WELL-Learning

Promoting learner well-being through
deployable schooling infrastructure

_ *tested at the Tshwane Secondary School in Pretoria Central*

PREFACE

WELL-Learning
Promoting learner well-being through deployable schooling infrastructure
_ tested at the Tshwane Secondary School in Pretoria Central

by Twané van der Merwe

Submitted in fulfilment of part of the requirements for the
degree of Master of Interior Architecture (Professional)

Department of Architecture
Faculty of Engineering, Built Environment and
Information Technology

University of Pretoria
2019

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DECLARATION :

In accordance with Regulation 4(e) of the General Regulations (G.57) for dissertations and theses, I declare that this thesis, which I hereby submit for the degree Master of Interior Architecture (Professional) at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution. I further state that no part of my thesis has already been, or is currently being submitted for any such degree, diploma or other qualification.

I further declare that this thesis is substantially my own work. Where reference is made to the work of others, the extent to which that work has been used is indicated and fully acknowledged in the text and list of references

Twané van der Merwe

PROJECT SYNOPSIS :

Project Description :	The dissertation is concerned with the effect of the built environment on the well-being of its occupants, specifically considering the effect of current prefabricated portable classrooms, used as schooling infrastructure, on the well-being of learners. A further consideration is given to the well-being of teachers and the Tshwane Secondary School as a whole, as it serves as a testing site for the project. A new prefabricated learning unit is proposed, along with the configuration thereof to address the contextual issues.
Programme :	Secondary School (whole day use)
Site Description :	Prefabricated infrastructure, primarily in the form of portable classrooms, as the secondary schooling environment, which is situated on the corner of Lilian Ngoyi and Visagie Streets.
Site Address :	389 Lilian Ngoyi Street (formerly Van der Walt Street), Pretoria Central, Pretoria, 0001, Gauteng
Research Field(s) :	Environmental Potential (EP) – Well-being Human Settlements and Urbanism (HSU)
Key Words :	Interior Architecture, learner well-being, deployable architecture, schooling infrastructure, Pretoria Central
Theoretical Premise :	Investigating the role of design to enable wellness and promote well-being within learning environments
Architectural Approach :	Interior Architecture promoting the well-being of learners and teachers through the design of deployable schooling infrastructure

ABSTRACT :

The diagnosis of the *Sick Building Syndrome* in the 1980s, raised concern for the effect of the built environment on its occupants. As adolescents spend ample time within **learning environments**, the design of schools, and more specifically classrooms, provide an opportunity for investigation in terms of the effect on learner well-being.

In South Africa, the urgent need for schools, especially within inner cities, typically demands for rapid construction. In doing so, there is a failure to consider the spatial quality of learning environments and the comfort of learners and teachers alike. One such example is Tshwane Secondary School in Pretoria Central, which serves as a testing site for this project, and primarily employs pre-fabrication methods in the form of portable classrooms. **Insufficient and ill-conceived** facilities disregard the spatial experience and well-being of learners.

In order to discover and define the complexity of learner well-being and unravel the **physical, social and psychological implications** of school buildings, several research methods were used. 'The Wheel of Wellness', a holistic counselling model developed within the field of Psychology, forms the theoretical premise of the study. Available norms and standards for well-building, as well as South African school infrastructure, provide further guidance. An in-depth context analysis, including a psychology report, seeks to critically investigate the existing school infrastructure. The tri-angulation of textual studies, along with an in-depth context analysis seeks to critically investigate the existing condition, both globally and within a local context.

The theoretical and contextual inquiry therefore support an iterative design process of prototyping and scenarios, which explores portable architecture alternatives for learning environments. As a result, the tested design proposal envisions the potential to act as either additional or founding school infrastructure in varying contexts.

The design vision recognises the need for a **deployable teaching-learning unit** that fosters the well-being of learners in its individual capacity, but also in the collective configuration on site. The facilitation of social interaction, multiple learning experiences and user control stand as three essential design considerations. The aspect of control becomes particularly important as it not only allows for the adaptability of space, but furthermore supports the **social and learning experiences**. The intention is for both the physical parameters and interior furnishing of the unit to be responsive towards the collective and individual needs of users. Keeping design for disassembly and the ease of operation in mind, the construction of a deployable unit requires critical consideration for well-being. Subsequently, the technical investigation questions how the assembly design could enable **user control,** to allow for the flexibility and personalisation of space.

By better understanding the concept of well-being and its relation to the built environment, interior architecture could promote the well-being of learners and teachers through the design of a more enabling model of deployable schooling infrastructure.

Keywords :

Interior Architecture, learner well-being, deployable architecture, schooling infrastructure, Pretoria Central

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Firstly, a big thanks to Catherine and Anika. Thank you for the advice and guidance, and the continued motivation throughout this year. Without your insight and faith in me, this year would not have been the same.

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To my family, thank you for all the love and support during my years of study. Thank you for the care and prayers to carry me through. I hope I made you proud.

To Warren : you have been my pillar and an incredible source of love and support. Thank you for always being there to help, to motivate, to dry up the tears and to bring a smile to my face.

And lastly, to the newly acquainted with whom my path crossed this year, thank you for all the well-wishes, the bits of advice and whichever form of help or support offered.

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TABLE OF CONTENTS

PREFACE

DECLARATION	II
PROJECT SYNOPSIS	IV
ABSTRACT	VI
ACKNOWLEDGEMENTS	VIII
TABLE OF CONTENTS	IX
LIST OF FIGURES	XVII

PART A _ APPROACH

01. Proposing the Project

1.1 INTRODUCTION	3
1.2 TERMINOLOGY	4

scene a : problem outline

1.3 BACKGROUND	9
1.4 PROBLEM STATEMENT	10
1.5 RESEARCH QUESTIONS	11

scene b : project brief

1.6 AIMS	12
1.7 DELIMITATIONS	14

1.8 LIMITATIONS 15

1.9 ASSUMPTIONS 15

1.10 METHODOLOGY 16

1.11 SIGNIFICANCE OF THE STUDY 22

1.12 CONCLUSION 25

PART B _ ARGUE

02. Unfolding Theory

2.1 INTRODUCTION 29

scene a : wellness & well-being

2.2 WELLNESS THEORIES 32

2.3 ADOLESCENT WELL-BEING 42

scene b : the education sector

2.4 EDUCATIONAL APPROACHES 45

2.5 THE PHYSICAL ENVIRONMENT 52

scene c : WELL-Learning*

2.6 WELL_CONSIDERATIONS 56

2.6.1 Guideline A _ The WELL Building Standard 57

2.6.2 Guideline B _ Norms and Standards for South African School Infrastructure 58

2.7 'THE CHECK-UP' 59
2.8 CONCLUSION 61

03. Understanding Typology

3.1 INTRODUCTION 63
3.2 SCHOOLING INFRASTRUCTURE TYPOLOGIES 64
3.3 IN THE SOUTH AFRICAN CONTEXT 68
3.4 PORTABLE ARCHITECTURE 71
3.5 CONCLUSION 77

04. Unpacking the Context

4.1 INTRODUCTION 79

scene a : macro study

4.2 LEARNING ENVIRONMENTS IN PRETORIA 82
4.3 SITE SELECTION 84
4.4 FEEDER ZONES 85
4.5 MACRO STUDY SCENE CONCLUSION 87

scene b : meso study

4.6 URBAN & BLOCK VISION 88
4.7 LAND USE & AMENITIES 90
4.8 TRANSPORT & ACTIVITY 91
4.9 MESO STUDY SCENE CONCLUSION 93

scene c : micro study

4.10 ACT A _ THE PHYSICAL

4.10.1 School Details & History 94

4.10.2 Users & Programme 96

4.10.3 Building layout 97

4.10.4 Building features 99

4.10.5 Access & Edge Conditions 104

4.10.6 Circulation 105

4.10.7 Climatic Conditions 106

4.10.8 Physical Comfort 108

4.10.9 Concluding SWOT Analysis 111

4.11 ACT B _ THE SOCIAL & PSYCHOLOGICAL

4.11.1 Social interaction 112

4.11.2 Empathy Mapping 113

4.11.3 User Narratives 114

4.11.4 Concluding Psychology Report 118

scene d : an overall experience

4.12 SITE OPPORTUNITIES & CONSTRAINTS 120

4.13 CONCLUSION 123

05 Unravelling the Layers

5.1 INTRODUCTION 125

5.2 PHYSICAL: THE EFFECT OF PORTABLE CLASSROOMS ON LEARNERS 126

5.3 SOCIAL & PSYCHOLOGICAL: COGNITIVE AND PSYCHOSOCIAL DEVELOPMENT OF LEARNERS 128

5.4 CONCLUSION 133

PART C _ ADJUST

06 Studying Precedents

6.1 INTRODUCTION 137

6.2 ANALYSIS CRITERIA 138

6.3 PRECEDENT ANALYSIS

6.3.1 Micro Hutong Renewal Project 140

6.3.2 Kavel K 142

6.3.3 Aula K 144

6.3.4 AltSchool 146

6.3.5 Streetlight Schools : Jeppe Park Primary 148

6.3.6 SAGE Classroom 150

6.3.7 Hex House 152

6.3.8 Flex: Flexible Learning Environment 154

6.4 CONCLUSION 157

07 Conceptualising a Response

7.1 INTRODUCTION 159

7.2 CONCEPTUAL DEVELOPMENT 161

7.3 FINAL CONCEPTUAL APPROACH 165

7.4 CONCEPTUAL DRIVERS 165

7.5 CONCLUSION 167

PART D _ ARTICULATE

08 Formulating a Design Response

8.1 INTRODUCTION 171

8.2 DESIGN INFORMANTS 172

8.2.1 Assessment tool 174

8.3 UNIT DESIGN CONCEPT 176

8.3.1 'Form' Strategy 176

8.3.2 'Function' Strategy 178

8.3.3 Size Strategy 182

8.4 TECHNICAL APPROACH 184

8.4.1 Technical Question 185

8.4.2 Material strategy 186

8.4.3 Colour strategy 188

8.4.4 Construction strategy 189

8.5 CONCLUSION 191

09 Designing the Technical

9.1 INTRODUCTION 193

scene a : deployability

9.2 UNIT COMPOSITION 195

9.2.1 On-site assembly manual 210

9.2.2 Section and Details 212

scene b : control

9.3 FURNITURE & FIXTURES 218

9.3.1 Learner Desks 219

9.3.2 Learner Desks 220

9.3.3 Additional furniture and fixtures 221

9.4 TEACHING WALL 222

9.4.1 Moveable write-boards 222

9.5 SUPPORT WALL 226

9.6 UNIT COMPOSITION SCENARIOS 232

9.6.1 Rules to follow 232

scene c : spaces for learning

9.7 PHYSICAL COMFORT & EXPERIENCE 234

9.8 TEACHING-LEARNING SCENARIOS 238

9.9 A LEARNING ENVIRONMENT 244

scene d : social interaction

9.10 SITE SCENARIO 246

9.10.1 Social Encounters 248

scene e : a WELL-experience

9.11 ASSESSMENT 250

9.12 CONCLUSION 253

10 Envisioning the potential 255

11 Concluding a response 259

PART E _ ASSIST

12 Stating references 267

13 Providing appendices

13.1 THE 'CHECK-UP AUDIT' 278

13.2 FINAL PROJECT PRESENTATION 302

LIST OF FIGURES

Figure 01:	Defining Well-being, Wellness and Health	5
Figure 02:	Schooling Infrastructure	6
Figure 03:	Prefabricated (elements)	6
Figure 04:	Deployable (structure)	6
Figure 05:	Portable Classroom	6
Figure 06:	Project Background	8
Figure 07:	Problem Statement	10
Figure 08:	Methodological approach roadmap	21
Figure 09:	Defining Wellness	30
Figure 10:	Defining Well-being	31
Figure 11:	Sustainability / Health and Well-being Timeline of Development	32
Figure 12:	'Wheel of Wellness', author adaptation of (Myers et al., 2000; Johnston, 2012)	33
Figure 13:	'Wheel of Wellness'_defining five main life tasks. Information sourced from (Myers et al., 2000:252-257)	34
Figure 14:	Wheel of Wellness_defining twelve sub-tasks. Information sourced from (Myers et al., 2000:253-256)	35
Figure 15:	Hettler's Six Dimensions of Wellness, Information sourced from (National Wellness Institute. n.d.)	36
Figure 16:	Relating *wellness* to *well-being*	37
Figure 17:	Social Attributes	38
Figure 18:	Psychological Attributes	39
Figure 19:	Physical Attributes	40
Figure 20:	Theoretical Informants_Wellness & Well-being	41
Figure 21:	Current state of adolescent well-being	42
Figure 22:	The adolescent stage of development	43
Figure 23:	Teacher-fronted plan layout	45
Figure 24:	Flexible & Convertible plan layout	45
Figure 25:	Timeline of the Development of Educational Approaches	46
Figure 26:	Social and Emotional Learning (SEL)	48
Figure 27:	Active Learning Classroom (ALC)	49
Figure 28:	21st Century Learning	49
Figure 29:	Key concepts derived from recent educational approaches	50
Figure 30:	Theoretical Informants_Educational Approach	51
Figure 31:	Guideline A_The WELL Building Standard	57
Figure 32:	Guideline B_ Norms and Standards for South African Schoos, graphic adapted from (Equal Education, 2019)	58
Figure 33:	'The Check-Up' example segment	59
Figure 34:	Theoretical Informants_Complete summary	60
Figure 35:	Schooling Infrastructure Typologies	64
Figure 36:	Time-line compilation of wellness and well-being,, and the education sector development	67
Figure 37:	South African School typologies_type a & b	68
Figure 38:	South African School typologies_type c & d	69
Figure 39:	Three portable systems, as defined by Kronenburg	71
Figure 40:	Panellised and Portable classrooms distinguished	73
Figure 41:	Portable architecture	74
Figure 42:	Typological Informant	75
Figure 43:	Learning Environments in Pretoria	82
Figure 44:	Secondary Schools in Pretoria Central	83
Figure 45:	Site selection	84
Figure 46:	Feeder Zones to Tshwane Secndary School	85
Figure 47:	Urban & Block Vision	89
Figure 48:	Meso Study _ Land use & amenities	90
Figure 49:	Meso Study _ Transport & activity	91
Figure 50:	Tshwane Secondary School Details & History	95
Figure 51:	Main User Group	96
Figure 52:	Programme	96
Figure 53:	Daily Routine	96
Figure 54:	Tshwane Secondary School Floor plan	97

Figure 55:	Building systems on site	98
Figure 56:	Building layout analysis	99
Figure 57:	Portable Classrooms Analysis	101
Figure 58:	Panelised Building Analysis	103
Figure 59:	Access and edge conditions analysis	104
Figure 60:	Street Approach	104
Figure 61:	Circulation analysis	105
Figure 62:	Solar Study	106
Figure 63:	Pretoria Annual Rainfall Graph	107
Figure 64:	Pretoria Wind Rose	107
Figure 65:	Existing Light level measurements	108
Figure 66:	Existing Noise level measurements	109
Figure 67:	Existing Temperature and humidity measurements	109
Figure 68:	Existing Maintenance & Cleanliness	110
Figure 69:	Existing Universal design	110
Figure 70:	Existing Social Interaction	112
Figure 71:	Empathy mapping of the existing	113
Figure 72:	Existing User Narratives 01	114
Figure 73:	Existing User Narratives 02	116
Figure 74:	Concluding Psychology Report	118
Figure 75:	Site Opportunities & Constraints (completed 'The Check-Up' audit of existing site)	121
Figure 76:	Cognitive and Psychosocial Development of adolescents	128
Figure 77:	Adolescent Cognitive Development, as per Jean Piaget's theory	129
Figure 78:	Adolescent Psychosocial Development, as per Erik Erikson's theory	130
Figure 79:	Precedent analysis criteria unpacked	138
Figure 81:	Zang Mingming, 2015 [1]	140
Figure 80:	Precedent analysis_1. Micro Hutong Renewal Project	140
Figure 84:	Section 2-2, ZAO/standardarchitecture, 2015 [1]	140
Figure 83:	Su Shengliang, 2015 [1]	140
Figure 82:	Wang Ziling, Su Shengliang, Zhang Mingming, 2015 [2]	140
Figure 89:	Marleen Beek, 2014 [1]	142
Figure 85:	Precedent analysis_2. Kavel K	142
Figure 86:	Marleen Beek, 2014 [1]	142
Figure 88:	Marleen Beek, 2014 [1]	142
Figure 87:	Marleen Beek, 2014 [1]	142
Figure 91:	(above): Marcela Grassi, 2019 [1]	144
Figure 90:	Precedent analysis_3. Aula K	144
Figure 93:	(above & below): BCQ Arquitectura, 2019 [1]	144
Figure 92:	(left and above): Marcela Grassi, 2019 [1]	144
Figure 94:	Precedent analysis_4. Alt School	146
Figure 95:	(left and below): Magda Biernat, 2018 [1]	146
Figure 96:	Precedent analysis_5. Streetlight Schools Jeppe Park Primary	148
Figure 97:	(left and below): Streetlight Schools, n.d [2]	148
Figure 98:	Precedent analysis_6. Sage Classroom	150
Figure 99:	(above and right) SAGE Classroom[1]	150
Figure 101:	Hex House Images, Dezeen, 2016[1]	152
Figure 100:	Precedent analysis_7. Hex House	152
Figure 103:	View from second floor balcony, HMC Arcitects, 2011[1]	154
Figure 102:	Precedent analysis_6. Flex: Flexible Learning Environment	154
Figure 106:	Architizer, n.d.[2]	154
Figure 104:	View inside learning environment, HMC Arcitects, 2011[1]	154
Figure 105:	Aerial view, HMC Arcitects, 2011[1]	154
Figure 107:	Precedent analysis_Assesment compilation	156
Figure 108:	Four initial conceptual ideas	162

Figure 109:	Conceptual Development	164
Figure 110:	Conceptual Drivers	165
Figure 111:	Design Informants	173
Figure 112:	Assessment tool _ Legend	174
Figure 113:	Assessment tool	175
Figure 114:	Form strategy and design application	176
Figure 115:	'Function' strategy _ Subject Scenarios	178
Figure 116:	'Function' strategy _ Five scenarios and their design application	179
Figure 117:	'Function' strategy _ Spatial zones & control, with design application	181
Figure 118:	Size strategy and design application	183
Figure 119:	Material Matrix	186
Figure 120:	Colour Strategy & Palette	188
Figure 121:	Unit Front and Back Views	196
Figure 122:	Unit Composition and Assembly Sequence	197
Figure 123:	Adjustable footings _ Final iteration	198
Figure 124:	Floor structure _ Final iteration	199
Figure 125:	Floor panels _ Final Iteration	200
Figure 126:	Corner posts _ Final Iteration	201
Figure 127:	Corner posts _ Profile A-D	202
Figure 128:	Louvre Panels _ Final iteration	203
Figure 129:	Facade panels _Exploded axonometric	204
Figure 130:	Facade panels _ Final iteration	205
Figure 131:	Roof Structure _ Final Iteration	206
Figure 132:	Roof Structure _ Extruded trusses	207
Figure 133:	Roof panels _ Final iteration	208
Figure 134:	Water Tank Connection	209
Figure 136:	Learner desks_Iterative Process	219
Figure 135:	Learner desks _ Final Iteration	219
Figure 137:	Teacher desks_Final Iteration	220
Figure 138:	Furniture & Fittings palette	221
Figure 139:	'Write'-boards _ Initial Iterative Process	223
Figure 140:	'Write'-boards _Iterative Process Finalisation	224
Figure 141:	'Write'-boards _Final Iteration Composition	225
Figure 143:	'Write'-board_Final Iteration	225
Figure 142:	Trolley	225
Figure 144:	Support Wall _ Iterative Process 01	227
Figure 145:	Support Wall _ Iterative Process 02	228
Figure 146:	Support Wall _ Final Iteration	229
Figure 147:	Support Wall _ Section: Utility Segment	230
Figure 148:	Support Wall _ Section: Multi-Functional Segment	231
Figure 150:	Unit composition legend	232
Figure 149:	Unit composition rules to follow	232
Figure 151:	Unit composition scenarios	233
Figure 152:	Natural Ventilation	235
Figure 153:	Lighting	235
Figure 154:	Acoustics	236
Figure 155:	Spatial Quality	237
Figure 156:	Teaching-learning scenarios _ Teacher fronted	239
Figure 157:	Teaching-learning scenarios _ Hybrid layout	240
Figure 158:	Teaching-learning scenarios _ Peer learning	241
Figure 159:	Teaching-learning scenarios _ Exploration	242
Figure 160:	Teaching-learning scenarios _ Social / Kinetic	243
Figure 161:	A Learning Environment _ Potential scenario	244
Figure 162:	Site Transformation	247

Figure 163: Alternative Site Scenarios 247
Figure 164: Social encounters 248
Figure 165: Existing Scenario Assessment 250
Figure 166: Design Proposal Assessment 251
Figure 167: Final Pin-up and Model 302
Figure 168: Final Exam Crit 303
Figure 169: Presentation layout 01 304
Figure 170: Presentation layout 02 305
Figure 171: Presentation layout 03 306
Figure 172: Presentation layout 04 (to the right) 306
Figure 173: Presentation layout 05 308
Figure 174: Presentation layout 06 309

CHAPTER 01 : PROPOSING THE PROJECT

Part A serves as the **introduction to the project** undertaken by the author. It consists of the first chapter, which outlines the problem at hand and proposes the approach to the investigation and ultimate design process.

PART A _ APPROACH

PROPOSING THE PROJECT 01

1.1 INTRODUCTION

This chapter illustrates the approach to the project and serves as the basis for all the subsequent chapters to build upon. The topic of investigation is firstly introduced and framed in the form of the main research question. Three sub-questions seek to outline a general, contextual and design problem. The chapter further stipulates the project brief, as well as a methodological approach towards addressing the aforementioned problems. In successfully doing so, several contributions can be made to both the discipline and the context.

1.2 TERMINOLOGY

As conflicting definitions for and interchangeable use of certain terms were found throughout the study, a clear distinction is made between the following terms to clarify their definition within the dissertation.

Well-being :

This refers to a whole of life experience and 'good feeling' condition of health, happiness and prosperity which is characterised and defined by environmental factors (McMahon, Williams and Tapsell, 2010:5; Perez, 2017; Buildingcentre.co.uk, 2019). It can further be described as the functioning of a specific domain of life, such as the physical, social and psychological domains (Kirsten, Van der Walt and Viljoen, 2009; Assana, Wongsa and Poonsri, 2017:3). Well-being is ultimately seen by the author of this dissertation as a state of being which is influenced by the physical, social and psychological environments in which individuals find themselves.

Wellness :

This relates to one's individual journey towards enhanced well-being, where one's personal choice and behaviour shapes a conscious and self-directed process (Buildingcentre.co.uk, 2019). It is defined as "a way of life oriented toward optimal well-being in which the body, mind and spirit are integrated to live more fully" (Myers, Sweeney and Witmer, 2000; Johnston, 2012:68); thus a state of living (Stoewen, 2015). The author, therefore, regards wellness as the internal or personal aspects relating to an individual's choices and behaviours that influence their physical body, mind and spirit during their daily functioning.

Health :

As umbrella term, 'health' embodies both wellness and well-being, and is currently defined by the World Health Organisation (WHO) as a "state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity" (Perez, 2017; Buildingcentre.co.uk, 2019).

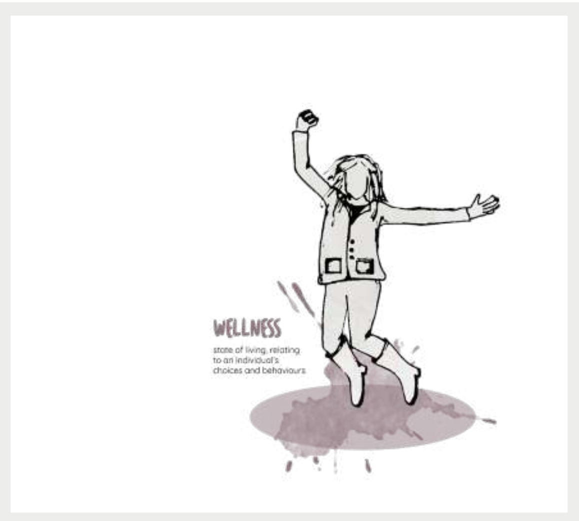


Figure 01: Defining Well-being, Wellness and Health

Ultimately, *wellness* and *well-being* are different, but interrelated concepts of *health* where neither can be achieved in isolation. As a designer, we have the opportunity and ability to shape the environment, which inherently affects the well-being of users.

These terms, particularly *wellness* and *well-being,* are further elaborated on in *Chapter 2_ Unfolding Theory*

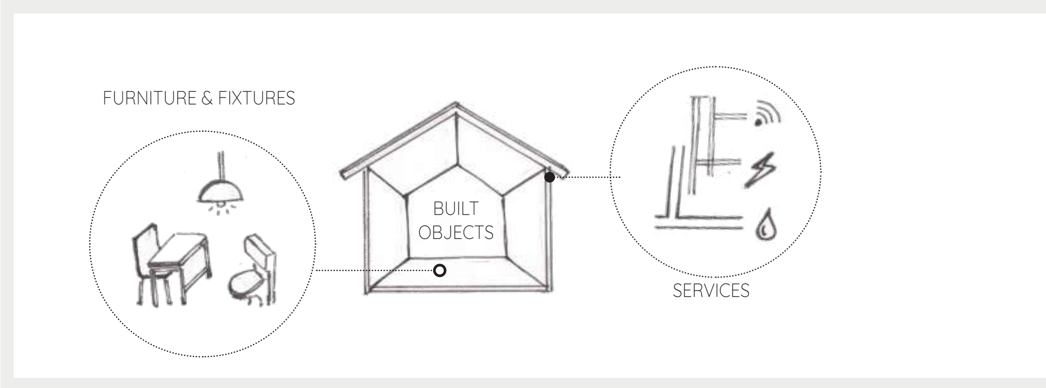


Figure 02: Schooling Infrastructure

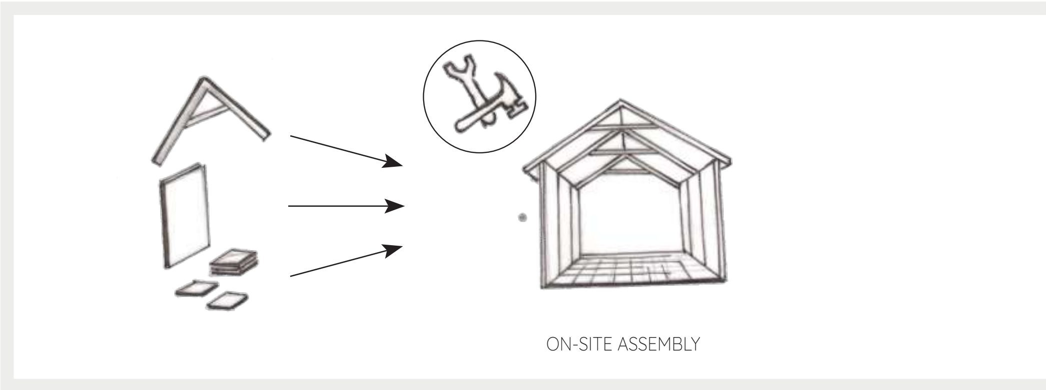


Figure 03: Prefabricated (elements)

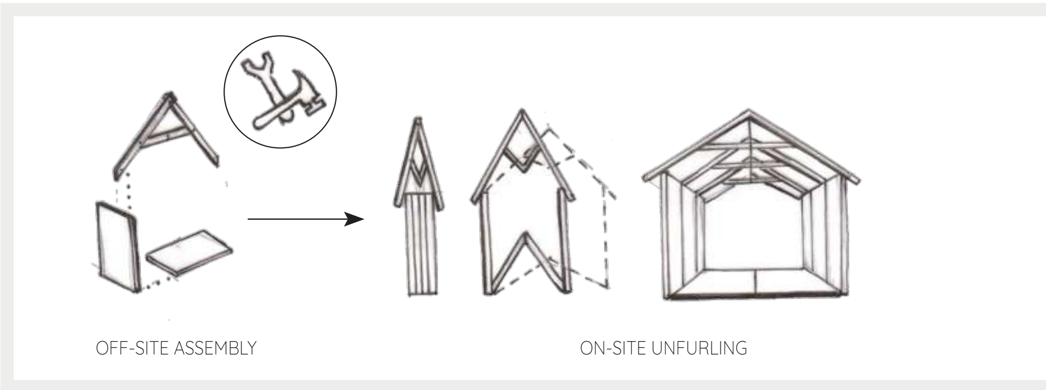


Figure 04: Deployable (structure)

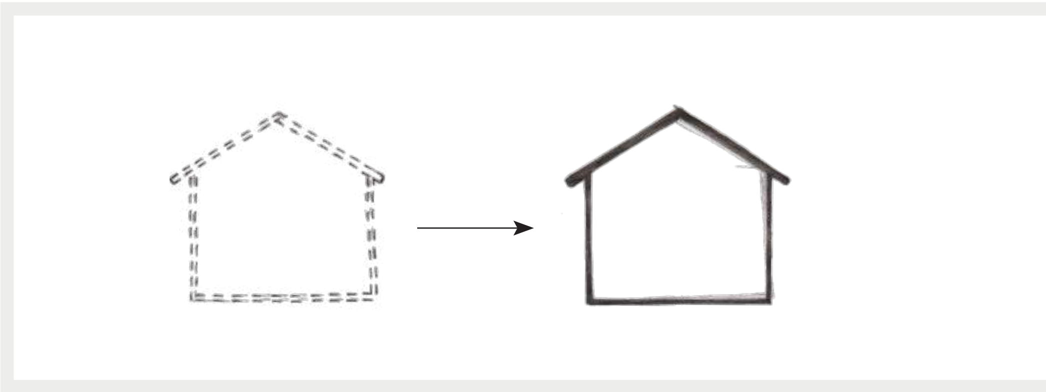


Figure 05: Portable Classroom

01

Additional explanation for the terms below can be found in *Chapter 3_ Understanding Typology* and *Chapter 4_ Unpacking the Context* :

School(ing) Infrastructure :

These terms are used to refer to the physical and organizational structures and facilities needed for the operation of a school. Simply put, the building itself and the systems within. This includes circulation routes and access, learning spaces (such as classrooms), and ablution facilities, furniture and fixtures; as well as water, sanitation, electricity and internet connectivity to support these facilities. Several typologies are possible, as discussed in *Chapter 3_ Understanding Typology.*

Prefabricated (elements) :

Prefabrication is seen as a method of construction where building elements are manufactured off-site (Cambridge Dictionary, 2019a), to allow for quick assembly and reduced labour intensity on site (Brooks, 1998:117). A fairly permanent structure results. 'Prefabricated' serves as a category of portable architecture (Brooks, 1998:116).

Deployable (structure) :

This refers to another category of portable architecture which is not concerned with the prefabrication of elements, but rather the pre-assembly of a structure off-site, and the unfolding thereof on-site (Brooks, 1998:116). It further suggests a sense of collapsibility (O'Neil, 2009) or disassembly.
The word 'deploy' also refers to the movement of soldiers or equipment to a place where they can be used when needed (Cambridge Dictionary, 2019b), thus implying a sense of mobility.

Portable Classroom :

A portable classroom can be defined as a "trailer or transportable prefabricated building used as a temporary classroom" (Lexico Dictionaries, 2019). The portable nature of an element or structure allows for it to be moved, usually because of its relatively lightweight and / or small size (Cambridge Dictionary, 2019c). In architectural terms, "portable systems are categorized as either deployed or prefabricated structure" (Brooks, 1998:116). More information on this can be found in *Chapter 3_ Understanding Typology.*

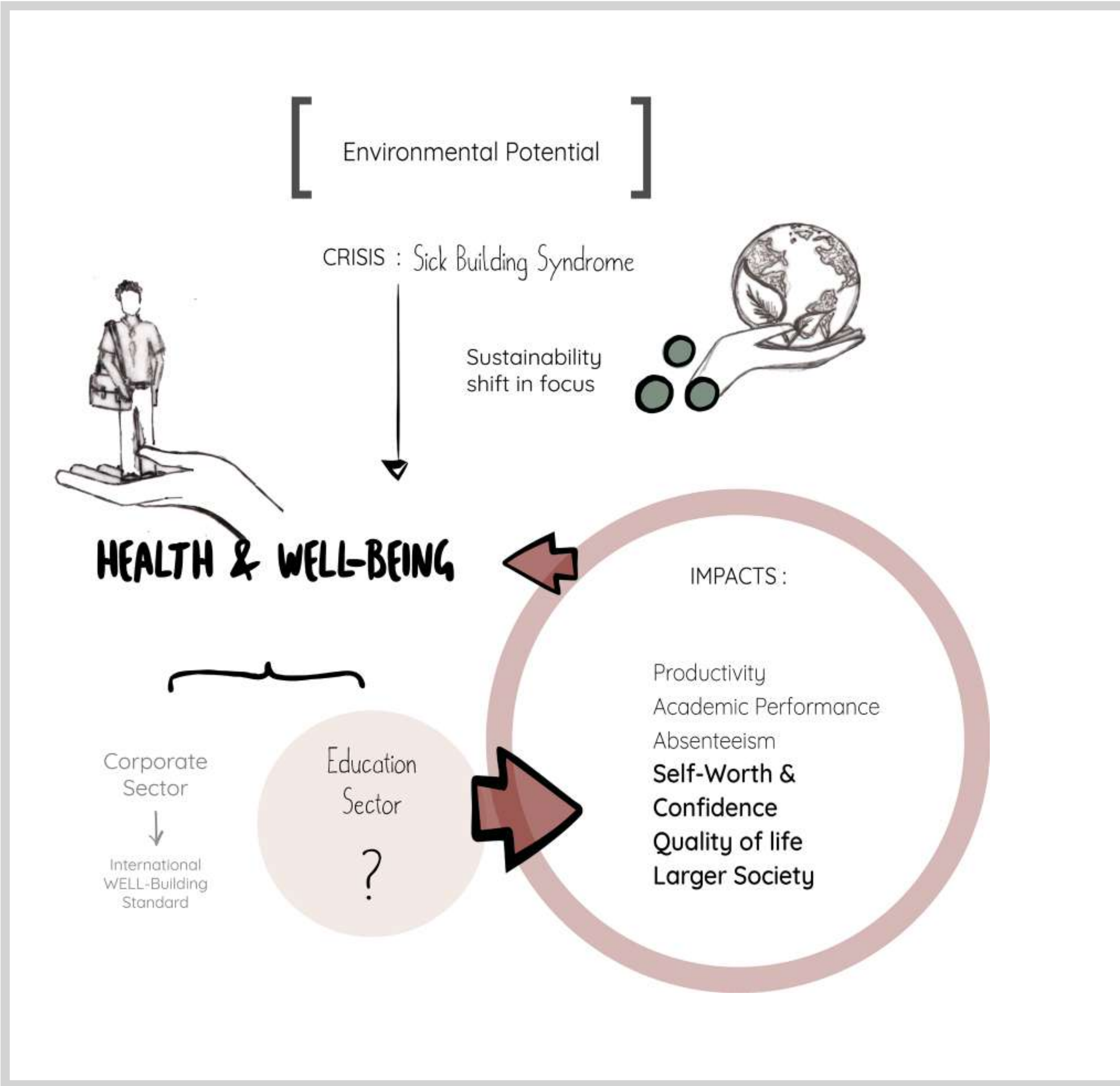


Figure 06: Project Background

1.3 BACKGROUND

A shift in the focus of sustainability occurred due to the 'Sick Building Syndrome' (SBS)[1], which originally emerged as a workplace problem in the 1980s and introduced a concern for health and productivity (Kang, 2003:1; Smith and Pitt, 2011:148). This placed more emphasis on the effect of the built environment on its occupants. As humans spend at least 80% of their time indoors, the interior environment requires critical consideration in terms of the impact it has on the user's health and well-being (Capolongo et al., 2013:1; Mehta and Lokhandwala, 2017:1003). In addition to physical well-being, a positive state of emotional well-being contributes to a better society (Choi, 2018). Careful consideration should be given to the spaces in which we live, work, learn and heal.

