



Cairo University

**ADMISSION POLICIES  
TO ARCHITECTURE EDUCATION  
APPLYING SPATIAL ABILITY TESTS TO ASSESS  
STUDENTS' READINESS  
TO ARCHITECTURE EDUCATION**

By

**ENAS MOHAMED ABDEL MONEM ELGAZZAR**

A Thesis Submitted to the  
Faculty of Engineering at Cairo University  
in Partial Fulfillment of the  
Requirements for the Degree of  
**DOCTOR OF PHILOSOPHY**  
in  
**ARCHITECTURAL ENGINEERING**

FACULTY OF ENGINEERING, CAIRO UNIVERSITY  
GIZA, EGYPT  
2019

**ADMISSION POLICIES  
TO ARCHITECTURE EDUCATION  
APPLYING SPATIAL ABILITY TESTS TO ASSESS  
STUDENTS' READINESS  
TO ARCHITECTURE EDUCATION**

By  
**ENAS MOHAMED ABDEL MONEM ELGAZZAR**

A Thesis Submitted to the  
Faculty of Engineering at Cairo University  
in Partial Fulfillment of the  
Requirements for the Degree of  
**DOCTOR OF PHILOSOPHY**  
in  
**ARCHITECTURAL ENGINEERING**

Under the Supervision of

**Prof. Dr. Sawsan Ahmed Helmy**

**Prof. Dr. Raghad Mofeed Ibrahim**

.....  
Professor of Architecture  
Department of Architecture  
Faculty of Engineering, Cairo University

.....  
Professor of Architecture  
Department of Architecture  
Faculty of Engineering, Cairo University

FACULTY OF ENGINEERING, CAIRO UNIVERSITY  
GIZA, EGYPT  
2019

**ADMISSION POLICIES  
TO ARCHITECTURE EDUCATION  
APPLYING SPATIAL ABILITY TESTS TO ASSESS  
STUDENTS' READINESS  
TO ARCHITECTURE EDUCATION**

By  
**ENAS MOHAMED ABDEL MONEM ELGAZZAR**

A Thesis Submitted to the  
Faculty of Engineering at Cairo University  
in Partial Fulfillment of the  
Requirements for the Degree of  
**DOCTOR OF PHILOSOPHY**  
in  
**ARCHITECTURAL ENGINEERING**

Approved by the  
Examining Committee

**Prof. Dr. Sawsan Ahmed Helmy,**

**Thesis Main Advisor**

---

**Prof. Dr. Raghad Mofeed Ibrahim,**

**Advisor**

---

**Prof. Dr. Sherine Mohy El-Dine Wahba, Internal Examiner**

---

**Prof. Dr. Ayman Fathalla Wanas,**

**External Examiner**

Professor of Urban and Environmental Design- Arab Academy for Science,  
Technology and Maritime Transport

FACULTY OF ENGINEERING, CAIRO UNIVERSITY  
GIZA, EGYPT  
2019

**Engineer's Name:** Enas Mohammed Abdelmonem Elgazzar  
**Date of Birth:** 15/06/1973  
**Nationality:** Egyptian  
**E-mail:** [Inesh2000@hotmail.com](mailto:Inesh2000@hotmail.com)  
**Phone:** 00201222322183  
**Address:** St.9, Mokattam. # 64, Cairo. Egypt  
**Registration Date:** 01/10/2011  
**Awarding Date:** ....../....../2019  
**Degree:** Doctor of Philosophy  
**Department:** Architecture Department



**Supervisors:**  
Prof. Sawsan Ahmed Helmy  
Prof. Raghad Mofeed Ibrahim

**Examiners:**  
Prof. Ayman Fathalla Wanas (External examiner)  
Prof. Sherine Mohy El-Dine Wahba (Internal examiner)  
Prof. Sawsan Ahmed Helmy (Thesis main advisor)  
Prof. Raghad Mofeed Ibrahim (Advisor)

