

**ARCHITECTURAL RENEWAL AND RETROFIT
DESIGN OF RURAL PRIMARY SCHOOL
LEARNING SPACE IN JIANGSU PROVINCE,
CHINA**

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DESIGN OF RURAL PRIMARY SCHOOL
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by

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TABLE OF CONTENTS

ACKNOWLEDGEMENT	ii
TABLE OF CONTENTS	iii
LIST OF TABLES	xix
LIST OF FIGURES	xxv
LIST OF ABBREVIATIONS	xxxiii
LIST OF SYMBOLS	xxxiv
LIST OF APPENDICES	xxxv
ABSTRAK	xxxvi
ABSTRACT	xxxviii
CHAPTER 1 INTRODUCTION	1
1.1 Introduction	1
1.2 Background of the study	1
1.2.1 Overview of rural primary education in China	1
1.2.2 Current situation of rural primary school construction in China	2
1.3 Education reform has new requirements for the learning space	4
1.3.1 Changes in teaching practices	4
1.3.2 Changes in teaching and learning (TnL) activities.....	4
1.3.3 The importance of renewal or retrofitting for optimizing rural primary school learning space.....	6
1.4 Problem statement	6
1.5 Research aim	10
1.6 Research objectives (ROs)	11
1.7 Research questions (RQs)	12
1.8 Significance of the study	12

1.8.1	Make contributions to the Rural Revitalization Policy	12
1.8.2	Research contribution to China’s overall development	13
1.9	Scope of Research	14
1.10	Research limitations	14
1.11	Research framework.....	15
1.11.1	Observation	16
1.11.2	Questionnaire survey.....	16
1.11.3	Consultation methods.....	17
1.11.4	Simulation	17
1.12	Thesis outline	18
1.12.1	Chapter 1: Introduction	19
1.12.2	Chapter 2: Research literature review	19
1.12.3	Chapter 3: Methodology.....	19
1.12.4	Chapter 4: Data analysis and discussion	19
1.12.5	Chapter 5: Conclusion and recommendations.....	19
1.13	Summary	20
CHAPTER 2 LITERATURE REVIEW.....		21
2.1	Introduction	21
2.2	Definition of key terms	21
2.2.1	The definition of rural regions	21
2.2.2	The introduction of Lianyungang.....	22
2.2.3	The definition of renewal or retrofitting	24
2.2.4	Categories of Chinese primary schools	25
2.2.4(a)	Urban primary schools.....	25
2.2.4(b)	Rural primary schools.....	25
2.2.5	The definition of learning space.....	25
2.2.5(a)	Types of learning spaces.....	26

	2.2.5(a)(i)	Formal learning space.....	26
	2.2.5(a)(ii)	Informal learning space	26
	2.2.5(a)(iii)	New types of learning spaces have emerged	27
	2.2.5(b)	Learning space performance attributes	27
	2.2.5(b)(i)	Spatial Layout.....	28
	2.2.5(b)(ii)	Physical Attributes	28
	2.2.5(b)(iii)	Technology	29
	2.2.5(b)(iv)	Furniture	29
2.2.6		Type of teaching and learning activities	32
	2.2.6(a)	Presentation.....	33
	2.2.6(b)	Discussions	34
	2.2.6(c)	Individual learning.....	35
	2.2.6(d)	Team-teaching	36
2.3		The design of learning space	37
	2.3.1	Spatial layout.....	37
	2.3.2	Physical attributes	41
	2.3.3	Technology.....	44
	2.3.4	Furniture	47
2.4		End user perception of learning spaces	51
	2.4.1	End-users perceptions of spatial layout.....	51
	2.4.2	End-users perceptions of physical attributes.....	53
	2.4.3	End-users' perceptions of technology	55
	2.4.4	End-users' perceptions of furniture.....	57
2.5		The influence of end-user perceptions on teaching and learning (TnL) activities	59
	2.5.1	Perception of spatial layout on TnL activities.....	59
	2.5.2	Perception of physical attributes on TnL activities.....	61

2.5.3	Perception of technology on TnL activities	62
2.5.4	Perception of furniture on TnL activities	63
2.6	Global trends and strategies for learning space renewal and retrofit	65
2.6.1	Global typical case analysis	65
2.6.1(a)	American rural school alliance and technology integration	65
2.6.1(b)	Finnish educational equality and standardized design	66
2.6.1(c)	Flexible learning spaces in Australia	66
2.6.1(d)	Learning spaces design in British	67
2.6.1(e)	Singapore Smart Learning Space	67
2.6.2	Global trend for designing learning spaces	68
2.7	China Educational Reform requirements for learning space	69
2.7.1	Educational equity and rural revitalization	69
2.7.2	Innovation in TnL models	73
2.7.3	Technology empowers education	73
2.7.4	The need for renewing and retrofitting learning spaces in rural schools	73
2.8	Application of agent-based simulation software in architectural design	78
2.9	Research gaps	79
2.10	Theoretical framework	80
2.10.1	The perception of affordance	80
2.10.2	Physical information from affordances	81
2.10.3	Satisfying the perceiver	83
2.10.4	Building the theoretical framework	84
2.11	Conceptual framework	86
2.12	Summary	88

CHAPTER 3	METHODOLOGY.....	89
3.1	Introduction	89
3.2	A case study as a quantitative and qualitative research method.....	89
3.3	The research design framework	90
3.3.1	The case study questions	91
	Phase 1 for RQ1	91
	Phase 2 for RQ2	92
	Phase 3 for RQ3	92
	Phase 4 for RQ4	92
3.4	The criteria for case-study selection.....	95
3.4.1	The method of case-study selection	96
	3.4.1(a) Typical Case	97
3.4.2	First-stage case selection.....	97
	3.4.2(a) Defining the case	97
	3.4.2(b) Bounding the case.....	97
	3.4.2(c) Development of selection criteria.....	98
3.4.3	Second-stage case selection	101
	3.4.3(a) The criteria for case-study selection	103
	3.4.3(b) Initial screening	104
	3.4.3(c) Conducting a site assessment.....	106
	3.4.3(d) Consult with stakeholders.....	107
	3.4.3(e) Finalize the selection	108
	3.4.3(f) Triangulating data to strengthen validity.....	113
3.5	Study Population	114
3.5.1	Target population	114
3.5.2	Source population/sampling pool.....	115
3.6	Inclusion and exclusion criteria.....	117

3.6.1	Inclusion criteria.....	117
3.6.2	Exclusion criteria.....	118
3.7	Sample Size Estimation.....	121
3.7.1	Selection of participants for the quantitative research	121
3.7.1(a)	Sample size for participants in the observation inventory (RQ1).....	121
3.7.1(b)	Sample size for the pilot study (RQ2)	122
3.7.1(c)	Sample size for the questionnaire (RQ2).....	123
3.7.2	Selection of participants for the qualitative research	124
3.7.2(a)	Criteria for focus group interview respondents (RQ2) 125	
3.7.2(b)	Criteria for the interviewed school teachers (RQ3 and RQ4).....	126
3.7.2(c)	Criteria for the students' interviews and card sorting (RQ3 and RQ4).....	126
3.8	Sampling method and subject recruitment	127
3.8.1	For students	127
3.8.1(a)	Stratified Sampling	127
3.8.1(b)	Subject recruitment.....	127
3.8.2	For teachers, architects, school administrators, and government administrators.....	128
3.8.2(a)	Purposive Sampling.....	128
3.8.2(b)	Subject recruitment.....	129
3.9	Data Collection.....	132
	Phase 1 for RO1	132
3.9.1	Observation for case study schools	132
3.9.2	Observation inventory	133
	Phase2 for RO2	134
3.9.3	Questionnaire	134

3.9.3(a)	Students and teachers.....	135
3.9.3(b)	School administrators	136
3.9.4	Focus group discussion	136
Phase 3 for RO3	137
3.9.5	Semi-structured interview (Round 1).....	138
3.9.6	Card sorting.....	138
Phase 4 for RO4	140
3.9.7	Semi-structured interview (Round 2).....	140
3.9.8	Simulation	142
3.9.8(a)	Bathroom simulation	143
3.9.8(b)	Corridor simulation.....	144
3.9.8(c)	Makerspace simulation	144
3.10	Data Analysis	148
3.10.1	Data analysis for quantitative data	148
3.10.1(a)	For observation inventory (RQ1).....	148
3.10.1(b)	For questionnaire (RQ2).....	149
3.10.1(c)	For simulation (RQ4).....	150
3.10.1(d)	Data analysis indicator interpretation	151
3.10.1(d)(i)	Reliability and Validity Tests.....	151
3.10.1(d)(ii)	Non-Parametric Tests.....	152
3.10.1(d)(iii)	Spearman Correlation Analysis	153
3.10.1(d)(iv)	Path Analysis Parameters.....	153
3.10.1(d)(v)	Data Distribution Tests	154
3.10.2	Data analysis for qualitative data	154
3.10.2(a)	For observation and focus group discussion (RQ1 and RQ2).....	155
3.10.2(b)	For semi-structured interviews and card sorting (RQ3 and RQ4).....	156

3.11	Duration of participant involvement	159
3.12	Validity and reliability	163
3.12.1	Validity and reliability for quantitative research.....	163
3.12.1(a)	Validity in quantitative research.....	163
3.12.1(b)	Reliability in quantitative research	164
3.12.1(b)(i)	Reliability of the observation inventory .	164
3.12.1(b)(ii)	Questionnaire reliability	164
3.12.2	Validity and reliability for qualitative research.....	165
3.12.2(a)	Validity in qualitative research.....	165
3.12.2(b)	Reliability in qualitative research	165
3.13	Ethical considerations	166
3.14	Summary	167
3.14.1	Questionnaire pilot test.....	167
3.14.2	Summary of Chapter 3	171
CHAPTER 4	DATA ANALYSIS AND DISCUSSION	172
4.1	Introduction	172
4.2	Information on case studies.....	173
4.2.1	Case Study 1: Lianyungang Luowei Primary School	173
4.2.2	Case Study 2: Lianyungang Xunanzhuang Primary School	174
4.2.3	Case Study 3: Lianyungang Xuwei Primary School.....	175
4.3	Phase 1 for RQ 1	179
4.3.1	Spatial layout.....	179
4.3.1(a)	Observation.....	179
4.3.1(b)	Observation Inventory	182
4.3.1(b)(i)	Normal classroom.....	182
4.3.1(b)(ii)	Professional classroom	183
4.3.1(b)(iii)	Library and resource space	184