In recent years, the corporate sector has received a lot of attention in this regard, as several studies primarily focus on the health impact of workspaces and the relation to employee productivity. Businesses have since adopted wellness strategies for office design, with the further establishment of the WELL Building Standard (WELL)[2] in 2014. Similarly, the fields of Medicine and Psychology altered their approach to focus more on ill-health prevention and promoting wellness and well-being.

Learning environments do not only offer the workspaces for younger generations, but also create the indoor spaces in which they spend long durations of time (Singh and Arora, 2014; Puteh, 2012:1835). School buildings provide the physical, social and psychological environment that supports teaching and learning activities (Muhammad et al, 2014). As the bodies of younger generations are still developing, children and adolescents[3] are uniquely vulnerable, especially considering the fact that the occupancy density of learning environments are much higher than that of corporate environments (Martin, 2012). The design of schools, and more specifically classrooms, provide an opportunity for investigation in terms of the effect of the built environment on the well-being of learners.

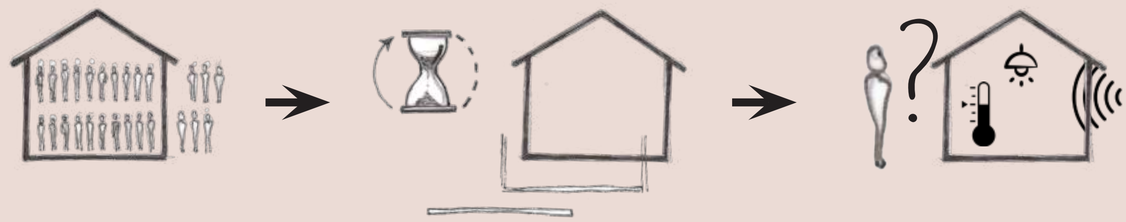
1 : Health problems, ranging from skin rashes to fatigue and personality changes, are experienced by occupants, with the occurrence of symptoms directly correlating with their inhabitation within a particular building (Babatsikou, 2011; Smith and Pitt, 2011). Various factors contribute to these symptoms including chemical pollutants, ventilation problems, psychological factors and other inadequacies regarding lighting, ergonomics, noise and thermal properties (Burge, 2004; Babatsikou, 2011; Smith and Pitt, 2011; Mehta and Lokhandwala, 2017).

2 : Defined as "a performance-based system for measuring, certifying, and monitoring features of buildings that impact the health and well-being of the people who live, work and learn in them" (International WELL Building Institute, 2018). Discussed in *Chapter 2_ Unfolding Theory*.

3 : Young people in the adolescent phase of development between childhood and adulthood; pertaining to secondary school learners as they are between the ages of 13 and 19 (Assana, Wongsa and Poonsri, 2017:1). Discussed in *Chapter 2_ Unfolding Theory*, and *Chapter 5_ Unravelling the Layers*.

1.4 PROBLEM STATEMENT

Figure 07: Problem Statement



In 2018, 2077 ordinary public schools accommodated 2 109 890 learners in Gauteng alone, with 719 926 learners in the secondary school phase (Department of Basic Education, 2019:1). Schools within the inner city of Pretoria have been, and continue to be established to provide a larger community of children with access to education, further **relieving the pressure of overcrowding in public schools.** These inner-city schools often employ **rapid construction methods** to address the urgent need (Visser, 2016:8). One such example is the Tshwane Secondary School, which makes use of **portable architecture** as schooling infrastructure.

However, the facilities provided by the school neglect a number of programmatic requirements, and fail to consider the **spatial quality** and **comfort** of learners and teachers alike. **Insufficient and ill-conceived** schooling infrastructure consequently threatens the **learning experience and well-being** of learners.

1.5 RESEARCH QUESTIONS

The study seeks to respond to a main research question and three sub-questions which outline a general (theoretical), contextual and design problem.

MAIN RESEARCH QUESTION

How can interior architecture enable schooling infrastructure to facilitate the well-being of learners?

SUB-QUESTIONS

theory

A general concern for well-being presents the need to extend available theories and design guidelines regarding wellness and well-being, into the education sector.

How can available theories and design guidelines pertaining to wellness and well-being, be translated to address learning environments?

context

What are the physical, social and psychological implications of existing schooling infrastructure, specifically considering the portable building systems found at Tshwane Secondary School?

design

How can the design of deployable schooling infrastructure promote the physical, social and psychological well-being of learners, in both its individual capacity and collective configuration?

1.6 AIMS

The aims of the project consider an assessment or benchmark, a practical investigation and a process of reflection within two phases, as a means to understand the problem and provide a solution.

A holistic understanding through theory and context

I. **Translate** the concepts of **wellness and well-being into the education sector**, by triangulating available wellness theories and well-being design approaches, along with the norms and standards for South African school infrastructure, as set out by the Department of Basic Education. Therefore, establishing an audit document with which to assess the general quality of learning environments.

II. Critically **investigate the context** through multiple lenses to holistically view the physical, social and psychological attributes.

III. Identify the **shortfalls and potential of existing** schooling infrastructure, and the implications for learner well-being and design.

An appropriate design response

IV. **Define scenarios** and spatial experiences or qualities that relate most to the domains of well-being and should therefore be prioritised in the design.

V. Develop an **assessment tool**, informed by I - IV and which could be used during the process of design iterations.

VI. **Technically resolve** a design intervention to adequately promote the well-being of learners by addressing the key aspects identified in IV, along with the assessment developed in V.

VII. Consider the **larger implication** of the design response in different contexts, providing a detailed methodology for the process.

Ultimately, the project aims to address the larger issue of inadequate and ill-conceived schooling infrastructure that neglects learner well-being, while making use of the Tshwane Secondary School as a testing ground with unique challenges and opportunities specific to site. Potentially the design intervention could be employed elsewhere, and contextualised by following a similar methodology within the given context.

1.7 DELIMITATIONS

Secondary schooling infrastructure :

The study focuses on the education facilities for secondary schools, specifically addressing the physical environment rather than critiquing the education approach. Various approaches to learning and teaching are still considered as it affects the physical environment and informs the design.

Well-being as environmental potential :

Focus is placed on the aspects of well-being, as opposed to sustainable systems and 'green building'. Sustainable design would remain a consideration, but be integrated as a sub-layer / concern.

Learner as primary focus :

Multiple users are identified during the context analysis. The project places the physical, psychological and social well-being of the learners as the primary focus within the design and technical resolution. The well-being of teachers becomes a secondary focus, which is conceptualised throughout the site, but not necessarily resolved during the design and technification process. A third user group, with overlapping needs to that of the first two, consists of the learners and teachers from outside the school, as part of the Pretoria Central Adult Education Centre with whom the site facilities are shared.

1.8 LIMITATIONS

Qualitative research design :

Participatory research & design could not be used due to ethics clearance concerning children and vulnerable groups, therefore relying on a qualitative research design.

Available textual studies, which employed qualitative research projects, can be interpreted to provide an empirical theoretical grounding as secondary data. This dissertation consulted a *Holistic Evidence and Design (HEAD)* study, conducted in the United Kingdom in 2013, which investigated the effect of school buildings on learners (Barrett et al., 2015).
For the contextual study, unobtrusive observation methods were used to collect primary data, and included a psychology report conducted on site by a graduate psychology student, Warren Wallendorf.

These methods of enquiry seek to eliminate personal biases and further ground findings within theory and available, reliable data.

1.9 ASSUMPTIONS

Government funding :

As the testing site for investigation, Tshwane Secondary, is a public school, it is assumed that government funding would be used to implement the design intervention, implying budget constraints. An economical design solution should therefore be considered, while further exploring the potential for private investment.

The well-being of all :

As children and adolescents are more vulnerable, it is assumed that by promoting the well-being of secondary school learners through the design of the physical environment, the well-being of teachers would also be promoted. This assumption extends to the well-being of the third user group (teachers and learners of the Adult Education Centre), as they have overlapping needs.

1.10 METHODOLOGY

The methodological approach defines multiple stages of investigation taken by the author in a quest to answer the research questions. This broadly includes the formulation of a better understanding of the problem on a theoretical and contextual basis, while furthermore aiming to develop an appropriate design response. Each stage finds relevance within a specific chapter still to follow, leaving the methodology with the role as roadmap to the dissertation, as seen in Figure 08.

PART A _ APPROACH

1. A Factual Outline

During the initial phase of the project, several theoretical texts and statistics relating to sustainability and well-being in the built environment, along with schooling infrastructure in general, were gathered and briefly explored to compile factual extracts which are used to introduce the project and outline the problem. This also provided a vast collection of research, to be more closely examined and interpreted later on.

PART B _ ARGUE

2. A Literature Review

In order to provide a theoretical overview of the project, further research was gathered selectively, according to the scope of the project. This ensured a more comprehensive understanding and theoretical grounding for the concepts of wellness and well-being, as well as the educational approaches and the physical learning environment. The *Holistic Evidence and Design (HEAD)* study, conducted in the United Kingdom in 2013, investigated the effect of school buildings on learners (Barrett et al., 2015) and provided insight into the problem at hand.

3. Triangulation[4] : theory[*] and guidelines

Within the literature review, 'The Wheel of Wellness' forms the theoretical premise of the study, with two guidelines providing further insight. Guideline A : The WELL Building Standard, brings wellness and well-being to architecture, with Guideline B : South African Norms and Standards for school infrastructure providing design parameters for schools. The objective is to triangulate the aforementioned theory and guidelines, to formulate an audit document which specifically focuses on well-being in learning environments and could be used to assess the existing site conditions.

4. Desktop study

Before investigating the current condition on the selected site, the author found it necessary to briefly conduct a typology study, in order to identify different schooling infrastructure possibilities, and understand their unique characteristics. This was done by way of online research and personal observations.

5. Qualitative research design : Unobtrusive observation methods as field study

To analyse the tangible and intangible qualities present on site, unobtrusive observation methods[5] (O'Brien, 2010) were used to collect primary data, as participatory research was prohibited. First is a general mapping exercise which explores the existing site condition with regards to spatial dimensions; access and circulation; and light, noise, temperature and humidity level measurements. The patterns of use and social interactions were also observed, along with a process of empathy mapping[6] (Dam and Siang, 2019). The findings were interpreted in the form of user narratives which seek to illustrate the non-physical parameters and perceived spatial experiences. A graduate psychology student, Warren Wallendorf, further conducted a psychology report through observations on site.

No interviews or discussions with learners are conducted, i.e. participatory research, due to ethics clearance relating to children and vulnerable groups.

4 : Triangulation sees the use of multiple sources or research methods to investigate a topic from various viewpoints, ensuring greater accuracy and a deeper understanding (Neuman, 2014:166). Four types exist, namely the triangulation of either measures, observers, theory or method (Neuman, 2014:166).
** Triangulation of theory explores multiple theoretical perspectives by using several sources of information on topics interrelated to the investigation (Neuman, 2014:167).*

5 : Unobtrusive methods sees the researcher acquiring qualitative insight without interrupting or disturbing the subjects, making use of exploration and interpretation (O'Brien, 2010:2-5). This includes non-reactive behavioural observation, the examination of existing and historical records and statistics, as well as the study of physical traces (O'Brien, 2010:2).

6 : Empathy maps summarize the user's experience by showcasing what they said, did, thought and felt during the time of observation, utilizing four quadrants (Dam and Siang, 2019) as a visual tool. When analysed, these observations give insight to the user needs, which could inform the design process.

6. Qualitative research design : Textual study

With the contextual study posing additional concerns, theoretical texts and research studies, functioning as secondary data, are consulted to fill the gaps in the understanding of the physical, social and psychological attributes of the context.

Jean Piaget's theory on the four stages of cognitive development (Hazen et al., 2008; Cherry, 2019b), along with the psychosocial development theory of Erik Erikson (Hazen et al., 2008; Cherry, 2019a), add a social and psychological depth to the user profiles.

The contextual analysis of the physical environment is further supported by research on the effect of portable classrooms on learners.

PART C _ ADJUST

7. Precedent Studies

Part B concludes with the pinpointing of key issues regarding the topic of investigation. The *HEAD study* mentioned above, serves as a theoretical precedent, which highlights design principles requiring consideration.

Design precedents are analysed to derive potential design principles, in order to address the issues that were identified during the initial phases of the project. Four overarching themes are identified among the issues. Using these themes as a guide for the overall selection of design precedents, a range of functional spaces were covered. These problems function as the criteria for analysis, with a tool developed to indicate the correlation between each precedent and the relevant issues.

8. Triangulation[7] : methods[..] of inquiry

Through a process of triangulation, several factors, instrumental in facilitating the well-being in learning environments, were derived from the literature review, typology and contextual study and the precedent studies. These are framed as seven conceptual drivers for the design process, each entailing specific design informants, which in some cases include principles for consideration.

Iterative Design Process

The conceptual drivers with their subsequent design informants are translated into an assessment tool which enables critical reflections and appropriate alterations during an iterative design process. The tool further prioritises certain drivers and indicates a level of success in achieving the design informants. It can therefore be argued that a sufficient design response can be achieved by optimally addressing the drivers of the highest priority whilst achieving some level of success in the remaining, lower priority drivers.

'Prototyping'[8] (Hanington and Martin, 2012:138) and 'scenarios'[9] (Hanington and Martin, 2012:152) are two methods used for the design and technical exploration, using the assessment tool to test the feasibility. An additional method of 'scenarios' is used to explore the potential of the design intervention within different contexts.

7 : Triangulation sees the use of multiple sources or research methods to investigate a topic from various viewpoints, ensuring greater accuracy and a deeper understanding (Neuman, 2014:166). Four types exist, namely the triangulation of either measures, observers, theory or method (Neuman, 2014:166). ** *Triangulation of methods entails a combination of qualitative and quantitative research approaches to collect data through different lenses, resulting in a more comprehensive understanding (Neuman, 2014:167).*

8 : Prototyping is a research and analysis technique used to develop and test ideas within the design process, making use of tangible artifacts which are resolved a different levels (Hanington and Martin, 2012:138).

9 : Scenarios explore the potential and future use of a product within the user's daily life by creating a narrative, through their perspective (Hanington and Martin, 2012:152).

For a different testing site :

- Repeat step 5 within the context, to identify any additional unique issues
- Review step 6 to ensure the correct phase of development is addressed according to the ages of the particular user group (differing for primary schools)
- Revise step 7 to address additional concerns, if necessary
- Reorganise step 9 scenarios, in terms of the unit composition and collective configuration to ensure that the unique needs are accommodated for on site

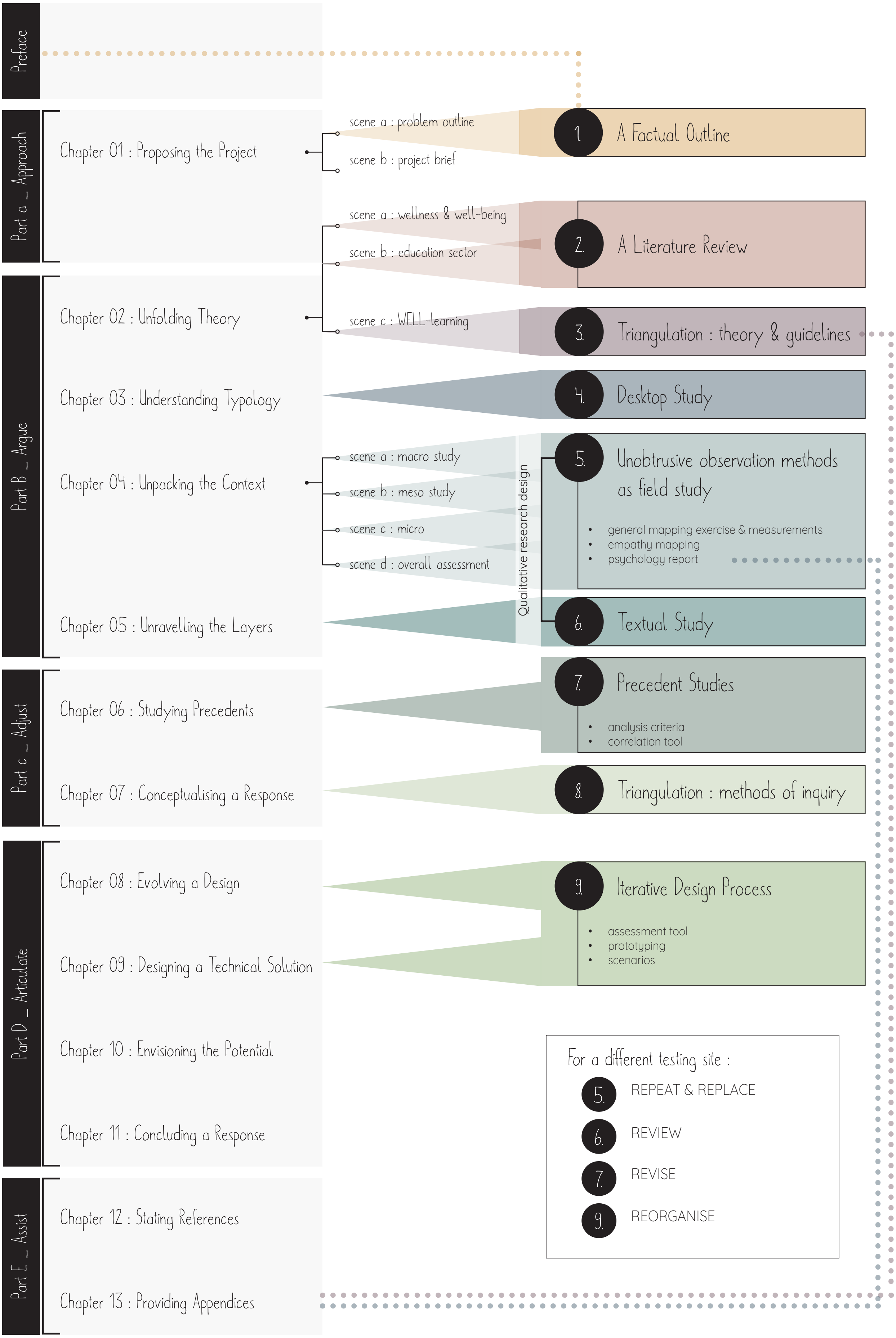


Figure 08: Methodological approach roadmap

1.11 SIGNIFICANCE OF THE STUDY

A real-life scenario

Theoretical research regarding well-being and the education sector is explored and connected through triangulation, to argue for schools to promote the well-being of learners.
Within the theoretical framework, the real-life scenario is presented in a South African context.

School assessment _ 'The Check-Up'

The theoretical framework is related to design through the establishment of an audit document compiled by the author, namely 'The Check-Up'. This comprises of wellness and well-being design considerations in learning environments and becomes a valuable instrument to assess secondary schools throughout South Africa and to inform the future design of schools.

A discipline contribution

Even though the quality of teaching and external factors relating to social, political and economic backgrounds have been found to affect the well-being and academic performance of learners, interior architecture could make a contribution to the education sector of South Africa through the design of the physical learning environment.

Spatial qualities and parameters affecting learner well-being is formulated into design principles for well-learning environments. By promoting learner well-being through the design of a more enabling physical learning environment, one could envision the larger societal impact of improved quality of life.

Project as prototype

The project itself exhibits the application of 'The Check-Up' as a general assessment, whilst demonstrating the qualitative research design method necessary to contextualise the study and derive conceptual drivers and design informants. Therefore, the use of a prototypical methodological approach allows for further and future research and application.

Using a testing site, the project serves as a prototype for the site-specific implementation of the design intervention. However, several different site scenarios can be tested to support the broader implication of the design as it could be deployed to a variety of contexts.

An architectural contribution to well-being

With the proposal of a new deployable architecture for learning, the design intervention provides an alternative method of rapid construction for schooling infrastructure, which better facilitates well-being than the existing portable classrooms.
The roll-out potential of such a deployable unit also finds significance.

1.12 CONCLUSION

The first chapter introduces well-being in learning environments as the topic of investigating, and sets out what the project intends to achieve. The problem outline poses a main research question, with three sub-questions pertaining to the theoretical, contextual and design problem. A methodological approach suggests how the answers to these questions could be found, by defining multiple stages of investigation. As the chapters to follow employ these stages, the methodology serves as a roadmap.

CHAPTER 02 : UNFOLDING THEORY

CHAPTER 03 : UNDERSTANDING TYPOLOGY

CHAPTER 04 : UNPACKING THE CONTEXT

CHAPTER 05 : UNRAVELLING THE LAYERS

Part B argues for a new approach to schooling infrastructure by firstly taking a **theoretical stance** in Chapter 2. Chapter 3 continues with a **typological study**, afterwhich the **context** is examined in Chapter 4. Additional theory supports the contextual analysis in Chapter 5.

Overall, this part views the topic of investigation through the physical, social and psychological lenses to present a real-life, problematic scenario.

PART B _ ARGUE

UNFOLDING THEORY 02

2.1 INTRODUCTION

As the project proposal in *Chapter 1* presents the opportunity to promote learner well-being through the design of schooling infrastructure, this chapter explores the theoretical framework for the proposal. In *scene a*, the concepts of wellness and well-being are discussed, specifically relating to children and adolescents. *Scene b* investigates the education sector in terms of a teaching-learning experience, through different educational approaches, and the effects of the physical environment on learners. Both of these aspects would impact the well-being of learners.

I. DEFINING WELLNESS

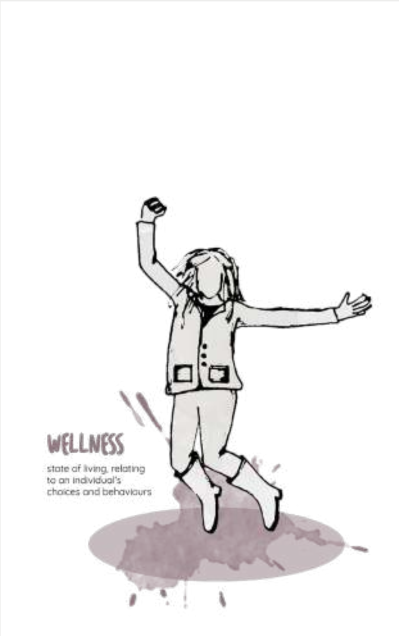


Figure 09: Defining Wellness

Wellness is considered to be a series of choices made during one's daily functioning; integrating mind, body and spirit on an **individual, self-directed journey** towards enhanced well-being (Myers, Sweeney and Witmer, 2000; Johnston, 2012:68; Buildingcentre.co.uk, 2019). It is thus a state of living, aimed towards optimal human functioning (Johnston, 2012:68; Stoewen, 2015), which is dependent on the actions and behaviours of an individual. Within their study, Horton & Snyder further regard wellness as the "preparation for and anticipation of environmental challenges that are sure to come" and being 'healthy' is seen as the ability to resist these environmental challenges (Horton and Snyder, 2009:217). The National Wellness Institute offers the following definition of wellness: "an active process through which people become aware of and make choices towards a more successful existence" (Norris, 2010). The author therefore regards wellness as the internal or personal aspects relating to an individual's **choices and behaviours that influence their physical body, mind and spirit** during their daily functioning.

II. DEFINING WELL-BEING

Well-being refers to a whole of life experience and **'good feeling' condition** of health, happiness and prosperity, which is characterized and defined by environmental factors (McMahon, Williams and Tapsell, 2010:5; Perez, 2017; Buildingcentre.co.uk, 2019). It can further be described as the functioning of a specific domain of life, such as the physical, social and psychological domains (Kirsten, Van der Walt, and Viljoen, 2009:5; Assana, Wongsa and Poonsri, 2017:3). Feeling good and functioning well are two key elements encompassed by the notion of well-being (Steemers, 2015). The first considers a **positive sense of self** which results from feelings of happiness, curiosity and engagement, with the second element including the ability to foster **positive relationships and a sense of control and purpose** (Steemers, 2015). Well-being is ultimately seen by the author as a state of being which is **influenced by external factors**, present in the **physical, social and psychological environment** in which individuals find themselves.

Figure 10: Defining Well-being

Ultimately, *wellness* and *well-being* are two different, but interrelated and interdependent concepts of health where neither can be achieved in isolation. This means that the domains of well-being would affect aspects of wellness and vice versa. As designers, we have the opportunity and ability to shape the environment, which inherently affects the well-being of users. It is important to note that design not only affects the user's well-being through the static built space, but also through the functional spatial design as this could influence the actions, and wellness, of the user.

2.2 WELLNESS THEORIES

After the diagnosis of the Sick Building Syndrome (SBS), originally emerging as a workplace problem during the 1980s, a concern for employee health and productivity arose (Kang, 2003:1; Smith and Pitt, 2011:148). A shift in the focus of sustainable development occurred, giving more consideration to the building occupants' quality of life.

The medical field has seen a similar paradigm shift taking place, focussing on the preventative measures for mental and physical disorders by promoting wellness, rather than merely treating disease and illness (Myers et al., 2000:251; Johnston, 2012:1). This led to 'wellness' forming the central construct in professional psychological counselling.

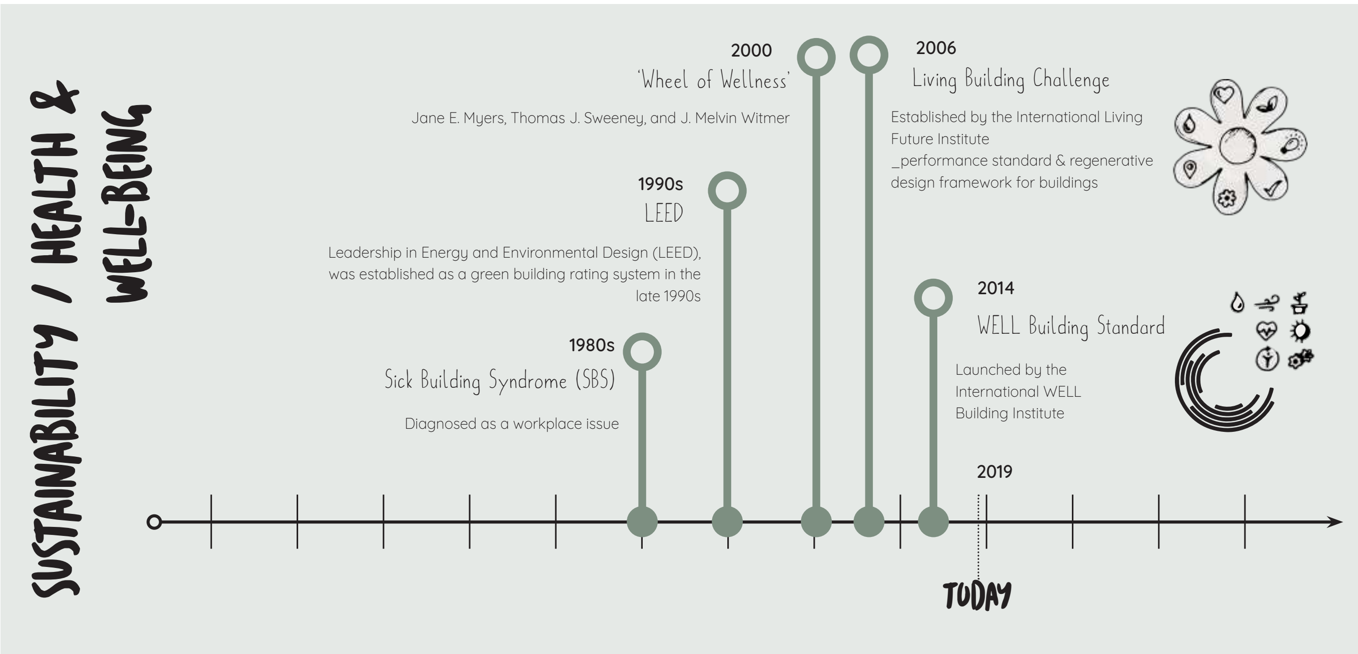


Figure 11: Sustainability / Health and Well-being Timeline of Development

The 'Wheel of Wellness' provides a holistic model for wellness counselling which is theoretically grounded in multiple disciplines regarding human growth and behaviour, and is proposed as a basis for counsellors to develop personal wellness plans for clients (Myers et al., 2000). It is regarded as the theoretical premise of the study, due to its elaborate nature of stipulating and discussing wellness factors in detail.

Despite the general perception of 'wellness' only pertaining to the physical aspects of health, the 'Wheel of Wellness' demonstrates a more holistic approach. It considers aspects beyond the mere physical and incorporates research from both the social and psychological sciences (Myers et al., 2000).

As seen in figure 12, the outer band of the wheel resembles the natural and human events that occur globally and furthermore affect several life forces, such as family and community, the media and government, as well as business and **education** (Myers et al., 2000).

These global events and life forces subsequently affect and dynamically interact with the various life tasks, which will be discussed below (Myers et al., 2000). This highlights the possible impact of the education sector on wellness.

The inner band and dual core of the wheel identifies five (5) main life tasks, with the twelve (12) spokes stipulating the sub-tasks related to the main life task of self-direction. Each of the sixteen (16) tasks are clearly defined and explained within the concept of wellness.

The tasks are all seen as characteristic of a healthy person and would therefore affect not only the healthy functioning of an individual, which occurs on a developmental continuum, but also their overall wellness (Myers et al., 2000:252). The interdependent relationship between the different wellness components means that changes in any one could positively or negatively impact the others, with the consequences of changes possibly multiplying over time (Myers et al., 2000:252).

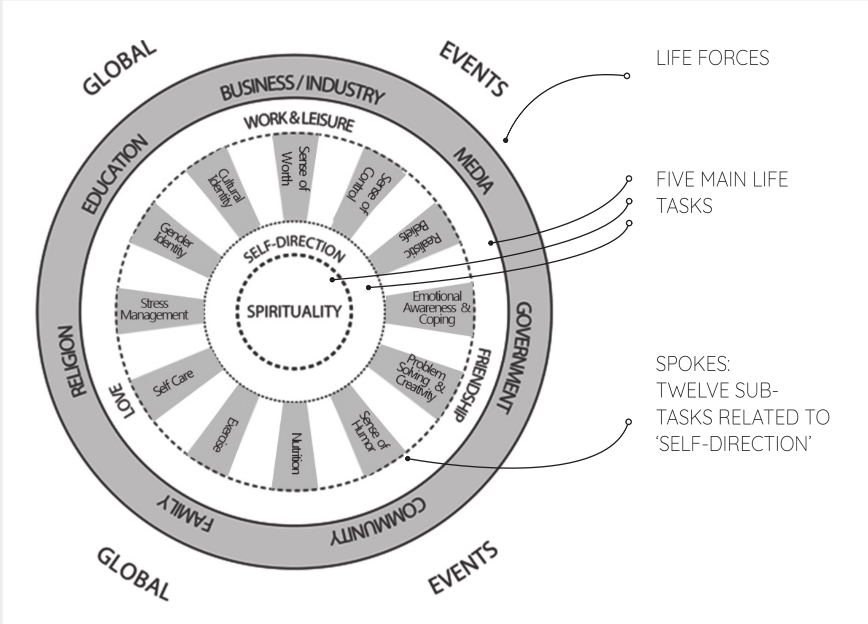


Figure 12: 'Wheel of Wellness', author adaptation of (Myers et al., 2000; Johnston, 2012)

'WHEEL OF WELLNESS'

FIVE MAIN LIFE TASKS

3. WORK & LEISURE

These are two tasks that engage our senses, skills and interests as we partake in activities that provide an opportunity for pleasurable experience and a sense of accomplishment.
Work : activities useful to the community, with either an economic, psychological or social gain. Work satisfaction affects our perceived quality of life, where a sense of competence affects overall life satisfaction. The experiences and outcomes of work, affect emotional well-being.
Leisure : play or recreation which could include physical, social, intellectual, voluntary or creative activities. The participation in these activities could reduce stress and affect self-esteem.

4. FRIENDSHIP

Regarded as the social relationships in connection with other individuals or communal groups, with no marital, sexual or familial commitment. This is motivated by the basic human need for connection with others and the frequent, positive interaction with familiar people, as well as the "search for a long-term, stable and caring support network".

5. LOVE

"A relationship formed on the basis of a sustained, long term commitment and involve intimacy". it also includes a family, or family-like structure that is characterised by shared interests, values and time; good communication; the encouragement of individuals and an expression of appreciation.

2. SELF-DIRECTION

"The manner in which an individual regulates, disciplines and directs the self in daily activities and in pursuit of long-range goals" (Myers et al., 2000). It is the conscious methods performed to meet major life tasks, and accounts for twelve (12) sub-tasks (Myers et al., 2000).

1. SPIRITUALITY

Seen as a core characteristic of healthy people, it entails being conscious of the presence of a higher power that transcends life's material nature. Spirituality represents a private issue in the form of personal beliefs and values. It differs from, but includes religiosity which relates to more publicly expressed, institutional beliefs and behaviours.

Figure 13: 'Wheel of Wellness'_defining five main life tasks. Information sourced from (Myers et al., 2000:252-257)

TWELVE SUB-TASKS OF SELF-DIRECTION

"self-concept"/ "self-esteem"/ "self-worth"
The perceptions we have of ourselves, stemming from the confirmation or disconfirmation of self-appraisals received from others; our expectations of self and importance we assign to our lives, as well as our level of confidence.

The actual or perceived ability to dictate what happens to us. This includes participation in positive health practices (e.g. exercise).

Being able to experience and positively manage one's emotions through expression. Appropriate expression of negative emotions and the presence of positive emotions could assist with physical health.

The ability to identify stressors and employ strategies to reduce their effect on our lives. Successful management improves mental health and bestows a sense of control.

Involved in our thinking, these forms of intellectual stimulation are necessary for healthy brain functioning. Effective problem-solving increases perceived control, while lowering irrational beliefs and self-criticism. Creativity involves the formation of new ideas and concepts, and could positively affect mental health and life satisfaction.

Humour is a cognitive and emotional process which includes the recognition, appreciation and creation of humorous stimuli. Often including laughter, the body responds with the essential release of endorphins into the brain to enhance physical well-being, and create a sense of enjoyment through positive experience.

Substances consumed by eating or drinking; affecting our physical health, mood, performance and longevity.

Regular physical activity; beneficiary to both physical and psychological well-being as it increases strength, self-esteem and self-confidence, and reduces anxiety, depression and stress.

