulation; Window Sill Height 500mm	219
Figure 4.53: Simulation Model; Window Sill Height 600mm	220
Figure 4.54: Illuminance Level Simulation; Window Sill Height 600mm	221
Figure 4.55: Simulation Model; Window Sill Height 600mm	222
Figure 4.56: Illuminance Level Simulation; Window Sill Height 700mm	223
Figure 4.57: Simulation Model; Window Sill Height 800mm	224
Figure 4.58: Illuminance Level Simulation; Window Sill Height 800mm	225
Figure 4.59: Simulation Model; Window Sill Height 900mm	226
Figure 4.60: Illuminance Level Simulation; Window Sill Height 900mm	227
Figure 4.61: Window Sill Height Relation with Average Illuminance Level	228

LIST OF APPENDICES

- Appendix A: Questionnaire Sample
- Appendix B: Experiments Raw Data Collection Results
- Appendix C: IESVE Simulation Parameter Setup Results
- Appendix D: Experiment Result Graphs
- Appendix E: Publications
- Appendix F: Awards



GLOSSARY

Ambiance	- the character and atmosphere of a place
Bookrest	- a support that holds a book while it is being read.
Circadian	- (of biological processes) recurring naturally on a twenty-four-hour cycle, even in the absence of light fluctuations.
Circular	- a written document that is addressed for circulation to general people, usually formal and official.
Cross-legged	- (of a seated person) with the legs crossed at the ankles and the knees bent outwards.
Daylighting	- the illumination of buildings by natural light.
Daylight Factor	- the ratio of the light level inside a structure to the light level outside the structure
Diurnal	- of or during the day.
Emittance	- the energy radiated by the surface of a body per second per unit area.
Equator	- a line notionally drawn on the earth equidistant from the poles, dividing the earth into northern and southern hemispheres and constituting the parallel of latitude 0°.
Exitance	- a measure of the ability of a surface to emit radiation
Eye chart	- a chart used in measuring the sharpness of a person's vision, typically consisting of a number of rows of letters of decreasing size.
Flux	- the rate of flow of a fluid, radiant energy, or particles across a given area.
Glare	- (of the sun or an electric light) shine with a strong or dazzling light.
Guidelines	- a general rule, principle, or piece of advice for daylighting
Handwriting	- writing with a pen or pencil by hand.
Illuminance	- the amount of luminous flux per unit area.
Illumination	- lighting or light.
Irradiance	- the flux of radiant energy per unit area (normal to the direction of flow of radiant energy through a medium)
Luminous	- relating to light as it is perceived by the eye, rather than in terms of its actual energy
Memorization	- the process of committing something to memory or learning something by heart.
Module	- each of a set of independent units of study or training that can be combined in a number of ways to form a course at a school.
Optimum	- most conducive to a favourable outcome; best.
Performance	- Reading and writing task or operation seen in terms of how successfully it is performed
Photobiology	- the study of the effects of light on living organisms.
Photometric	- the measurement of the intensity of light or of relative illuminating power.
Physiology	- the branch of biology that deals with the normal functions of living organisms and their parts.

Quran	- the Islamic sacred book, believed to be the word of God as dictated to Muhammad by the archangel Gabriel and written down in Arabic.
Radiance	- the flux of radiation emitted per unit solid angle in a given direction by a unit area of a source.
Ray-traces	- a rendering technique for generating an image by tracing the path of light as pixels in an image plane and simulating the effects of its encounters with virtual objects.
Recommendation	- a suggestion or proposal as to the best course of action for daylighting, especially one put forward by an authoritative body
Recitation	- the action of repeating something aloud from memory.
Reflectance	- the measure of the proportion of light or other radiation striking a surface which is reflected off it.
Regulations	- a rule or directive made and maintained by an authority.
Religious	- (of a belief or practice) forming part of someone's faith in a divine being
Revelation	- the divine or supernatural disclosure to humans of something relating to human existence
Secondary	- a secondary school or education in British system
Simulation	- the production of a computer model of something, especially for the purpose of study
Sky condition	- description of the appearance of the sky
Skylight	- a window set in a roof or ceiling at the same angle
Solstice	- either of the two times in the year, the summer solstice and the winter solstice, when the sun reaches its highest or lowest point in the sky at noon, marked by the longest and shortest days.
Standards	- a required or agreed level of quality or attainment for daylighting
Stereographic	- of, relating to, or being a delineation of the form of a solid body (such as the earth) on a plane stereographic projection
Sunlight	- light from the sun.
Sun-path	- the apparent significant seasonal-and-hourly positional changes of the sun (and length of daylight) as the Earth rotates, and orbits around the sun.
Sustainable	- able to be maintained at a certain rate or level.
Transmittance	- the ratio of the light energy falling on a body to that transmitted through it.
Visual	- relating to seeing or sight, human comfort and performance
Window sill	- a slab of stone, wood, or metal at the foot of a window opening
Extramission	- the proposal that visual perception is accomplished by eye beams emitted by the eyes
Work plane	- a flat surface on which a work task is performed
Zenith	- the point in the sky or celestial sphere directly above an observer.