	4.3.1(b)(iv) Corridors and circulation spaces.....	185
	4.3.1(b)(v) Public and other spaces.....	186
	4.3.1(c) Comparison of the three case studies.....	187
4.3.2	Physical Attributes	188
	4.3.2(a) Observation.....	188
	4.3.2(b) Observation Inventory	190
	4.3.2(b)(i) Normal classroom.....	190
	4.3.2(b)(ii) Professional classroom	191
	4.3.2(b)(iii) Library and resource space	192
	4.3.2(b)(iv) Corridors and circulation spaces.....	193
	4.3.2(b)(v) Public and other spaces.....	194
	4.3.2(c) Comparison of the three case studies.....	197
4.3.3	Technology.....	197
	4.3.3(a) Observation.....	197
	4.3.3(b) Observation inventory	200
	4.3.3(b)(i) Normal classroom.....	200
	4.3.3(b)(ii) Professional classroom	200
	4.3.3(b)(iii) Library and resource space	201
	4.3.3(b)(iv) Corridors and circulation spaces.....	202
	4.3.3(b)(v) Public and other spaces.....	202
	4.3.3(c) Comparison of the three case studies.....	203
4.3.4	Furniture.....	204
	4.3.4(a) Observation.....	204
	4.3.4(b) Observation inventory	207
	4.3.4(b)(i) Normal classroom.....	207
	4.3.4(b)(ii) Professional classroom	208
	4.3.4(b)(iii) Library and resource space	209

	4.3.4(b)(iv) Corridors and circulation spaces.....	210
	4.3.4(b)(v) Public and other spaces.....	211
	4.3.4(c) Comparison of the three case studies.....	212
4.3.5	Analysis of learning space impact on TnL activities	213
	4.3.5(a) Spearman correlation analysis	213
	4.3.5(b) Paired sample Wilcoxon analysis	215
4.4	Discussion for Phase 1	216
	4.4.1 Spatial Layout	216
	4.4.2 Physical Attributes	218
	4.4.3 Technology.....	219
	4.4.4 Furniture.....	220
4.5	Phase 2 for RQ2	223
	4.5.1 Reliability and validity of the questionnaire	225
	4.5.1(a) Reliability and validity of teacher questionnaire	225
	4.5.1(b) Reliability and validity of student questionnaires	226
	4.5.2 Spatial layout.....	227
	4.5.2(a) Questionnaire results	227
	4.5.2(a)(i) Teachers	227
	4.5.2(a)(ii) Students.....	229
	4.5.2(a)(iii) Comparison of the teachers' and students' questionnaire results	231
	4.5.2(a)(iv) Principals	232
	4.5.2(b) Focus group discussion results	233
	4.5.3 Physical attributes	236
	4.5.3(a) Questionnaire results	236
	4.5.3(a)(i) Teachers	236
	4.5.3(a)(ii) Students.....	237
	4.5.3(a)(iii) Comparison of the teachers' and students'	

4.7.1(a)	Path analysis	270
4.7.1(a)(i)	Teachers	270
4.7.1(a)(ii)	Students.....	271
4.7.1(a)(iii)	Comparison of the teachers' and students' results.....	272
4.7.1(b)	Round 1 Interview and card sorting results	273
4.7.2	Physical attributes	276
4.7.2(a)	Path analysis	276
4.7.2(a)(i)	Teachers	276
4.7.2(a)(ii)	Students.....	277
4.7.2(a)(iii)	Comparison of the teachers' and students' results.....	278
4.7.2(b)	Round 1 Interview and card sorting results	279
4.7.3	Technology.....	282
4.7.3(a)	Path analysis	282
4.7.3(a)(i)	Teachers	282
4.7.3(a)(ii)	Students.....	284
4.7.3(a)(iii)	Comparison of the teachers' and students' results.....	285
4.7.3(b)	Round 1 Interview and card sorting results	285
4.7.4	Furniture.....	288
4.7.4(a)	Path analysis	288
4.7.4(a)(i)	Teachers	288
4.7.4(a)(ii)	Students.....	289
4.7.4(a)(iii)	Comparison of the teachers' and students' results.....	290
4.7.4(b)	Round 1 Interview and card sorting results	290
4.7.5	Teaching and learning activities.....	293
4.7.5(a)	Spearman correlation analysis from teachers	293

	4.7.5(b) Spearman correlation analysis from students	294
4.8	Discussion for Phase 3	295
	4.8.1 Spatial layout.....	295
	4.8.2 Physical attributes	297
	4.8.3 Technology.....	298
	4.8.4 Furniture	300
4.9	Phase 4 for RQ4	303
	4.9.1 Introduction of the renewal and retrofit strategy formation process.....	303
	4.9.1(a) Spatial layout	303
	4.9.1(b) Physical attributes.....	304
	4.9.1(c) Technology	304
	4.9.1(d) Furniture	304
	4.9.2 Spatial Layout	305
	4.9.2(a) Normal classroom.....	305
	4.9.2(b) Professional classrooms.....	309
	4.9.2(c) Library and resource space	313
	4.9.2(d) Corridors and circulation spaces.....	315
	4.9.2(e) Public and other spaces.....	318
	4.9.3 Physical attributes	320
	4.9.3(a) Normal classroom.....	320
	4.9.3(b) Professional classrooms.....	324
	4.9.3(c) Library and resource space	326
	4.9.3(d) Corridors and circulation spaces.....	329
	4.9.3(e) Public and other spaces.....	331
	4.9.4 Technology.....	333
	4.9.4(a) Normal classroom.....	333
	4.9.4(b) Professional classrooms.....	336

4.9.4(c)	Library and resource space	339
4.9.4(d)	Corridors and circulation spaces.....	342
4.9.4(e)	Public and other spaces.....	345
4.9.5	Furniture.....	348
4.9.5(a)	Normal classroom.....	348
4.9.5(b)	Professional classrooms.....	350
4.9.5(c)	Library and resource space	353
4.9.5(d)	Corridors and circulation spaces.....	356
4.9.5(e)	Public and other spaces.....	357
4.9.6	Teaching and learning activities.....	360
4.9.6(a)	Simulation of TnL activities in the Makerspace.....	360
4.9.6(a)(i)	Case Study 1	360
4.9.6(a)(ii)	Case Study 2	360
4.9.6(a)(iii)	Case Study 3	361
4.9.6(a)(iv)	Normality analysis	364
4.9.6(a)(v)	Nonparametric test.....	364
4.9.6(a)(vi)	Paired analysis	365
4.9.6(a)(vii)	Correlation analysis	368
4.9.6(b)	Corridors and public spaces.....	369
4.9.6(b)(i)	Comparison of crowd density before and after renewal and retrofitting	369
4.9.6(b)(ii)	Comparison of communication frequency before and after renewal and retrofitting	372
4.9.6(c)	Comparison of the restrooms before and after renewal and retrofitting.....	374
4.9.6(c)(i)	Case Study 1	374
4.9.6(c)(ii)	Case Study 2	376
4.9.6(c)(iii)	Case Study 3	378

4.10	Discussion for Phase 4	380
4.10.1	Spatial layout.....	380
4.10.1(a)	Simulated impacts of makerspace and facility upgrades on teaching and learning	383
4.10.1(a)(i)	Comparison of makerspace model spatial design on teaching and learning activities	383
4.10.1(a)(ii)	Comparison of communication activities among students in the corridor before and after renewal and retrofitting	385
4.10.1(a)(iii)	Comparison of students' restroom usage times before and after renewal and retrofitting	386
4.10.2	Physical attributes	386
4.10.3	Technology.....	390
4.10.4	Furniture	393
4.10.5	Overall Findings	396
4.10.5(a)	Spatial layout	396
4.10.5(b)	Physical attributes.....	398
4.10.5(c)	Technology	399
4.10.5(d)	Furniture	401
4.11	Key areas requiring renewal and retrofit.....	404
4.11.1	Key areas requiring renewal and retrofit for spatial layout.....	404
4.11.2	Key areas requiring renewal and retrofit for physical attributes	405
4.11.3	Key areas requiring renewal and retrofit for technology	406
4.11.4	Key areas requiring renewal and retrofit for furniture	407
4.12	Comparison of urban and rural primary schools with renewal and retrofit strategies.....	408
4.12.1	Normal classroom	409
4.12.2	Professional classrooms	410

4.12.3	Library and resource space.....	414
4.12.4	Corridors and circulation spaces	415
4.12.5	Public and other spaces	416
4.12.6	Implications for renewal and retrofit of rural learning space.....	421
4.13	Summary	422
CHAPTER 5 CONCLUSION AND RECOMMENDATIONS		424
5.1	Introduction	424
5.2	Answer the research question and accomplish the research objectives	424
5.2.1	Research Questions (RQ).....	425
5.2.2	Research Objectives (RO).....	429
5.3	Contributions of the Study	431
5.3.1	Theoretical Contribution of the Study.....	431
5.3.2	Contributions to Practice.....	432
5.4	Research limitations	434
5.5	Future research recommendations.....	436
5.6	Summary	437
REFERENCES.....		439
APPENDICES		
LIST OF PUBLICATIONS		

LIST OF TABLES

	Page
Table 1.1	Comparison of education expenditures, the population aged 0-14, and the number of primary schools in Jiangsu Province9
Table 1.2	Comparison of education expenditure and number of primary schools in 2023, Lianyungang..... 10
Table 2.1	Area and population of Lianyungang.....23
Table 2.2	Summary of physical learning space's domains to influence the teaching and learning (TnL) activities30
Table 2.3	Summary of types of teaching and learning activities (TnL).....33
Table 2.4	The summary of global trends in learning space design69
Table 2.5	Summary of China's Educational Reform requirement 71
Table 2.6	Closing the research gap 79
Table 3.1	Distribution and selection of rural primary schools by district/county.....99
Table 3.2	The mean value of build-up area per student for the 72 sample schools..... 101
Table 3.3	The results of β_0 , β_1 , and β_2 from the SPSS analysis..... 105
Table 3.4	The names and locations of the potential case studies..... 106
Table 3.5	The names and locations of the potential case schools after the site assessment..... 107
Table 3.6	The comparison with schools, built-up area, population (number of students), and location of the selected case schools..... 110
Table 3.7	Research approaches and corresponding target and source populations 116
Table 3.8	The sample size of students and teachers for the selected schools .. 124

Table 3.9	Age range of the target population.....	124
Table 3.10	Lianyungang's typical rural primary school class timetable	145
Table 3.11	Summary of data collection methods, participants, and locations in Jiangsu Province schools study	147
Table 3.12	The interpretation of reliability and validity tests	152
Table 3.13	The interpretation of non-parametric tests	153
Table 3.14	The interpretation of Spearman correlation analysis	153
Table 3.15	The interpretation of path analysis.....	154
Table 3.16	The interpretation of data distribution tests	154
Table 3.17	Mixed methods integration plan for learning space study	158
Table 3.18	Research methods, participants, data collection, analysis techniques, and duration of participant involvement	161
Table 3.19	Reliability of the principal questionnaire pilot test	168
Table 3.20	Validity of the principal questionnaire pilot test.....	169
Table 3.21	Reliability of the teacher pilot test	169
Table 3.22	Validity of the teacher pilot test.....	170
Table 3.23	Reliability of the student questionnaire pilot test.....	170
Table 3.24	Validity of the student questionnaire pilot test	170
Table 4.1	Basic information for the three case study schools.....	178
Table 4.2	Key problems for spatial layout	180
Table 4.3	Comparison of area indicators of rural primary school building standards and three case study schools	182
Table 4.4	Key problems for physical attributes	189
Table 4.5	Comparison of physical attributes of rural primary school standards and three case studies.....	196
Table 4.6	The key problems of technology.....	198