Personal habits and preventive behaviours in which responsibility is taken for one's wellness. Three aspects are included: safety habits to protect ourselves, regular check-ups with physical, medical and dental professionals, and avoiding the intake or exposure to harmful substances; all of which affect physical functioning, quality of life and longevity.

Relating to our internal logic, it entails having rational views to aspects of reality, such as approval from others, competence, fairness and difficulties in life. This prevents a disturbance to ourselves and allows for a self-acceptance of imperfection. For healthier behaviours, this private logic should be as closely aligned with reality as possible.

An introspective, self-defined conviction of being male or female, directed by subjective feelings of masculinity and femininity. Gender role identity refers to the identification with "social prescriptions or stereotypes associated with each sex, to which an individual may or may not conform".

Culture is defined as "a multidimesional concept that encompasses the collective reality of a group of people"; therefore one's identification with a specific group of people and their ideas, customs or social behaviours. Different cultures could differ in perceptions and definitions of health and happiness.

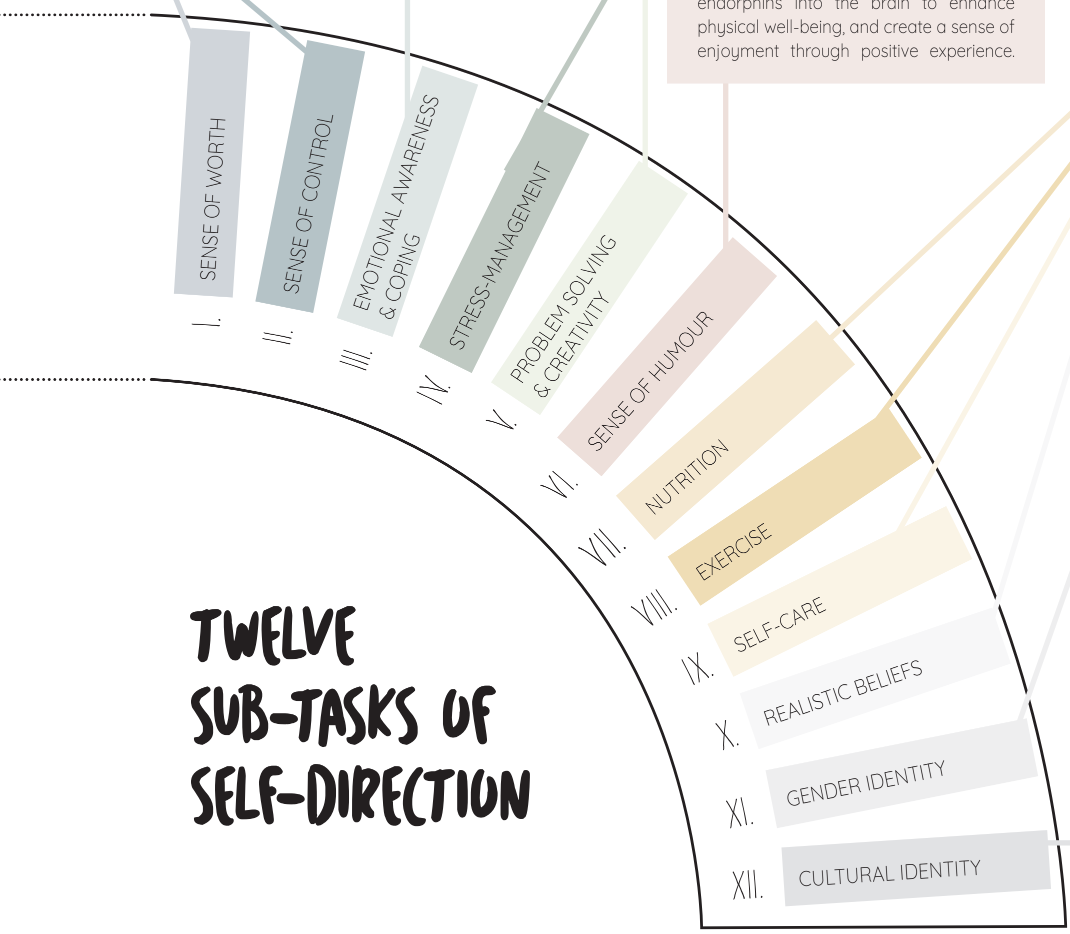


Figure 14: Wheel of Wellness_defining twelve sub-tasks. Information sourced from (Myers et al., 2000:253-256)

An additional wellness model, provided by Dr. Bill Hettler in 1976 and currently still in use by the National Wellness Institute, stipulates six (6) dimensions of wellness (National Wellness Institute, n.d.). These six dimensions are used within the dissertation to more broadly categorise the sixteen (16) tasks stipulated within the Wheel of Wellness above. Figure 15 illustrates Hettler's six dimensions of wellness.

Through this categorisation, a connection to the three domains of well-being becomes more evident. For this dissertation, the author considers the wellness theory as a more detailed description of the necessary considerations required to facilitate and promote the specific domain of well-being within this project. The Wheel of Wellness is therefore the main theoretical base for the project to pinpoint important actions that need to be accommodated, while Hettler's six-dimension model is used as a tool to relate the wellness aspects to the domains of well-being (see figure 16).

A. SPIRITUAL

A 'worldview' is formed once your actions align with your beliefs and values (National Wellness Institute. n.d.). One's value system results from personal emotions which are experienced during the search for meaning and purpose in life (National Wellness Institute. n.d.).

B. OCCUPATIONAL

Considering one's contribution of skills and talents towards personally meaningful and rewarding work in order to achieve life satisfaction and enrichment through work (National Wellness Institute. n.d.).

C. INTELLECTUAL

Expand skills and knowledge through creative and stimulating mental activities such as problem-solving, and learning within and beyond the classroom (National Wellness Institute. n.d.). It also entails the development of intellectual curiosity and pursuing personal interests.

D. EMOTIONAL

While being aware of and accepting one's personal feelings, it is also important to manage one's feelings and related behaviours, as well as coping effectively with stress (National Wellness Institute. n.d.). Stress and stress management should be addressed in schools and workplaces as it not only manifests within the psychological domain but could potentially cause physical illness (Horton and Snyder, 2009).

E. SOCIAL

Living in harmony with others, contributing to the community and enhancing personal relationships and friendships; while being aware of one's impact on multiple environments and one's place in society (National Wellness Institute. n.d.). By further appreciating the help and support from others, one can develop interdependent relationships which are grounded in mutual commitment, trust and respect.

F. PHYSICAL

This includes regular exercise and healthy eating habits, while avoiding the use of drugs and excessive alcohol (National Wellness Institute. n.d.). It further includes self-care and paying attention to one's medical condition (National Wellness Institute. n.d.). By feeling and looking good, the psychological aspects of self-esteem, self-control and determination is affected.

Figure 15: Hettler's Six Dimensions of Wellness, Information sourced from (National Wellness Institute. n.d.)

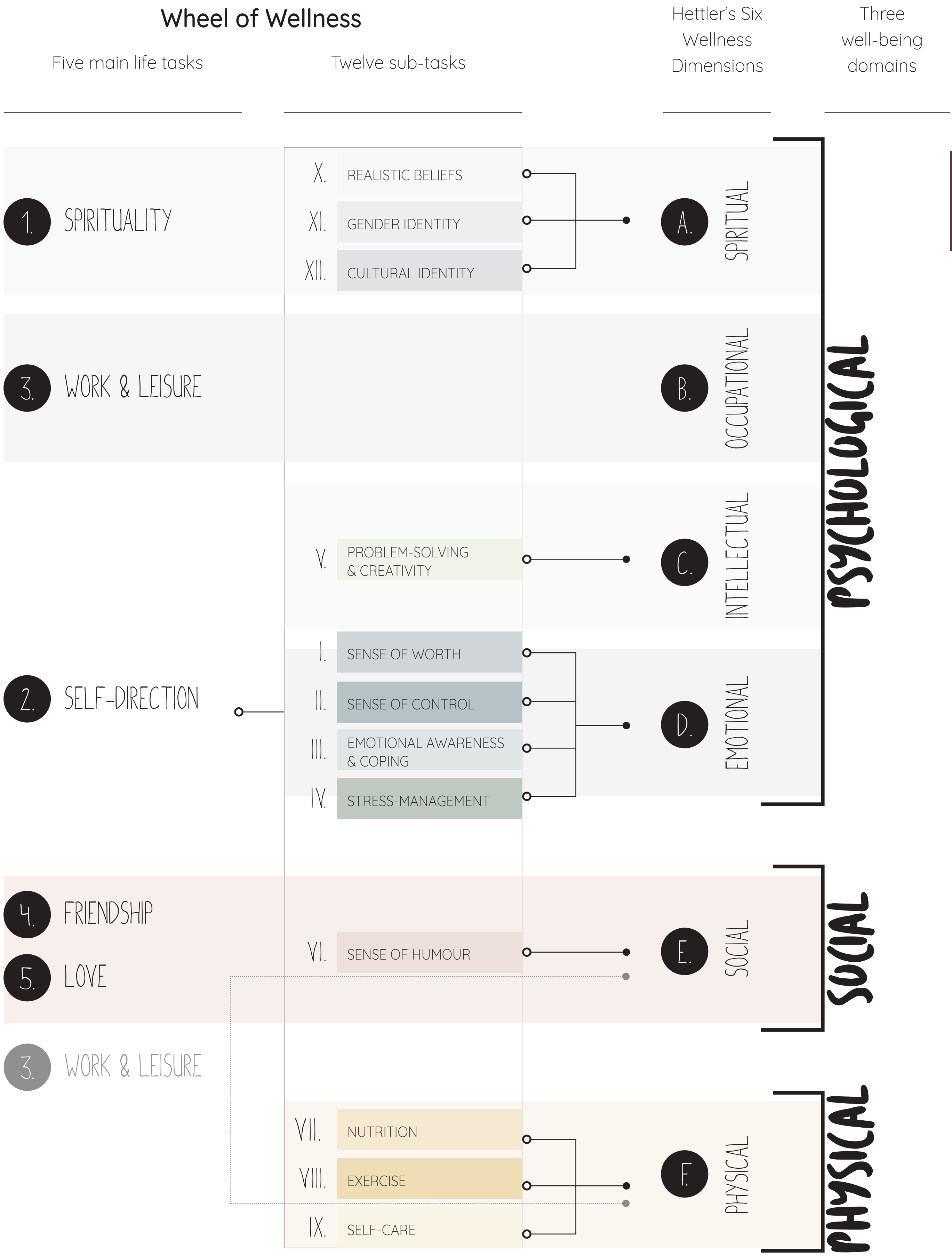


Figure 16: Relating *wellness* to *well-being*

The author accepts certain tasks as more important due to their greater connectedness within the wheel, and possible relevance to learning environments. These stand as theoretical informants, and are discussed below.

Social attributes

The first informant considers **04_Friendship** as it particularly involves social support. Social support is described as the "degree to which one's basic social needs are met through interaction with others", and affects both physical and emotional health (Myers et al., 2000:257). The feeling of being loved and valued by others stand as a core component (Myers et al., 2000:257). Consequently, the social environment is of utter importance as social support, with its 'stress-buffering' effect, proves vital for positive mental health (Myers et al., 2000:253-4). Friendship and social interaction could also combat a feeling of loneliness, which affects the quality of dietary intake and overall well-being (Myers et al., 2000:255-7).

VI_A sense of humour is seen as an integral element of friendship and social interaction. Humour has been shown to reduce stress and depression, relieve pain, and improve self-esteem (Myers et al., 2000:254). A positive sense of humour also assists with insight into personal problems, social cohesion, conflict resolution, creativity, decision-making and negotiating skills, individual and group performance, and a sense of power.

A connection between social and physical attributes exists, as later discussed with regard to 'self-care' under the *Physical attributes* section. Social interests such as empathy, cooperation and altruism could also be beneficial to one's health (Myers et al., 2000:256).

Love and friendship are important aspects for one's quality of life, with proper support systems positively affecting one's mental health (Johnston, 2012:15). Considering learning environments, the aspect of *05_Love* is less applicable, due to its characteristic of intimacy. As the 'support structure' characteristic overlaps with that of friendship, the friendship life task is rather prioritised, with the sub-consideration of levels of friendship and commitment.

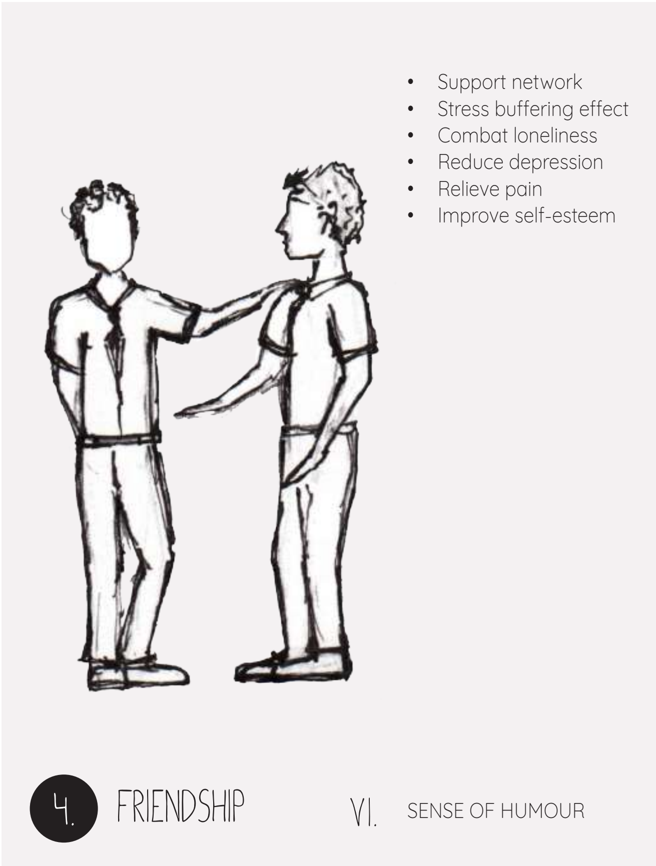


Figure 17: Social Attributes

Psychological attributes

The second informant would be **02_Self-direction,** and more specifically a **sense of control** and a **sense of worth**. *II_Sense of control* is "associated with emotional well-being, successful coping with stress, improved physical health and mental health over the life span" (Myers et al., 2000:254). When enjoying a sense of control, anxiety and depression could be reduced while positively affecting self-esteem and life satisfaction (Myers et al., 2000:254). **By experiencing a sense of control, one's sense of worth can intrinsically be affected.** Furthermore, self-esteem, i.e. *I_a sense of worth*, enhances life satisfaction and overall well-being, and could prevent illness or help with the recovery process (Myers et al., 2000:254). Meaning and purpose in life corresponds with the importance we assign to our lives, essentially acting as an additional factor to wellness. The perception of one's meaning and purpose begin during adolescent years, with sources of meaning including achievement, relationships and self-acceptance (Johnston, 2012:1 & 59). A link between sense of worth and a social support system, mentioned above, can be seen as the appraisals of others could positively impact self-esteem. Both a sense of control and a sense of worth are key factors to mental health (Myers et al., 2000:254).

III_Emotional awareness and coping introduces the idea of allowing for the expression of emotions, whether positive or negative, and providing positive experiences that perhaps induce feelings of joy and excitement. *IV_Stress management* could be achieved through social support and *04_Friendship* humour; the above mentioned *II_sense of control* and *IV_Emotional awareness and coping*, and through *03_Work and Leisure* and *VIII_exercise*, which will be discussed later on.

03_Work and Leisure becomes relevant when one considers learning environments as the 'work spaces' for younger generations.. Our quality of life is affected by work satisfaction and participation in recreational activities, with the latter also reducing stress. Mental health and life satisfaction is further impacted by *V_Problem-solving and creativity*, which forms part of the intellectual activities within learning environments. This represents the need to carefully consider the programmatic functioning of learning environments, to allow for positive and pleasurable experiences.

01_Spirituality, along with *iii_realistic beliefs, xi_gender identity* and *x_cultural identity* define more personal and introspective views of reality, intrinsic to individual thinking. Considering learning environments and the diversity of these aspects within the user group, these are not regarded as high priority informants for the design.

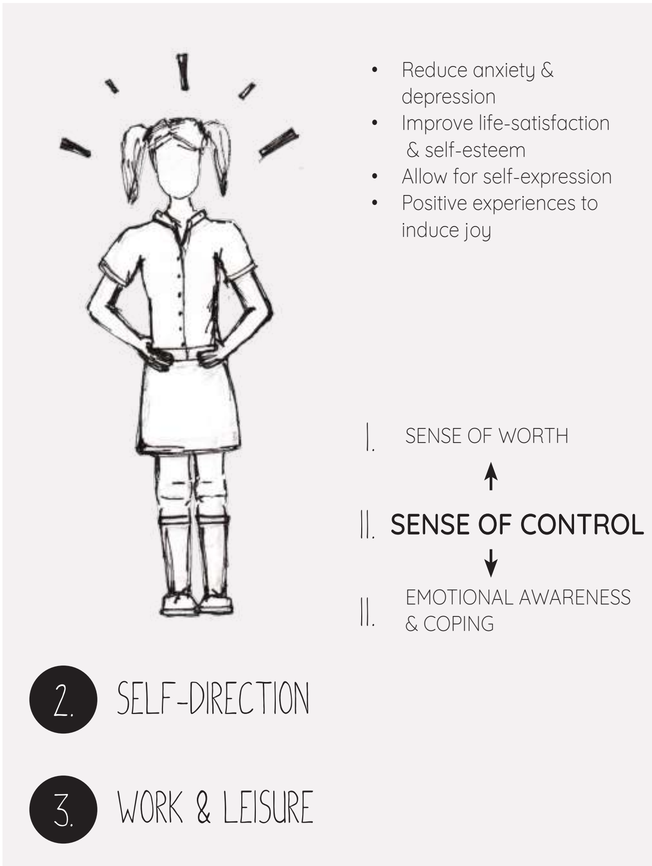


Figure 18: Psychological Attributes

Physical attributes

Regarding the physical dimension, **VIII_exercise** is prioritised. It not only influences emotionality, but could also improve cognitive functioning (Myers et al., 2000:255), which is essential in learning environments. Exercise could be incorporated into recreational activities, and ultimately reduce stress. In addition, studies also suggest the provision of sport and recreation activities or relaxation techniques could combat stress and support physical and mental health (Cooper, De Lannoy and Rule, 2015:64 & 66; Subramani and Kadhiravan, 2017:406). Even though *VII_nutrition* and *IX_self care* encompasses personal behaviours and activities mostly falling outside of the spectrum of learning environments, the safety of, and care for learners should still be considered.

Risk-taking behaviour is higher at the adolescent phase, and could negatively affect self-care due to the intake of, and exposure to harmful substances or the practice of unsafe activities. These activities are more likely to result from low levels of meaning and purpose in life, leading to individuals finding other ways, such as drugs and alcohol to fill the void (Johnston, 2012:23). Evidently, a perception of meaning in life could buffer risk-taking behaviour, establishing a connection between self-care and a sense of worth. The importance of **sense of worth** is reiterated as it could help an individual find significance in their thoughts, feelings and behaviours. Risky behaviour could further be dependent on the influence of peers, placing more emphasis on the aspect of **friendship**. As a result, **positive social interactions and support becomes important for both social & physical well-being.**

Figure 19: Physical Attributes

ALLOWING FOR SOCIAL INTERACTION AS A MEANS TO EFFECT A SENSE OF WORTH AND BELONGING, PRIMARILY CONTRIBUTING TO THE SOCIAL AND PSYCHOLOGICAL WELL-BEING.

FRIENDSHIP & SOCIAL SUPPORT

FOR THE PSYCHOLOGICAL WELL-BEING OF LEARNERS, ALLOWING FOR CONTROL OVER ONE'S EMOTIONS AND ENVIRONMENT

SENSE OF CONTROL

INCLUDING A VARIETY OF WORK, LEISURE AND SOCIAL ACTIVITIES IN BOTH INDIVIDUALAND GROUP FORM, FOR THE SOCIAL, PSYCHOLOGICAL AND PHYSICAL WELL-BEING OF LEARNERS.

PLEASUREABLE EXPERIENCES

THEORETICAL INFORMANTS :
WELLNESS & WELL-BEING

Figure 20: Theoretical Informants_Wellness & Well-being

2.3 ADOLESCENT WELL-BEING

Worldwide, a concern for the well-being of adolescents[10] has been raised. It is estimated by the World Health Organisation (WHO), "that 70% of premature deaths in adults are the result of behaviours begun in adolescence" (Cooper, De Lannoy and Rule, 2015:60). Being successful in later life is likely dependent on one's well-being during adolescence (Assana, Wongsa and Poonsri, 2017:3; Cooper, De Lannoy and Rule, 2015:60). Behavioural patterns and health that develop during the stages of adolescence, determine that of adulthood. It is therefore of paramount importance to promote the wellness and well-being of today's youth, in order to secure greater levels of happiness, resiliency, healthy development, and a better future state (Johnston, 2012:1 &59; Cooper, De Lannoy and Rule, 2015:62; SACAP, 2019).

In South Africa, the youth (under the age of 25) make up more than half of the country's population and is burdened by a shocking state of mental illness. "One in six South Africans suffer from anxiety, depression or substance-use problems" (SACAP, 2019).

Anxiety and depression have shown to affect our physical health, with hostility contributing to high blood pressure, coronary artery disease and death (Myers et al., 2000:254). Adolescents are more susceptible to feelings of depression, which poses a risk to academic performance and self-confidence, potentially leading to substance abuse and suicide (Assana, Wongsa and Poonsri, 2017:3; Cooper, De Lannoy and Rule, 2015:63).

Alternatively stated, the emotional state of adolescents affects their physical well-being and academic performance, which in turn influences other dimensions of psychological well-being.

A Youth Risk Behaviour survey found that many young people experience feeling hopeless and sad (24,7%), with 18% having attempted suicide at least once in their life (Cooper, De Lannoy and Rule, 2015:63). Only 37.2% of these young individuals reached out to professionals for help (Cooper, De Lannoy and Rule, 2015:63), perhaps raising a concern for the provision of health and support services.

Figure 21: Current state of adolescent well-being

Currently, South Africa's mental health services are curatively oriented and poorly resourced, calling for a more preventative approach with greater focus on the health promotion of youth (Cooper, De Lannoy and Rule, 2015:65).

Several factors beyond the reach of the health sector could however impact the health and well-being of youth, such as poverty, poor nutrition and living conditions, domestic violence and harsh discipline, as well as physical inactivity, criminality and substance abuse (Cooper, De Lannoy and Rule, 2015:60). Emotional well-being can also be negatively impacted by the absence of supportive and positive family or community structures (Myers et al., 2000:253-4; Johnston, 2012:15; Cooper, De Lannoy and Rule, 2015:60 & 62). Even though there are so many external factors affecting our youth from various backgrounds, we need to consider making a difference where the best degree of common ground can be found. As a diversity of young people come together for educational purposes, learning environments could stand as the common ground through which to intervene.

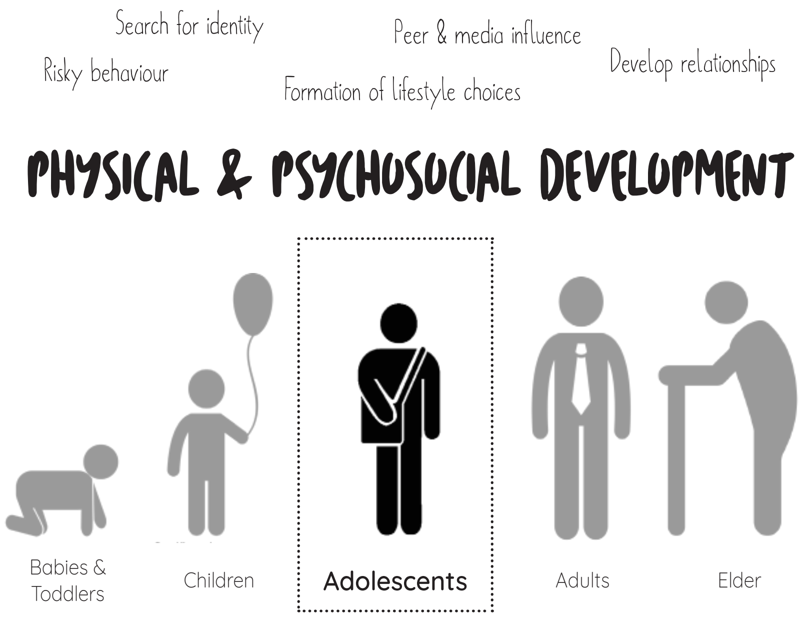


Figure 22: The adolescent stage of development

The adolescent phase of vast physical and psychosocial development, holds with it several stress causing challenges, experimental and risky behaviour, a search for identity, the development of relationships, increased influence of peers and the media, as well as the formation of lifestyle choices (Johnston, 2012:2 & 59; Cooper, De Lannoy and Rule, 2015:60; Subramani and Kadhiravan, 2017:404).

These facets of adolescent life are all related to wellness aspects, as mentioned in the theory above, and require special attention. Greater levels of happiness, resiliency and healthy development could be achieved by promoting the wellness of adolescents (Johnston, 2012:1&59). The potential to address the well-being of adolescents lies in the learning environments they occupy for so many hours during their developmental years.

10. Adolescents: Young people in the adolescent phase of development between childhood and adulthood, during which identity development is considered a primary function (Johnston, 2012:1& 20). During this phase, individuals experience enormous personal change and growth, with many of the decisions made during this period having lasting and often life-long consequences (Johnston, 2012:75). This is applicable to the age group of secondary school learners as they are between the ages of 15 and 19 (Assana, Wongsa and Poonsri, 2017:1).

scene b : the education sector

It can be argued that it is the role of education to prepare learners to become “active, successful and contributing members of society” (Nichols, 2019). It is here where not only the academic curriculum is taught, but children and adolescents acquire life skills through experience and interaction with others.

Studies have shown that health and safety, amongst other aspects such as comfort, inclusiveness and interaction act as crucial parameters for student well-being in relation to academic buildings (Muhammad et al, 2014). Schools further pose unique challenges to the social and emotional well-being of adolescents in the form of bullying and peer pressure, as well as academic stress. These threaten the mental and physical health in both the short and long term, and the academic performance of learners (Assana, Wongsa and Poonsri, 2017:3). Educational facilities offer more than just academic environments, they could contribute to the social, recreational and personal needs of not only the learners, but also the larger community (Sanoff and Walden, 2012:287; Muhammad et al, 2014). This essential contribution calls for the design of school buildings to be critically considered.

Within the education sector, two aspects find relevance. Firstly, it is important to look at teaching methods and ways of learning. This is termed as ‘educational approaches’, which often have spatial implications for the design of schools and classrooms. Research has also found that the teaching methods chosen by staff, often depend on the physical learning environment available to them (Rands and Gansemer-Topf, 2017:31). Hence the reciprocal relationship between the educational approach and the physical space. This physical environment, crucial to the learning experience and the impact on learner health and well-being, is thus explored as the second aspect relating to the education sector.

2.4 EDUCATIONAL APPROACHES

Schooling methods have changed significantly over the past 150 years, especially in the American schooling system, with each approach affecting the spatial design of schools and classrooms. Some of these have been translated into the education systems in South Africa and find contextual relevance.

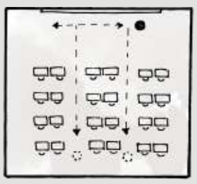
From the initial elitest one-room schoolhouses and later public education that accommodated the traditional fronted layout for teacher instruction (figure 23), to the reform pedagogies during the Progressive Movement between 1890 and 1932, which argued for more flexible and convertible spaces that could adapt to changing teaching methods (Sanoff and Walden, 2012:278) (figure 24), it can be seen that the educational approach significantly impacts the design of classrooms.

There was however a time when teaching methods were found less relevant, and school architecture was directed by the financial economy. As the idea of mass production emerged with industrialisation, the education sector employed prototype school buildings that were economic and allowed fast construction; without questioning how these buildings fit to the education process and whether they provide unique solutions (Sanoff and Walden, 2012:278). The choice was mostly dictated by budget constraints while the social organisation, spatial layout and other physical features received minimal attention (Sanoff and Walden, 2012:278). Today we see a similar situation with prefabricated buildings and portable classrooms being used as schooling infrastructure, which could be assumed to have emerged during this time and possibly remain to be an economic choice.

In the 1960s and '70s, "open-design" was introduced where classrooms and school buildings could be re-organised depending on the need, allowing flexible grouping of learners and individual instruction (Sanoff and Walden, 2012:278). Furthermore, social interaction and communication, as well as collaboration among learners were accommodated in these 'modern' schools (Sanoff and Walden, 2012:278-9). This however, became problematic later on due to the noise and visual distractions, along with the need for different activity settings; finally resulting in the return to more traditionally organised classrooms (Sanoff and Walden, 2012:279).

Educational approaches continue to develop. Today, we see Social and Emotional Learning, the idea of active learning and the 21st Century learning concept shaping school environments. In order for the spatial layout and design of learning environments to function successfully, it is critical to understand the different educational approaches and to ensure the compatibility thereof with the physical environment provided.

Figure 25, illustrates this timeline of development.



Teacher-fronted

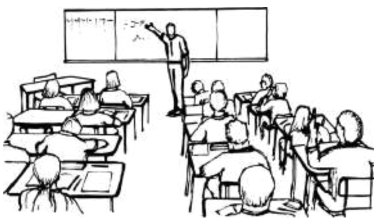
Traditional teacherfronted layout, with rows of desks and chairs for learners

Figure 23: Teacher-fronted plan layout

Flexible & Convertible

More **flexible & convertible** spaces that could adapt to changing teaching methods

Figure 24: Flexible & Convertible plan layout



TEACHER-FRONTED INSTRUCTION

Prior to the 19th Century, education was reserved for the elite and learners of all ages were taught in one-room schoolhouses through teacher instruction (Sanoff and Walden, 2012:277).

Public education, only came about later, during the Common School Movement in the 1830s, and sought to provide equal education to the diverse community (Wagoner and Haarlow, 2002; Sanoff and Walden, 2012:277).

These ideologies questioned the school structure and supported the idea of a more explorative approach to learning, as opposed to the traditional teacher instruction as seen before this period of reformation. Today, some of these approaches can be seen in the private schooling sector, with the Montessori and Waldorf schools as examples.

SELF-DIRECTED AND PEER-LEARNING

A new, more flexible school architecture is required : 'Living room' approach, creating inviting and aesthetically pleasing spaces for stimulating instruction as well as retreat and relaxation (Sanoff and Walden, 2012:277).

Georg Kerchensteiner: 'Work-school' _ manual activity & learning through practical experience rather than one-sided book learning (Sanoff and Walden, 2012:277).	Peter Peterson: 'Tribe' groups _collaboration between learners of different ages whom are grouped together according to interests, as apposed to grade groups. (Sanoff and Walden, 2012:277).	Maria Montessori: Child-centred education _ a self-directed learning process through discovery and exploration (Sanoff and Walden, 2012:278).	John Dewey: Learning by doing and the interaction between learners (Sanoff and Walden, 2012:278).

During the Progressive Era of education between 1890 and 1932, reform pedagogy brought several ideologies about in order to rethink the "drill-school" approach previously present (Sanoff and Walden, 2012:277).

Common School Movement

Progressive Movement

Prior to 19th C | 1800 | 1830 | 1890-1932 | 1900 | 1940

EDUCATIONAL APPROACHES

Figure 25: Timeline of the Development of Educational Approaches

SOCIAL AND EMOTIONAL LEARNING (SEL)

Teach five interrelated sets of skills which deal with cognitive and behavioural competencies namely,

- self-awareness
- self-management,
- social awareness
- relationship skills and
- responsible decision making

(Barry, Clarke and Dowling, 2017:435).

These teachings most often address problem solving abilities, communication, cognitive coping and support networking (Barry, Clarke and Dowling, 2017:441).

ACTIVE LEARNING CLASSROOM (ALC)

Described as a "flexible, open classroom design" (Rands and Gansemer-Topf, 2017:26), these classrooms allow motivatoinal support & supportive relationships, emphasising student engagement.

Incorporates audiovisual tools (e.g. portable white boards and large writing surfaces, video projectors and monitors) to enable collaboration and frequent assessment, allowing for students to visualise their thinking in multiple ways and monitor their own understanding of concepts (Rands and Gansemer-Topf, 2017:29-31).

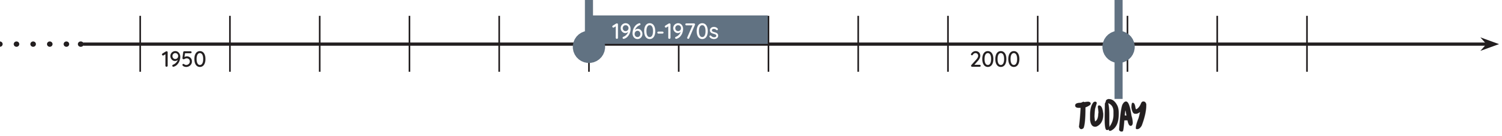
21ST CENTURY LEARNING

A more student-centred approach with teacher as facilitator and learners engaged in more collaborative education activities (Nichols, 2019).

Integration of technology and digital tools into learning environments, creating a more symbiotic and interactive relationship between learners and teachers (Buthelezi, 2017).

Integrate schools within society through community-based programmes; teaching learners to have an impact on both the local and global community through technology use (Nichols, 2019).

'Open-Design' Schools: To allow flexible grouping of learners and individual instruction, communication and social interaction, as well as collaboration among learners, classrooms could be re-organised depending on the need



SOCIAL AND EMOTIONAL LEARNING (SEL)

Studies suggest schools be places of living and learning where a diverse range of educational needs are met, as well as promoting collaboration, individuality and conflict resolution by acting as meeting points for social learning (Sanoff and Walden, 2012:279).

This idea of teaching social and emotional skills for a more successful and positive future, is supported by Barry, Clark and Dowling (2017) in their Social and Emotional Learning (SEL) approach. **Anxiety** and **depression, anti-social** and **risky behaviours** as well as **behavioural problems** such as bullying, conflict and substance misuse can all be **combated** by developing learners' social and emotional skills (Barry, Clarke and Dowling, 2017:436). Evidence shows that these programmes could have long term benefits for the youth, as it assists in **building resiliency and supporting the success of learners** in their academic performance, work and life (Barry, Clarke and Dowling, 2017:435-437). "These core skills play a crucial role in empowering young people in realising their potential, maximising their participation in education, work and society and are key determinants of future mental health and well-being" (Barry, Clarke and Dowling, 2017:435).

Figure 26: Social and Emotional Learning (SEL)

ACTIVE LEARNING CLASSROOM (ALC)

In a study conducted by Shernoff, Ruzek and Sinha, two attributes were found important in assisting students to accomplish academic goals and tasks. These were identified as **motivational support**, to respond to interests and allow self-expression and a feeling of competence; and supportive relationships between both the learner and teacher, and peer learners (Shernoff, Ruzek and Sinha, 2016:3). Often, learners do not receive the necessary support from family and school management which leave them feeling anxious and frustrated (Shernoff, Ruzek and Sinha, 2016:10; Subramani and Kadhiravan, 2017:405); negatively affecting youth development and overall well-being. Both attributes relate to teacher-learner and peer learner interactions which mostly depend on the engagement within educational environments.