**Title of Thesis:**

**ADMISSION POLICIES TO ARCHITECTURE EDUCATION  
APPLYING SPATIAL ABILITY TESTS TO ASSESS STUDENTS' READINESS  
TO ARCHITECTURE EDUCATION**

**Key Words:**

Admission policies; Spatial ability; Readiness; Prediction of Success

**Summary:**

The research aims to find a valid tool that can measure the state of readiness of architecture students to reduce the obstacles. Also, this research proposes a predictive model of success that complements current procedures of admission to architecture higher education in Egypt to overcome its limitation on predicting success. It is proposed to utilize spatial ability and assess its capacity to measure student readiness and assess its capability to predict success in first studio.

This research is an empirical, quantitative case study. The results show a strong significant correlation between students' skill-level on spatial ability and studio performance. Also, this thesis outlines a predictive equation model of success. Findings suggest incorporating the spatial ability test score in the admission process to architecture education as a better predictor of success

## **Disclaimer**

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: Enas Mohamed Abdel Monem Elgazzar

Date: / /2019

Signature:

## **Dedication**

*To my beloved husband Hesham and my two precious children  
Youssef & Yahya*

# Acknowledgments

Thanks to all who encouraged and helped me complete this thesis.

My sincere appreciation and grateful thanks goes to my supervisors, Prof. Sawsan Ahmed Helmy and Prof. Raghad Mofeed Ibrahim, who showed great patience and concern in reviewing this thesis. I wish to express a particular gratitude for their inspiring suggestions, motivating criticism, and for their professional advice.

I am grateful to the participating students for taking the time to complete the tests used in this study. I am also grateful to all design studio professors: Prof. Ali Hatem Gaber; Prof. Sami Serag-Eldeen, and Prof. Mona Elbasioni for arranging the time for the tests to be given. I would like to thank my postgraduate colleagues, Maha Abu-Bakr and Ahmed Eldessoki for their precious help and support. Also, thanks to my friend Miada M. Husein for her friendship and encouragement during this time. Moreover, I would like to thank my friend Prof. Heba Safi-Eldein for her precious advice and care.

Thanks to the examination committee members: Prof. Sherine Mohy El-Dine Wahba and Prof. Ayman Fathalla Wanas, for their valuable suggestions that helped in the completion of this thesis.

And most of all, I am deeply grateful to my parents for always being there for me. I owe a debt of gratitude to Hisham Farhoud, my husband, best friend, and supporter, for his relentless support and encouragement throughout this time. I also want to thank my children Youssef and Yahya for their love that kept me going and helped me see this project through to completion.

# Table of Contents

<b>TABLE OF CONTENTS.....</b>	<b>IV</b>
<b>LIST OF TABLES.....</b>	<b>VII</b>
<b>LIST OF FIGURES.....</b>	<b>IX</b>
<b>NOMENCLATURE .....</b>	<b>XI</b>
<b>ABSTRACT .....</b>	<b>XII</b>
<b>CHAPTER 1/ INTRODUCTION .....</b>	<b>ERROR! BOOKMARK NOT DEFINED.</b>
1.1. MOTIVATIONS .....	2
1.2. PROBLEM STATEMENT .....	3
1.3. RESEARCH QUESTIONS AND ASSUMPTIONS.....	4
1.4. AIM AND OBJECTIVES .....	4
1.5. METHEDOLOGY .....	4
1.6. ORGANIZATION OF THE THESIS .....	6
1.6.1. Chapter Two: Readiness for University Education.....	6
1.6.2. Chapter Three: Measuring Readiness Of Architecture Students .....	6
1.6.3. Chapter Four: The Abilities Required In Architecture Students.....	6
1.6.4. Chapter Five: Assessing Spatial Ability as A Predictor Of Success In Architecture Education .....	6
1.6.5. Chapter Six: Discussion and Conclusion .....	7
1.7. RESEARCH SCOPE AND LIMITATIONS .....	9
<b>CHAPTER 2.....</b>	<b>12</b>
<b>CHAPTER2/READINESS FOR UNIVERSITY EDUCATION.....</b>	<b>12</b>
2.1. INTRODUCTION.....	13
2.2. THE MEANING OF READINESS .....	13
2.2.1. The Components of the Comprehensive Definition of Readiness .....	14
2.2.1.1. Key Cognitive Strategies .....	15
2.2.1.2. Key Content Knowledge.....	16
2.2.1.3. Key Academic Behaviors .....	16
2.2.1.4. Key Contextual skills and Awareness.....	17
2.3. HOW IS READINESS CONCEPT IDENTIFIED IN THE UNIVERSITY EDUCATIONAL POLICY IN EGYPT? .....	18
2.3.1. Egypt's Efforts Towards Diverse University Admission Policies.....	20
2.4. CONCLUSION.....	22
<b>CHAPTER 3.....</b>	<b>24</b>
<b>CHAPTER3/MEASURING READINESS OF ARCHITECTURE STUDENTS ..</b>	<b>24</b>
3.1. INTRODUCTION.....	25
3.2. ADMISSION POLICIES FRAMEWORK.....	25
3.3. MEASURING READINESS IN ARCHITECTURE GLOBALLY .....	28
3.3.1. Admission Policies by Old Architecture Schools.....	28
3.3.1.1. La Ecole des-Beaux Arts .....	28
3.3.1.2. Bauhaus .....	29