Table 4.7	Comparison of urban primary school building standards and the current status of technical equipment in three case study schools ...	199
Table 4.8	The key problems for furniture	205
Table 4.9	Comparison of urban primary school building standards and the current status of furniture in three case study schools	206
Table 4.10	Spearman correlation analysis results	214
Table 4.11	Paired Sample Wilcoxon Analysis Results	216
Table 4.12	The respondents for the focus group discussion	223
Table 4.13	Information about the teacher questionnaire participants	224
Table 4.14	Information about the student questionnaire participants	224
Table 4.15	Reliability of teacher questionnaire	225
Table 4.16	Validity of teacher questionnaire	226
Table 4.17	Reliability of student questionnaires	226
Table 4.18	Validity of student questionnaires.....	226
Table 4.19	Teacher questionnaire responses for spatial layout.....	228
Table 4.20	Student questionnaire responses for spatial layout	230
Table 4.21	Principal questionnaire responses for spatial layout	233
Table 4.22	The key responses obtained from the teachers, principals, and architects on the spatial layout	235
Table 4.23	Teachers questionnaire responses for physical attributes	237
Table 4.24	Student questionnaire responses for physical attributes.....	239
Table 4.25	The key responses obtained from the teachers, principals, and architects on the physical attributes	242
Table 4.26	Teacher questionnaire responses for technology	243
Table 4.27	Student questionnaire responses for technology	245
Table 4.28	Principal questionnaire responses for technology.....	247

Table 4.29	The key responses obtained from the teachers, principals, and architects on the technology.....	249
Table 4.30	Teacher questionnaire responses for furniture	251
Table 4.31	Students questionnaire responses for furniture	252
Table 4.32	The key responses obtained from the teachers, principals, and architects on the furniture.....	255
Table 4.33	Teacher questionnaire responses for the actual practised TnL activities	257
Table 4.34	Teacher questionnaire responses for the ideal practised TnL activities	257
Table 4.35	Student questionnaire responses for the actual practised TnL activities	258
Table 4.36	Principal questionnaire responses for the actual practised TnL activities	260
Table 4.37	Student respondents for card sorting and interviews	269
Table 4.38	The teacher respondents for the interviews (Rounds 1 and 2).....	270
Table 4.39	The path analysis of the teacher responses on spatial layout.....	271
Table 4.40	Path analysis of the student responses on spatial layout.....	272
Table 4.41	Recommendations from teacher and students for spatial layout.....	275
Table 4.42	Path analysis of the teacher responses on physical attributes	277
Table 4.43	Path analysis of the student responses on physical attributes	278
Table 4.44	Recommendations from teacher and student for physical attributes	281
Table 4.45	Path analysis of the teacher responses on technology.....	283
Table 4.46	Path analysis of the student responses on technology.....	285
Table 4.47	Recommendations from teachers and students for technology.....	287
Table 4.48	Path analysis of the teacher responses on furniture	289
Table 4.49	Path analysis of the student responses on furniture	290

Table 4.50	Recommendations from teachers and students for furniture	292
Table 4.51	Spearman correlation analysis of the teachers' responses.....	294
Table 4.52	Spearman correlation analysis of the students' responses.....	295
Table 4.53	Strategies for the spatial layout of the classroom.....	309
Table 4.54	Strategies for the spatial layout of the professional classroom	312
Table 4.55	Strategies for the spatial layout of the library and resource space...	315
Table 4.56	Strategies for the spatial layout of corridors and circulation spaces	317
Table 4.57	Strategies for spatial layout for public and other spaces.....	320
Table 4.58	Strategies for physical attributes of the classroom.....	324
Table 4.59	Strategies for physical attributes of professional classroom	326
Table 4.60	Strategies for physical attributes of library and resource space.....	329
Table 4.61	Strategies for physical attributes of corridors and circulation spaces	331
Table 4.62	Strategies for physical attributes of public and other spaces	333
Table 4.63	Strategies for technology in the classroom	336
Table 4.64	Strategies for technology in professional classrooms	339
Table 4.65	Strategies for technology in library and resource spaces	342
Table 4.66	Strategies for technology for corridors and circulation spaces	345
Table 4.67	Strategies for technology for public and other spaces	348
Table 4.68	Strategies for furniture in the classroom	350
Table 4.69	Strategies for furniture in professional classrooms.....	353
Table 4.70	Strategies for furniture in the library and resource space	355
Table 4.71	Strategies for furniture for corridors and circulation spaces.....	357
Table 4.72	Strategies for furniture for public and other spaces	359
Table 4.73	Nonparametric test analysis results.....	365

Table 4.74	Paired sample Wilcoxon analysis results for Case Study 1	366
Table 4.75	Paired sample Wilcoxon analysis results for Case Study 2	367
Table 4.76	Paired sample Wilcoxon analysis results for Case Study 3	368
Table 4.77	Spearman Correlation analysis for three case studies' models.....	369
Table 4.78	Comparison of crowd density before and after renewal and retrofit	371
Table 4.79	Comparison of the colour proportion of crowd density before and after renewal and retrofit.....	372
Table 4.80	Comparison of interactions before and after renewal and retrofit in three case studies.....	373
Table 4.81	Comparison of communication frequency before and after renewal and retrofit.....	374
Table 4.82	Comparison of restroom before and after renewal and retrofit for Case Study 1.....	376
Table 4.83	Comparison of restroom before and after renewal and retrofit for Case Study 2.....	377
Table 4.84	Comparison of restroom before and after renewal and retrofit for Case Study 3.....	379
Table 4.85	Comparison of the architectural standards, renewal strategies and CER requirement for spatial layout	382
Table 4.86	Comparison of the architectural standards, renewal strategies and CER requirements for physical attributes	389
Table 4.87	Comparison of the architectural standards, renewal strategies and CER requirement for technology	392
Table 4.88	Comparison of architectural standards, renewal strategies and CER requirements for furniture	395
Table 5.1	Addressing Research Gaps and Effectiveness of Solutions in Enhancing Learning Space.....	425

LIST OF FIGURES

	Page
Figure 1.1	Current Status of rural primary schools in China.....3
Figure 1.2	Research goals and domains 11
Figure 1.3	Research framework of the study..... 18
Figure 2.1	Area of Lianyungang.....23
Figure 2.2	The spatial layout of the future school.....39
Figure 2.3	A: The Kensington Learning Space40
Figure 2.4	Proper lighting design in China urban School42
Figure 2.5	Acoustics Design in Sonia Delaunay School.....43
Figure 2.6	A: The classroom is equipped with an air conditioner.....44
Figure 2.7	A: Hybrid learning space design in Hebei Province, China.....46
Figure 2.8	A: Flexible layout supports the arrangement of technical equipment B: Technology-supporting learning space design in Ransom Everglades School.....47
Figure 2.9	Flexible furniture arrangement supports diverse TnL activities48
Figure 2.10	The corridors in Jiulong School, Nanjing, China, serve as informal learning spaces with movable partitions49
Figure 2.11	A: Display cabinets, blackboards and TV that support different activities B: Furniture arrangement with diverse display interfaces50
Figure 2.12	Three stages of learning spatial forms 75
Figure 2.13	Design drawings for classroom retrofit. A: Before retrofit; B: After retrofit..... 76
Figure 2.14	Four forms of learning space in the rural area 77
Figure 2.15	Position of this present study80

Figure 2.16	Learning space affordance theoretical framework.....	85
Figure 2.17	Conceptual framework of end-user needs, TnL activities, and learning spaces	87
Figure 3.1	Research design diagram.....	94
Figure 3.2	The case study selection process.....	96
Figure 3.3	Linear regression analysis of the population and area of the 72 sample schools	100
Figure 3.4	The quadratic line obtained from the SPSS analysis	105
Figure 3.5	The Selected Case Study Schools	113
Figure 3.6	The selection criteria for the first focus group members	125
Figure 3.7	The selection criteria for the third focus group members	126
Figure 3.8	Student sampling method and subject recruitment	130
Figure 3.9	Sampling method and subject recruitment for Teachers, architects, school administrators, and government administrators.....	131
Figure 3.10	Print screen for AnyLogic Version 8.8.1	143
Figure 3.11	The furniture set for the four types of TnL activities.....	145
Figure 4.1	General layout of Case Study 1.....	173
Figure 4.2	Aerial view of Case Study 1.....	174
Figure 4.3	General layout of Case Study 2.....	175
Figure 4.4	Aerial view of Case Study 2.....	175
Figure 4.5	Aerial view of Case Study 3.....	176
Figure 4.6	General layout of Case Study 3.....	177
Figure 4.7	Comparison of spatial layout for normal classrooms.....	183
Figure 4.8	Comparison of spatial layout in professional classrooms	184
Figure 4.9	Comparison of the spatial layout for the library space and resource space.....	185
Figure 4.10	Comparison of spatial layout for corridors and circulation spaces ..	186

Figure 4.11	Comparison of spatial layout for the public and other spaces	187
Figure 4.12	Mean value for spatial layout of three case study schools.....	188
Figure 4.13	Comparison of the physical attributes of normal classroom.....	190
Figure 4.14	Case Study 3's science classroom	191
Figure 4.15	Comparison of physical attributes of professional classrooms	192
Figure 4.16	Comparison of physical attributes of library and resource space	193
Figure 4.17	Comparison of physical attributes of corridors and circulation spaces	194
Figure 4.18	A and B: Leaking rooms in Case Study 1; C: Storage rooms in Case Study 3	195
Figure 4.19	Comparison of the physical attributes of the public space and other spaces	195
Figure 4.20	Mean value for physical attributes of three case study schools	197
Figure 4.21	Comparison of technology for normal classroom.....	200
Figure 4.22	Comparison of technology in professional classrooms.....	201
Figure 4.23	Comparison of technology for the library space and the resource space.....	201
Figure 4.24	Comparison of technology for corridors and circulation spaces.....	202
Figure 4.25	Comparison of technology for public and other spaces	203
Figure 4.26	Mean value for the technology of three case study schools.....	204
Figure 4.27	Comparison of furniture for normal classroom.....	208
Figure 4.28	Comparison of furniture in professional classrooms	209
Figure 4.29	Comparison of furniture for library space and resource space	210
Figure 4.30	Comparison of furniture for corridors and circulation spaces	211
Figure 4.31	Comparison of furniture for public and other spaces.....	212
Figure 4.32	Mean value for furniture of three case study schools	213
Figure 4.33	The impact of learning spaces on TnL activities	222