The quality of a learning environment can significantly affect the engagement of learners and their learning experience, which subsequently affects their academic performance (Shernoff, Ruzek and Sinha, 2016:2). Learner engagement is thus placed as the mediator between the impact of a learning environment and student learning (Shernoff, Ruzek and Sinha, 2016:2). The engagement of learners is conceptualised as a "heightened, simultaneous experience of concentration, interest and enjoyment" (Shernoff, Ruzek and Sinha, 2016:4), and can be promoted by offering a variety of teaching-learning methods ranging from formal programmes to more informal educational games, as well as the opportunity for experimentation, problem solving and peer interactions (Shernoff, Ruzek and Sinha, 2016:4; Rands and Gansemer-Topf, 2017:26). Allowing for participation and collaboration, while creating spaces that respond to individual learner interests and are able to adapt to instruction methods, thus become crucial to the design of schools.

One way of achieving this is through the design of an Active Learning Classroom (ALC) as described in figure 25. The psychological separation between teachers and learners, experienced in more traditional classroom design, can be removed through the interaction and collaboration between both teacher and learner, and peer learners (Rands and Gansemer-Topf, 2017:29 & 31). The result is a learner community where students experience a **sense of worth** and respect, while teachers act as facilitators rather than instructors (Rands and Gansemer-Topf, 2017:29). An increase in student engagement ultimately has a positive effect on the academic outcome and performance, and perceived learning (Shernoff, Ruzek and Sinha, 2016:10; Rands and Gansemer-Topf, 2017:26); furthermore giving learners a greater sense of belonging and potentially avoiding absenteeism (Shernoff, Ruzek and Sinha, 2016:11).

Figure 27: Active Learning Classroom (ALC)

The latest concern or pressing issue regarding educational thinking is the concept of 21st Century learning and whether South African schools are ready for such a revolution. This concept relates to the Fourth Industrial Revolution[11] and sees the integration of technology and digital tools into learning environments in order to prepare learners for the diverse society in the external world. Using technology in education could assist in creating a more symbiotic and interactive relationship between learners and teachers (Buthelezi, 2017), and allow for innovation (Niall, 2018). Schools need to provide safe spaces; a psychological and physical environment conducive to learning while fostering innovation and cultivating imagination (Buthelezi, 2017). Even though technology and digital tools have been incorporated into learning environments since the start of the 20th Century, the physical spaces do not support the proper integration thereof (Sanoff and Walden, 2012:284). By **incorporating information technology (IT)** within the design of schools, self-learning and community networking could be enabled (Sanoff and Walden, 2012:284).

11 : Technological advancement characterised by a “fusion of technologies, blurring the lines between the physical, digital and biological spheres” (Niall, 2018; Buthelezi, 2017). This includes artificial intelligence and robotics, networks, internet and cloud computing or automation.

Figure 28: 21st Century Learning

By investigating teaching methods throughout history, the unfolding of education from the traditional teacher instruction to learner-centred approaches becomes clear. Despite the development of educational approaches, classroom design has remained fairly static in its provision for the traditional teacher-fronted instruction methods (Sanoff and Walden, 2012:282). Consideration should be given to a contemporary approach to education which would inform the design of future learning environments.

The idea of interactive learning in flexible spaces, along with the importance of academic and social engagement and support, can be extracted as overlapping concepts in recent educational approaches. In addition, studies also suggest the provision of sport and recreation activities or relaxation techniques which could combat stress and support physical and mental health (Cooper, De Lannoy and Rule, 2015:64 & 66; Subramani and Kadhiravan, 2017:406).

- Importance of social interaction between learners
- Need for interactive learning
- Integrate collaboration into classroom activities

SOCIAL AND EMOTIONAL LEARNING (SEL)

- Interaction & collaboration
- Increased student engagement
- Incorporate writable surfaces to express & share ideas
- Potentially include technology into learning environments

ACTIVE LEARNING CLASSROOM (ALC)

- Include technology into learning environments
- Integrate school within larger, and global community

21ST CENTURY LEARNING

Interactive learning
Academic and social engagement
Sport & recreation activities
Flexible spaces to accommodate various teaching methods

[FUTURE SCHOOLS]

Figure 29: Key concepts derived from recent educational approaches

THEORETICAL INFORMANTS : *EDUCATIONAL APPROACH*

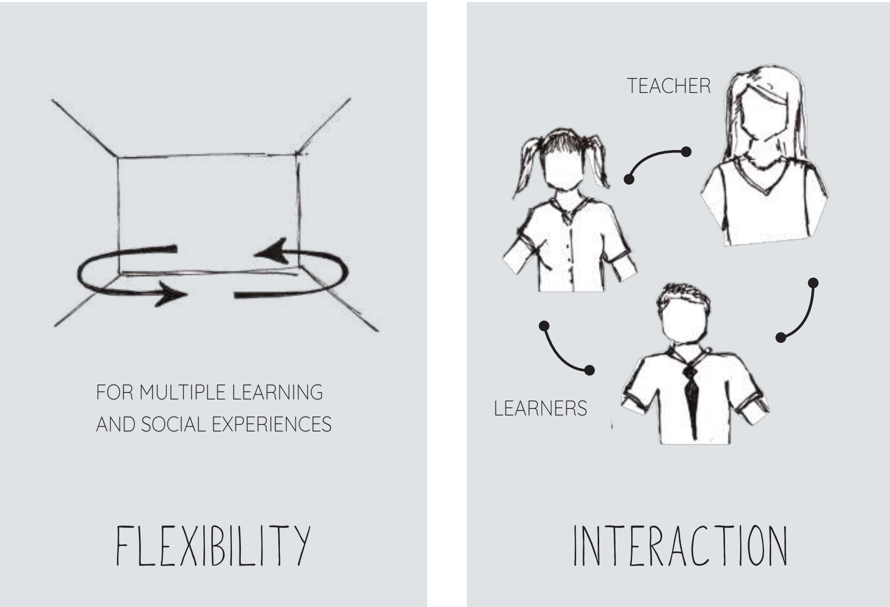


Figure 30: Theoretical Informants_Educational Approach

The wellness, and ultimate well-being of learners can thus be impacted through the design of a flexible space that allows for multiple teaching methods and encourages engagement between both the teacher and learner, and learners themselves. The degree of flexibility should however be limited as to not repeat the mistakes experienced with the 'open-school' design where complete flexibility lacked functional setting and infringed on the acoustic and visual comfort of learners.

Extending the list of theoretical informants, this ultimately means that learning environments now need to be more responsive to diverse learner needs. Various ways of learning need to be accommodated in a variety of spaces, with collaboration and interaction taking place between learners (Sanoff and Walden, 2012:283). Schools should create a safe social environment which teaches communication and coping skills, and builds self-esteem and respect amongst the learners (Cooper, De Lannoy and Rule, 2015:66).

Social interaction and support systems, a sense of control and belonging, and a feeling of competence all relate to the *social, self-direction* and *work* aspects within the wellness wheel. The wellness and well-being of learners could be iproved by adopting these characteristics within the future design of learning environments.

2.5 THE PHYSICAL ENVIRONMENT

School buildings can be regarded as tools for teaching and learning that could either hinder or enhance learning (Sanoff and Walden, 2012:276). The correlation between the quality of the physical learning environment and academic performance, as well as learner behaviour, is undeniable (Sanoff and Walden, 2012:280-1). As the physical learning environment further affects the health and well-being of learners, the design discipline is offered an opportunity to make a valuable contribution.

Throughout history, several studies have been conducted to illustrate how certain design parameters or building factors individually affect the user. The combination of these factors and their overall, cumulative effect does however become complicated and is still unclear (Barrett et al., 2015). A Holistic Evidence and Design (HEAD) study was conducted in the United Kingdom in 2013 to establish the impact of physical space on human health and well-being, using primary schools to assess the impact on learning outcomes. The findings of the study can be correlated with additional writings to compile a more comprehensive understanding of the effects of physical space on learners.

Spatial qualities such as aesthetics, lighting, colour, acoustics, temperature and air quality could affect not only physical matters relating to health and safety, but also a sense of self and the overall psychological state of learners (Sanoff and Walden, 2012:276). The HEAD study identified similar key design parameters, namely light, sound, temperature, air quality, links to nature, ownership, flexibility, connection, complexity and colour as having an impact on the academic performance of learners. These parameters are organised within a model of three design principles, namely **'Naturalness', 'Individualisation' and 'Stimulation'** (Barrett et al., 2015)

Naturalness

A variety of activities take place within classrooms, requiring the infrastructure to accommodate concentration, calculation and memory. Appropriate natural daylighting and artificial **lighting** would therefore affect the well-being and performance of scholars (Singh and Arora, 2014). Better control over direct sunlight and possible glare, could assist in regulating thermal properties and visual distractions to learning (Sanoff and Walden, 2012:287).

Thermal comfort can be regarded as a subjective measure which is difficult to convert into a physical parameter; more specifically defined as "that condition of mind which expresses satisfaction with the thermal environment" (Puteh, 2012). It does however play a vital role in academic activities as it promotes concept comprehension, problem solving abilities, social contact and positive behaviour in class (Puteh, 2012). It further affects concentration, productivity and the quality of work produced by learners (Sanoff and Walden, 2012:287). An **optimal classroom temperature of 22 °C** is suggested (McGuire, 2016; Park, 2017), with a humidity range of 40% - 60%, relative to the temperature (Ohsrep.org.au, 2018).

The HEAD study found that **noise levels** within classrooms generally exceed optimal conditions, with inadequate **ventilation** placing the health of students at risk (Barrett et al., 2015). Additional studies have shown that traffic noise and noisy activities, such as social interaction, could cause stress and annoyance while furthermore affecting productivity and performance (Seetha et al, 2008:659). In addition to this, the World Health Organisation (WHO) stipulates that noise interferes with spoken communication and the transmission of information during lessons (Seetha et al, 2008:659).

Increased **integration of nature** into learning environments and the interaction therewith offers learners greater physical well-being, as well as social and educational abilities (Sanoff and Walden, 2012:285). Outdoor activities prove to be more creative and positively affect cognitive development and cooperation between learners (Sanoff and Walden, 2012:284). Today, learning is not restricted to indoor classrooms environments, but take place in a variety of spaces with different qualities and through multiple schooling activities (Sanoff and Walden, 2012:284).
This highlights the potential integration of interior and exterior spaces into the overall learning experience, while critically considering the spatial qualities within each.

Individualisation

'Individualisation' considers **ownership, flexibility and connection,** and is ultimately concerned with the ability of students to identify with and personalise spaces to meet individual needs (Barrett et al., 2015). This is an important factor as the ability to absorb, memorise and recall information is higher within intimate and **personalised** spaces (Barrett et al., 2015). A sense of ownership would furthermore cultivate feelings of responsibility (Barrett et al., 2015), which is especially significant as it enables a more responsible society.

Spatial form and the arrangement of furniture are seen as spatial cues concerned with privacy, involvement, speed of movement and the type of activity that should take place (Sanoff and Walden, 2012:283). Flexible seating arrangements within classrooms affect the movement patterns of both learners and teachers, and influences interaction as it can be arranged for either individual or communal work (Sanoff and Walden, 201:283). A supportive environment which creates a **sense of belonging** could positively affect learner participation (Sanoff and Walden, 2012:283). These spatial characteristics point to aspects within the 'Wheel of Wellness', and provide more design specific implications for increasing learner engagement. It can thus be seen that a sense of personalisation and the adaptability or flexibility of learning environments influence not only the learning process, learner engagement and academic performance, but also their psychological and social well-being.

Stimulation

With regards to 'Stimulation', consideration is given to the **visual coherence and vibrancy** within a classroom (Barrett et al., 2015). Colour psychology could be considered within the aesthetic design of school buildings with studies showing how colour impacts the mood of learners and teachers, and potentially result in increased concentration and lower drop-out rates (Sanoff and Walden, 2012:281). The visual appearance of school buildings could also convey meaning and should symbolise hope and a safe haven rather than failure and oppression (Sanoff and Walden, 2012:282); a consideration that could be valuable in South African contexts where poverty and social issues are prominent and learners might need these feelings of security.

Several of the above mentioned parameters are found to align with aspects of the 'Wheel of Wellness', placing emphasis on and prioritising these overlapping ideas of self-direction and social engagement. Non-built environment factors, acknowledged within the HEAD study as teachers and a school ethos, also have an impact on learners (Barrett et al., 2015). Educational approaches could be considered additional non-built environmental factors, with a direct implication for the built environment and spatial quality. Due to the vastly different geographical location in which the study was conducted, it is necessary to derive more context specific implications of existing school environments.

scene c : WELL-Learning*

*Inspired by the term 'WELL-Building', the scene title 'WELL-Learning' refers to learning environments that promote the wellness and well-being of learners, through design.

2.6 WELL_CONSIDERATIONS

From *scene a* we see the importance of considering wellness and well-being, especially with regard to children and adolescents. This is however based on broader theoretical texts and needs to be translated to the design discipline. *Scene b* explores the more direct effect of the built environment on learners and their quality of life through the spatial design and educational approaches.

Existing norms and standards, available within the public domain, were consulted to assist in the translation of theory into design. These two sources are referred to as 'Guidelines'.
Guideline A, the Well Building Standard (WELL), is an international design guideline closely related to the concepts of wellness and well-being of building occupants. The second, Guideline B, stipulates local norms and standards for the design of schools, as set out by the South African Department of Basic Education.

2.6.1 GUIDELINE A _ THE WELL BUILDING STANDARD (WELL)

Spending more than 80% of their time within indoor environments, humans are greatly affected by the built environment, assigning architects with a key role in protecting the health and quality of life of occupants through sustainable design practices (Capolongo, 2014; Mehta and Lokhandwala, 2017). Despite the establishment of several organisations that aim to improve building standards and promote more environmentally conscious buildings and 'green design', very few strategies regarding the improvement of health and well-being have been established (International WELL Building Institute, 2018).

To address this issue, the International WELL Building Institute developed a WELL Building Standard (WELL) in 2014, which places a focus on the building occupant and aims to enhance human health and comfort within buildings (International WELL Building Institute, 2018:1). Several performance metrics, design strategies and policies are identified within the WELL to inform the design and functioning of buildings that are not only better for the environment, but also for the users (International WELL Building Institute, 2018:1). The International WELL Building Institute defines the WELL standard as "a performance-based system for measuring, certifying, and monitoring features of buildings that impact the health and well-being of the people who live, work and learn in them" (International WELL Building Institute, 2018:3).

Although originally developed for office projects, some aspects of the standard were found to be relevant within other building types, thus resulting in the development of Pilot Projects. These revisions stipulate modifications to the original WELL Standard and seek to test and refine the application of the standard to various other building types (International WELL Building Institute, 2015:3). The Educational Facilities Pilot Addendum was developed in 2015, including additional metrics and guidelines relating to educational facilities, while removing those of office buildings which were deemed less relevant. The 2019 version of the Educational Facilities Pilot Addendum was used within the project and will remain to be referred to as the 'WELL', thus implying specific reference to this addendum.

The WELL considers seven main categories as seen in figure 31. Each of these are divided into several parts which address different design aspects. Some are labelled as a 'precondition' for certification, while others would be considered as 'optimisation' for additional points for higher levels of certification (International WELL Building Institute, 2015).

Figure 31: Guideline A_The WELL Building Standard

2.6.2 GUIDELINE B _ NORMS AND STANDARDS FOR SOUTH AFRICAN SCHOOL BUILDINGS

The Department of Basic Education first laid out certain regulations relating to the minimum norms and standards for public school infrastructure in the South African Schools Act of 1996 (Act no. 84 of 1996). An amendment was released in 2013.

These norms stipulate the facilities necessary within South Africanschools, along with their quality and size requirements. In some cases, deadlines by which to achieve this has also been set.
Figure 32 below presents a summary. The full extent of the Guideline can be seen within Annex A.

Figure 32: Guideline B_ Norms and Standards for South African Schoos, graphic adapted from (Equal Education, 2019)

2.7 'THE CHECK-UP'

In order to distil the insights gained through theoretical texts and guidelines, the author triangulated the 'Wheel of Wellness' and both Guideline A and B into a wellness audit labelled 'The Check-up'. The audit categorises the different insights into Programme, General Design, Technification / Specification and Policy. Each category describes the different considerations required, while further stipulating the implications for school design. Certain domains of well-being are also affected.

The audit captures an extensive amount of insights and considerations, as extracted from the different sources. This however, functions as an overall informant and method of assessing the existing. Specific aspects will be prioritised as conceptual drivers and design informants for the project, later on.

The intention is for the audit to be used for future assessment of the performance of South African Secondary schools in response to learner well-being. Minor adjustments could be made in order for the audit to be applicable to primary schools as well.

The full audit can be found in Chapter 13, as Annexure A. Figure 33 below presents a segment from the Audit.

GENERAL DESIGN

Aspect	Description	Implication		Source	
Education areas*	The minimum teaching and learning areas essential for functioning. Including the following:	• required facilities / learning areas with minimum sizes • spatial layout & room dimensions		Dept of Basic Education : SA Norms & Standards for schools	
	Classrooms (Grade 1-12) - maximum of 40 learners per class	• 1m² per learner & 7m² per educator • Minimum unit size 48m²			
	Part 1: Classroom Space Allocation: a. Early education, elementary, middle & high school; class: 4 m² per student overall. b. Adult education; seminar classroom: 2 m² per student overall. c. Adult education; lecture hall: 1.5 m² per student overall.	• 4 m² per student in classroom • classroom dimensions		WELL-Building Standard : Mind_*P6* *(Optimisation)*	
	Library : School library / media centre with adequate and suitable school library collection must be present with core collection regularly replenished according to requirements of particular school.	• School library / media centre (mobile library, cluster library, classroom library, centralised school library / school community library)		Dept of Basic Education : SA Norms & Standards for schools	
	Laboratory with necessary apparatus & consumables in accordance with specific curriculum needs of particular school to make possible to conduct experiments and scientific investigations - May be combined where practicable. Maintained in good working order. Lockable facility for apparatus & consumables in accordance with safety standards	• Options : lab / mobile lab / classroom / safe container • Maintenance • Lockable (security & safety) • Minimum unit size for science laboratory = 60m²			
	Sport & recreation: spaces allowing for physical education, sporting & recreational activities. May use facilities of another school / local community, if so consulted.	• Sport / recreational activities			
	Storage per classroom & teaching space	• Minimum size : 12m²			
*Refer to original document (Annex E) for Education area requirements per school type					

social

psychological

physical

Figure 33: 'The Check-Up' example segment

Figure 34: Theoretical Informants_Complete summary

2.8 CONCLUSION

Through the theoretical framework, the concepts of wellness and well-being are explored in greater detail and related to the quality of life of South African adolescents. In response to learner well-being in schools, educational approaches and the effects of the physical space were investigated. Available design guidelines, such as the WELL (Educational Facilities Pilot Addendum) and South African norms and standards for school buildings have been further consulted. This chapter ultimately identifies overlaps in theory and design approaches regarding wellness and well-being, and culminates in 'The Check-up' wellness school audit. Several theoretical informants were deducted from this chapter, and form an intrinsic part of the design process later on in the project.

UNDERSTANDING TYPOLOGY 03

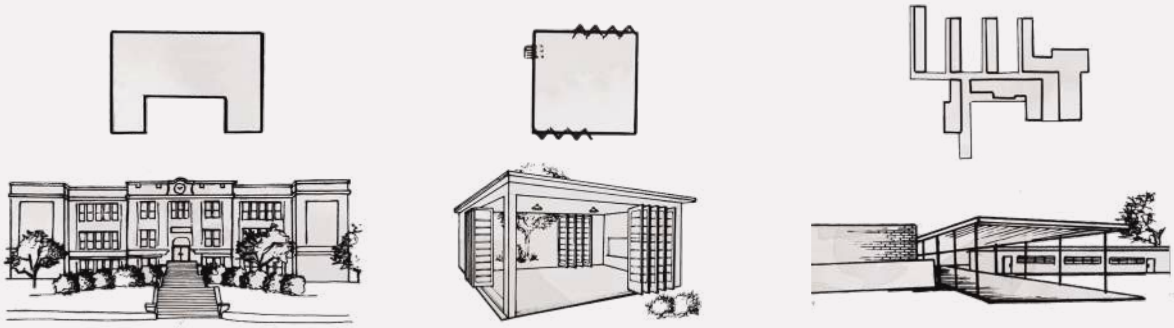
3.1 INTRODUCTION

In preceding chapters, it became clear that the design of schooling infrastructure is vital to the well-being of learners. This chapter more closely considers the physical learning environment as it appears in various typological forms. These typologies are broadly identified within a South African context. Prefabrication becomes critical to consider as a method of rapid construction, especially considering the provision of schooling infrastructure in inner-cities. This is examined in greater detail as a typology of Portable Architecture. Hence, Chapter 3 aims to provide insight into the types of school buildings apparent within South Africa, and more specifically understanding the typology of prefabrication as it is under critical investigation in the context of the project.

3.2 SCHOOLING INFRASTRUCTURE TYPOLOGIES

When looking back, history tracks several school typologies that originated from various concerns and the situation at the time. In order to ensure a positive development within the future design of schools, there is value in investigating these typologies, to learn from their successes and shortcomings.

SCHOOLING INFRASTRUCTURE



After the Common School Movement in the 1830s, a surge in enrolment called for the establishment of larger schools (Nelson, 2014). The United States of America saw the rise of **stately school buildings with Neoclassical facades** and a **utilitarian** interior layout comprised of multiple rows of desks with chairs (Nelson, 2014).

The Progressive Movement during the early 1900s introduced **open air schools, and hygienic architecture** for bigger schools, in an attempt to suppress the spread of tuberculosis (Nelson, 2014). This movement emphasised the need for **fresh air, exposure to sunlight, outdoor learning** and easy flow through buildings to potentially aid the health and mental well-being of learners (Nelson, 2014).

Between the 1940s and 1950s, **Post-war schools** were more cost conscious due to the budget constraints associated with the baby boom (Nelson, 2014). The **'Finger-plan' layout** became very popular, with finger-like corridors to expose each classroom to as much fresh air, daylight and outdoor space as possible (Nelson, 2014).

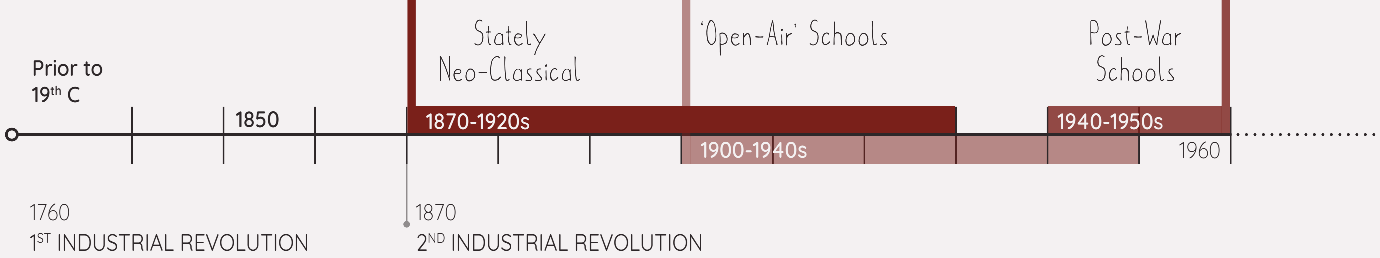


Figure 35: Schooling Infrastructure Typologies

Several of these, especially the typologies arising since 2000 onwards, can still be found in the present day construction of schools and continue to develop.

An **experimental phase** followed.

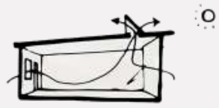
Prefabrication techniques in school construction came about during the 1960s (Nelson, 2014).

Open plan classrooms with a flexible interior layout, or **'Open Design'** also made an appearance and were found **problematic due to their acoustic properties and visual distraction** (Nelson, 2014).

Furthermore, the 1970s witnessed **shopping mall-like buildings** with minimal windows and air-conditioned interiors (Nelson, 2014).

In response to the post-World War II increase in illnesses attributed to faulty construction practices, consideration was given to **healthier** and more **environmentally friendly buildings**, which lead to the formation of the **Baubiology Movement,** or building biology concept in the 1970s (Nelson, 2014).

Soon after, **portable classrooms** were installed during the time of decline in schools in 1980-1990 (Nelson, 2014). Initially intended to be temporary classrooms, these became more permanent and under-went great **scrutiny** (Nelson, 2014).



The Leadership in Energy and Environmental Design **(LEED),** was established as a green building rating system in the late 1990s (Nelson, 2014). Since 2000, **Green Schools** have become a new avenue of exploration that places emphasis on **environmentally friendly buildings** that simultaneously provide a **high quality of indoor air** (Nelson, 2014).

Similarly, the **'Living Building Challenge'** presented seven design principles as a flower petal, which included **water harvesting, electrical generation, non-toxic materials and the possible promotion of health and well-being** (Nelson, 2014). This was applied to schools, and later resulted in the Smart Academic Green Environment **(SAGE) portable classroom.**

Experimental Schools

Portable Classrooms

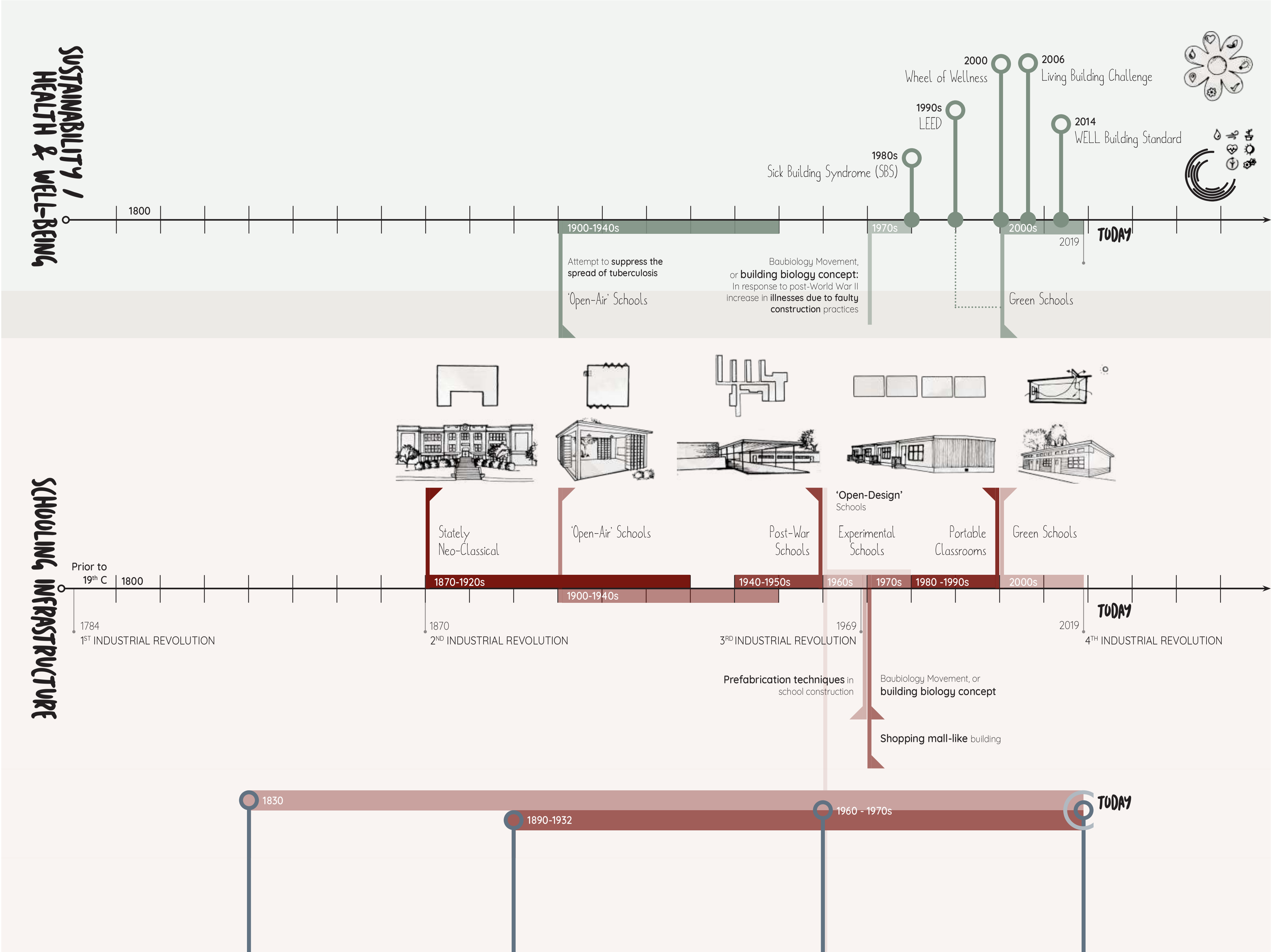
Green Schools

1960s | 1970s | 1980 -1990s | 2000s

1969
3RD INDUSTRIAL REVOLUTION

TODAY

4TH INDUSTRIAL REVOLUTION


SUSTAINABILITY / HEALTH & WELL-BEING
1800
1900-1940s
Attempt to suppress the spread of tuberculosis
'Open-Air' Schools
Baubiology Movement, or building biology concept:
In response to post-World War II increase in illnesses due to faulty construction practices
1970s
1980s
Sick Building Syndrome (SBS)
1990s
LEED
2000
Wheel of Wellness
2006
Living Building Challenge
2014
WELL Building Standard
2000s
Green Schools
2019
TODAY
SCHOOLING INFRASTRUCTURE
Prior to 19th C
1800
1784
1ST INDUSTRIAL REVOLUTION
1870-1920s
1870
2ND INDUSTRIAL REVOLUTION
Stately Neo-Classical
1900-1940s
'Open-Air' Schools
1940-1950s
Post-War Schools
1960s
'Open-Design' Schools
Experimental Schools
1970s
1969
3RD INDUSTRIAL REVOLUTION
Prefabrication techniques in school construction
Baubiology Movement, or building biology concept
Shopping mall-like building
1980 -1990s
Portable Classrooms
2000s
Green Schools
2019
4TH INDUSTRIAL REVOLUTION
TODAY
1830
1890-1932
1960 - 1970s
TODAY

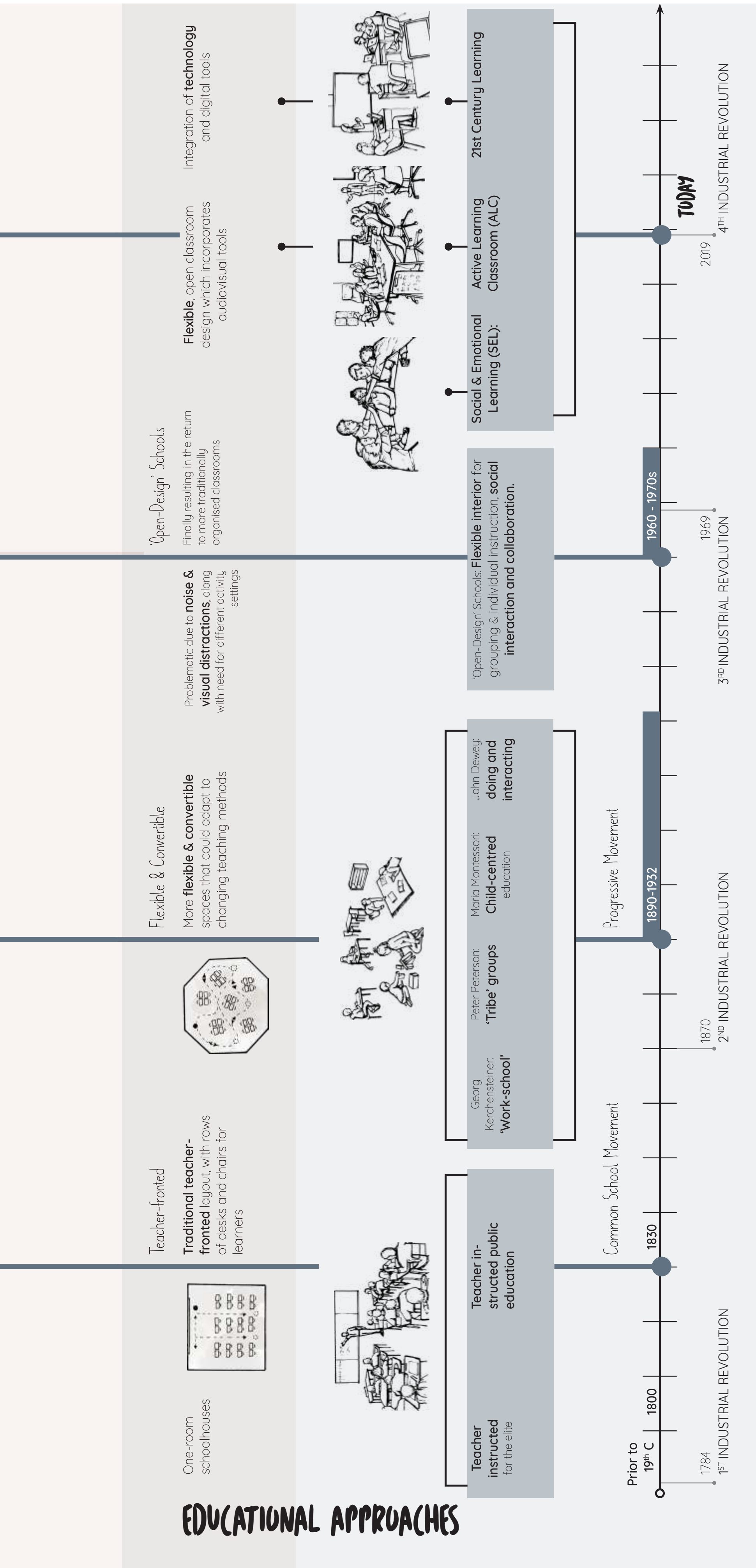


Figure 36: Time-line compilation of wellness and well-being,, and the education sector development

Considering the concern for health and well-being, as well as the educational approaches discussed in *Chapter 2*, figure 36 on the left illustrates the relation of these two aspects to the schooling typologies covered above.

03

3.3 IN THE SOUTH AFRICAN CONTEXT

In South Africa, physical environments for learning take on various forms as we observe a variety of school typologies throughout the country, especially when considering public schools.

type a _ large multi-story building

The first typology reminds of the stately Neo-Classical buildings found in the United States from the 1870s to 1920s. These are often seen with older, more traditional schools where classrooms and administrative spaces are integrated within a multi-story building. Spaces are arranged along interior or semi-indoor corridors. When looking at larger schools, the premises usually includes sporting facilities, fairly removed from these academic and administrative buildings.

type b _ low-rise buildings along a main corridor

Especially seen with previously Model C schools, the second typology brings to mind the 'Finger Plan' schools previously mentioned. Although layouts vary, a common thread is identified. Multiple multi-, or single-story buildings are connected with a main corridor which forms the spine from which all buildings flank out in an orthogonal manner. Classrooms and administration spaces occupy separate buildings, and are typically situated parallel to one another. In addition, sporting grounds and assembly spaces and/or halls are often present.