3.3.1.3.	Vkhutemas .....	30
3.3.2.	Measuring Readiness in Current Schools Worldwide .....	33
3.3.2.1.	The High School Record (HSR) .....	33
3.3.2.2.	The Scholastic Aptitude Tests.....	34
3.3.2.3.	The Portfolio.....	34
3.3.2.4.	Letters of recommendation .....	34
3.3.2.5.	Essay .....	34
3.3.2.6.	The Interview .....	35
3.3.2.7.	The Written Statement .....	35
3.3.2.8.	The Architectural Aptitude Test .....	35
3.3.3.	Analysis of the Admission Policies by Current Architecture Schools.....	35
3.4.	MEASURING READINESS IN ARCHITECTURE DEPARTMENTS IN EGYPT.....	40
3.5.	THE VALIDITY OF READINESS MEASUREMENTS IN PREDICTING SUCCESS ....	42
3.6.	CONCLUSION.....	46
<b>CHAPTER 4.....</b>		<b>48</b>
<b>CHAPTER4/THE ABILITIES REQUIRED IN ARCHITECTURE STUDENTS</b>		<b>48</b>
4.1.	INTRODUCTION.....	49
4.2.	ABILITIES NEEDED BY POTENTIAL STUDENT .....	49
4.2.1.	Measuring Abilities and Predicting Performance .....	51
4.3.	WHY SPATIAL ABILITY? .....	55
4.3.1.	The Importance of Spatial Ability for the Design Process .....	55
4.3.1.1.	Definitions of Spatial Ability and its Components .....	56
4.3.2.	The Implications of Spatial Ability for Design Studio .....	59
4.3.2.1.	Visual Spatial Form (Sketching).....	60
4.3.2.2.	Spatial Analogy (Data Analysis And Concept Diagrams) .....	60
4.3.2.3.	Design Developing (representation in 2D drawing and 3D modeling) .....	62
4.4.	THE POSSIBILITY OF MEASURING SPATIAL ABILITY .....	65
4.5.	THE CAPACITY OF SPATIAL ABILITY IN PREDICTING SUCCESS.....	66
4.6.	CONCLUSION.....	74
<b>CHAPTER 5 : .....</b>		<b>ERROR! BOOKMARK NOT DEFINED.</b>
<b>ASSESSING SPATIAL ABILITY AS A PREDICTOR OF SUCCESS IN</b>		
<b>ARCHITECTURE EDUCATION .....</b>		<b>ERROR! BOOKMARK NOT DEFINED.</b>
<b>(A CASE STUDY IN FIRST DESIGN STUDIO) .....</b>		<b>ERROR! BOOKMARK NOT DEFINED.</b>
5.1.	INTRODUCTION.....	78
5.2.	LIMITATIONS.....	78
5.3.	PARTICIPANTS .....	78
5.4.	PROCEDURES OF TESTING .....	79
5.4.1.	Applying the Two Spatial Ability Instruments:.....	79
5.4.1.1.	Spatial Ability Test 1 .....	79
5.4.1.2.	Santa Barbara Solid Test.....	81
5.5.	VARIABLES .....	83
5.6.	RESULTS AND ANALYSES .....	83
5.6.1.	Descriptive Statistics: .....	85
5.6.2.	Mean and Scores:.....	86
5.6.3.	Measuring Spatial Ability .....	86
5.6.4.	Differentiation in Spatial Ability According to Gender.....	88
5.7.	STATISTICAL ANALYSIS .....	90