Figure 4.34	Comparison of teacher questionnaire responses for spatial layout ..	228
Figure 4.35	Comparison of student questionnaire responses for spatial layout ..	231
Figure 4.36	Comparison of teacher and student questionnaire results	232
Figure 4.37	Comparison of teachers' questionnaire responses for physical attributes.....	237
Figure 4.38	Comparison of student questionnaire responses for physical attributes.....	239
Figure 4.39	Comparison of teacher and student questionnaire results regarding physical attributes.....	240
Figure 4.40	Comparison of teacher questionnaire responses for technology.....	244
Figure 4.41	Comparison of students' questionnaire responses for technology ...	245
Figure 4.42	Comparison of teacher and student questionnaire results	246
Figure 4.43	Comparison of teacher questionnaires for responses on furniture ...	251
Figure 4.44	Comparison of students' questionnaire responses for furniture	252
Figure 4.45	Comparison of teacher questionnaire responses for the TnL in the three case study schools	257
Figure 4.46	Comparison of student questionnaire responses for the TnL in the three case study schools	259
Figure 4.47	The challenges of learning spaces to support TnL activities	267
Figure 4.48	A: Case Study 1 normal classroom; B: Case Study 2 normal classroom	274
Figure 4.49	Summary of end-user preferences for learning space design.....	302
Figure 4.50	Modular design supports different TnL activities	306
Figure 4.51	Opening and closing of movable partitions	307
Figure 4.52	Folded wall before and after opening.....	307
Figure 4.53	Normal classroom design with green plant arrangement.....	308
Figure 4.54	Support rates of strategies for the spatial layout of the classroom...	308

Figure 4.55	Modular design in the professional classroom.....	310
Figure 4.56	Music classroom display space	311
Figure 4.57	Folded walls in the professional classroom	312
Figure 4.58	Support rates of strategies for the spatial layout of the professional classroom	312
Figure 4.59	A book drifting area at the reading corner in Case Study 1	314
Figure 4.60	Modular design in the library	314
Figure 4.61	Support rates of strategies for the spatial layout of the library and resource space	315
Figure 4.62	Corridor layout with traffic and resting areas	316
Figure 4.63	Support rates of strategies for the spatial layout of the library and resource space	317
Figure 4.64	Flexible public spaces in Case Study 2	319
Figure 4.65	Support rates of strategies for the spatial layout of public and other spaces	319
Figure 4.66	Modular design for fans and lamps in the classroom.....	321
Figure 4.67	Seasonal sunlight design strategy and roof retrofit.....	322
Figure 4.68	Support rates of strategies for physical attributes of the classroom.	323
Figure 4.69	Modular design for fans and lamps in the professional classroom ..	325
Figure 4.70	Support rates of strategies for physical attributes of professional classroom	326
Figure 4.71	Modular design for fans and lamps in the library	327
Figure 4.72	A: Sunlight angle design for seasonal optimization B: Natural material and warm-toned design in library	328
Figure 4.73	Support rates of strategies for physical attributes of library and resource space	328

Figure 4.74	Support rates of strategies for physical attributes of corridors and circulation spaces	330
Figure 4.75	Support rates of strategies for physical attributes of public and other spaces	333
Figure 4.76	A: Portable interactive TV; B: Sound reinforcement system in the classroom	335
Figure 4.77	Support rates of strategies for technology in the classroom	336
Figure 4.78	Power supply and network in professional classrooms.....	337
Figure 4.79	A: Computer classroom in Case Study 2; B: Science classroom in Case Study 2.....	338
Figure 4.80	Support rates of strategies for technology in professional classrooms	339
Figure 4.81	A: Case Study 2 library; B: Case Study 3 library with computers...340	
Figure 4.82	Power and network interfaces and loudspeaker in Case Study 1	341
Figure 4.83	Support rates of strategies for technology in library and resource spaces	342
Figure 4.84	Corridors with surveillance and emergency alarm bells in Case Study 3	344
Figure 4.85	Support rates of strategies for corridors and circulation spaces.....	345
Figure 4.86	Speaker and TV system in Case Study 2	346
Figure 4.87	Support rates of strategies for public and other spaces	347
Figure 4.88	Adjustable height desks and chairs with fan and lamp	349
Figure 4.89	Adjustable desk and chair design for rest and learning	349
Figure 4.90	Support rates of strategies for furniture in the classroom	350
Figure 4.91	Adjustable and movable desk and chair in Case Study 1.....	351
Figure 4.92	Seats made of old tyres and paint buckets in Case Study 1	351
Figure 4.93	A: Sports equipment room in Case Study 3; B: Art classroom in Case Study 1.....	352

Figure 4.94	Support rates of strategies for furniture in professional classrooms	352
Figure 4.95	A: Low-height bookshelf in Case Study; B: Sofa setup in Case Study 2	354
Figure 4.96	A: Reading furniture with sockets in Case Study 3; B: Whiteboard at the entrance in Case Study 1	355
Figure 4.97	Support rates of strategies for furniture in library and resource space	355
Figure 4.98	A: Bench at the corridor in Case Study 3; B: Whiteboard at the corridor in Case Study 3	356
Figure 4.99	Support rates of strategies for furniture in corridors and circulation spaces	357
Figure 4.100	A: Recreation area in Case Study 1; B: Display cabinets in Case Study 2	358
Figure 4.101	A: Modular cube furniture in Case Study 2; B: Moveable and splicing furniture in Case Study 3	359
Figure 4.102	Support rates of strategies for furniture in corridors and circulation spaces	359
Figure 4.103	Three makerspace models for the three case study schools	362
Figure 4.104	Models and renderings of furniture layout designs for each makerspace case study (three models per case)	363
Figure 4.105	A: Status Quo Corridor for Case Study 2; B: Corridor After Renewal and Retrofitting for Case Study 2; C: Status Quo Corridor for Case Study 3; D: Corridor After Renewal and Retrofitting for Case Study 3	370
Figure 4.106	Case Study 1 restroom location before and after renewal and retrofit	375
Figure 4.107	Comparison of the cumulative probability before and after renewal and retrofitting for Case Study 1	376
Figure 4.108	Case Study 2 restroom locations before and after renewal and retrofit	377

Figure 4.109	Comparison of the cumulative probability before and after renewal and retrofitting for Case Study 2.....	378
Figure 4.110	Case Study 3 restroom location before and after renewal and retrofit.....	379
Figure 4.111	Comparison of the cumulative probability before and after renewal and retrofitting for Case Study 3.....	380
Figure 4.112	Key points about renewal and retrofit strategies for rural primary schools.....	403
Figure 4.113	Typical urban primary school normal classroom.....	409
Figure 4.114	Typical urban primary school professional classrooms.....	411
Figure 4.115	Normal classroom proposal for Case Study 3.....	412
Figure 4.116	Markerspace proposal for Case Study 1.....	413
Figure 4.117	Typical urban primary school library.....	415
Figure 4.118	Typical urban primary school corridor	416
Figure 4.119	Typical urban primary school public space	417
Figure 4.120	Typical urban primary school botanical garden.....	417
Figure 4.121	Botanical garden design from author recommendation for Case Study 2	417
Figure 4.122	Library proposal for Case Study 1	418
Figure 4.123	Corridor proposal for Case Study 3	419
Figure 4.124	Public space proposal for Case Study 2	420
Figure 5.1	Changes in the perceptions of end users via renewal and retrofit strategies.....	432

LIST OF ABBREVIATIONS

AR	Augmented reality
CER	China's Education Reform
CI	Confidence intervals
DLS	Divisions of the learning spaces
ICT	Information and Communications Technology
ILE	Innovative Learning Environment
ILS	Impact of learning spaces
MOE	Ministry of Education, PRC
MHURD	Ministry of Housing and Urban-Rural Development, PRC
MR	Mixed reality
NADPC	National Administration of Disease Prevention and Control
OECD	Organization for Economic Co-operation and Development
PST	Pedagogy-space-technology
PE	Physical environment
RO	Research objective
RQ	Research question
RSL	Responses on spatial layout
RPA	Responses on physical attributes
RT	Responses on technology
RF	Responses on furniture
SDG 4	Sustainable Development Goal 4 for the United Nation's 2030 Agenda
SMSL	School management and learning spaces
TnL	Teaching and learning
TLAP	Teaching and learning activities for actual practices
TLI P	Teaching and learning activities for ideal practices
UNESCO	United Nations Educational, Scientific and Cultural Organization
VR	Virtual reality

LIST OF SYMBOLS

n'	Sample size with finite population correction
N	Population size
Z	the Z statistic for a level of confidence
P	Expected proportion (in the proportion of one)
d	Precision (in the proportion of one)
E	Building area per student (m ² /people)
E (Area)	Building area (excluding dormitories) (m ²)
P (Population)	The number of students (people)
β_0	Intercept
β_1	Slope 1
β_2	Slope 2
X	Independent variable
Y	Dependent variable
n	Sample size for the pilot study
g	Confidence level
p	Probability of encountering surprising reasons for exclusion in a given participant
S_x^2	Variance of each item
S_i^2	Sum of various points of each item in the measuring instrument
α	Cronbach's Alpha Coefficient
p	p value is the probability of obtaining test results at least as extreme as the result actually observed

LIST OF APPENDICES

APPENDIX A	THE LIST OF RURAL PRIMARY SCHOOLS IN LIANYUNGANG
APPENDIX B	EVALUATION TABLE OF LEARNING SPACE
APPENDIX C	QUESTIONNAIRE FOR END-USERS (STUDENTS, TEACHERS, AND SCHOOL LEADERS)
APPENDIX D	QUESTIONS FOR FOCUS GROUP INTERVIEWS
APPENDIX E	QUESTIONS FOR SEMI-STRUCTURE INTERVIEW
APPENDIX F	CARD SORTING FOR STUDENTS
APPENDIX G	CODES FOR ANYLOGIC SIMULATION OF MAKER SPACES
APPENDIX H	PERMISSION LETTER FOR THREE CASE STUDY SCHOOLS
APPENDIX I	DESCRIPTIVE STATISTICS AND NORMALITY ANALYSIS FOR OBSERVATION INVENTORY AND QUESTIONNAIRES
APPENDIX J	THE ORIGINAL DATA FOR OBSERVATION
APPENDIX K	THE ORIGINAL DATA FOR THE FOCUS GROUP DISCUSSION
APPENDIX L	THE ORIGINAL DATA FOR THE FIRST ROUND INTERVIEW AND CARD SORTING

**PEMBAHARUAN SENI BINA DAN PENGUBAH SUIAN REKA
BENTUK RUANG PEMBELAJARAN DI SEKOLAH RENDAH LUAR
BANDAR DI WILAYAH JIANGSU, CHINA**

ABSTRAK

Kajian ini membincangkan keperluan untuk mengadaptasi ruang pembelajaran sekolah rendah luar bandar di China bagi menyokong peralihan daripada kaedah pengajaran tradisional berasaskan syarahan kepada pelbagai aktiviti pengajaran dan pembelajaran (PnP), selaras dengan Matlamat Pembangunan Lestari UNESCO 4 dan Reformasi Pendidikan di China. Dengan memberi tumpuan kepada sekolah rendah luar bandar di Lianyungang, Wilayah Jiangsu, kajian ini mengkaji hubungan antara reka bentuk ruang pembelajaran dan aktiviti PnP, terutamanya dari segi susun atur ruang, ciri fizikal, teknologi, dan perabot. Pengumpulan data dilaksanakan dalam empat fasa: Fasa 1 – pemerhatian tapak dan inventori pemerhatian; Fasa 2 – soal selidik dan perbincangan kumpulan fokus; Fasa 3 – pusingan pertama temu bual, dan penyisihan kad; serta Fasa 4 – simulasi berkomputer menggunakan perisian AnyLogic, dan pusingan kedua temu bual. Hasil kajian mendapati beberapa kekangan utama seperti susun atur ruang yang tidak fleksibel, kawalan suhu yang tidak mencukupi, teknologi yang ketinggalan zaman, serta perabot tetap, yang kesemuanya menghalang penyertaan aktif dan interaksi dalam bilik darjah. Hasil simulasi menunjukkan model ruang pembuat (*makerspace*) yang berbeza mempunyai perbezaan ketara dalam menyokong aktiviti PnP, terutama dalam aktiviti PnP berbentuk pembentangan dan pengajaran berpasukan. Berdasarkan penemuan ini, kajian mencadangkan strategi pembaharuan dan penambahbaikan bagi mewujudkan ruang pembelajaran yang fleksibel, dipertingkatkan dengan teknologi terkini, dan ergonomik yang lebih baik.