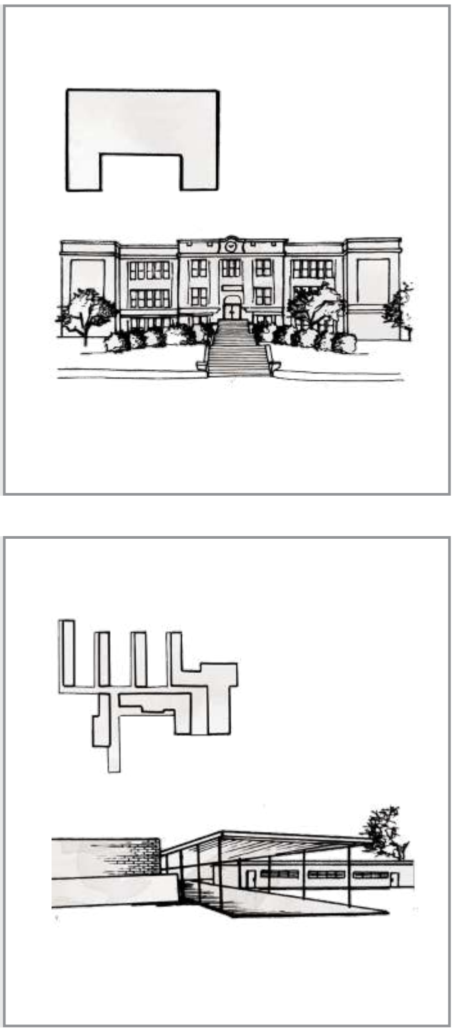
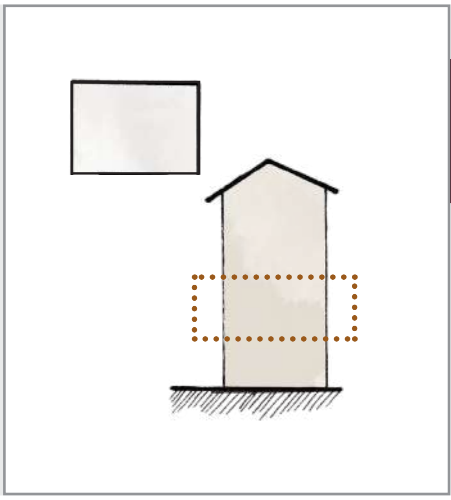


Figure 37: South African School typologies_type a & b

More recently, as we see the need for more schools and to accommodate the increase in enrolments and overcrowding within public schools, rapid construction methods can be noted. The resulting typologies include prefabrication systems and adaptive reuse projects, especially within inner-cities.

type c _ adaptive reuse projects

In recent years, adaptive reuse projects have been employed to accommodate the need for more schools. This can be seen where existing residential buildings and office stock, or portions thereof, have been re-appropriated to function as a learning environment - in both inner-cities and more suburban areas. Space is limited, which minimises the opportunity for sport and recreational facilities and often results in activities being restricted to the building envelope.



type d _ single story prefabricated / portable classrooms

Prefabricated building systems could include structure-and-panel-infill panel construction (discussed later on), where building elements are manufactured off-site to allow for quick assembly on site. Most often, prefabrication takes place in the form of portable classrooms which are pre-assembled and delivered to site (figure to the right). The placement of these buildings generally depend on the available space on site, being grouped either in a linear order or cluster. In some cases, space is limited and no additional (sport & recreational) facilities are offered on site.

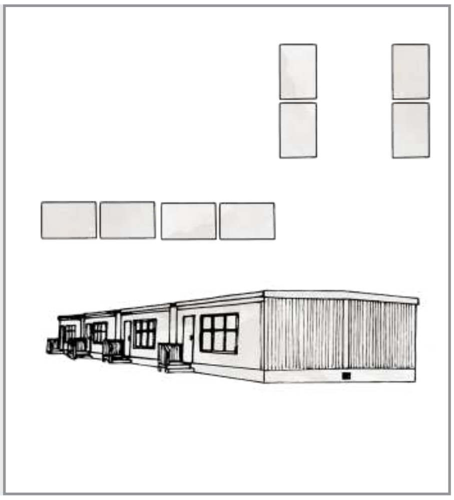


Figure 38: South African School typologies_type c & d

Type d can act as founding infrastructure or additions to existing school environments. Considering the latter, it is typically found in conjunction with *type b*, to speedily increase the school's capacity. The placement of these do not always correspond with the ordered / parallel layout patterns of the brick and mortar buildings as they are mostly placed wherever space is available. In doing so, the erection of these classrooms usually reduces the greenery and open landscape on site. The variation in scale, construction and materials creates contrast between the different typologies on site, further impacting aspects such as foot traffic and noise levels.

Not making use of traditional brick and mortar construction, *type d* poses a unique typology which includes prefabricated systems for rapid construction, resulting in either structure-and-panel-infill buildings or portable classrooms. For clear distinction and short-hand of terms, the classrooms constructed by way of structure-and-panel-infill, will be referred to as panellised buildings. The portable classrooms are termed so due to the universal use of the term, even though it inherently implies the prefabrication, and pre-assembly, of panels.

Prefabrication is seen as a method of construction where elements of the building are manufactured off-site (Cambridge Dictionary, 2019a), to allow for quick assembly and reduced labour intensity on site (Brooks, 1998:117). The off-site manufacturing suggests a certain degree of transportability to site for rapid construction. Awareness is awarded to the concept of portable architecture as *type d* considers different levels of prefabrication.

3.4 PORTABLE ARCHITECTURE

As stated by Robert Kronenburg, “portable architecture consists of structures that are intended for easy erection on a site remote from their manufacture” (Kronenburg, 2008:8). In more general terms, ‘portable’ is used to describe an object which can be easily moved due to its lighter weight or relatively small nature, allowing for it to be taken to a different place (Kronenburg, 2008:8; Cambridge Dictionary, 2019c). Portable, or transportable buildings offer opportunity for quick assembly and almost immediate use on site, possible reuse at a later stage in a different location and could be employed on sites where conventional construction methods are not considered viable (Kronenburg,1998:3).

Kronenburg further identifies three types of portable systems (See figure 39 below). The first considers the simplest form, with buildings being transported in one piece and erected on site for instant use (Kronenburg, 2008:8). The limitations associated with their transport, could restrict the size of such buildings. The transportation method, such as an underlying framework for example, could be incorporated within the permanent structure (Kronenburg, 2008:8).

A second, and more common system, makes use of prefabricated elements which are transported to site as a partly complete package (Kronenburg, 2008:9). This allows for quick assembly on site and offers a larger degree of variety with regards to the built form (Kronenburg, 2008:9).

The last and most flexible system considers a more complex, usually dry assembled organisation of several, easily transportable, modular parts (Kronenburg, 2008:9).

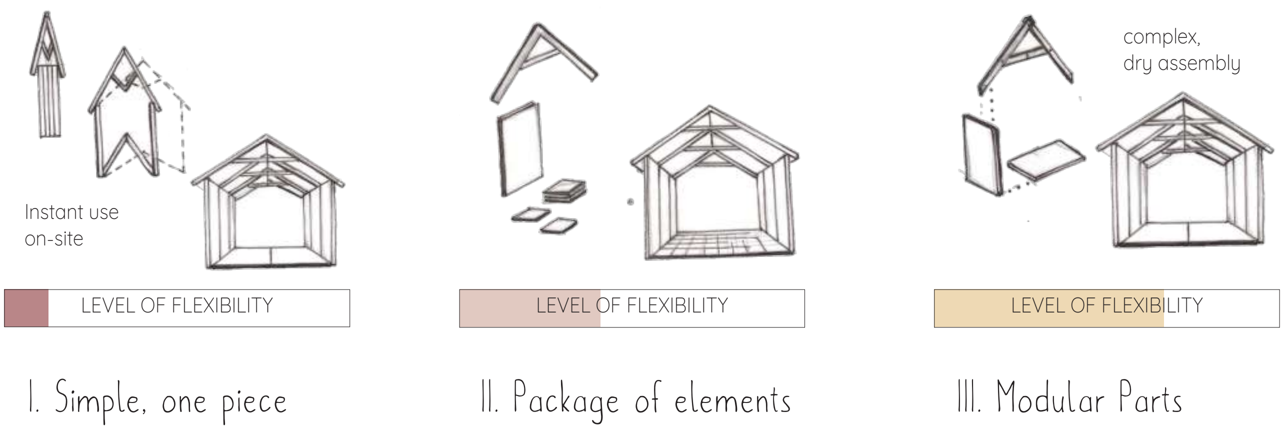


Figure 39: Three portable systems, as defined by Kronenburg

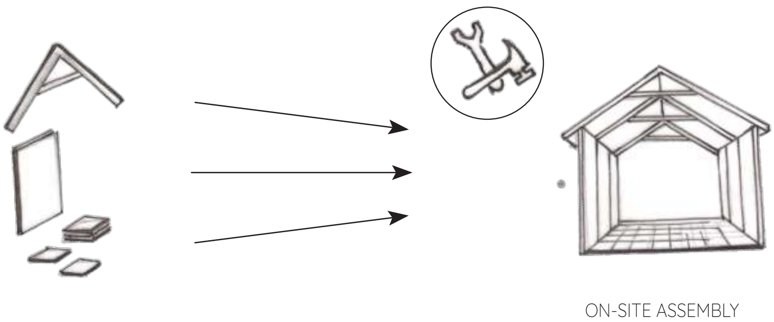
As a continuation, Brookes condenses this argument in stating that all portable systems fall under either the 'prefabricated' or 'deployed' category (Brooks, 1998:116). 'Prefabricated' refers to the pre-manufacture of elements, as is the case with the last two systems mentioned by Kronenburg. On the other hand, 'deployed' is more concerned with the pre-assembly of whole structures and their unfurling on site (Brooks,.1998:116), potentially including system one or three mentioned above, depending on the assembly method taking place on site.

According to Brookes, 'Deployed' structures include six main types, namely flat packed, pantograph, membrane systems, pneumatic, tensegrity structures and pods or capsules (O'Neil, 2009).

In a South African educational sector context, schooling *typology d* acknowledges single story, prefabricated classrooms in the form of panellised buildings and portable classrooms. These are both considered to be forms of (trans)portable architecture, with movable buildings parts and a system of prefabrication.

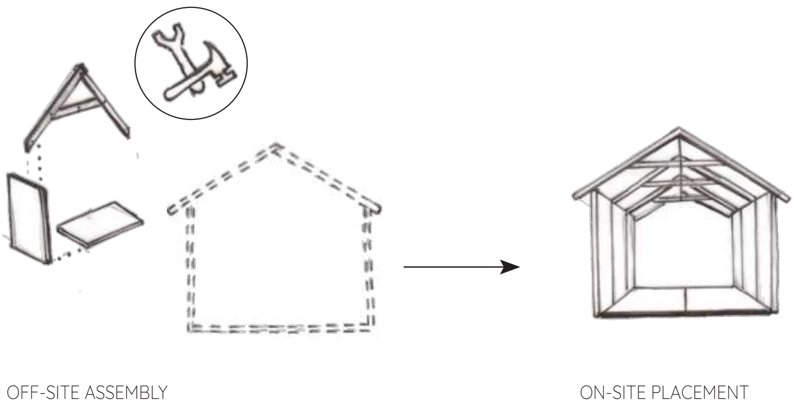
Within this typology, the transportability of the panellised buildings is attributed to the elements that are assembled on site into a fairly permanent structure. A structural frame and infill panels are pre-manufactured and delivered to site as individual elements, where construction takes place on a concrete slab. Applying Brookes's argument, the 'prefabricated' category finds relevance. The potential expansion of these buildings affords some flexibility, although still limited.

Portable classrooms, however, are mostly pre-assembled off-site and delivered to site as either a single structure, or two halves - depending on the size of the complete unit. The final assembly takes place on site. An underlying frame structure is present, similar to the first system described by Kronenburg above. As Kronenburg stipulates, the size of these portable classrooms is limited to allow for the transportability, further limiting the flexibility as it is pre-assembled off site and delivered to site as an object. Although able to be moved and deployed to site as pre-assembled units, Brookes's classification of 'deployed' is not fully assigned. This is due to the fact that these portable classrooms do not unfurl or change shape and size once on site. 'Prefabricated' is therefore still applicable, while making an attempt towards deployability.



PANELLISED BUILDINGS

Elements pre-manufactured and delivered to site, resulting in structure-and-panel-infill assembly on-site.



PORTABLE CLASSROOMS

Elements pre-manufactured and assembled off-site, delivering a nearly complete unit to site.

Figure 40: Panellised and Portable classrooms distinguished

Figure 41 below highlights the aspects of portable architecture and provides an indication as to the classification of the panellised and portable classrooms within *type d* schooling infrastructure.

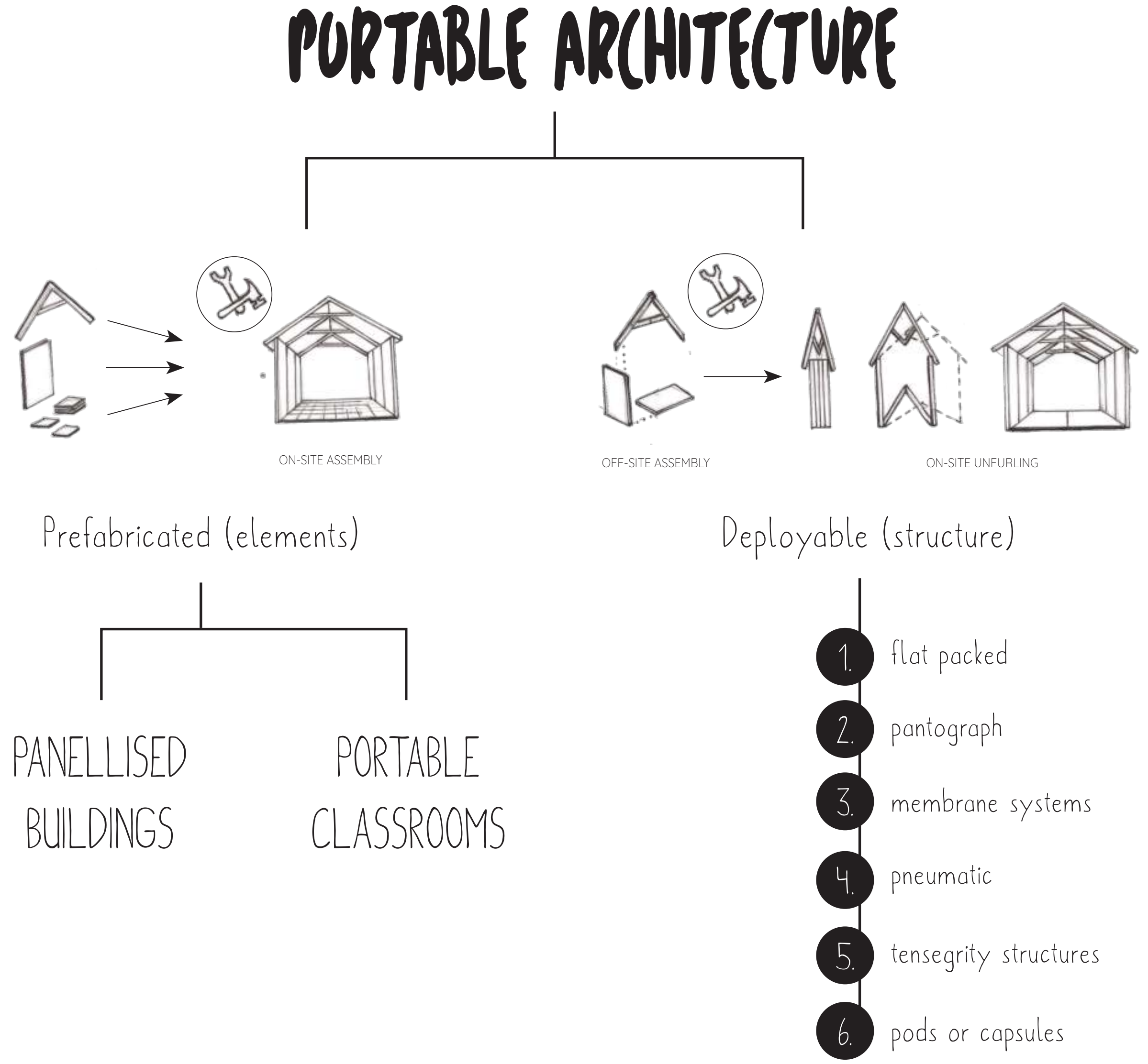


Figure 41: Portable architecture

Kronenburg argues for efficiency in form, light weight in materials and flexibility in purpose to be achieved in order to ensure good portable architecture (Kronenburg, 1998:3). These three characteristics constitute the ephemeral nature of buildings, which usually means that standard construction methods are not suitable (Kronenburg, 1998:3).

Theory therefore suggests that **deployability would allow for greater flexibility** in terms of the structure, and requires the careful consideration of **material selection** and **construction techniques.**

To achieve the theoretical informants of *control* and *flexibility*, one could make the argument for more **deployable classroom** units that are easy to transport and assemble, making use of any of the six types of deployed structures.

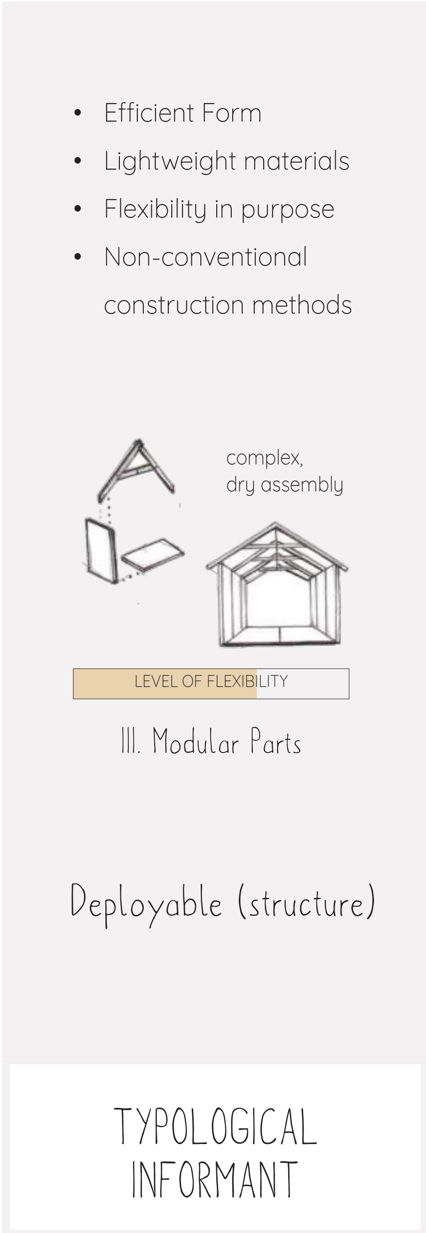


Figure 42: Typological Informant

3.5 CONCLUSION

As the physical space of learning environments affect learners, it is important to understand the different forms these spaces take on. This chapter briefly explored international typologies throughout history, as well as identifying four general school typologies in South Africa, with prefabricated buildings as the focus of the investigation. Portable Architecture was examined more closely as it relates to the typology of panellised and portable classrooms. Both of these building systems employ prefabrication, with portable classrooms suggesting a consideration for deployability. Several types of deployable systems are considered, with a predominant benefit being the greater sense of flexibility it allows. To achieve the theoretical informants, this chapter advocates for deployability in the future design of classrooms.

UNPACKING THE CONTEXT 04

4.1 INTRODUCTION

To contextualise the investigation, *Chapter 4* introduces the site and examines the various layers of the current condition and the effect it has on learners. From macro to micro study, the context analysis considers the physical, social and psychological implications of the existing site. The specific concerns and opportunities of site, related to learner well-being, will be identified and discussed during this chapter, proposing the contextual informants for the project going forward.

Within the Gauteng province, the city of Pretoria has been selected with specific focus on the inner city. The larger urban area receiving attention is located on the South-Eastern corner of Pretoria Central, bordering on Sunnyside. The site of choice, Tshwane Secondary School is situated on the corner of Lilian Ngoyi and Visagie Streets.

scene a : macro study

LARGER AREA : INNER CITY OF PRETORIA

URBAN BLOCK :

SOUTH-EASTERN CORNER OF PRETORIA CENTRAL, BORDERING ON SUNNYSIDE

scene b : meso study

04

SITE : TSHWANE SECONDARY SCHOOL

scene c : micro study

4.2 LEARNING ENVIRONMENTS IN PRETORIA

In South Africa, and Pretoria specifically, the Department of Basic Education faces the challenge of overcrowding in public schools (Marais, 2016; Kubheka, 2019). Inner-city schools are often established to not only relieve the pressure of overcrowding in existing schools, but further address the need for more schools to provide the next phase of education as learners progress from primary to secondary schools for example. Figure 43 below presents the mapping of learning environments in Pretoria, ranging from pre-primary to tertiary.

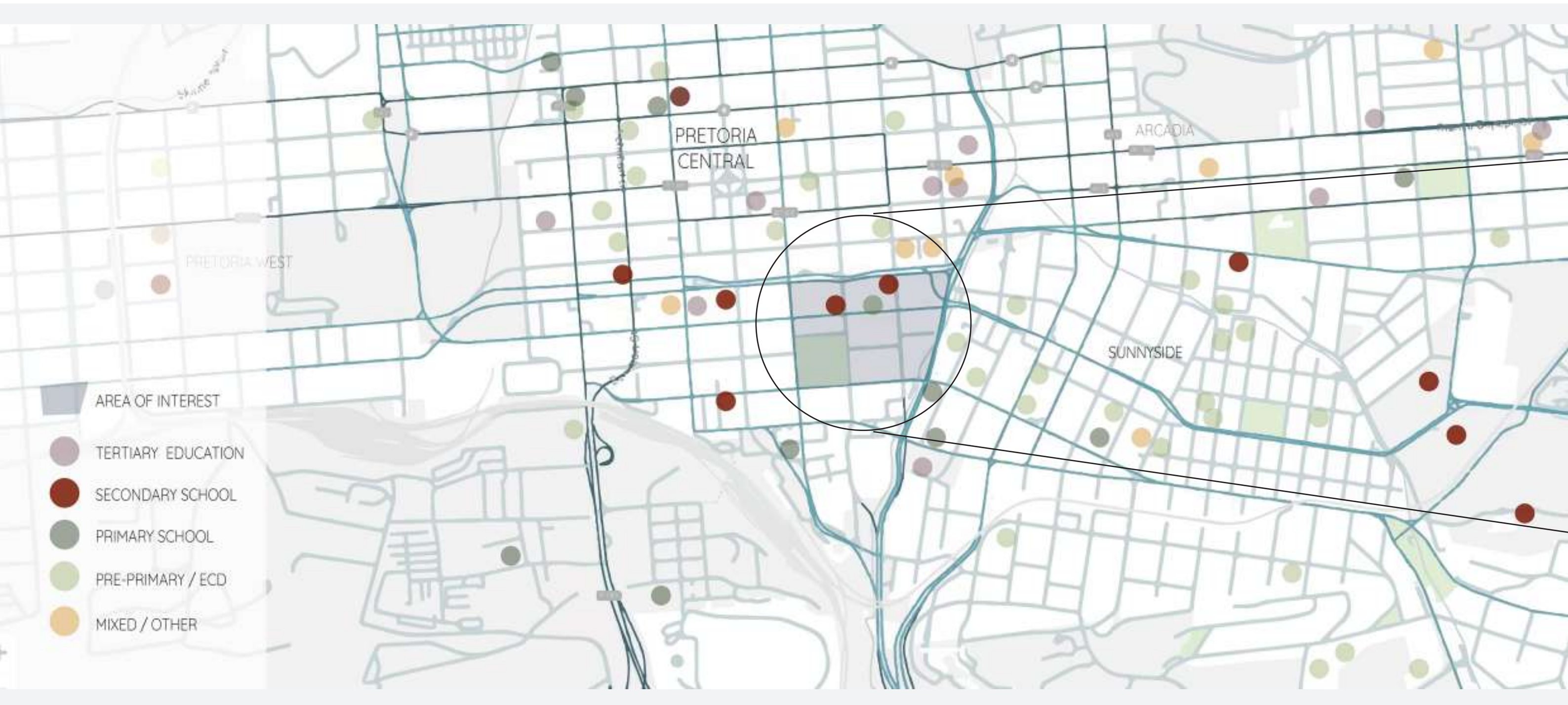


Figure 43: Learning Environments in Pretoria

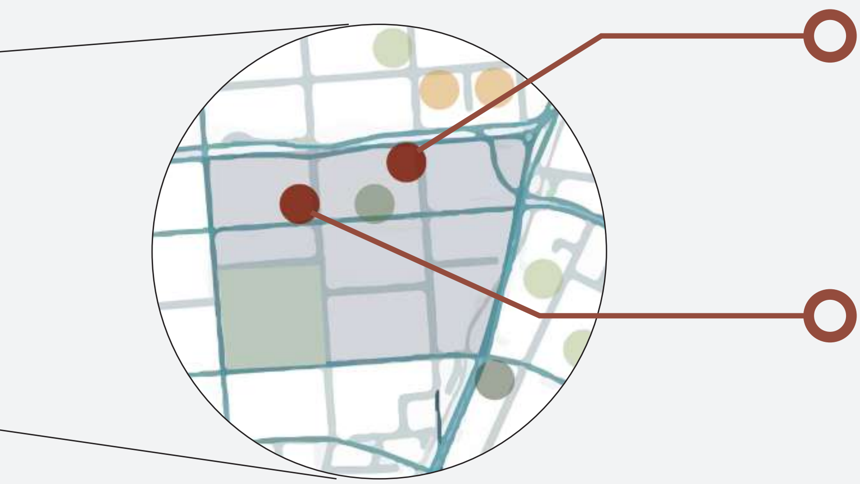
Supported by the mapping of learning environments in Pretoria, it can be seen that the inner city has a number of pre-primary schools and early childhood development centres (ECD's) to accommodate the very young child community. Several primary schools are also available on the periphery. Secondary or High schools are however limited, with only two public secondary schools available in the immediate area of Pretoria Central.

The first is Pretoria Secondary School, located on the corner of Sisulu Street (previously Prinsloo Street) and Nana Sita Street (previously Skinner Street). Pretoria Secondary was established in 2003 due to an urgent need for secondary education facilities as several Grade 7 learners of 2002 could not be accommodated for their Grade 8 year (Pretoria Secondary School, 2015). The existing multi-story building was re-appropriated to accommodate the educational programme, thus making use of adaptive reuse.

Tshwane Secondary School provides the second and more recent solution to the need, as it was established in 2009 (Matimela, 2019). Time constraints demanded rapid construction, resulting in prefabricated buildings.

These two inner-city secondary schools have evidently only been established within the past 10-20 years, both in response to the pressing issue of overcrowding and a need for schooling infrastructure, faced by the Department.

One could question the ongoing need for secondary schools in the area as the primary education accommodates an even larger number of pupils



Pretoria Secondary School

Corner of Sisulu Street (previously Prinsloo Street) and Nana Sita Street (previously Skinner Street). Established in 2003 due to an urgent need for secondary education facilities, making use of adaptive reuse.

Tshwane Secondary School

Established in 2009 (Matimela, 2019).
Time constraints demanded rapid construction, resulting in prefabricated buildings.

Figure 44: Secondary Schools in Pretoria Central

4.3 SITE SELECTION

Considering the general issue of insufficient schooling infrastructure and the well-being impact of rapid construction methods currently used, inner-city schools were considered first choice options for further investigation as they are heavily concerned by this issue due to the urgent need for establishment.

For the study, the decision to focus on Secondary / High School learners was made by the author, as most of the available research studies and projects found during the initial conception phase of the proposal, focused either on primary or tertiary education students.
The research potential of the secondary phase of education is thus identified, especially considering the concern for adolescent well-being as they undergo unique physical and emotional development, as seen in the theoretical framework in Chapter 2.

Ultimately, the site selection see the identification of a secondary school within the inner-city of Pretoria, making Tshwane Secondary School (TSS) a viable choice. In addition to this, the prefabricated infrastructure currently available at TSS ascribes to the concern for rapid construction methods' neglect of learner well-being.

As the project investigation seeks to respond to a testing site, the specific choice of school would pose unique opportunities and challenges. In this case, it becomes clear that the limited ground floor area, as well as the domestic scale of the built infrastructure need to be carefully considered throughout the study.

As rapid construction methods are employed to accommodate the time constraints of new school establishment, the quality of infrastructure could be questioned.

The choice of site seeks to find answers to the impact of prefabricated buildings on learners, and potentially provide an opportunity to design a contextual response. Additional testing sites, with their unique traits, could be identified later on to demonstrate the broader potential of the design.

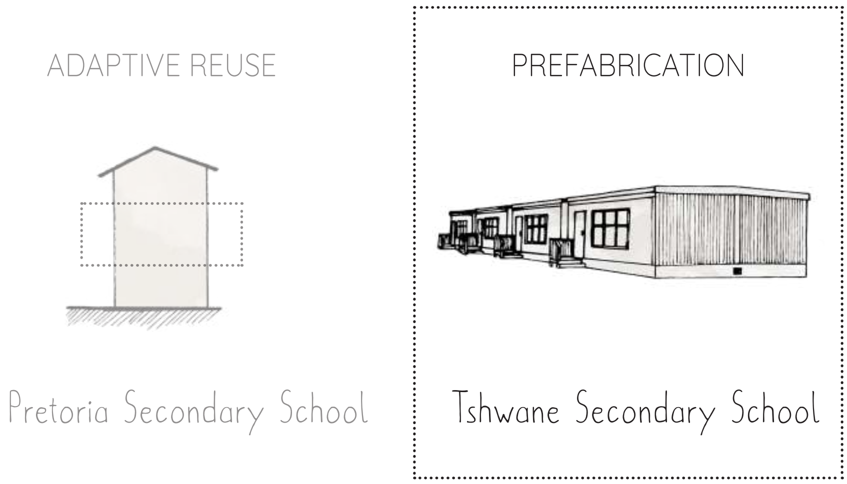


Figure 45: Site selection

4.4 FEEDER ZONES

It was further noted that only approximately 30% of the student body of Tshwane Secondary School (TSS) reside in the area, leading to the identification of several feeder zones such as Hammans-kraal, Mamelodi, Atteridgeville and Soshanguve (Matimela, 2019).

The question then arises, why do these children travel so far to attend TSS?

As reported by the local news platforms, quality education has been found to be lacking in local communities, leading to children traveling long distances every day to receive what is perceived to be quality education in nearby towns and cities (Mail & Guardian, 2018). When however, comparing the ma-triculation results of recent years between inner-city, specifically TSS, and feeder zone secondary schools, it was found to be fairly similar. The question of travel thus remains.

04

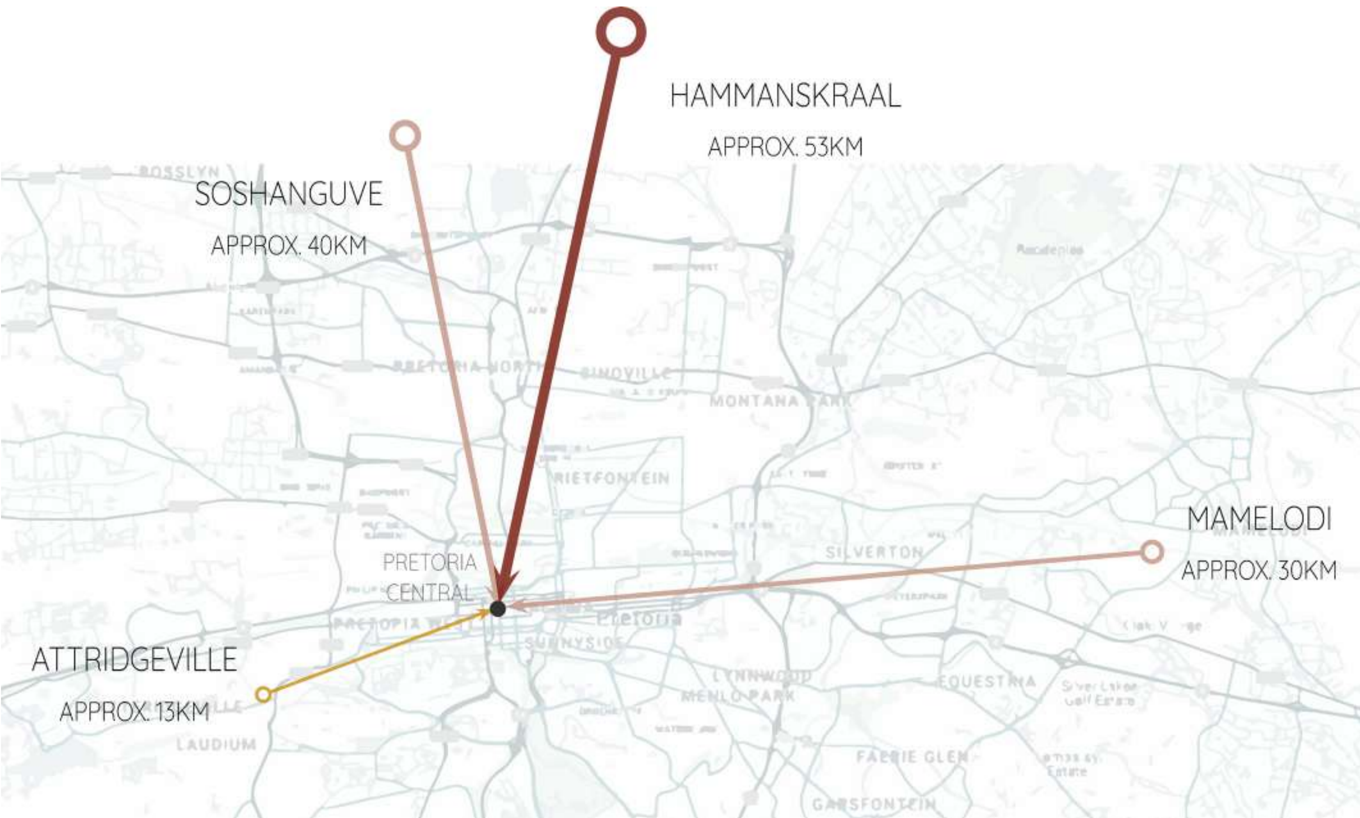


Figure 46: Feeder Zones to Tshwane Secndary School

In order to provide possible answers for these questions raised, and to better understand the daily routine of users, the following scenarios are created by the author:

1. **Learners live within the area**, as is the case with approximately 30% of the learners, and travel to school either by foot, public transport or vehicular transport as they might be dropped off by family.

2. Learners travel with parents, either by own transport or public transport, from feeder zones to the inner city as **parents work in the area.**

3. Learners attended ECD's or primary schools in the area, for any of the above-mentioned reasons, and now **continue their education within the inner-city** due to familiarity and language barriers that might occur should they return to feeder zone schools where the language of instruction potentially differs to that of inner-city schools.

04

4.5 MACRO STUDY SCENE CONCLUSION

Through the macro study, it is clear that Pretoria offers a variety of learning environments, ranging from pre-primary to tertiary, for learners from various areas beyond the inner city. Tshwane Secondary School is chosen as a testing site for the project, to critically investigate the effect of an inner-city secondary school and prefabricated schooling infrastructure on the well-being of adolescent learners.