5.7.1.	Testing Correlations.....	90
5.7.1.1.	Correlations Between First Studio Scores:.....	90
5.7.1.2.	Correlations Between Spatial ability and First Studio Scores: .....	90
5.7.2.	Testing the Prediction of Success: .....	92
5.7.2.1.	Cross tabulation (SA1 and SBST with D).....	92
5.7.2.2.	Comparing Results of the two Tests in Relation with (D) .....	93
5.7.2.3.	Cross tabulation (GPA and HSR with D).....	95
5.7.2.4.	Comparing Results of previous Academic Scores (GPA&HSR) in Relation to Design ..	96
5.7.3.	Testing of the Effects of other Subjects: ANOVA .....	98
5.7.4.	Testing the Prediction of Success (Logistic Regression Analysis) .....	98
5.7.5.	How does the Statistical Analysis test the Research Assumptions and Research Question?.....	100
5.8.	CONCLUSION.....	101
<b>CHAPTER 6.....</b>		<b>104</b>
<b>CHAPTER 6/ DISCUSSION AND CONCLUSION .....</b>		<b>104</b>
6.4 COMPLEMENTING CURRENT POLICIES FOR ADMISSION TO ARCHITECTURE		
	EDUCATION.....	104
6.1.	INTRODUCTION.....	105
6.2.	THE VALIDITY OF APPLYING PSYCHOMETRIC INSTRUMENTS TO MEASURE FIRST YEAR STUDENTS' READINESS .....	106
6.3.	THE CAPABILITY OF SPATIAL ABILITY TEST SCORE TO PREDICT SUCCESS ..	108
6.4.	COMPLEMENTING CURRENT ADMISSION POLICIES .....	110
6.4.1.	Overcoming the limitation in Current Egyptian Admission Policies.....	111
6.5.	CONCLUSION .....	114
6.6.	RECOMMENDATIONS .....	114
6.7.	FUTURE WORK.....	115
<b>REFERENCES .....</b>		<b>117</b>
<b>APPENDIX 1 .....</b>		<b>ERROR! BOOKMARK NOT DEFINED.</b>
<b>APPENDIX 2 .....</b>		<b>ERROR! BOOKMARK NOT DEFINED.</b>