Strategi-strategi ini telah disahkan keberkesanannya melalui dapatan simulasi AnyLogic dalam meningkatkan aktiviti PnP. Sumbangan utama kajian ini adalah pembangunan sistem inventori reka bentuk ruang pembelajaran sekolah rendah luar bandar, yang merakam persepsi pengguna akhir dan membantu dalam proses pembaharuan dan penambah baikan. Sistem ini, digabungkan dengan simulasi AnyLogic, mengesahkan strategi reka bentuk yang dicadangkan sebelum dilaksanakan secara muktamad. Pendekatan ini menyediakan kaedah komprehensif bagi merancang ruang yang lebih menyokong pelbagai aktiviti PnP, sekaligus menawarkan rangka kerja praktikal bagi pembaharua dan pengubah suaian reka bentuk ruang pembelajaran. Tambahan pula, kajian ini turut menjadi rujukan untuk mengemaskini piawaian pembinaan sekolah rendah luar bandar di China, memastikan ia memenuhi tuntutan reformasi pendidikan moden.

ARCHITECTURAL RENEWAL AND RETROFIT DESIGN OF RURAL PRIMARY SCHOOL LEARNING SPACE IN JIANGSU PROVINCE, CHINA

ABSTRACT

This study addresses the need to adapt rural primary school learning spaces in China to support the transition from traditional lecture-based teaching to diverse teaching and learning (TnL) activities in line with UNESCO's Sustainable Development Goal 4 and China's Educational Reform. Focusing on rural primary schools in Lianyungang, Jiangsu Province, the research investigates the relationship between learning space design and TnL activities, focusing on spatial layout, physical attributes, technology, and furniture. Data collection included 4 phases: Phase 1 - site observation and observation inventory; Phase 2 - questionnaire survey and focus group discussion; Phase 3 - first round of interviews and the card sorting; and Phase 4 - AnyLogic computer simulation and the second round of interviews. The findings revealed critical limitations such as inflexible layouts, inadequate temperature control, outdated technology, and fixed furniture, all of which hinder active participation and interaction in the classroom. The simulation results show that the different makerspace models can vary significantly in supporting TnL activities, especially in presentation and team teaching. Based on these findings, the study proposed renewal and retrofitting strategies to create flexible, technologically enhanced, and ergonomically improved learning spaces. The strategies were validated using AnyLogic simulation software, demonstrating their effectiveness in improving TnL activities. The main contribution of this study is developing a design inventory system for rural primary school learning spaces, which captures end-users' perceptions and informs the renewal and retrofitting process. This system, combined with AnyLogic simulations, verifies

proposed design strategies before final implementation. The approach provides a comprehensive method for designing spaces that better support diverse TnL activities, thus offering a practical framework for renewing and retrofitting learning spaces. Additionally, this research serves as a reference for revising the construction standards for rural primary schools in China, ensuring they meet the demands of modern education reform.

CHAPTER 1

INTRODUCTION

1.1 Introduction

The research background is discussed in the first section of this chapter, including an overview of rural primary school education in China, the status of rural primary school construction in China, the new specifications for primary school learning spaces under education reform, and the significance of renewal or retrofitting for maximizing rural primary school learning spaces. This includes the problem statement, research aim, objectives, and questions. Subsequently, the definitions of critical terms are provided, followed by the significance of the study, the study's methodology, research limitations, and a summary of this chapter.

1.2 Background of the study

1.2.1 Overview of rural primary education in China

In China, compulsory education provides free schooling to children between the ages of seven and fourteen in primary and secondary classes (MOE [Ministry of Education of the People's Republic of China], 2018). Rural education is vital to the Chinese educational system and shapes its overall quality. According to a report by China's National Bureau of Statistics (2024), approximately 56.2% of children in China are not urban dwellers. Additionally, data from the China Statistical Yearbook (2024) indicate that 20,296,822 children aged 7-12 are enrolled in primary schools in rural regions. As a result, rural primary schools play an essential role in meeting the educational needs of the more than 800 million people residing in such areas. Primary schools in rural areas educate students and spread culture and knowledge to farmers,

thus improving their lifestyles (China's Rural Education Development Report, 2020) and promoting rural education related to educational fairness, social justice and peaceful development.

The current design of learning spaces in rural schools still follows the *Construction Standards for Ordinary Primary and Secondary Schools in Rural Areas* promulgated by China in 2008. The standard lacks a description of specific teaching equipment and facilities. At the same time, in the current situation in rural China, there are still a large number of buildings built in the 1990s and 2000s, which makes it difficult to support the current diverse TnL activities. Survey data reveals that while 36.52% of students use the presentation layout daily, only 32.39%, 28.85%, and 20.18% use team teaching, individual learning, and group cooperation layouts, indicating limited engagement in more flexible learning environments. Similarly, 43.05% of teachers use the demonstration layout daily, with the team teaching layout being the least used (8.58%) (CAES, 2022b). This lack of learning space design to support diverse TnL activities has further exacerbated the urban-rural education gap and has failed to improve the quality of education in rural areas effectively.

Compulsory rural education remains lacking, as the gap between urban and rural areas is increasing (Guo & Li, 2024). Therefore, improving China's capacity for rural primary education is essential to promoting the economy's and society's comprehensive development.

1.2.2 Current situation of rural primary school construction in China

There are currently two ways to establish a primary school in many rural locations, either (i) constructing from an empty site or (ii) adding functional components to existing schools. Prior research has shown that rural primary school campuses often lack adequate learning spaces that support teaching and learning, and due to limitations

in funding and educational resources, these demands cannot be addressed in the short term (Song et al., 2010; Wen, 2016; Zhuang, 2020). Low standards for construction, minimal capital investment, and little social attention have ensured that many rural primary schools lack modern education and learning spaces within their current building services (*China's Rural Education Development Report, 2020*). In other words, in the context of China's educational reform, the federal government and its educational authorities must acknowledge the requirements for advanced learning environment spaces and thus the needs of end-users (i.e., teachers and students) in rural areas. This research will investigate this crucial situation and design an approach to satisfy end-user needs from an architectural viewpoint. This has not been extensively studied in China (Figure 1.1).



Figure 1.1 Current Status of rural primary schools in China (A: Outdated classroom buildings in need of renovation; B: Students using worn-out, old-fashioned classroom furniture; C: Limited outdoor space for students' recreational activities; D: Overcrowded and cold teachers' office)

1.3 Education reform has new requirements for the learning space

The Chinese Ministry of Education (MOE) has released the *Curriculum Plan and Curriculum Standards for Compulsory Education* to guide the direction of future curriculum education reform (MOE, 2022). This reform emphasizes cultivating talent with core literacy and fostering creative learning, emphasizing the need for innovative spaces like makerspaces to support these objectives. The evaluation system revolves around four core abilities (communication, cooperation, innovation, and critical thinking), requiring adjustments to educational spaces (Taylor & Enggass, 2009; Zhou, 2013; Nair, 2014; Nair & Jacobs, 2020). The impact of education reform on learning spaces is mainly focused on the following three aspects (Hod, 2017; Hughes & Morrison, 2020; Connolly et al., 2023).

1.3.1 Changes in teaching practices

In the information age, it is challenging for the teacher-centred teaching mode formed in the industrial age to meet the diverse needs of students for knowledge acquisition. Students can quickly obtain learning content from mobile devices, and heuristic education gradually replaces cramming teaching (He et al., 2018). Therefore, the student-centred teaching mode is being increasingly accepted by educators, which is a change in teaching methods and a need to design a suitable learning space (Shehata, 2024). Classrooms must shift from traditional lecture-based setups to more adaptable environments, which allow for greater flexibility in fostering collaboration and independent study and align with modern educational practices emphasising student-centred learning (Hughes & Morrison, 2020).

1.3.2 Changes in teaching and learning (TnL) activities

Cultivating talent with core competitiveness involves activities such as group discussions, individual learning, and one-on-one discussions between teachers and

students (Nair et al., 2020). Additionally, informal learning, such as recess and sports activities, is essential for knowledge acquisition (Taylor & Enggass, 2009). Informal learning provides opportunities for students to learn beyond the classroom, fostering enhanced learning abilities (Choi & Jacobs, 2011).

For example, urban schools can support group collaboration and innovative activities through flexible and diverse teaching spaces and equipment. However, in rural schools, it is difficult for teachers and students to fully implement these teaching models due to insufficient facilities, large class sizes, and even a lack of professional teaching tools.

The design of future school spaces should be more flexible to accommodate a variety of learning activities. Paniagua & Istance (2018) argue that learning spaces should promote collaborative and individual learning, positioning teachers as designers of learning spaces that enrich students' learning experiences. Learning spaces should support student interaction and discussion through informal activities, which are critical for enhancing their core competencies and developing problem-solving skills and teamwork abilities in a real-world context (Kapur & Ghose, 2018).

In addition, changes in curriculum content and teaching methods brought about by education reform have also impacted rural schools. Although the new curriculum emphasizes students' core competencies, such as communication, cooperation, innovation, and critical thinking (MOE, 2022), teachers in rural areas often lack sufficient professional development opportunities, making it challenging to implement these new methods effectively. In contrast, urban schools are generally better able to adapt to these reforms because they have more resources, newer facilities, and a more flexible educational environment (Zhou, 2013). This urban-rural difference has led to a significant gap in the implementation of curriculum reform in various regions,

especially in the development of teaching activities and the cultivation of students' comprehensive abilities. Rural schools still face severe challenges.

1.3.3 The importance of renewal or retrofitting for optimizing rural primary school learning space

Most rural primary school buildings in China were built from the 1980s to the early twenty-first century; thus, today's learning spaces have a considerably large gap compared with the need for education reform (Zhang, 2015). Considering the lack of capital, it would not be realistic for every rural primary school to be demolished and rebuilt by the government (Feng, 2020). Nevertheless, the development of education reform requires suitable learning spaces, and the tension between learner needs and spatial characteristics directly results in learners' instructional process and success.