TRANSLITERATION

<i>Agama</i>	-	Religious
<i>Albab</i>	-	A clear mind and heart
<i>Chi</i>	-	New memorization
<i>Deobandy</i>	-	Quran memorization method from India
<i>Firmitas</i>	-	Durability
<i>Hafazan</i>	-	Quran memorization
<i>Halaqah</i>	-	Small group for Islamic lessons
<i>Has</i>	-	Special memorization
<i>Jabatan Agama Islam</i>	-	Selangor Islamic Religious Department
<i>Selangor</i>		
<i>Jama'</i>	-	Quran memorization through recitation
<i>Khatm</i>	-	Having exhausted the Quran
<i>Kitabah</i>	-	Quran memorization through writing
<i>Madrasah</i>	-	Any type of educational institution
<i>Muraja'ah</i>	-	Quran memorization through systematic process
<i>Panipati</i>	-	Quran memorization through recitation checking
<i>Pismis</i>	-	Well done or finish memorizing
<i>Kolay Pismis</i>	-	Easily finish memorized
<i>Pondok</i>	-	Traditional Islamic school
<i>Rehal</i>	-	Low reading table; a holder for the Holy Quran
<i>Sama'i</i>	-	Quran memorization through listening
<i>Sekolah Menengah</i>	-	Public High School
<i>Kebangsaan</i>		
<i>Surah</i>	-	Quran scripture
<i>Syafawi</i>	-	Quran memorization through recitation
<i>Tahfiz</i>	-	Religious Islamic school
<i>Tahriri</i>	-	Quran memorization through writing
<i>Talaqqi</i>	-	Islamic lesson conducted in a small group
<i>Tasmi'</i>	-	Quran memorization through process checking
<i>Tekrar</i>	-	Repeat the memorization
<i>Tekrar Hepsi Seyfa</i>	-	Repeat all the memorization
<i>Ulu</i>	-	Have or having
<i>Ulul albab</i>	-	Islamic education
<i>Utilitas</i>	-	Utility
<i>Venustas</i>	-	Beauty
<i>Wahdah</i>	-	Quran memorization through reading paragraph by paragraph
<i>Zor</i>	-	Force memorization

ABBREVIATION

ALPM	-	alphabet letters per minute
ASHRAE	-	The American Society of Heating, Refrigerating and Air-Conditioning Engineers
BAL	-	Balsam Alabdulkader-Leat eye chart
CHaP	-	Children's Questionnaire for Handwriting Proficiency
CIE	-	International Commission on Illumination
DASH	-	Detailed Assessment Speed Handwriting
DF	-	Daylight Factor
DSR	-	Design Science Research
EFM	-	Education Facilities Manual
EN12461	-	The Indoor Lighting Standard 12461
ERC	-	externally reflected component
GBI	-	Green Building Index
GRBP	-	Guidelines and Regulations for Building Planning
HHE	-	Hebrew Handwriting Evaluation
HPT	-	Handwriting Performance Test
HSPQ	-	Handwriting Proficiency Screening Questionnaire
HST	-	Handwriting Speed Test
IESNA	-	Illuminating Engineering Society of North America
IESVE	-	Integration Environment Solution - Virtual Environment
IRC	-	internally reflected component
JKR	-	Jabatan Kerja Raya (Malaysian Public Works Department)
KSS	-	Sleepiness Scale
LogMAR	-	Logarithm of the Minimum Angle of Resolution
LPM	-	letters per minute
MNREAD	-	Minnesota Near Reading Test
MoEM	-	Ministry of Education Malaysia (Kementerian Pendidikan Malaysia)
MS1525	-	Malaysian Standard 1525
NOTPZ	-	Non-Optimum Task Performance Zone
OSHA	-	Occupational Safety and Health Administration
OTPZ	-	Optimum Task Performance Zone
PCA	-	Principal Component Analysis
PTB	-	Physicalish Technische Bundesanstalt
RA	-	Reading Acuity
SAR	-	Sekolah Agama Rakyat
SAT	-	Handwriting Style and Neatness
SC	-	sky component
SF-36	-	Short-form 36 Items
SLWPM	-	standard-length words per minute
SMKA	-	Sekolah Menengah Kebangsaan (Agama)
SPSS	-	Statistical Package for the Social Sciences
TOLH	-	Test of Legible Handwriting
UBBL	-	Uniform Building by Law
VDE	-	Virginia Department of Education
WFR	-	Window-to-Floor Ratio
WWR	-	Window-to-Wall Ratio