## List of Tables

Table 3.1: Typology of Admission Policies Worldwide, .....	27
Table 3.2: Admission Criteria as Adopted by 118 Schools of Architecture in Different Regions .....	38
Table 4.1: Comparing The Different Architecture Schools Models To Conly's Model Of University Readiness .....	54
Table 4.2a: Samples of Testing Psychometric Instruments Used for Spatial Ability Evaluation.....	69
Table 4.2a: Samples of Testing Psychometric Instruments Used for Spatial Ability Evaluation.....	70
Table 4.2b: Samples of Testing Psychometric Instruments Used for Spatial Ability Evaluation ( <i>Multiple Tests</i> ) .....	70
Table 4.2b: Samples of Testing Psychometric Instruments Used for Spatial Ability Evaluation ( <i>Multiple Tests</i> ) .....	71
Table 4.2b: Samples of Testing Psychometric Instruments Used for Spatial Ability Evaluation ( <i>Multiple Tests</i> ) .....	72
Table 4.5: Reasons and Advantages of Selected Instruments .....	73
Table 5.1: Dependent and Independent Variables.....	83
Table 5.2: The Descriptive and Statistical Applied Tests, Source: [the researcher] .....	84
Table 5.3: Frequencies Descriptive Statistics, (n=353).....	85
Table 5.4: Descriptive Statistics for Predictors, (n=353) .....	86
Table 5.5: Differences In Students' Performance In Both Tests And The Interaction Of The Two Test Results, (n=353).....	86
Table 5.5: The Differences In Students' Performance According To Gender, (n=353) .....	88
Table 5.6:A Strong Correlation Between Studio Measurements, (n=353) .....	90
Table 5.7: Significant Positive Correlations Between Spatial Ability Scores And First Studio Measurements, (n=353) .....	91
Table 5.8:Significant Positive Correlations Between Spatial Ability Tests Scores And First Studio Measurements, (n=353) .....	91
Table 5.9a: Significant Correlation Between SA1 Scores and Design Studio Grades, (n=353) .....	93
Table 5.10a: Significant Correlation Between SBST Scores and Design Studio Grades, (n=353) .....	93
Table 5.9b: Analysis of SA1 Results and Academic Grades in Final Design (D)., (n=353) .....	94
Table 5.9b: Analysis of SA1 Results and Academic Grades in Final Design (D)., (n=353) .....	95
Table 5.11a: Significant Correlation Between GPA Scores and Design Studio Grades, (n=353) .....	96
Table 5.12a:Significant Correlation Between HSR Scores and Design Studio Grades, (n=353) .....	96
Table 5.11b:Analysis of the GPA Results and Academic Grades in Final Design (D)., (n=353) .....	97

Table 5.11b:Analysis of the GPA Results and Academic Grades in Final Design (D)., (n=353) .....	97
Table 5.13a: Significant Correlation Between HSR Scores And Design Studio Grades, (n=353) .....	98
Table 5.14a:Regression Model is significant in predicting success in first design, (n=353) .....	99
Table 5.14b:Coding of Categorical Variables .....	99
Table 5.15: Model of Dependent Variables D, (n=353).....	99
Table 5.16: How Does Statistical Analysis Test The Research Assumptions and Research Question .....	100

# List of Figures

Figure 1.1: Research Methodology .....	5
Figure 1.2: Research Organization .....	8
Figure 1.3: Summary for Introduction.....	10
Figure 2.1: The Four Keys of University Readiness .....	15
Figure 2.2: Spearman's General Intelligence. ....	15
Figure 2.4: The Factors of University Readiness .....	17
Figure 2.5 : Readiness In Egyptian Education Policy Means Eligibility .....	19
Figure 2.6a: The Keys of University Readiness .....	20
Figure 2.6b: HSR Represents the Key Knowledge Base in Egypt.....	20
Figure 3.1: Students Access to University Education .....	25
*(The (%) represents the participating group of the school leaver age group) .....	26
Figure 3.2: The Different Meaning of Ability of Benefit (Merit principle) in University Education Systems.....	26
Figure 3.3: The criteria of measuring readiness in La Ecole des-Beaux Arts.....	29
Figure 3.4: The Criteria Of Measuring Readiness In The Bauhaus .....	30
Figure 3.5: The Criteria Of Measuring Readiness In Vkhutemas .....	31
Figure 3.6: Educational Character Shaped the Admission Policy to Measure Readiness .....	32
Figure 3.7a:The Keys of University Readiness .....	33
Figure 3.7b:Three Keys of Architecture Readiness Formulated by Old schools, <i>Training Period is Recognized as a Necessary Requirement</i> .....	33
Figure 3.8: The Percentage Of Architectural Schools Using The More Dominant Criteria.....	36
Figure 3.9:The Percentage Of Architectural Schools Using General And Special Admission Policies .....	37
Figure 3.10:Controlling Acceptance Instead Of Measuring Readiness In Current Admission Policies Globally .....	40
Figure 3.11: Architecture Aptitude Tests Has A Limited Usage In Architectural Departments In Egypt.....	41
Figure 3.12a:The Keys of University Readiness .....	42
Figure 3.12b:Key Content Knowledge Is Only The Eligibility Key In Architecture Departments In Egypt.....	42
Figure 4.1:The essential Requirements for Potential Architectural Students Organized as the Comprehensive Model of Readiness.....	52
Figure 4.3: McKim's Model of Visualisation, .....	57
Figure 4.4: The Distinction Made In The Literature And The Definition By This Research .....	58
Figure 4.4: Spatial Ability Components .....	59
Figure 4.5: Initial Sketch Executed to a Finer Than Precise Shape .....	60
Figure 4.7: Symbols in Diagrams Convey Spatial Features.....	61
Figure 4.8: Rough Diagram: With Additional Details And With Alternative Details ...	61
Figure 4.9: GIS Data Structure .....	62
Figure 4.10: Comprehending Perspective And The Orthographic Views Is A Mental Rotation And Visualization Ability.....	62
Figure 4.11: Student With A Good Spatial Ability Usually Represents 2D & 3D Drawings Easily.....	63