This study investigates renewal or retrofitting as a “middle pathway” between demolition and the preservation of existing buildings. This attempts to maximize the usage of space in existing school buildings by picking out and reserving spaces that suit future school functions and needs, while also addressing areas in which demolition, transformation, or expansion is required (Hui, 2019).

In light of sustainable school architecture development, renewal or retrofitting should satisfy the needs of existing schools' end-users while considering future buildings' long-term usage (Hui, 2019). The proposed renewal or retrofit designs will enable positive interactions among architects, end-users, and policymakers to contribute more diversity to learning space, especially for primary schools in remote areas.

1.4 Problem statement

In the context of current educational reform, the design of learning spaces has a crucial impact on teaching and learning activities (TnL). According to research by

OECD (2009, 2013, 2018), an important criterion for evaluating the design of learning spaces is its ability to support TnL activities. However, there is still a disconnect between the current design field (spatial layout, physical properties, technology, and furniture) and TnL activities. This mismatch often leads to dissatisfaction among teachers and students, affecting teaching effectiveness and the achievement of educational goals (Sun & Firzan, 2024). Radcliffe (2009) pointed out that flexible learning spaces support more possibilities in contemporary education; he proposed the Pedagogy-Space-Technology (PST) framework to support this educational transformation. Scott-Webber (2004) and Fisher (2005) emphasized that the relationship between TnL activities and the performance characteristics of learning spaces needs to be specially considered during the design process, which is crucial for designing innovative learning spaces. Educational reforms have driven changes in the way knowledge is acquired in the 21st century, and these changes require learning spaces that are adapted to support them (Pearlman, 2010).

The different performance characteristics of learning spaces can significantly affect TnL activities (Sanoff, 2001; Graetz & Goliber, 2002; Scott-Webber, 2004; CABE., 2005; Tanner & Lackney, 2005; Taylor & Enggass, 2009; Woolner, 2010; Hinton et al., 2014; Barrett, 2015). The inadaptability of learning space design, such as outdated classroom layouts and insufficient technology facilities, will directly limit the diverse application of teaching methods and cause frustration for teachers and students (Zhang et al., 2022).

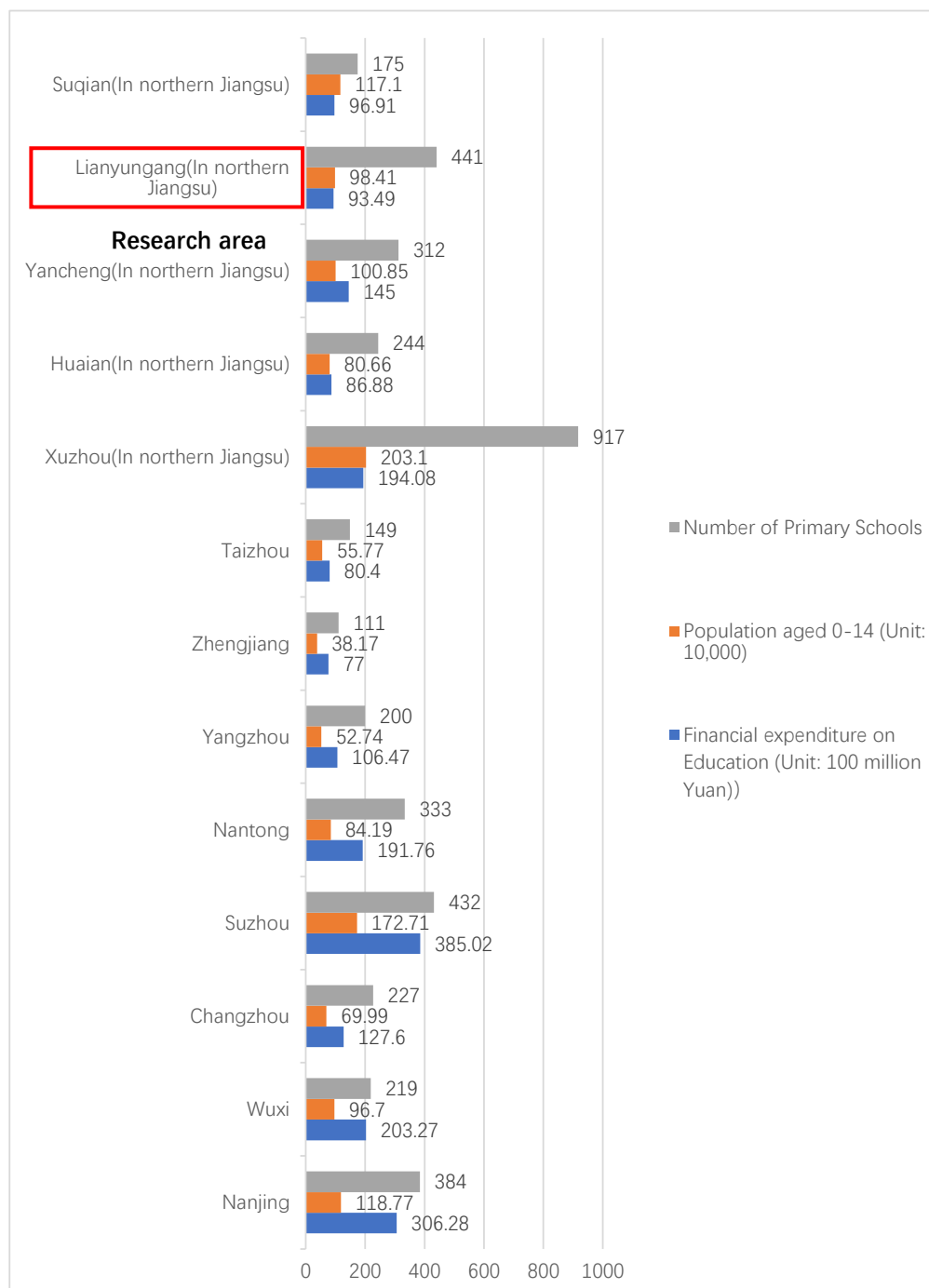
TnL activities should be supported by appropriate learning spaces, which should be consistent with the current curriculum reform of the Ministry of Education (MOE, 2022b). Many studies on learning spaces in China focus on urban schools, but less attention has been paid to remote rural areas (Li et al., 2012). Although China's rural

education policies actively promote the development of rural education, these policies mainly remain at the advocacy level and lack specific guidance on the construction and use of rural learning spaces (Chu & Zhang, 2012; Yang & Wang, 2013; Cai & Kong, 2014). When designing spaces, the actual needs of users should be fully considered to avoid design disconnection, which will help ensure the achievement of CER.

However, there is a lack of effective integration between the design field and TnL activities in rural schools. Due to the rigidity of spatial layout, defects in technology integration, TnL activities in rural schools have not been effectively supported, exacerbating the teaching dilemma and dissatisfaction of teachers and students (Ruiz & Gallagher, 2025).

Jiangsu Province is a significant education province in China. The government has continued to invest in constructing primary schools. However, the educational gap between urban and rural areas has widened. The building investment for rural primary schools and its counterpart for urban primary schools varied significantly (Jiangsu Provincial Bureau of Statistics, 2023). Rural primary schools lack financial and technical support for improving the campus environment and maintaining and renewing primary school building space, especially in the rural areas of northern Jiangsu Province—Lianyungang in particular (Jiangsu Provincial Bureau of Statistics, 2023). Table 1.1 compares education expenditures, the population aged 0-14, and the number of primary schools in 2023 Jiangsu Province.

Table 1.1 Comparison of education expenditures, the population aged 0-14, and the number of primary schools in Jiangsu Province

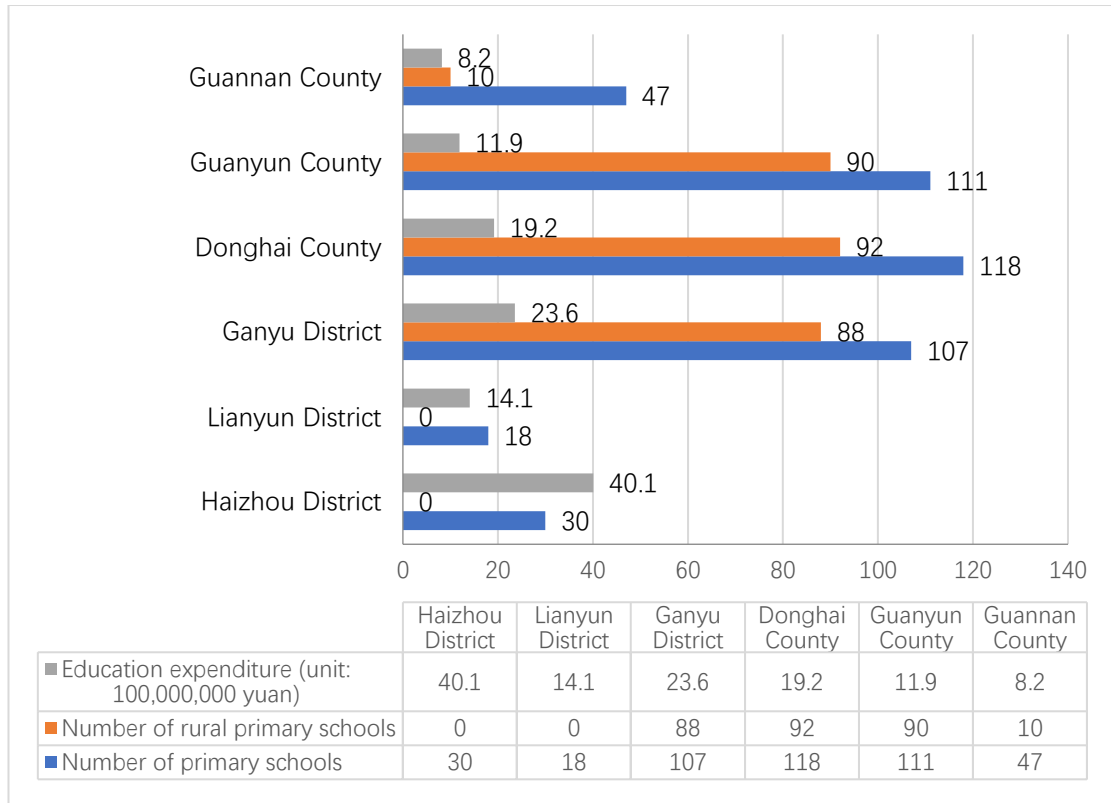


(Source: Jiangsu Provincial Bureau of Statistics, 2023)

In northern Jiangsu Province, the Lianyungang’s investment in compulsory education has increased, although the distribution of resources between urban and rural areas remains uneven (Lianyungang Statistics Bureau, 2023). Table 1.2 compares

education expenditures and the number of primary schools in 2023 Lianyungang (source: Statistical Yearbook of Lianyungang, 2023).