The larger urban area and specific block was analysed during a mapping exercise, with a group effort to establish an urban vision. Subsequently, a block vision was also derived.

4.6 URBAN & BLOCK VISION

The urban vision for the larger contextual area is to introduce well-being architecture within the urban context of Sunnyside. It considers the theory of Steemers, namely 'Five Ways to Well-being', which stipulates five behaviours that have been proven to positively affect the physical, psychological and social domains of well-being (Steemers, 2015). The five behaviours are as follows: connection, keep active, take notice, keep learning and lastly, giving. These behaviours further relate to the built environment (Steemers, 2015). As a group, connections were made between these behaviours and the three domains of well-being, while further deriving five architectural typologies as an urban framework to take forward. These architectural typologies include proximity to resources and facilities; sports fields and attractions; open arts and greenery; clean, safe and comfortable environments as well as community spaces such as soup kitchens and clinics.

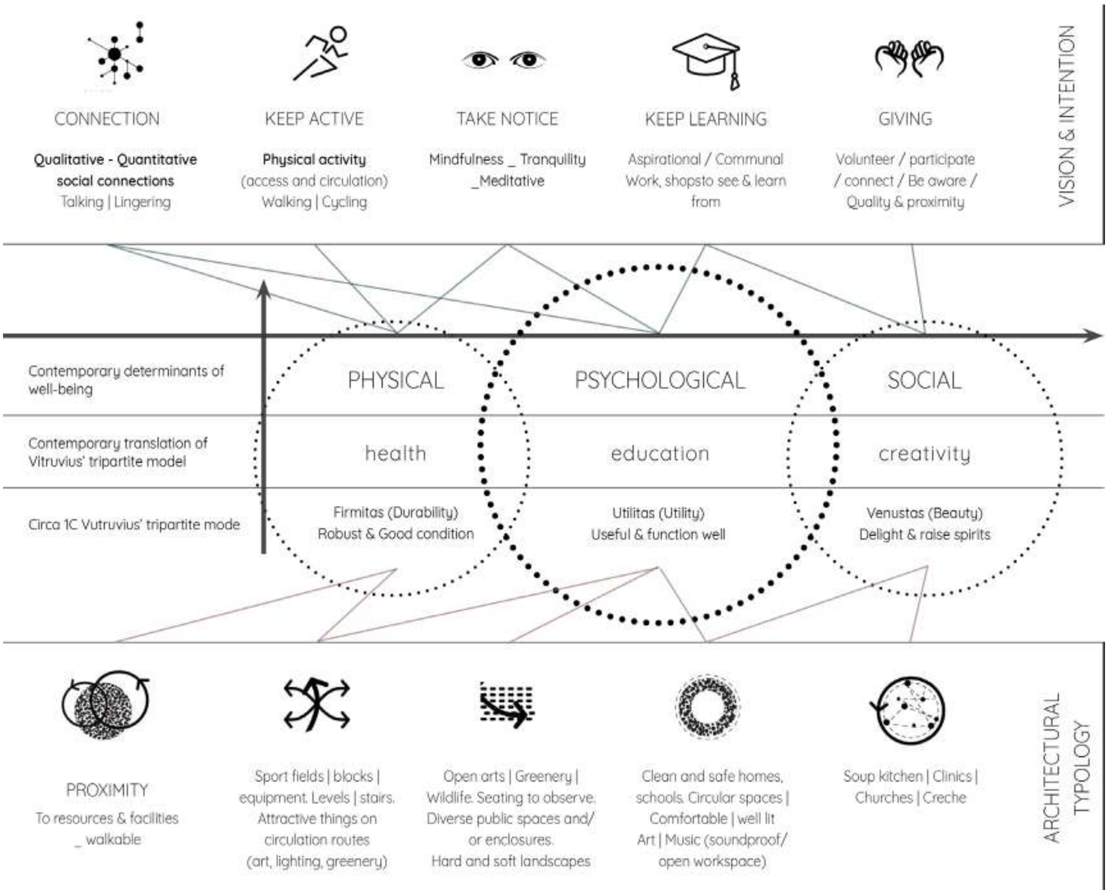
Within the block vision, these architectural typologies are potentially arranged and recognise the opportunities for increased surveillance, community engagement and connection. Surrounding blocks could assist in introducing activity and attractions, for example green lanes, public arts and utilising Burgers Park for sports and recreation.

The project incorporates Steemers's theory used within the urban vision, into its theoretical framework. It further seeks to overlay the characteristics and concepts of the architectural typologies onto the site, in order to respond to the context and conceptually achieve the block vision. It is thus necessary to consider the connection between the school and its surroundings, including the community, as well as considering how the services offered through the school and broader context, are complementary to one another.

GROUP :
AMY VD WALT
BRENIANN LABUSCHAGNE
NICOLA SMITH

Well-being Architecture

URBAN TRIANGULATION OF WELL-BEING IN SYNNYSIDE



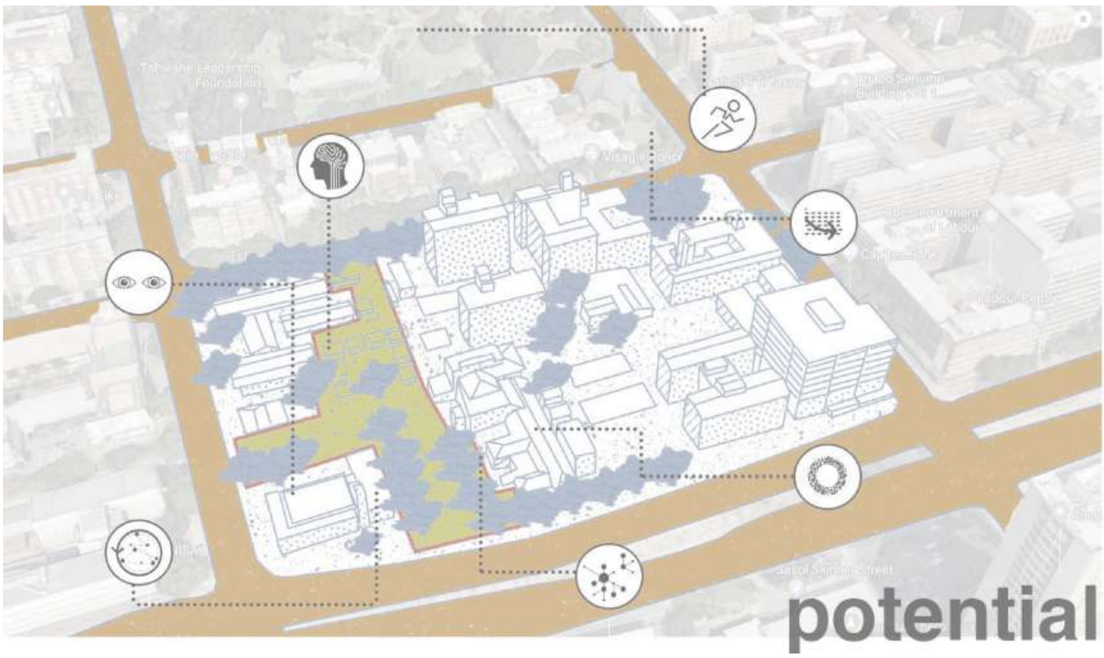


Figure 47: Urban & Block Vision

4.7 LAND USE & AMENITIES

Through the mapping exercise it was found that very few amenities are available in the area, especially related to the needs and use of learners. Several residential buildings are noted, with a few mixed-use buildings scattered to the north of Burgers Park. No public libraries, sport facilities or play areas are present; thus, no child-friendly spaces beyond the school environment. Learner activities within the urban area are limited to the activities and programmes offered by their specific school. With regards to Tshwane Secondary School specifically, no extra-curricular or sport facilities and programmes are provided or shared with other schools in the area. This results in learners leaving the premises, and potentially the area after attending school activities due to the lack of attraction keeping them occupied after school hours, or their wandering in an urban area which does not facilitate their needs and well-being.

A concern is raised for the land use diversity and the impact of such large-scale conditions on the well-being of adolescents. There is an opportunity to introduce new programmes / amenities which not only speak to the five behaviours and five architectural typologies within the urban vision, but furthermore could assist in addressing the aspects and shortcomings of wellness and well-being as identified through the audit. Special consideration could be given to learning activities such as sport and recreation, as well as libraries and arts and culture. Acknowledging other learning environments around the block, these additional activities and facilities could be shared between the different schools, accommodating the larger community of children and creating a better connection between the school and the larger context.

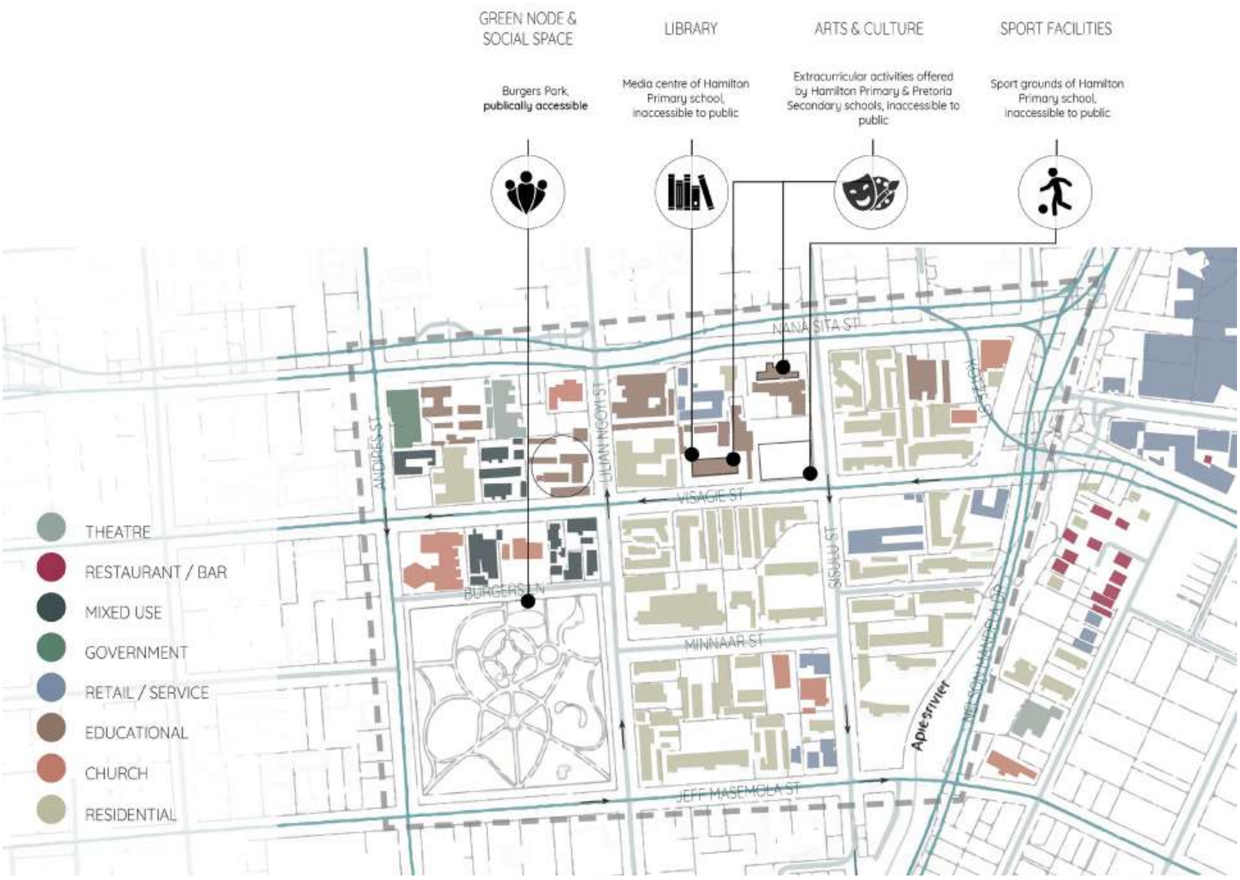


Figure 48: Meso Study _ Land use & amenities

4.8 TRANSPORT & ACTIVITY

Main vehicular roads, such as Nana Sita Street, Jeff Masemola Street and Nelson Mandela Drive, experience high traffic intensity with little pedestrian activity. Traffic in the area is regulated by the one-way streets such as Andries, Lilian Ngoyi, Sisulu and Visagie Streets – all of which experience higher pedestrian activity than the main roads to which they connect. The streets around Tshwane Secondary School are relatively pedestrianised and parking bays create a buffer zone between the fast-moving traffic and the walkways.

Due to the pedestrian activity around the school, the interface between the school and the street becomes important to consider. This includes the boundary condition and the potential views into the school.

The nearby traffic and bustling vehicular activity, however, pose a threat to the school environment as noise pollution is introduced. Once again, consideration should be given to the boundary condition as to minimise the disturbance to learning as much as possible. This also has implications for the classroom design in terms of the orientation on site and the buffer potential of the building skin, subsequently affecting material choice in accordance with the acoustic properties they offer.

Various modes of public transport are available in the area. Bus stops for Gautrain and A Re Yeng are however limited, especially around TSS, thus requiring learners to walk for some distance. For those traveling to school by car, parking is provided on both sides of the school. No drop-off zone is allocated to reduce traffic flow next to the school and provide an intermediate level of vehicular activity between the school entrance and the street.

04

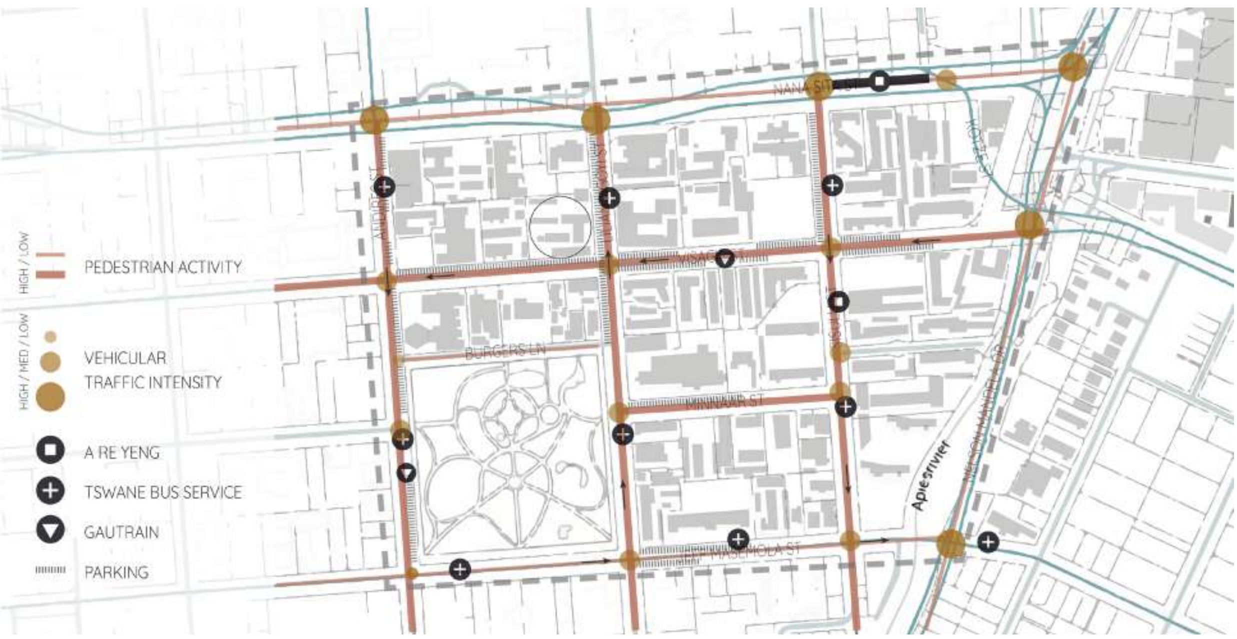


Figure 49: Meso Study _ Transport & activity

Heavy vehicular and foot traffic, as well as unsettling traffic conditions in pursuit, around the school could impact both the physical and psychological state of learners upon their arrival at the school. Some learners could perhaps arrive early, as a result of aiming to miss traffic or comply with the working hours of parents, and therefore would have free time before school. Learners travelling to school by foot or from afar, might be exhausted and uncomfortable when arriving at the school.

These scenarios have design implications as one considers the journey to school, and the need for recreational or relaxation space. Alternatively, ablution facilities could be reconsidered to allow for students to shower or freshen up before academic activities start.

- AMENITIES - ADD / SHARE
- RELAXATION & RECREATION
- NOISE POLLUTION (TRAFFIC)
- ABLUTION FACILITIES
- STREET INTERFACE & BOUNDARY CONDITION

4.9 MESO STUDY
SCENE CONCLUSION

The urban block holds great potential to improve the integration of the school within its community. The possibility for the diversification of land use is noted, specifically to consider learners and a safe urban environment for the youth. Although modes of public transport increase the accessibility of the school, the vehicular activity around the school propose challenges in terms of noise and air pollution. The pedestrian activity and street interface provide an opportunity for a better connection between the school and its surrounds. Ultimately it is important to consider the activities of learners to and from school, beyond the academic engagement during school hours, in order to create a holistic experience that promotes well-being.

4.10 act a _ the physical

4.10.1 SCHOOL DETAILS & HISTORY

In **2009**, TSS was established to address the Department of Basic Education, Gauteng Province's need for more schools. With most of the learners coming from Oost-Eind Primary, Sunnyside Primary and Hamilton Primary Schools, it started with only grade 8 and 9; adding a grade every year up to grade 12.

Additional portable classrooms accommodated this expansion in **2015,** with four classrooms and both male and female ablution facilities being added to the existing.

TSHWANE SECONDARY SCHOOL

ADDRESS : CORNER OF LILIAN NGOYI ST & VISAGIE ST, PRETORIA CENTRAL

SCHOOL TYPE : SECTION 21 GOVERNMENT SCHOOL[12], SMALL SCHOOL (MIN 200 LEARNERS)

HISTORY : The premises were originally used as the Educators Library, which later relocated to the corner of Skinner Street & Van der Walt Street. Thereafter, Pretoria Secondary School made use of the facilities before moving to their new premises on the corner of Skinner & Prinsloo Streets.

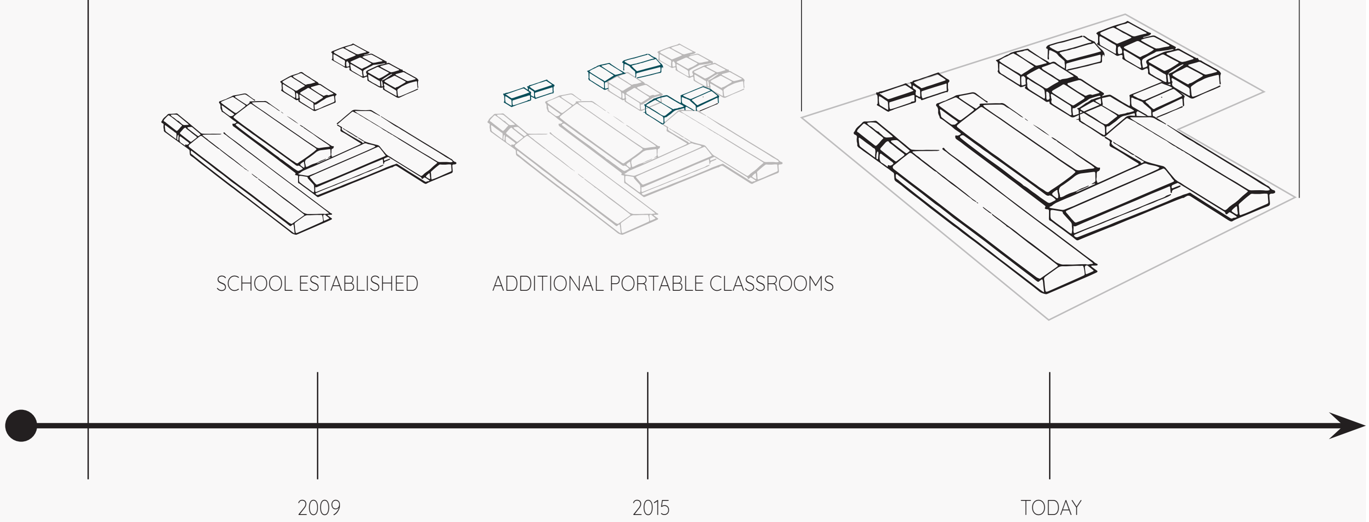


Figure 50: Tshwane Secondary School Details & History

12 : Section 21 Government school: mostly relying on school fees for funding, the Department of Basic Education allocates some finances to the school for stationary, textbooks, water and electricity bills and maintenance, all of which is the school management's own responsibility (Community Organisers Toolbox, n.d.). This category also means that the subjects and sport or extramural activities offered by the school, is decided by the school management themselves (Community Organisers Toolbox, n.d.).

4.10.2 USERS & PROGRAMME

Tshwane Secondary School learners and teachers are accepted as primary users for the project, with specific focus on the learners. Students and teachers of the Pretoria Central Adult Education Centre (AEC), with its administrative building situated on the site adjacent to the Tshwane Secondary School, could be regarded as secondary users, as the teaching and ablution facilities on site are shared between these institutions. It is assumed that by addressing the well-being of TSS learners and staff members, one would inherently address that of these secondary users.

The school programme offers only curricular activities, limited in subject options and the necessary administrative proceedings. Library, computer or media centre facilities are not available, mostly due to the lack of funding and the poor security offered by prefabricated classrooms. Sport- and extra-curricular activities and facilities are neither offered on site, nor provided in affiliation with any other schools or public spaces in the area.

As no after-school activities or supervision is provided, most learners leave the premises to return home. Some do stay and gather in and around classrooms, doing homework or socialising, as after-school access to the premise is available due to the AEC activities.
Consideration is required regarding after school activities for the TSS learners and the spaces and facilities provided for their occupation beyond the formal school hours and academic activities.

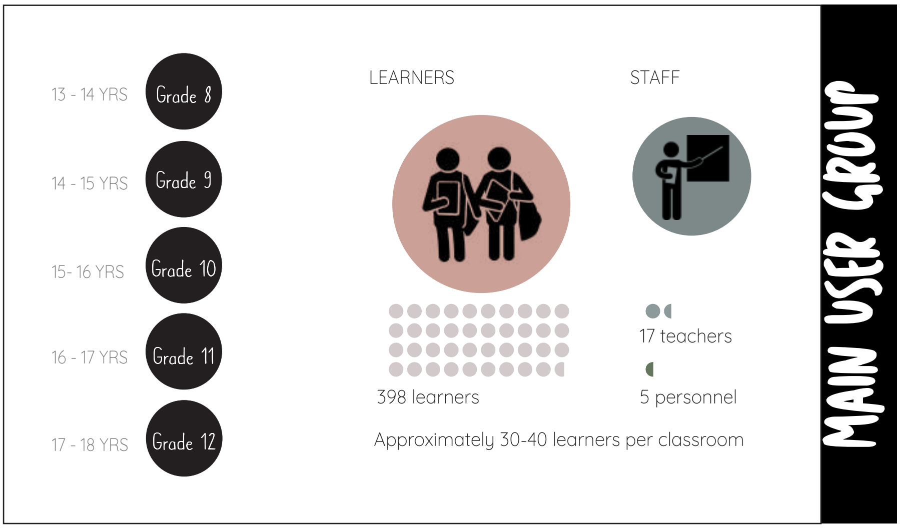


Figure 51: Main User Group

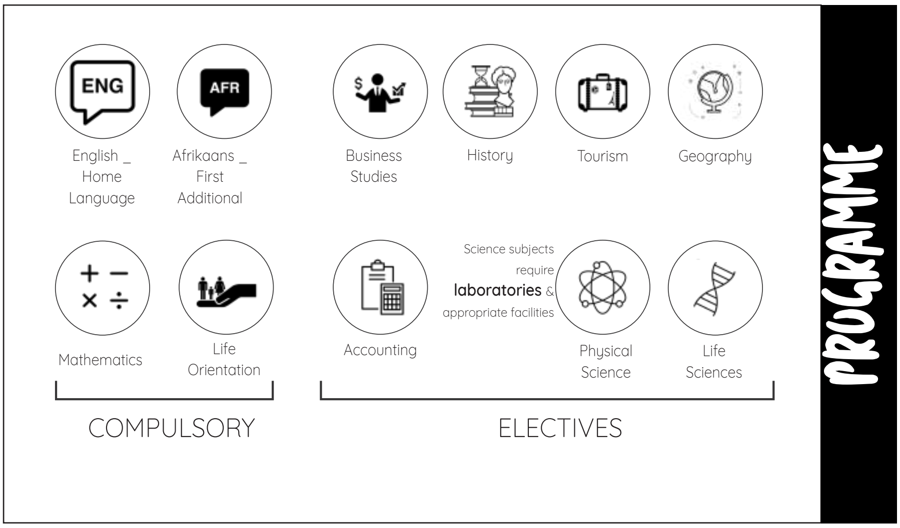


Figure 52: Programme

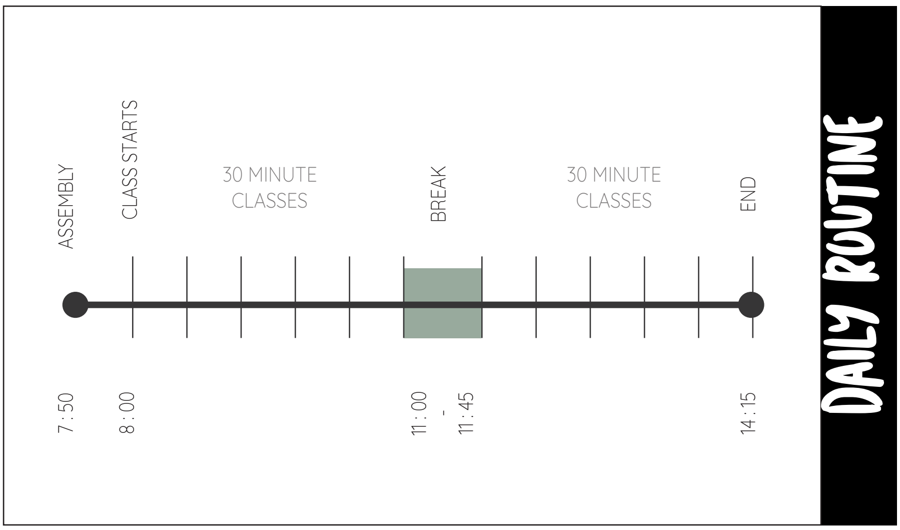


Figure 53: Daily Routine

4.10.3 BUILDING LAYOUT

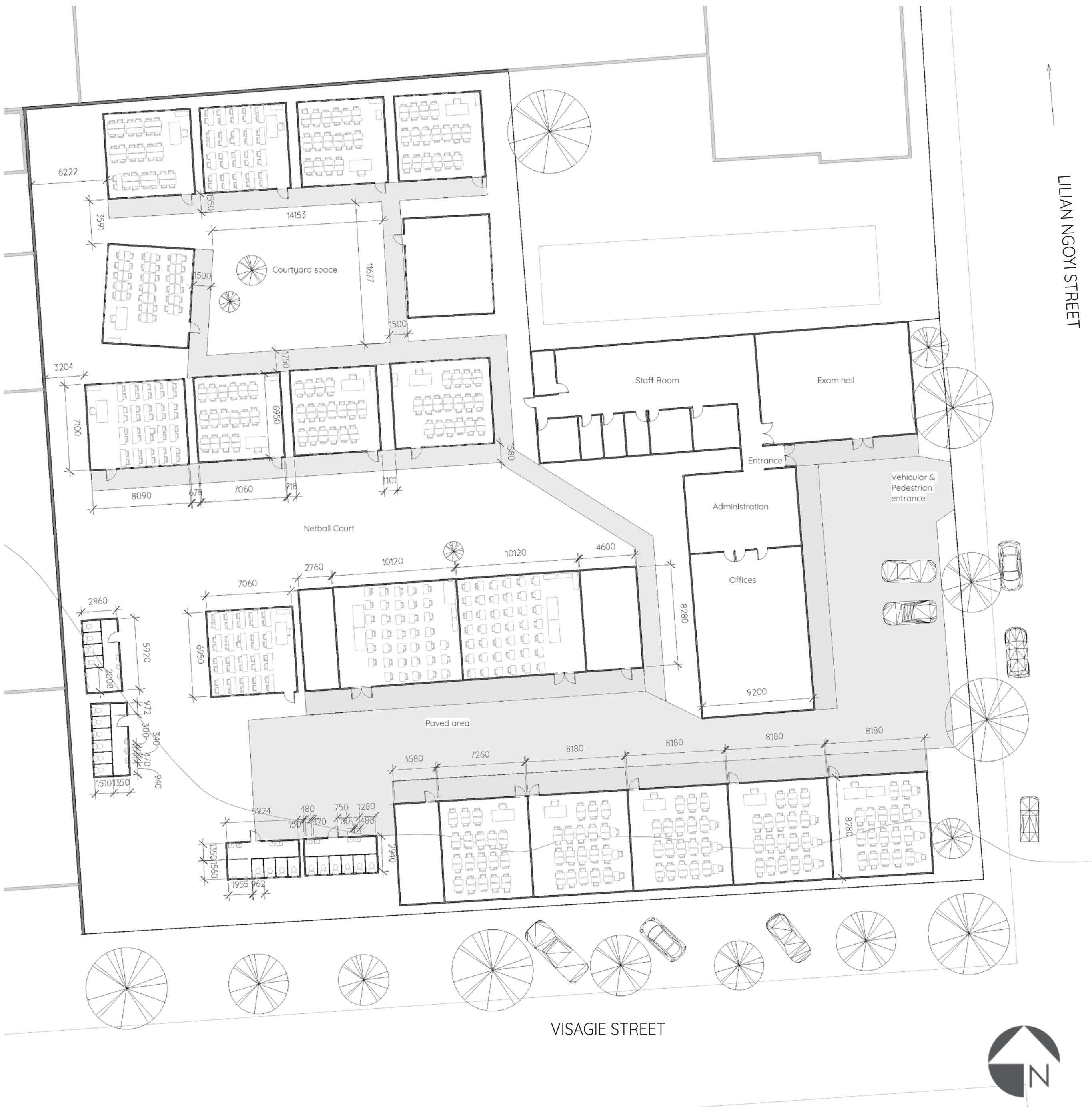


Figure 54: Tshwane Secondary School Floor plan

Buildings on site consist of two systems of prefabrication, namely panellised buildings and portable classrooms, as mentioned in *Chapter 3 _ Understanding Typology.* The latter is further divided into "old" (prior to 2015) and the 'new' which refers to those placed on site during the expansion in 2015. The characteristics of each will be examined and discussed after firstly noting the overall layout of the buildings on-site, as shown in figure 56.

An overall layout strategy or pattern regarding building placement has not been identified. Panellised buildings are organised in an orthogonal manner and face one another, with smaller clusters of portable classrooms either ordered around a central point, facing inwards, or linearly placed next to one another These building layouts further create corridors and courtyards, with the peripheral placement creating a boundary condition which limits public viewpoints into the school from the southern edge.

The administrative, panellised buildings (building P & Q) are regarded as the face of the school, being visible to the public and well-kept. Spatial hierarchy is indicated by the minimal interaction between these buildings and the rest of the buildings on site, highlighting the difference in use and user.

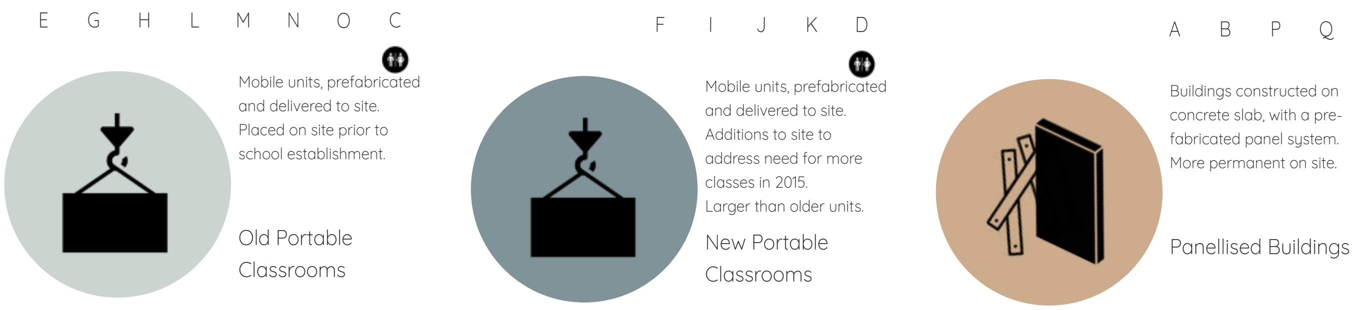


Figure 55: Building systems on site

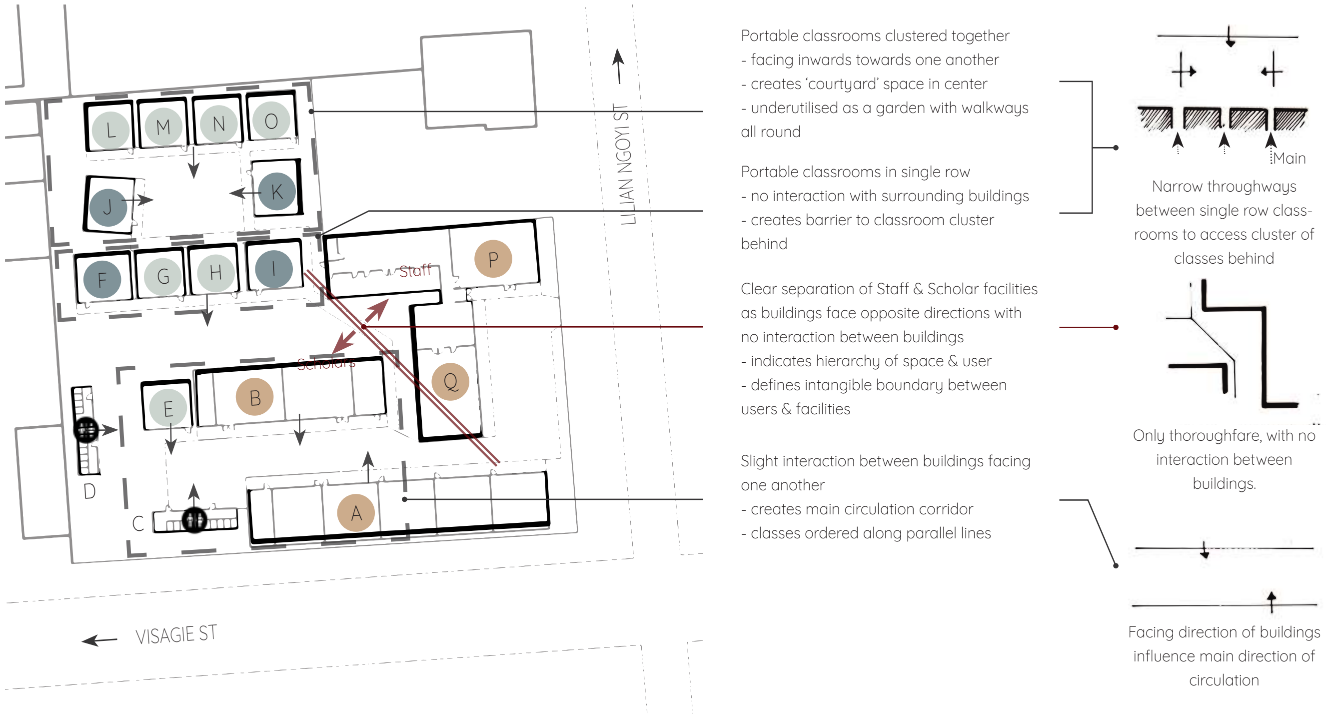


Figure 56: Building layout analysis

4.10.4 BUILDING FEATURES

The structural characteristics and spatial implications of each of the two methods of prefabrication is examined in greater detail below, as observed within the context.