Figure 4.12: Spatial Ability is Vital to All Design Process.....	64
Figure 4.13: The Importance Of (Speed/Power) (Left/Right Tasks ) .....	66
Figure 5.1:Each Set Of SA1 Tasks Focuses on One or More Of Spatial Ability Component .....	80
Figure 5.2: Geometric figures in the Santa Barbara Solid (SBST) Test Varied Along Two Parameters: Geometric Structure And Orientation Of Cutting.....	81
Figure 5.3:Three Samples From SBST With Different Levels Of Complexity .....	82
Figure 5.4a: SBST Tests Tasks Are More Difficult Than SA1 Tasks Concerning The Student Skill-Level.....	87
Figure 5.4b: More Than Half of The Students Reflected Under-Average Skill-Level On The Integration Of Spatial Ability Tests .....	87
Figure 5.5a:Female Students Skill-Level Is Lower Than Males on SA1 .....	89
Figure 5.5b: Male And Female Students Skill-Level Is Nearly Equal on SBST .....	89
Figure 5.6: Outcome Of Interaction Tests Score According To Gender.....	89
Figure 6.1:The Reasons for Proposing Spatial Ability as an Investigating Tool .....	105
Figure 6.2: Comprehending Relationships Reflects Mental Relation Ability.....	106
Figure 6.3: Externalizing Ideas is a Reflection of the Mental Visualization Ability ..	108
Figure 6.4:Scores on Spatial Ability Tests Strongly Correlated with Students' First	109
Figure 6.5: Students with above average spatial ability SA1 (left) and SBST (right) will have higher chances of performing better in design.....	110
Figure 6.6:The Predictive Model of Success for Frist Year .....	111
Figure 6.8: Proposal To Overcome The Limitations Of Admission Policies and Shifting From Using Policies For <i>Controlling Admission</i> To Using Policies For <i>Preparing Students</i> .....	113
Figure 6.6:Pathway to Frist Design Studio Through Readiness Proceduers.....	116

# Nomenclature

OECD	Organization for Economic Cooperation and Development
IBRD	The International Bank for Reconstruction and Development
UIA	Union International for Architects
UNESCO	United Nations Educational, Scientific and Cultural Organization
AIA	Australian Institute of Architects
SA1	Spatial Ability Test 1
SBST	Santa Barbara Solid Test
HSR	High School Record (the score which represents; the final secondary school leaving exam result or other equivalent certificates e.g. IGCSE, American Diploma, ...,etc)
GPA	Grade Point Average (of Engineering Preparatory Year)
ASAT	Architectural School Aptitude Test
SAT	Scholastic Aptitude Test
MCAT	The Medical College Admission Test
SPU	Strategic Plane Unite, Ministry of Higher Education
ESA	Education Sector Analysis
ESE	Egyptian Syndicate of Engineering in Egypt