Table 1.2 Comparison of education expenditure and number of primary schools in 2023, Lianyungang



(Source: Statistical Yearbook of Lianyungang, 2023)

This research aims to analyze the relationship between the design of learning spaces in rural areas, the end-users' perception of learning spaces, and TnL activities in Lianyungang, Jiangsu Province, in line with the China Education Reform goal and UNESCO's policy (2015), which promote educational equity in the 21st century.

1.5 Research aim

This research aims to identify the problems of learning space encountered by many rural primary school buildings in Lianyungang, Jiangsu Province, China, by selecting three rural schools serving as case studies. The objective is to examine how these spaces accommodate proper teaching and learning activities (TnL) to accommodate

the goals of China's education reform and UNESCO's Sustainable Development Goal 4 (SDG4) for 21st-century education goals. The renewal or retrofitting of architectural design strategies to improve the conditions of rural schools' learning space in Lianyungang, Jiangsu Province, are both essential and urgent. Figure 1.2 shows the relationship between rural primary schools' educational goals and the architectural domains for renewing and retrofitting learning spaces. This highlights the importance of aligning learning spaces with 21st-century TnL activities in order to address rural communities' social and educational needs.

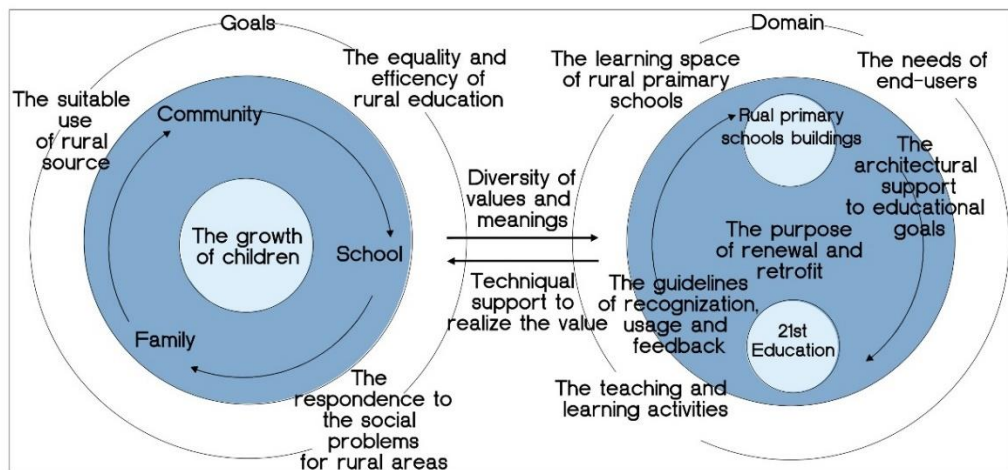


Figure 1.2 Research goals and domains

1.6 Research objectives (ROs)

There are four (4) main research objectives (ROs):

RO1: To investigate the impact of current learning spaces on teaching and learning activities in rural primary schools in Lianyungang, Jiangsu Province;

RO2: To identify challenges in designing learning spaces which support diverse teaching and learning activities in rural primary schools;

RO3: To examine how end-users' (teachers and students) perceptions of learning spaces influence their teaching and learning activities, and to inform renewal and retrofit strategies that align with China's Education Reform; and

RO4: To propose renewal and retrofit design strategies and interventions for improving learning spaces in rural primary schools to meet the expectations of 21st-century education goals.

1.7 Research questions (RQs)

RQ1: How do the current learning spaces in rural primary schools in Lianyungang, Jiangsu Province, affect teaching and learning activities?

RQ2: What are the challenges in designing learning spaces which support diverse teaching and learning activities in rural primary schools?

RQ3: How do end-users' (teachers and students) perceptions of learning spaces impact their teaching and learning activities and what insights do these perceptions provide for renewal and retrofit strategies?

RQ4: What renewal and retrofit strategies can be employed to improve the design of rural school buildings, ensuring that they meet the expectations of China's education reform goals, the UNESCO SDGs, and 21st-century education goals, thus enhancing the quality of learning spaces in rural primary schools in Lianyungang, Jiangsu Province, China?

1.8 Significance of the study

1.8.1 Make contributions to the Rural Revitalization Policy

General Secretary Xi Jinping's 19th CPC National Congress report states, "We will vigorously implement the rural rejuvenation strategy." One of the Party's seven strategies is to promote rural revitalization, rejuvenate the country via science and education, and strengthen it through human resources (Communist Party, 2021a). The essential policies for executing the rural revitalization strategy were presented as

“Opinions of the Central Committee of the Communist Party of China and the State Council on Implementing the Rural Revitalization Policy” at the 2017 Central Rural Work Conference (Communist Party, 2021b). The rural revitalization strategy focuses on revitalizing culture and social civilization in rural areas, which entails improving primary education. According to the government's policies (MOE, 2018, 2023b, 2024; MOE et al., 2023), it is vital to perform research on the learning space of rural primary school architectural renewal or retrofitting.

1.8.2 Research contribution to China’s overall development

Education has entered a new period of growth along with China's economic growth, but research on primary school buildings is insufficient. Problems with rural primary school buildings are complex. China is still exploring design principles for primary schools that align with contemporary educational needs. Compared to rural schools, urban primary schools have greater access to funding and resources, making urban schools better equipped (Guo et al., 2019; Zhang et al., 2024). The deficiencies in space and facilities in rural schools highlights the gap between urban and rural educational facilities and suggest a targeted, evidence-based, design approach to rural school design.

Through the in-depth study of the needs for educational reform, new educational ideas, and learning skills of the 21st century, researchers can develop exceptional rural primary school learning space designs to satisfy critical rural social development needs for future talent. Therefore, this research on rural primary school renewal or retrofitting in Lianyungang may help to build rural primary schools in other poor areas of China.

1.9 Scope of Research

This study focuses on rural primary schools in Lianyungang, Jiangsu Province. According to government departments, 280 rural primary schools in Lianyungang are currently distributed in Donghai County, Guanyun County, Guannan County and Ganyu District. Most of these schools still use buildings constructed from the 1990s to the 2000s. The building structures are mainly reinforced concrete and brick-concrete structures, and the building height is generally between 3.3 and 4 meters, which is in line with the *Construction Standards for Ordinary Primary and Secondary Schools in Rural Areas (JB109-2008)* (MOE, 2008). This study analyzed five types of learning spaces (i.e., classroom, professional classroom, library, corridor and public space) in these schools and evaluated their impact on TnL activities (i.e., presentation, discussion, team teaching and individual learning) from four aspects: spatial layout, physical attributes, technology, and furniture. This study chose three (3) case study schools and explored how to optimize these learning spaces to improve teaching quality and enhance student participation by renewing and retrofitting existing learning spaces.

1.10 Research limitations

This research's limitations include the author's degree of expertise, practical experience, and other factors.

- i. A combination of education, architecture, and environmental psychology is the goal of this research. The intricacy and breadth of cross-disciplinary research across several fields present significant hurdles to the study. Although curriculum development and teaching and learning activities (TnL) at the level of educational practice have

received attention in the context of education, the research material remains complicated, and the methods for validating renewal or retrofit design strategies still require further exploration and refinement;

- ii. This research does not compare or analyse the learning spaces of rural primary schools in other parts of Jiangsu Province; it exclusively examines the learning spaces of rural primary schools in Lianyungang;
- iii. This research is an academic investigation of the learning spaces of rural primary schools in Lianyungang. The recommended renewal or retrofit solutions have not been supported or validated in actual school building engineering practices; and
- iv. This research is based on an architectural perspective, focusing on the relationship between learning spaces and end users' TnL activities. However, it is not informed by a deeper understanding and exploration of other disciplines, such as educational psychology, curriculum and instruction, teacher professional development, and educational technology, which are also crucial for comprehensively improving the effectiveness of learning spaces.

1.11 Research framework

This research uses the mixed methodology approach, and incorporates observations, questionnaires, consultation methods, and computer simulations. Quantitative and qualitative data were analysed to evaluate and verify the variables found in the data collection process.

Analysis is appropriate for this study's investigation of the existing problems that end users encounter with learning spaces when they access teaching and learning. The

data was analysed using the SPSS (Version 26.0) and ATLAS.ti (Version 22) programmes. The relevant collected data was used to form recommendations to develop alternative renewal or retrofit techniques for learning spaces in rural primary schools before they were finalized via the decisions reached through the simulation programme and interviews to validate the research findings. Figure 1.3 illustrates the research framework.

1.11.1 Observation

The principal investigator conducted an in-depth analysis of the physical learning space of three selected schools. The process involved meticulously observing the spatial arrangement, photographing, and mapping the learning spaces. These observations identified the prevailing conditions and challenges in the three case studies. Then, the observation inventory evaluated the situations in the learning space of the case study building. The data from the observation inventory were further discussed during the follow-up semi-structured interviews and focus groups. The researcher thus produced a comprehensive result highlighting the significant issues and concerns in the learning spaces of the selected schools.

1.11.2 Questionnaire survey

The respondents (teachers, students and principals) were surveyed using a questionnaire survey form in order to collect quantitative data. The respondents were given this questionnaire survey form in person. The questionnaire's questions were used to gather information on fundamental problems faced by the learning space's end users and the situation of each TnL activity in rural primary schools.

1.11.3 Consultation methods

In order to target different populations and research objectives, this study uses three types of consultation methods: focus group discussion, semi-structured interview and card sorting.

The focus group discussion (FGD) gathered data on respondents' (architects, teachers, and principals) perspectives on particular topics connected to the observation inventory and questionnaire survey's findings. FGDs are conducted to understand better how individuals feel about various issues and, more importantly, why they feel that way (Fellows & Liu, 2015).

Semi-structured interviews (face-to-face) were conducted with representatives of principals, students, and teachers related to the case study schools, aiming to identify and deliver their opinions about the learning space's expectations for renewal or retrofitting.

Card sorting is a quick, fun and meaningful method, making it easy for younger respondents (students) to provide helpful feedback. In this study, the card sorting included five types of images of different learning spaces. The students categorized these pictures as “liked” or “disliked”, allowing them an intuitive, opinion-oriented way of expressing preferences.

1.11.4 Simulation

A simulation was used to verify the validity and reliability of the learning space design principles. It compares the strengths and weaknesses of different renewal or retrofit strategies for learning space in rural primary schools. The simulation software used in this research was AnyLogic, which is widely used in crowd simulations of buildings. The application of this software is further discussed in Chapter 3—Research Methodology.