PORTABLE CLASSROOMS






Portable ablutions (C & D) and -classrooms (E-O), could potentially be moved as they have an underlying frame structure which replaces the need for a fixed foundation. They are rather constrained in terms of size, limiting the ability to change according to programmatic needs and varying group sizes that need to be accommodated. This is the result of their method of construction and transportation which sees these units pre-manufactured and pre-assembled, to be delivered as a complete unit on site.

Consequent to the size constraints, portable classrooms are relatively small, with low ceilings and cramped interiors. Flat, acoustic ceiling panels can be found in the older classrooms, as opposed to the slanted ceilings in newer classrooms which gives the classroom a larger perceived volume.

As these classrooms are placed on site in isolation from one another, the only connection is created by the paved walkway laid on site. Each classroom merely has a step at the doorway, thus lacking any threshold and sheltering overhangs.

Large windows are placed on both the front and back facades. Newer classrooms make use of smaller windows on the front facade, once again limiting the visual distraction of passers-by as circulation would typically take place along this side, seeing though it accommodates the entrance doorway. Older classrooms have fewer, but equal windows on either side. Similar to the panellised buildings, blackboards are incorporated on the side of the classroom closest to the door, with the addition of a pin board on the opposite side.

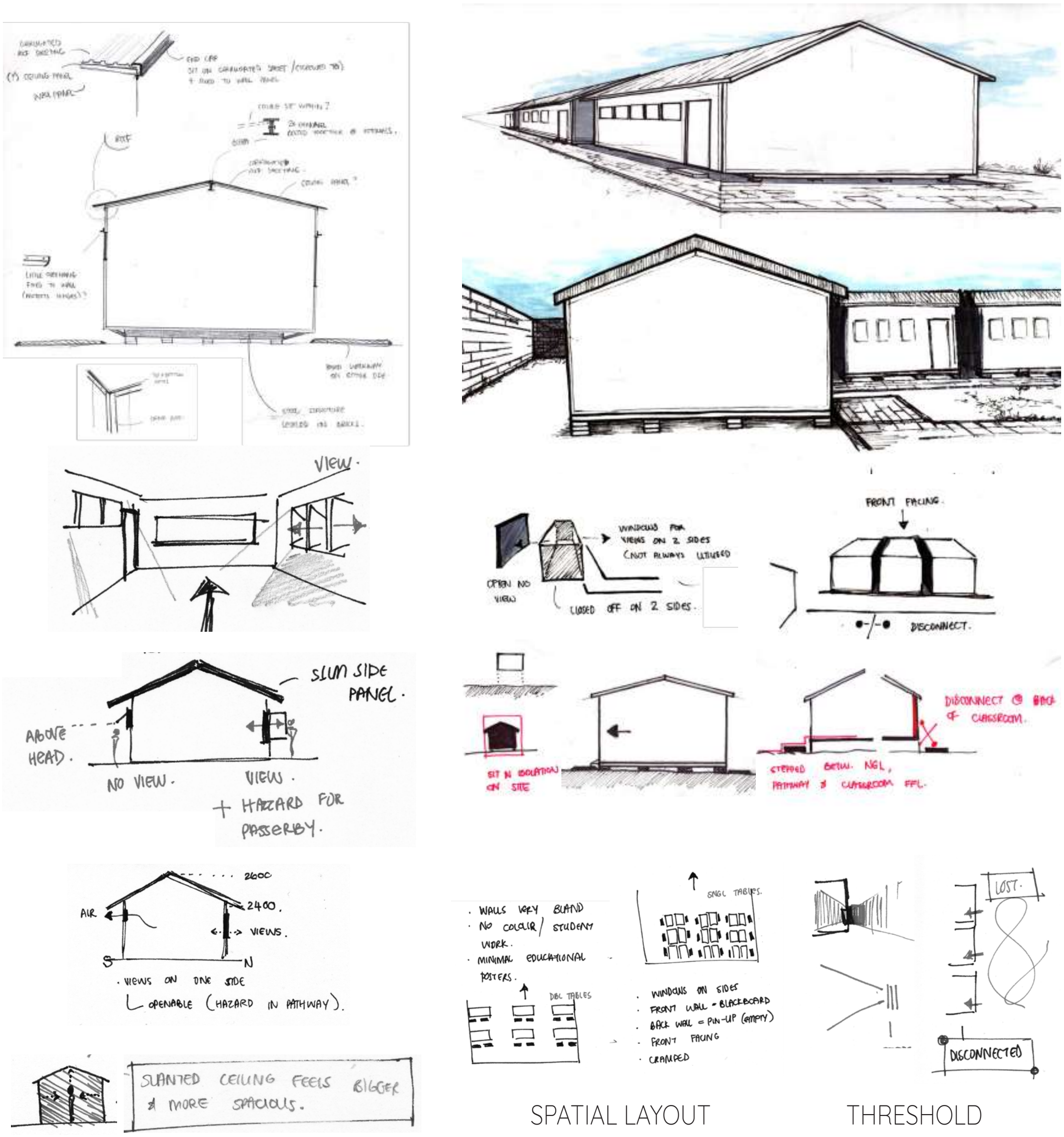


Figure 57: Portable Classrooms Analysis

PANELLISED BUILDINGS






The panellised buildings (A, B, P & Q,) are more permanently fixed on site with concrete slab foundations extending to create raised walkways along the front of these buildings, where the entrance doorway can also be found. A large roof overhang overshadows this extension, creating a threshold that connects several classrooms along a linear organisation. Long, continuous classroom structures are created, creating somewhat of an impermeable barrier to what lies beyond.

Classes are quite spacious with high ceilings and light interior surface finishes. Minimal colour is present, with a blackboard conventionally installed on the side of the classroom closest to the doorway. Window placement generally occurs on the front and back facade of the building, but varies from one building to the next. Building A rather installed smaller windows on the southern facade which faces the street edge, possibly in an attempt to limit the visual and noise distraction.

The lower pane of the large windows on most other facades are typically painted, assuming also to avoid the visual distraction of learners and staff passing-by, or to avoid the glare on desks along the windows.

Some degree of flexibility is awarded to these buildings as the structure-and-panel-infill allows for expansion.

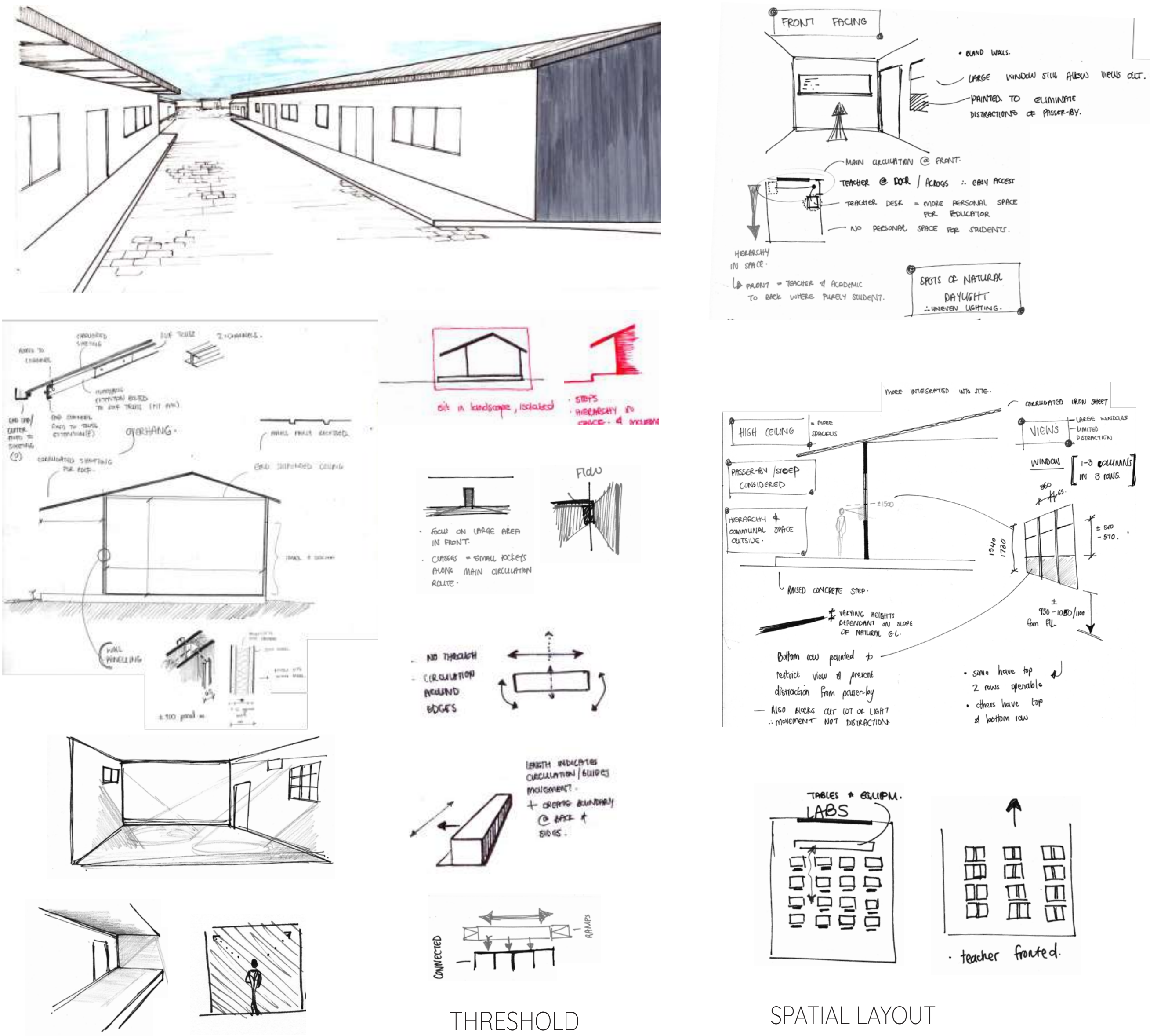


Figure 58: Panelised Building Analysis

As single-storey buildings, the prefabricated infrastructure provides the site with a domestic scale. Both the panellised and portable classrooms accommodate a large number of learners with 36 - 40 desks per class. This results in dense furniture layout that limits the flexibility in layout, and potentially the teaching method to the traditional teacher fronted layout with rows of desks.

4.10.5 ACCESS & EDGE CONDITIONS

Boundaries toward the street edge allow for visual access as fencing is used, with a boundary wall between the school and adjacent sites on the northern and western sides. Although trees along the eastern and southern boundary provide shading for passers-by on the pedestrian sidewalk, it can however not be utilised by the learners on the school grounds.

The main entrance to the school is situated on the eastern boundary, with an additional point of pedestrian access from the parking lot of the Pretoria Central AEC. The latter is only unlocked at the start and end of the school day to allow for learners to be dropped off and picked up or enter and exit through this parking area. The main entrance is guarded to receive visitors and control passage through. A few parking bays can also be used on site, once through the main entrance. This area at the front of the school is therefore accepted to be a more vehicular dominant space. Parallel street parking line the eastern perimeter, creating some buffer between the school and the street.

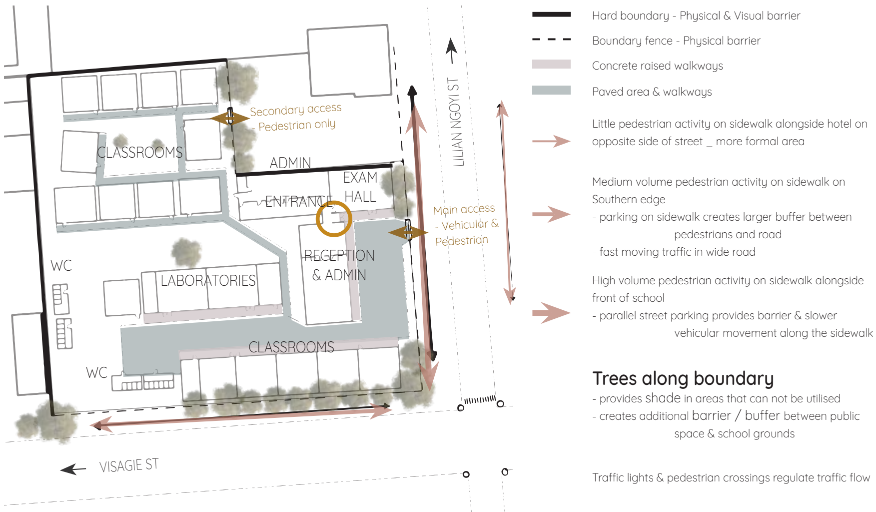


Figure 59: Access and edge conditions analysis

Figure 60: Street Approach

4.10.6 CIRCULATION

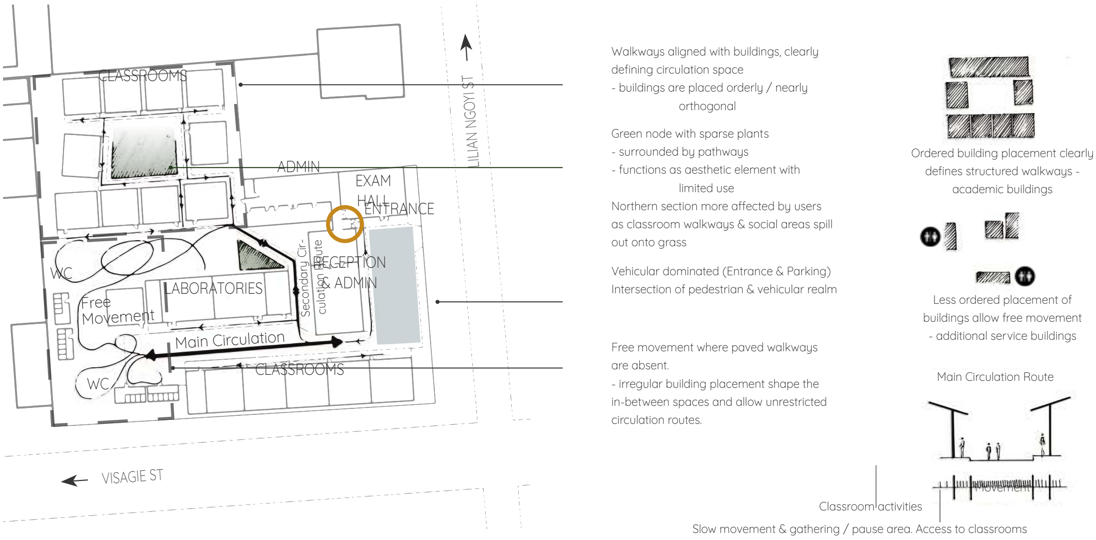


Figure 61: Circulation analysis

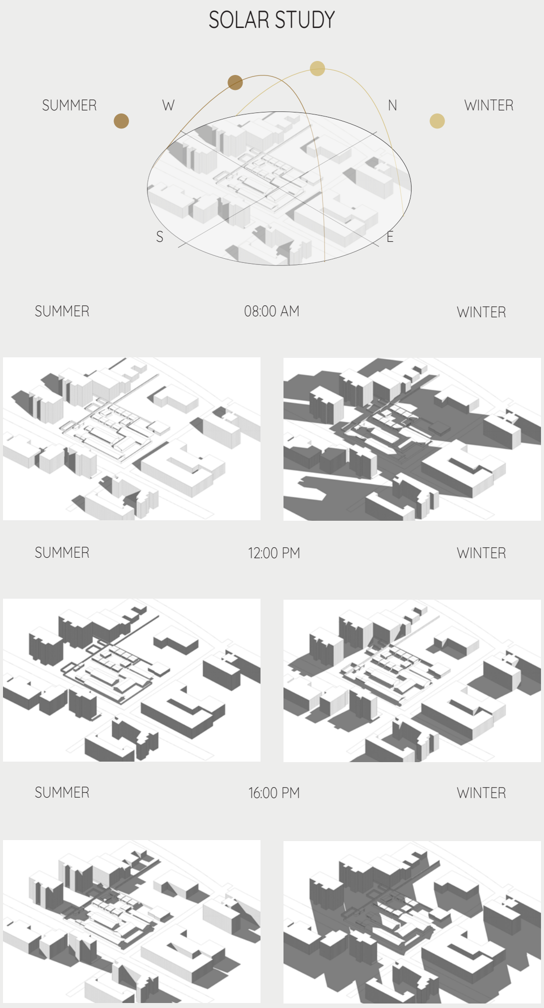
The learner and staff movement on the school grounds is mostly directed by the paved walkways between buildings, and concrete corridors along the panellised buildings. These circulation routes are determined by the layout of the buildings on site. Very little alternative movement options are available, with free movement only being observed around the ablution (WC) facilities in the south-western corner of the site.

Level differences occur due to the concrete walkways alongside panellised buildings which create a step from the natural ground level to the floor level of the walkway and panellised classrooms. The elevated entrances of portable classrooms afford an additional level difference to the site, and require a stair. Although minimal, the sloping nature of the natural ground level prohibits the uniformity of these level differences, resulting in different step heights. The level differences provide hierarchy in movement space, and should be considered within the design process to ensure a level placement of buildings on site.

4.10.7 CLIMATIC CONDITIONS

Minimal shelter is offered on site, apart from the classrooms themselves and roof overhangs of panellised buildings. No further roofing structures provide shelter over walkways and outdoor areas from environmental factors.

Sun



The site receives sunlight throughout most of the day irrespective of the season. In the morning and mid-day, very little shading is offered by adjacent buildings and buildings on site, leaving the learners quite exposed to direct sunlight.

The lack of roof overhangs and sheltering elements around portable classrooms see small groups of learners utilising every piece of shade they can find during sunny summer days. With minimal trees, the most shade is cast by the portable classrooms themselves, to the west and south. Buildings to the north of the site are too far and low-rise to provide any shading on the site. Tall, adjacent buildings to the west cast afternoon shade, unfortunately not being utilised as it falls outside of school hours. During winter months, more shade is seen during the mornings and afternoons. Learners potentially seek warmer areas in the sun at these times, even though no particular space or seating options are allocated for this purpose.

Figure 62: Solar Study

Rain

As the site is located in Pretoria, the graph below (figure 63) shows the annual rainfall received, with summer months receiving the majority of rainfall. One could assume that scholars stay indoors during rainy days, as far as possible, and potentially run from class to class between periods, as well as to and from the ablution (WC) facilities.

As most of the landscape is either exposed soil or unevenly paved, it could also be assumed that rain-water gathers in puddles throughout the site as no drainage provision is made. This would cause some areas to be quite muddy, possibly creating slip hazards for the learners and unappealing areas.

AVERAGE ANNUAL RAINFALL IN PRETORIA

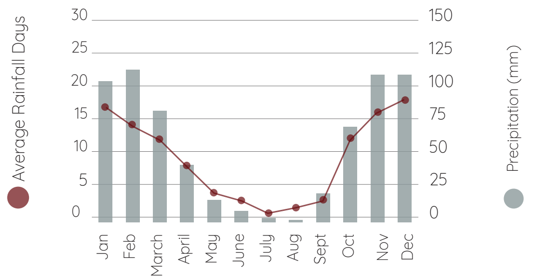


Figure 63: Pretoria Annual Rainfall Graph

Wind

Pretoria receives the most wind from the north-east, as shown by the wind rose below (figure 64). On site, one can experience a gust of wind from time to time, pushing through between the panellised build-ings as the layout of these create a wind tunnel. Spaces between the portable classrooms are fairly hot during sunny summer days as these buildings shield the inner courtyard spaces from wind. Fencing acts as a permeable eastern and southern boundary, therefore allowing the movement of wind through the site on ground level. As opposed to this, the northern and western boundary is walled, with taller adjacent buildings providing shielding from windy conditions.

WIND ROSE

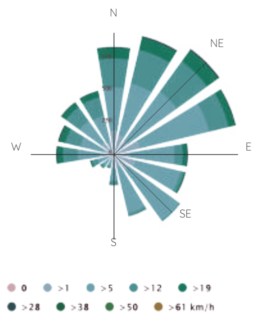


Figure 64: Pretoria Wind Rose

The hard surfaces on site, such as the exposed soil and paved areas, absorb the radiant heat and would subsequently increase the temperature experi-enced on site. A further lack of trees and shading limits the access of learners to comfortable outdoor areas where direct sunlight exposure could be avoided. Classroom interiors ultimately function not only as academic space, but also as shelter from the rain, wind, heat and cold throughout the year.

4.10.8 PHYSICAL COMFORT

During multiple site visits, observations were made regarding the user comfort and typical daily experience of scholars. Measurements in terms of light and noise levels, as well as temperature and relative humidity were all taken in and around classes. These measurements are discussed below. A rating is also given to the level of maintenance and cleanliness experienced on site

Lighting

A variety of activities take place within classrooms, requiring the infrastructure to accommodate concentration, calculation and memory as appropriate natural day lighting and artificial lighting affects the well-being and performance of scholars (Singh and Arora, 2014). The recommendation is made that work surfaces receive a light level of 300 lux at any point (Singh and Arora, 2014).
As shown in the data below the minimum illuminance is mostly met, with some areas being slightly inadequate and others far beyond, possible causing discomfort due to spaces being too bright.

Light levels fluctuate quite significantly depending on where a learner would be seated within a classroom, and depending on the type of classroom in terms of its composition and orientation on site. Generally, seats along the windows are observed to be more exposed to natural daylight than those situated in the middle of the classroom. These seats hardly require additional lighting, but artificial lighting is necessary to accommodate the learners situated in the darker centre of the classroom.

As seen through the building analysis, panellised classrooms vary in their orientation on site, direction of roof overhang and window placement.
Overall, the panellised buildings with overhangs facing north and east, limit direct sunlight and control glare in doing so. Those with roof overhangs facing south, still receive direct sunlight through the windows on the northern facade. Similarly, and in most cases, the portable classrooms have large windows on the northern facade, with large or small windows on the southern facade, and no roof overhangs provided on either side Direct sunlight illuminates the interior and reflects off of learner desks. It could perhaps be concluded that light levels on the northern side of the classroom are typically excessive, with darker centres, resulting in the uneven distribution of light throughout the classroom and slight glare along window seating.

Figure 65: Existing Light level measurements

Acoustics

High noise level measurements taken on site indicate the severe acoustic impact of passing traffic. Noise furthermore travels between classrooms and echoes within.

Studies have shown that traffic noise and noisy activities, such as social interaction, could cause stress and annoyance while affecting productivity and performance (Seetha et al, 2008:659). In addition to this, the World Health Organisation (WHO) stipulates that noise interferes with spoken communication and the transmission of information during lessons (Seetha et al, 2008:659). It is consequently necessary to introduce sounds barriers to ensure that background noise is reduced to a maximum of 35dB (Seetha et al, 2008:659 & 664). As displayed by the measurements below, the noise levels experienced on site are not adequate for the learning environment and have an impact on the well-being of learners.

NOISE LEVELS	NOISE LEVELS		NOISE LEVELS	
10:18	10:00	11:30	9:45	11:45
AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
66 dB	62 dB	73 dB	64 dB	70 dB
MAX	MAX	MAX	MAX	MAX
81 dB	76 dB	81 dB	70 dB	83 dB
Small group discussion	no class	Small group discussion	No class	Small group discussion

Figure 66: Existing Noise level measurements

Temperature & Humidity

Thermal comfort can be regarded as a subjective measure which is difficult to convert into a physical parameter, more specifically defined as "that condition of mind which expresses satisfaction with the thermal environment" (Puteh, 2012). It does however play a vital role in academic activities as it promotes concept comprehension, problem solving abilities, social contact and positive behaviour in class (Puteh, 2012). Theory suggests an optimal classroom temperature of 22 °C (McGuire, 2016; Park, 2017), with a humidity range between 40% and 60% relative to the temperature (Ohsrep.org.au, 2018).

Although temperatures were mostly measured within the generally accepted range, the indoor environment of classrooms is not considered to be thermally comfortable and optimal for learning purposes, especially considering the levels of relative humidity present.
Measurements were mostly taken without the presence of learners. This means that temperatures within the classrooms would be even higher when academic activities take place, afforded to the heat radiated by the bodies of learners and teachers. Regardless of the potential discomfort, these spaces are occupied beyond academic activities, such as during break time and after school, possibly due to their provision of shade and shelter from exterior conditions and no alternative options being available.

TEMPERATURE	TEMPERATURE		TEMPERATURE	
10:18	10:00	11:30	9:45	11:45
30.7 °C	28.8 °C	27.3 °C	17.8 °C	29.8 °C
46.7 % HUMIDITY	52.5 % HUMIDITY	54.8 % HUMIDITY	58 % HUMIDITY	45.4 % HUMIDITY
IDEAL : 21-24 °C 30 - 50% HUMIDITY	IDEAL : 21-24 °C 30 - 50% HUMIDITY		IDEAL : 21-24 °C 30 - 50% HUMIDITY	

Figure 67: Existing Temperature and humidity measurements

Maintenance & Cleanliness

Based on observations during site visits, a fairly low rating was given in terms of maintenance and cleanliness of site (see figure 68 below). This is mostly as a result of poor maintenance and the absence of bins throughout the site, which could be further related to a lack of funding. Several window panes and wall panels were also broken, possibly posing a safety hazard to learners. A lack of drainage causes the area around the water-point to be rather muddy and unappealing, further creating a slip hazard.

Cleanliness 5 / 10

- Litter - papers / wrappers lying on floor and in gardens, furthermore stuffed into broken wall panels
- Muddy area around water point

Maintenance 3 / 10

- Broken windows
- Broken wall panels with insulation removed
- Irregular paving
- Broken ceiling panels
- More garden upkeep needed

Attention needed with regards to maintenance and cleanliness. Further considerations include **material robustness** and the **ease of replacement / repair** within the built infrastructure

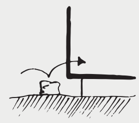
Figure 68: Existing Maintenance & Cleanliness

Universal Design

Considering the uneven paving of walkways and steps into portable classrooms and ablution facilities, wheelchair accessibility on site is limited. Ramps are provided at either end of the concrete platform in front of panellised buildings, affording some accessibility to these classrooms.

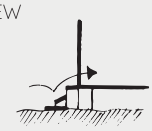
WC Accessibility

OLD

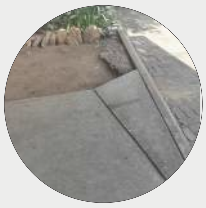


Concrete block used as step into old ladies WC unit

NEW



Broken steps leading into new ladies WC unit



Slight ramps provided to manage raised walkways. Often leading into more challenging situations

Irregular and poorly maintained walkway paving creates obstacles and uneven surface

Raised walkways as extension of prefabricated unit foundation. Differs in height depending on the slope of the natural ground level

Figure 69: Existing Universal design

4.10.9 CONCLUDING SWOT ANALYSIS

PANELLISED BUILDINGS

S

Overhang provides protection & shade - thermal impact
Large windows on one sides allow for **natural light and views,** with lower windows painted to **limit distraction of circulation / possible glare**
High ceiling increases volume = more comfortable space
Bigger size (Floor surface area) - opportunity for layout change & flexibility of space
'stoep'= out-spill & communal space - **threshold & spatial hierarchy**
Classes binded together into single element

W

Spots of natural light due to irregular window placement
Minimal opportunity for **personalisation**
Additional **security** needed - due to low robustness
Monotonous space; lack of colour & tactility
No interaction with exterior to the back (**isolated** on site) - barrier
Not easily repairable (panel system)
Concrete slab create level differences - insufficient ramps **(Universal Design)**

O

Structure & Infill : allow opening up & flexibility / expansion
Roof construction differs to that of the wall, easily changeable
Cut roof overhang back if needed to allow natural light
Integrate 'stoep' better with landscape
Separate / cut through the be less of a barrier
Blank walls = large surface where could add colour / tactility

T

Lack of **funds** to maintain - safety hazard due to broken fixtures
Window height & opening into circulation space = possible hazard & safety issue
Intervention might compromise structural integrity
Struggle to accommodate **future change** in learning / teaching methods
Need for storage reduces space further - feel cramped
Future expansion similarly placed in isolation - worsening the **'lost' space effect**

OLD PORTABLE CLASSROOMS

S

Large windows on both sides allow for **natural light and views**
Temporality on site **(Impermanence)**
Lower maintenance as no need for wall paint
Pin board : opportunity for display & personalisation
Light wall & ceiling colour increases perceptive volume

W

Not easily adaptable (Delivered to site as unit)
Low, flat ceilings make space seem smaller and cramped
Large windows on both sides could cause distractions of passers-by & cause **glare** due to direct sunlight
No overhangs for protection from elements
Poor acoustics - poorly maintained acoustic grid ceiling
Poor thermal insulation
Small volume - **Limited** layout options
Monotonous space; lack of colour & tactility
No interaction with exterior (**isolated** on site) - threshold

O

Roof construction differs to that of the wall, easily changeable
Move on site / rearrange
Better integrate with landscape (levelling out the various stepped areas) - Universal Design
Limit distraction of passers-by
Improve **threshold** & access
Improve **connection** to surroundings

T

Lack of **funds** to maintain - safety hazard due to broken fixtures
Intervention might compromise structural integrity
Struggle to accommodate **future change** in learning / teaching methods
Use by Adult Education limits personalisation & display - security & vandalism
Need for storage reduces space further - feel cramped
Future expansion similarly placed in isolation - worsening the **'lost' space effect**

NEW PORTABLE CLASSROOMS

S

Large windows on one sides allow for **natural light and views,** with higher windows on opposite side **limiting distraction of circulation**
Pin board : opportunity for display & personalisation
Light wall & ceiling colour increases perceptive volume
Lower maintenance as no need for wall paint, panels seem more durable
Slanted ceiling - increases perception of space
Concrete step into classroom - durable
Similar wall & ceiling panel offers continuity
Temporality on site **(Impermanence)**

W

Not easily adaptable (Delivered to site as unit)
Low ceilings make space seem smaller and cramped
Large windows cause possible **glare** due to direct sunlight
No overhangs for protection from elements
Poor acoustics & thermal insulation
Small volume - **Limited** layout options & dense furniture
Monotonous / clinical feel to space; lack of colour & tactility
No interaction with exterior (**isolated** on site) - threshold

O

Move on site / **rearrange** - placed on steel structures
Better integrate with landscape (levelling out the various stepped areas) - **Universal Design**
Improve **threshold** & access
Improve **connection** to surroundings
Improve furniture design to optimise space
Improve colour / tactility
Possibility to latch on, rather than intervene

T

Lack of **funds** to maintain - safety hazard due to broken fixtures
Window height & opening into circulation space = possible hazard & safety issue
Intervention might compromise structural integrity
Struggle to accommodate **future change** in learning / teaching methods
Need for storage reduces space further - feel cramped
Future expansion similarly placed in isolation - worsening the **'lost' space effect**

4.11 act b _ the social & psychological

4.11.1 SOCIAL INTERACTION

Social interaction is evident on site, regardless of the lack of infrastructure that specifically facilitates these interactions. Minimal interaction, other than regarding academic activities, takes place between staff and learners. Interaction between staff members also take place spontaneously during the passing by. Most importantly though, one notes the interaction between learners. These occur as they gather in friend groups, as well as spontaneously while making use of the water-point or passing each other by on walkways and between classes. Social interaction is not only a fundamental human need in itself, but also seems to revolve around other basic needs such as shade and shelter, and a communal gathering point - in this case being a tree or the water-point.

Third party interaction can be observed during the break time, where snacks and food are bought from a food vendor through the boundary fence between the school and the Adult Education Centre parking lot. It is also here where it becomes clear that eating and nourishment is a social event, even though no such facilities are provided. During break time, groups of various sizes gather in classrooms and any shaded areas available in the summer months, or sunny areas during winters. Seating space in the form of outdoor concrete benches are limited to only three. One is hardly used due to its fairly isolated placement between the panellised buildings, seeing though most of the social interaction takes place around the portable classrooms.

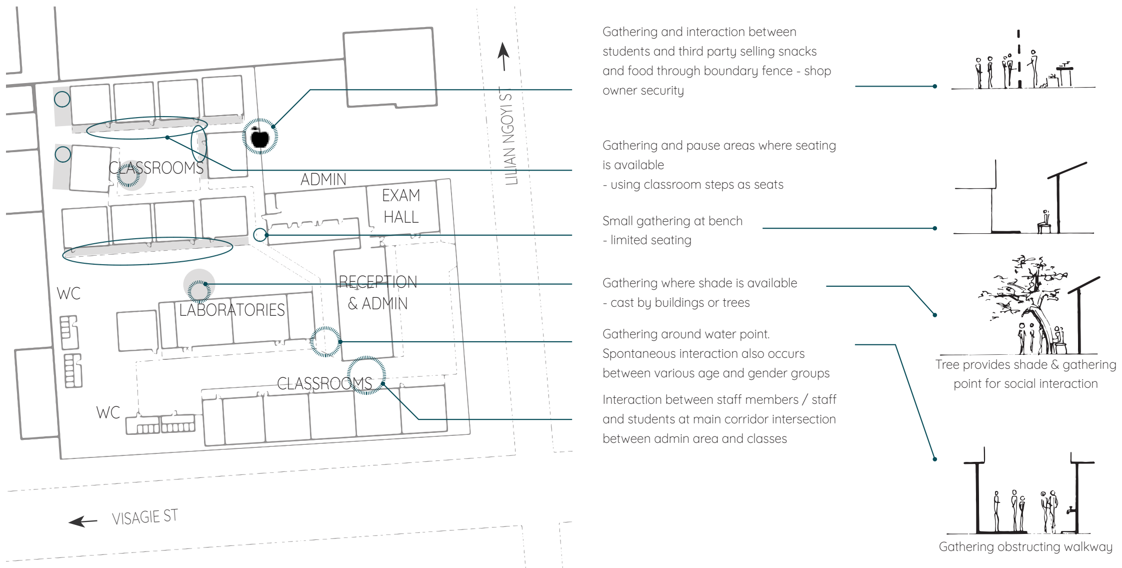


Figure 70: Existing Social Interaction

4.11.2 EMPATHY MAPPING

The empathy map (figure 71) seeks to understand the user experience by observing and interpreting what the users do and say, and what they could potentially feel or think. As no participatory research could be employed, the observations were made unobtrusively.

To visually represent the observations and draw comparison between the experiences of different user groups, **narratives** were created (see figure 72 & 73). These investigate the experience of the learners as main focus group, in relation to the experience of the observer, furthermore adding how the teachers could potentially perceive the space.