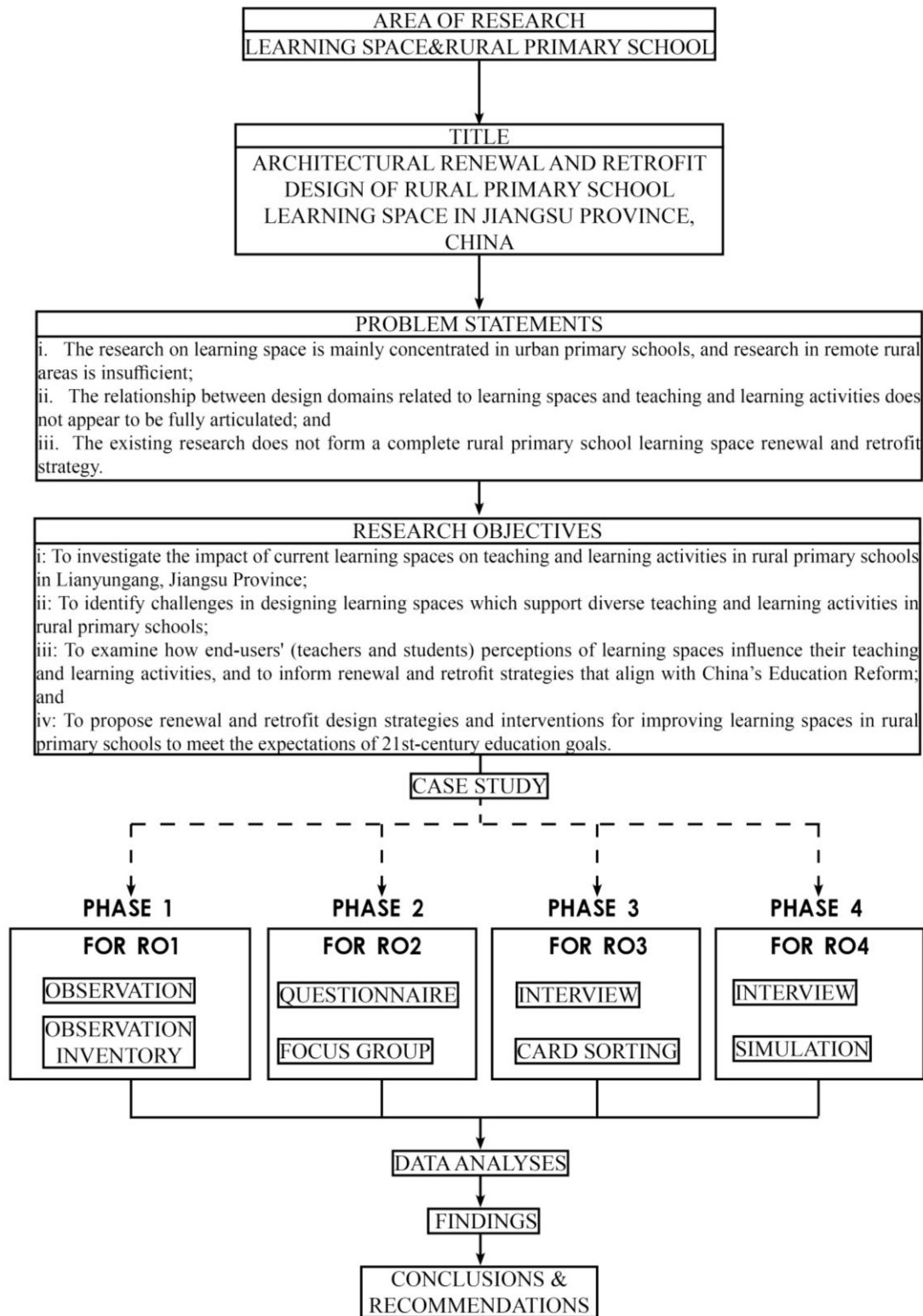


Figure 1.3 Research framework of the study

1.12 Thesis outline

This thesis is organised into six chapters, excluding appendices and references.

1.12.1 Chapter 1: Introduction

Chapter 1 is dedicated to an introduction encompassing the research background, research aims, research objectives, research questions, critical term definitions, and a discussion on the significance of this work. The chapter also discusses the methodology and the thesis outline.

1.12.2 Chapter 2: Research literature review

Chapter 2 outlines the research on learning space, perceptions of learning space and TnL activities. Then, the literature review discusses research on rural primary school renewal and the retrofitting of learning spaces.

1.12.3 Chapter 3: Methodology

Chapter 3 describes in-depth the research methodology, including methods used in the research design, case selection requirements and participant choice, data collection procedures and analysis, and validity and reliability.

1.12.4 Chapter 4: Data analysis and discussion

Chapter 4 presents and summarises the empirical findings from the data collection activities according to the four phases. The research findings are discussed in the four phases of the study. Each section provides a comprehensive analysis of the results from these phases, delves into the research implications, and compares design strategies with architecture standards and education policy documents.

1.12.5 Chapter 5: Conclusion and recommendations

Chapter 5 is the final part of the research. Conclusions are drawn based on the statements made in Chapter 4. In this chapter, the research limitations are also outlined, along with recommendations for further studies.

1.13 Summary

Overall, the main goal of this study is to investigate rural primary school learning spaces; therefore, alternative solutions for the renewal or retrofitting of learning spaces in Lianyungang, Jiangsu Province, China, can be formulated. This chapter explains the study's design in a short and precise manner. A discussion of the literature review will be presented in Chapter 2.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter consists of a five-part literature review. The first section discusses the types of learning spaces and their performance attributes. The second section discusses the types of teaching and learning activities in learning spaces and analyses the focus and shortcomings of recent research. The third section discusses the end-user perception of the learning space. The fourth section reviews the laws, regulations, and key documents concerning rural primary schools in China, examining how these policies shape their learning spaces. This section also addresses the challenges rural schools face in adapting their environments to meet the demands of China's Educational Reforms. The fifth section summarises the research on the renewal or retrofit of learning space in rural primary schools in China and the application of simulation in the education building design. Finally, the research gaps in the literature and this article's theoretical and conceptual framework are discussed.

2.2 Definition of key terms

2.2.1 The definition of rural regions

This research is limited to rural school buildings in Lianyungang, Province of Jiangsu, China. According to the classification system outlined by the *China Education Statistics Yearbook* (2019), the definition of a rural region includes villages, towns, and market towns, which are primarily agricultural-based and have a more scattered population than city areas. Despite some areas exhibiting semi-urban characteristics due to regional development, these regions are officially classified as rural by the Lianyungang government and the China Ministry of Education. This

administrative classification significantly impacts school governance, funding, and development.

2.2.2 The introduction of Lianyungang

This research concentrates only on studying rural primary schools in Lianyungang, Jiangsu Province. Lianyungang is located in the central part of China's coastal areas, in the northernmost part of Jiangsu Province, between 33°59'-35°07' north latitude and 118°24'-119°48' east longitude. The greatest vertical distance from north to south is approximately 132 km, while the maximum horizontal distance from east to west is approximately 129 km. The total land area is 7615 km². Table 2.1 describes the area, population and number of rural primary schools in Lianyungang. According to census data (2021), as November 2020, the resident population of Lianyungang was 4,599,360. Lianyungang has jurisdiction over three municipal districts—Haizhou District, Lianyun District, and Ganyu District (Haizhou District and Lianyun District are the urban areas; on July 9, 2014, Ganyu County was renamed Ganyu District)—and three counties—Guannan County, Donghai County, and Guanyun County—for a total of 6 county-level administrative districts. Figure 2.1 shows the area of Lianyungang.

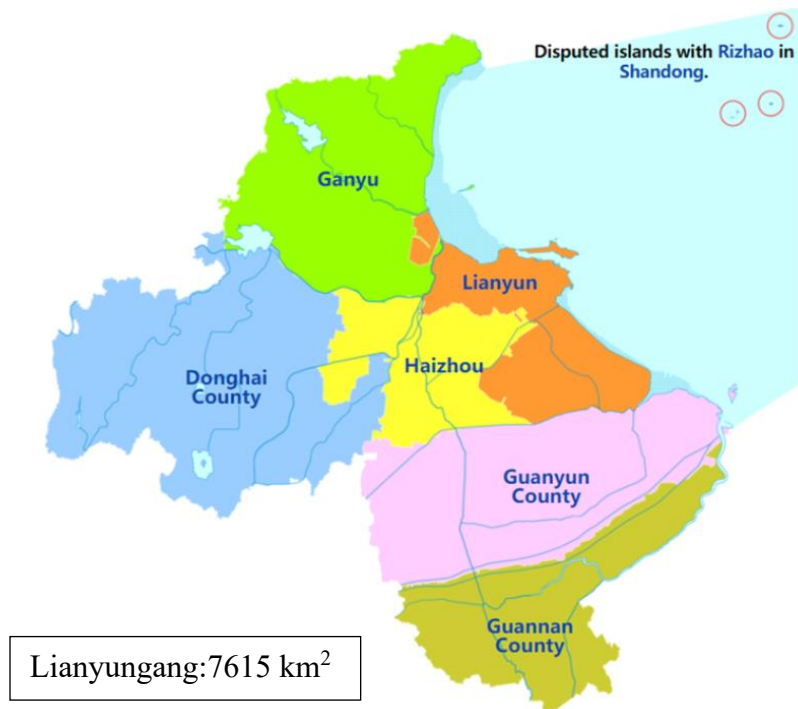


Figure 2.1 Area of Lianyungang (Source: Lianyungang, 2022; adapted by the author)

Table 2.1 Area and population of Lianyungang

	Area (unit:km ²)	Population (unit:10,000 people)	Number of primary schools
Haizhou District	727	91.8	30
Lianyun District	766	29.28	18
Ganyu District	1363	100.38	107
Guannan County	1033	61.23	47
Donghai County	2041	104.74	118
Guanyun County	1539	72.5	111
Total	7615	459.94	431

(source: Statistical Yearbook of Lianyungang, 2021)

In China, "districts" and "counties" represent two different levels of government in the country's administrative division hierarchy.

District (区): An urban administrative division level, often the location of urban centres, especially in larger metropolitan areas.

County (县): An administrative division level in remote urban and rural areas and which is usually part of a larger prefecture-level city or is administered directly by a province.

In the division of districts and counties in Lianyungang, the districts (Haizhou District and Lianyun District) are the urban areas of Lianyungang. In contrast, the counties of Guannan County, Donghai County, and Guanyun County are outlying or rural areas of Lianyungang. Ganyu District has been renamed Ganyu County, and there are still many rural primary schools.

2.2.3 The definition of renewal or retrofitting

Renewal: A procedure in which something gets better or improves after being in poor condition (Oxford University Press, 2022).

Retrofit: Giving a machine a part or a space with the equipment it did not have when it was first created (Oxford University Press, 2022).

In this study, renewal or retrofit refers to the structural and functional improvements of existing rural primary school buildings to adapt to new educational needs, improve spatial performance or meet modern technical standards. This includes adding new equipment or systems, changing spatial layout, improving technology and furniture, and enhancing environmental comfort. Renewal or retrofit is usually carried out based on the original building without complete demolition. By renewing or retrofitting existing school buildings, the efficiency of the use of learning space and meet the needs of modern teaching methods for space, technology and environment.

Many schools and educational institutions in Western countries, particularly Europe and the United States, are retrofitting their buildings to improve technology and functionality, supporting flexible TnL activities and technology integration. In China, especially in rural areas, due to funding constraints and the need for education reform, building retrofit has become an alternative way to improve the quality of school education.