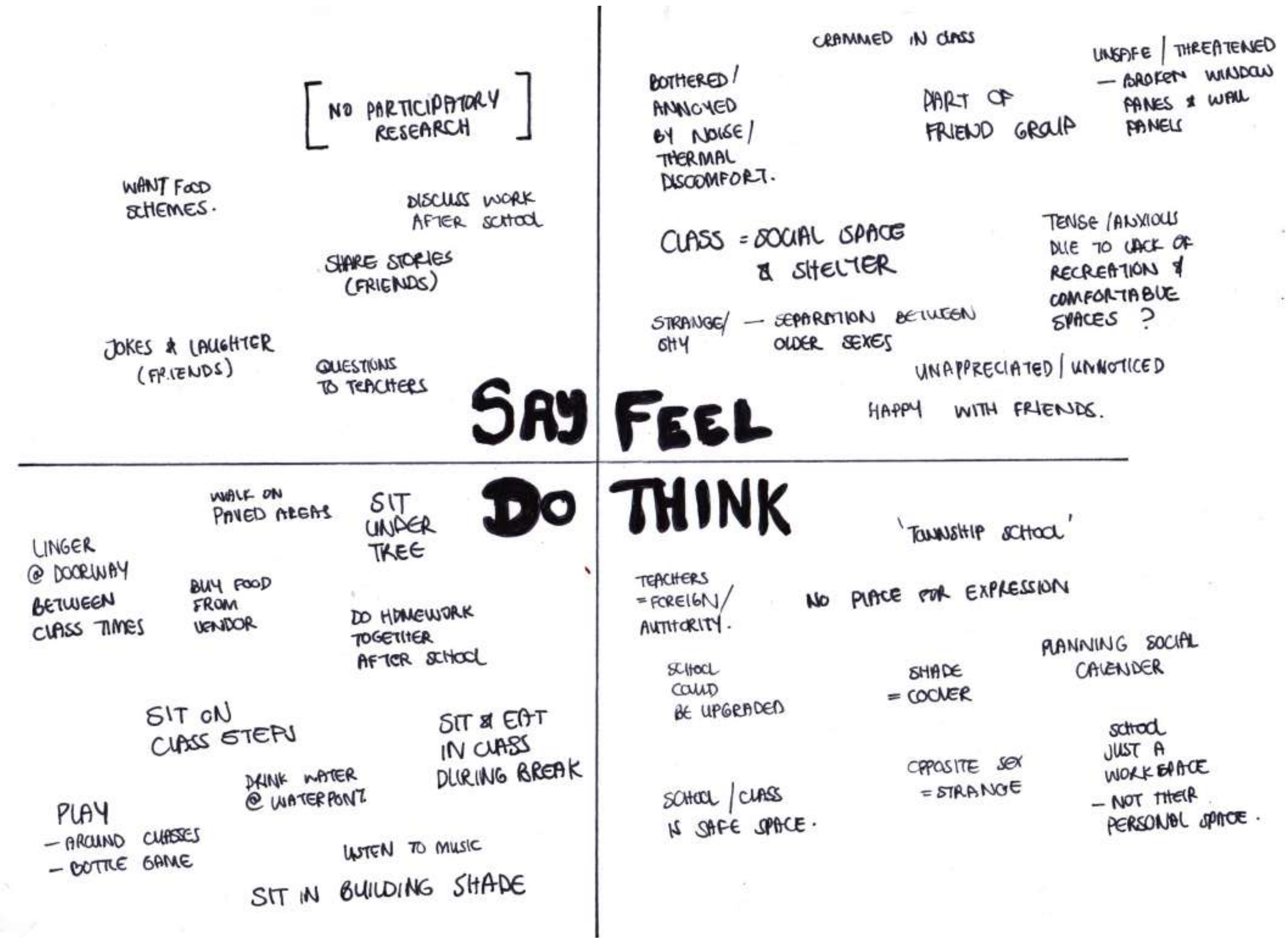


Figure 71: Empathy mapping of the existing

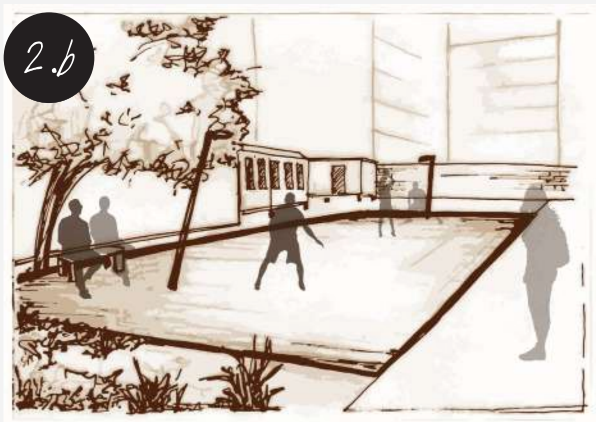
4.11.3 USER NARRATIVES

- Stepping stones to water point - human need
- Gathering & Social in shade
- Platform / safe space provided by walkway

- Tree provides shade and social gathering point
- Shade in front of classes act as social space and informal area for play and gathering
- Netball court seen as unappealing

INSIDER VOICE / LEARNER

- Muddy at water point and smelly bins
- Exposed soil & uneven surfaces - maintenance
- Slip hazard & obstacles with stones and mud
- Walkway as circulation space



- Classroom as academic space
- Walkway as circulation space
- Netball court provides play area & physical activity, along with social space & interaction

OUTSIDER VOICE / DESIGNER & VISITOR

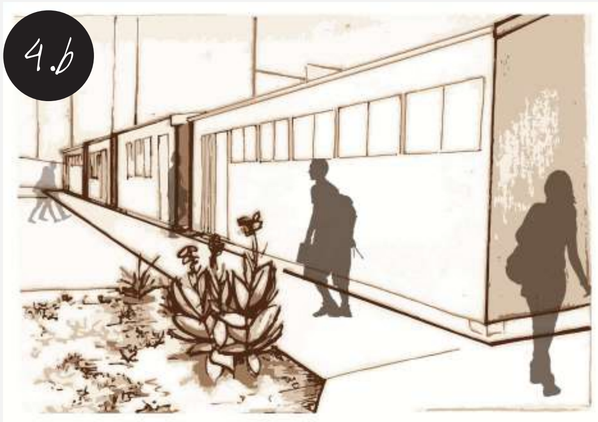
Figure 72: Existing User Narratives 01

- Food stall is social gathering point and fulfils need for nourishment (Food and snacks)
- Interaction with their party user

- Pathways and throughways between classes provides circulation and play /social area
- Class doorway is social gathering point & viewing platform
- Steps used as seating and shade

INSIDER VOICE / LEARNER

- Fence seen as obstacle & security issue
- Process of buying food is disorganised and seemingly chaos
- Seen as lost space along boundary



- Throughways between classes are narrow
- Pathways provide circulation space
- Classroom for academic purposes with doorway as access

OUTSIDER VOICE / DESIGNER & VISITOR

04

- *'Stoep'* provides circulation space and step before entering classroom
- Exposed, public space in front

- Large, open areas provide gathering space for small or larger groups
- Roof overhang provides shade in front of classes
- Step could be used as seating

- Newer ablutions accommodate need
- Circulation space around
- Exposed and barren areas (grassy & soil)

- Ablutions not clearly identified & poorly maintained
- Grassy area seen as play area
- Large, open areas provide gathering space for small or larger groups

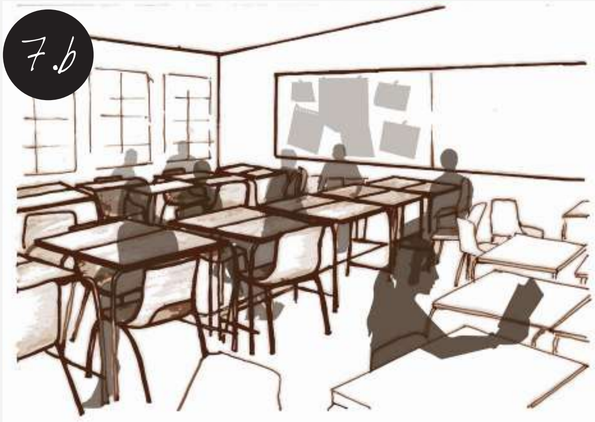
INSIDER VOICE / LEARNER

OUTSIDER VOICE / DESIGNER & VISITOR

Figure 73: Existing User Narratives 02

- Classroom : academic & social space / eating area
- Classroom provides shade & shelter
- Formal or informal

INSIDER VOICE / LEARNER



- Classroom : academic space
- Pin-boards allow for display of work
- Formal instruction & organised layout

OUTSIDER VOICE / DESIGNER & VISITOR

04

4.11.4 CONCLUDING PSYCHOLOGY REPORT

A graduate psychology student, Warren Wallendorf, was consulted to not only provide an additional set of observational notes on site but also compile a psychology report which relates the conditions on-site to the 'Wheel of Wellness' (Myers et al., 2000) theoretical text.

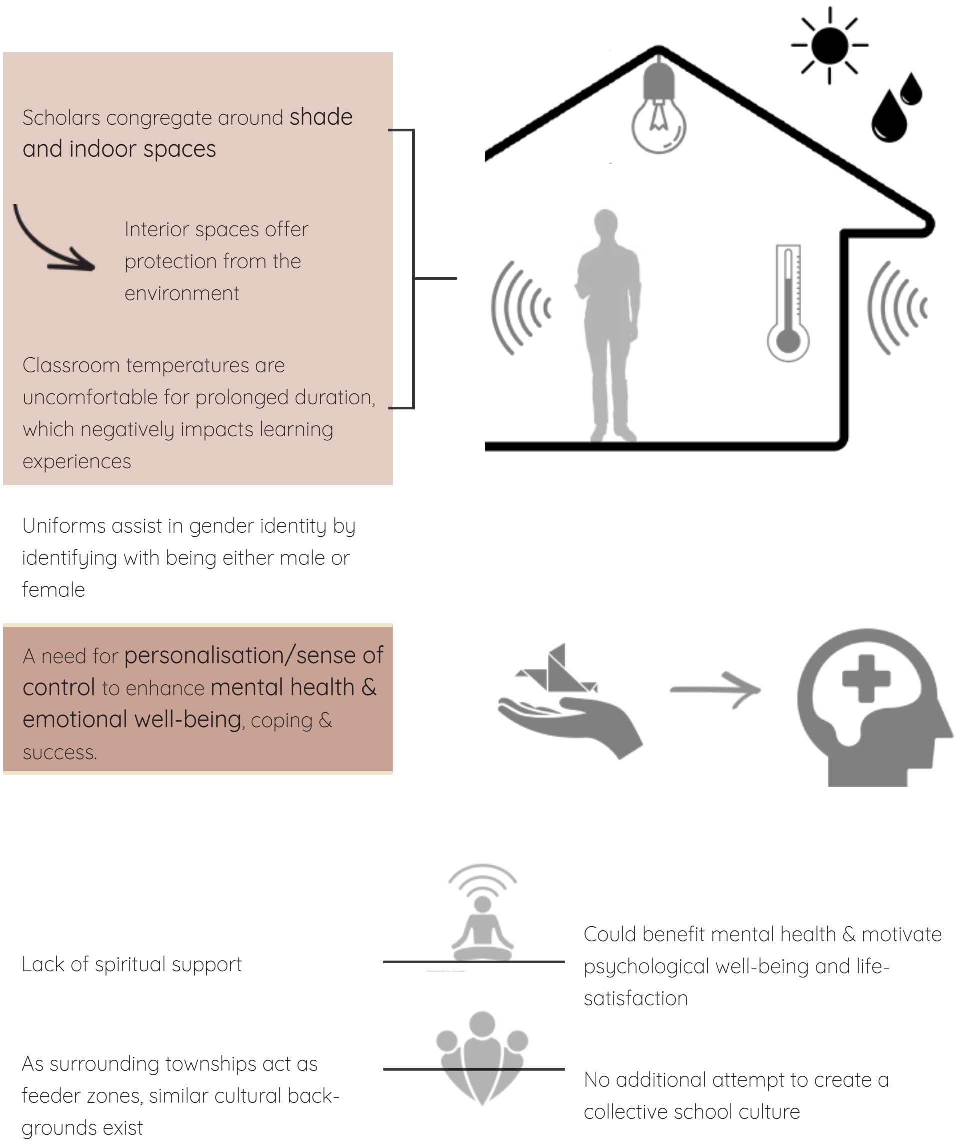


Figure 74: Concluding Psychology Report

Exterior environment is damaged and unappealing, barren and poorly maintained. Thus less conducive to facilitate a social environment

Scholars gravitates towards social interaction as it is critical human need

Scholars group together, rarely individuals

Believably due to physical and social differences and development during this phase

Social interaction takes place regardless of physical space provided

Improved facilitation of social interaction is necessary for a sense of humour

Classrooms act as social space & are more appealing than exterior spaces

Younger groups are mixed genders

Elder groups are more separated between the sexes

04

Lack of safety measure impacts self-care and could lead to injuries

Lack of benches / shade / sport & recreational facilities

Minimal leisure due to purely academic / curricular activities offered

Need for leisure & team sport to reduce stress and anxiety, and further improve self-esteem and life satisfaction

Lack positive & pleasurable experiences.
Impacts emotions - increases anxiety and depression

4.12 SITE OPPORTUNITIES & CONSTRAINTS

While investigating the existing conditions on-site through multiple lenses, it became clear that numerous factors contribute to the overall experience of learning environments and potentially affect the well-being of learners. The insufficient infrastructure with ill-conceived spatial qualities and possibly incomplete programme affect not only the learning process and academic success of learners, but furthermore, have a negative impact on their psychological and social well-being.

The contextual study supports the theoretical argument made in *Chapter 2 _ Unfolding Theory*, for more acoustically, thermally and visually comfortable interior spaces, as well as recreational activities and providing learners with a sense of control and belonging. Above all, the aspect of social interaction finds particular pertinence. Most importantly, the contextual study highlights the shortcomings of existing portable classrooms in terms of size, spatial quality, flexibility, accessibility and their isolated nature when placed on site. Limitations in size and flexibility are consequences of the structure, which is largely directed by the transportability of these classrooms, as discussed within *Chapter 3_Understanding Typology*. The case for more flexible, deployable units could assist in resolving these issues.

The lack of threshold and connection between individual classrooms creates lost in-between spaces on site. Consideration should, therefore, be given to not only the interior learning environment but also the exterior space and the transition between these two. This proposes a contextual informant relating to threshold and spatial hierarchy. When designing future classrooms, the individual unit, as well as its relation to the rest of the site is important.

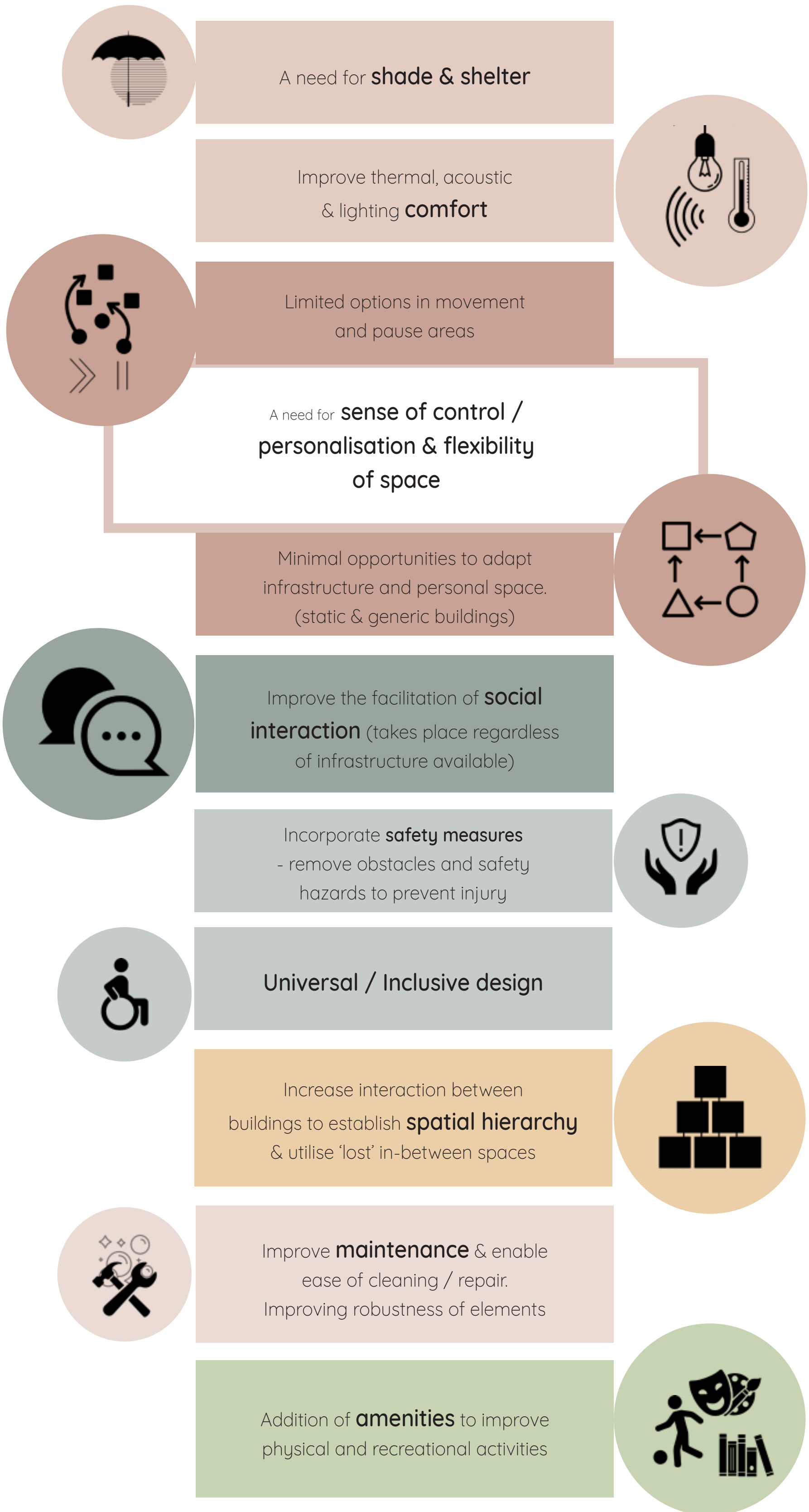


Figure 75: Site Opportunities & Constraints (completed 'The Check-Up' audit of existing site)

4.13 CONCLUSION

After introducing the Tshwane Secondary School as a testing site for the project, this chapter explores the site using multiple research methods. Support is provided for theoretical and typological informants presented in the preceding chapters while introducing threshold and spatial hierarchy as a contextual informant.

Within this specific context, two key factors find relevance. The first considers the physical environment and the effect of the portable classrooms on the learners and overall site condition. The second acknowledges the learners' experience through the physical, social and psychological lenses and the need to better understand their needs. These two factors are further explored in *Chapter 5_ Unravelling the layers.*

UNRAVELLING THE LAYERS 05

5.1 INTRODUCTION

After a contextual investigation, certain characteristics were brought to the author's attention and required additional information. This firstly includes the physical layer as a theoretical understanding of the impact of portable classrooms on learners and their well-being. Secondly, the social and psychological layer is explored through a deeper understanding of the user profile.
This chapter serves as an additional enquiry to support the main theoretical and contextual investigations.

5.2 PHYSICAL: THE EFFECT OF PORTABLE CLASSROOMS ON LEARNERS

Although initially intended as temporary infrastructure, portable classrooms typically become more permanent on-site and as a result, the negative impacts associated with these buildings take effect over the long term. Kronenburg identifies the potential of portable buildings to be reused and recycled due to their ability to move, with their temporality on site not necessarily signifying a temporality in existence (Kronenburg, 1998:1).

Portable classrooms offer a **less expensive and quicker,** more easily constructed alternative to traditional brick-and-mortar school buildings (Patterson et al., 2009:23; Wood, 2012; Drury and McClure, 2014). This could provide a reason as to why they find relevance in the South African context, where budget constraints and an urgent need for infrastructure are deciding factors for the choice of school typology implemented in the public education sector.

Better building conditions could positively affect the morale of learners and teachers and create a sense of safety and commitment to learning (Sanoff and Walden, 2012:281). A study conducted by the University of Houston found a relationship between high school drop-outs and absences, and the number of portable classrooms on-site (Wood, 2012).

Several public concerns regarding the spatial quality and the effect of portable classrooms on learners have been raised in the past, world-wide. These broadly include the **appalling aesthetics and need for regular maintenance, safety and security deficiencies, inadequate ventilation and thermal control, poor air quality and "potentially negative effect"** on the academic performance of learners (Patterson et al., 2009:24). In more general terms, portable buildings carry a perception of low-quality, cheap and disposable (Kronenburg, 1998:1).

With regard to **inadequate ventilation and poor air quality,** multiple health issues have been reported. Respiratory conditions such as asthma and allergies often relate to mould and mildew, and high levels of CO^2 or other volatile gasses which indicate a lack of fresh air (Drury and McClure, 2014). These health issues have serious implications for learners as higher CO^2 levels impair decision-making and academic performance, while asthma is "one of the leading causes of both school absences and child hospitalisation" (Drury and McClure, 2014). More significantly, learners are affected by the **poor lighting, lack of thermal comfort and noise levels non-conducive to learning** (Wood, 2012; Drury and McClure, 2014). A similar situation is found on site, as measured during the contextual analysis.

This thus provides a greater understanding of the effect of portable classrooms and ground site observations in theoretical texts.

And so, learners find themselves cramped within these **undesirable spaces** for multiple hours during their day, trying to process and retain information during a developmental phase which is crucial to their future quality of life.

05

5.3 SOCIAL & PSYCHOLOGICAL: COGNITIVE AND PSYCHOSOCIAL DEVELOPMENT OF LEARNERS

In order to better understand the specific needs of secondary school learners, with regard to their social and psychological well-being, it was necessary to consult theories regarding the stages of development of individuals. Adolescent development differs from one individual to the next, with complex biological, psychological and social influences playing a significant role, ultimately proposing the difficulty in determining what is 'normal' (Hazen et al., 2008). This includes cognitive development, as set out by Jean Piaget, as well as the theories of Erik Erikson regarding psychosocial development. Additional factors relating to adolescent well-being includes the physical and moral development (Hazen et al., 2008).

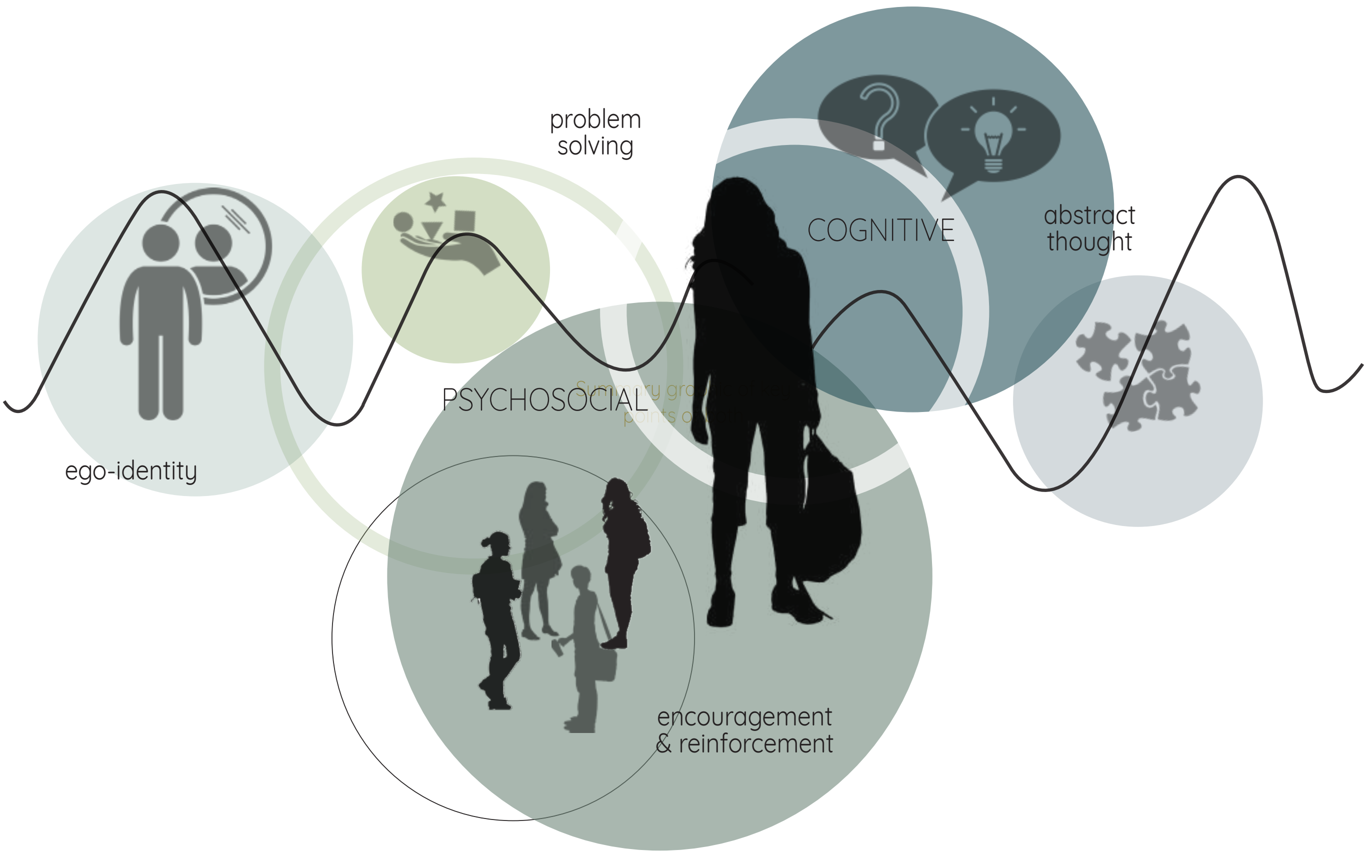


Figure 76: Cognitive and Psychosocial Development of adolescents

COGNITIVE DEVELOPMENT

With regards to the brain and cognitive development of individuals, Piaget identifies that adolescents embark on a journey of formal operations where a greater capacity for the abstraction of ideas and hypothetical thinking can be noted (Hazen et al., 2008; Cherry, 2019b). It is further found that the adolescent years could be coupled with impulsivity, short-sightedness and risk-taking behaviours, as the brain has not yet fully developed to assess risk factors and rewards (Hazen et al., 2008). This would support the idea of incorporating intellectual challenges and problem-solving opportunities into the learning environment, as well as ensuring social support and a safe space to combat potential risk-taking behaviours.

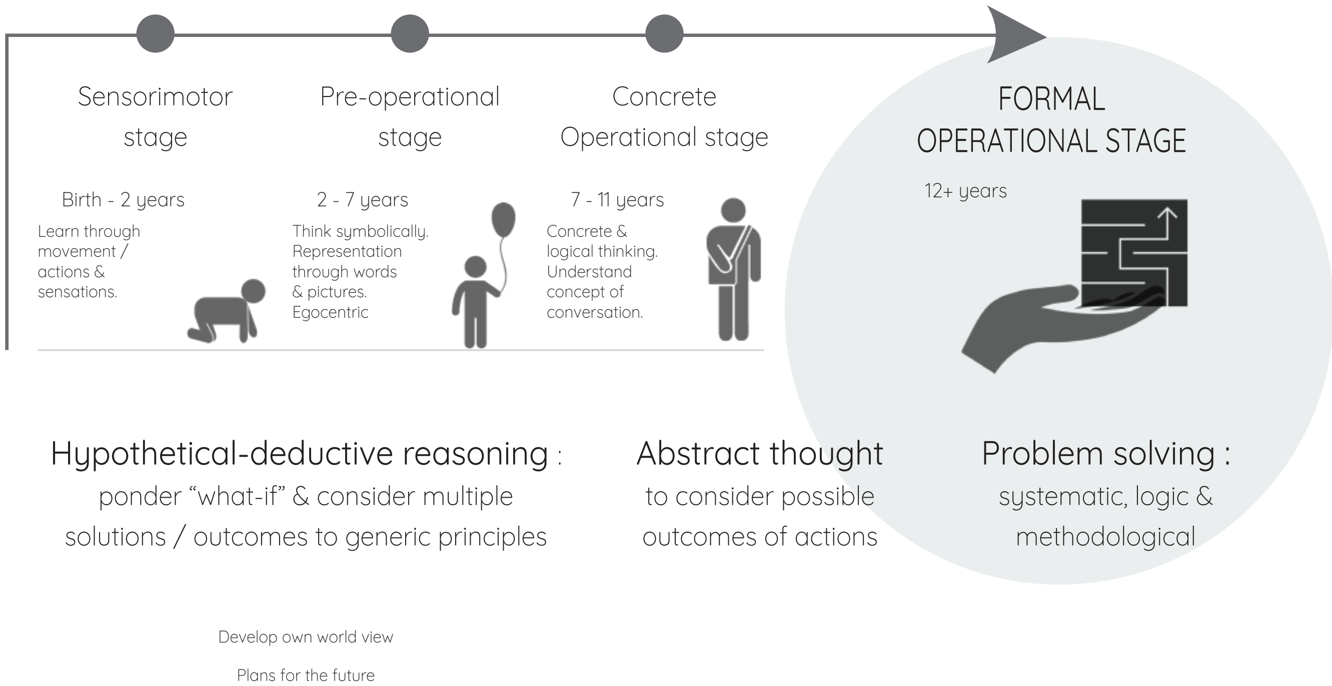


Figure 77: Adolescent Cognitive Development, as per Jean Piaget's theory

PSYCHOSOCIAL DEVELOPMENT

Erik Erikson developed an eight stage theory of development, centred around the psychosocial development from infancy through to maturity (Cherry, 2019a). This considers the effect of social interaction and relationships on one's development and growth throughout one's life (Cherry, 2019a). Within his theory, Erikson identifies a point of conflict within each stage, which could either result in personal development and attaining a certain psychological quality or failure to do so (Cherry, 2019a). This point of conflict is seen as the turning point in development as each stage builds on those before while leading to the next (Cherry, 2019a). The different stages are outlined in figure 78 below.

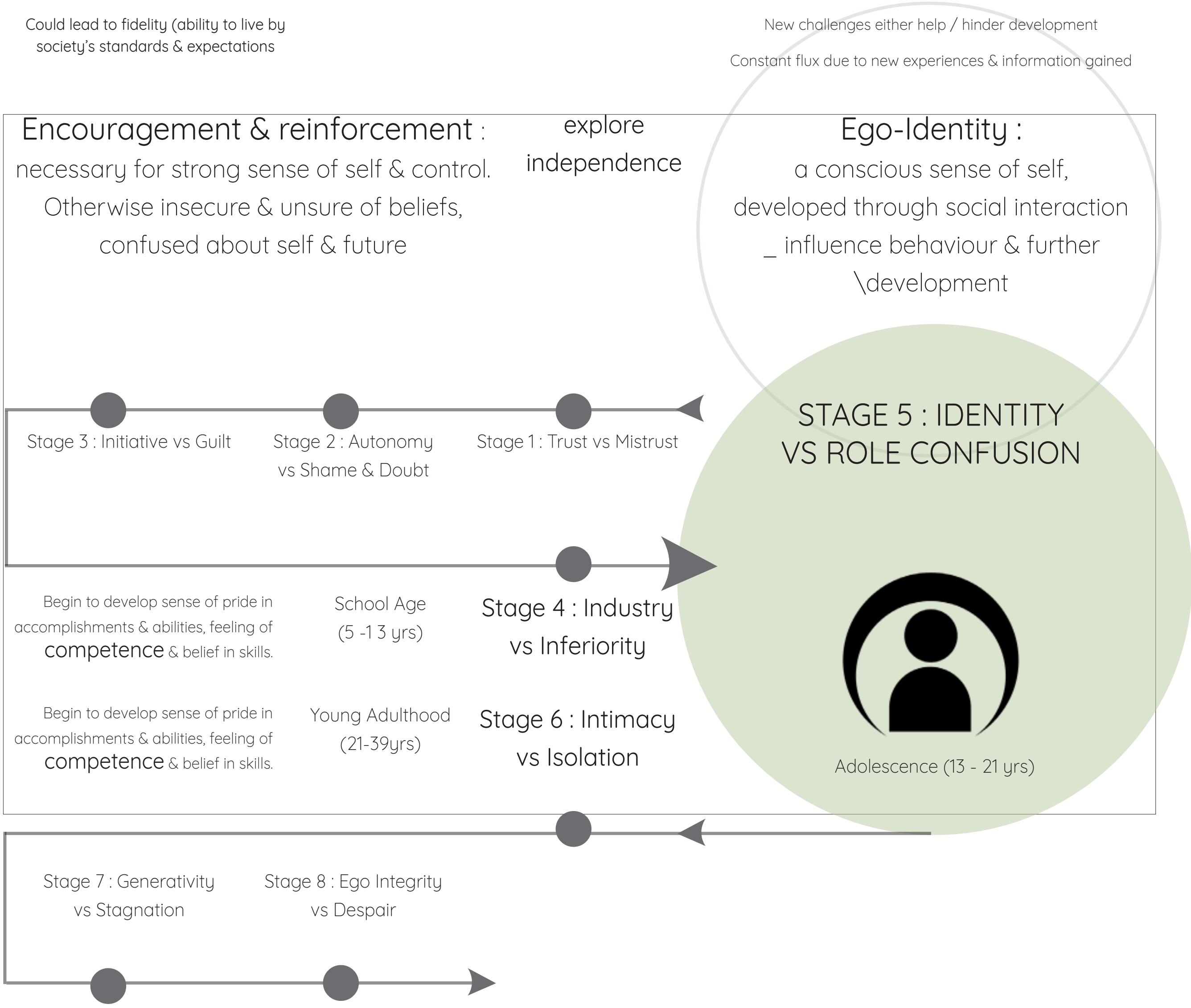


Figure 78: Adolescent Psychosocial Development, as per Erik Erikson's theory

As the project focuses on secondary school learners, the fifth stage, Identity vs Role Confusion, is critical. This stage is essential during the teenage years, or middle adolescent years, as independence is explored and a sense of personal identity and self is developed (Cherry, 2019a; Hazen et al., 2008). Insecurity and confusion, along with the absence of a coherent sense of self and values could result if children do not receive the necessary encouragement and reinforcement during this stage (Cherry, 2019a; Hazen et al., 2008).

Central to this phase and emphasised by Erikson as one of the most crucial stages of development throughout one's life, is the development of ego-identity (Cherry, 2019a). One's ego identity is defined as the conscious sense of self, which develops through social interaction and is prone to change due to new experiences and information gained on a daily basis (Cherry, 2019a). Other theorists, however, argue that early adolescence is more concerned with group cohesion and identifying with the values and norms of specific groups, rather than focussing their own unique sense of identity (Hazen et al., 2008). This also makes the younger adolescents more susceptible to peer pressure (Hazen et al., 2008). One's personal identity furthermore helps to guide one's actions, beliefs and behaviours as ageing takes place, showing the importance of this developmental phase as it has a long-lasting effect on one's life (Cherry, 2019a).

As preceding stage and dealing with the primary school years of individuals, stage four (Industry vs Inferiority) will also be taken into consideration as it is not guaranteed that this stage was successfully completed, and the necessary qualities developed. This stage entails the development of a sense of pride in abilities and requires of parents and teachers to encourage and commend children on their accomplishments in order for them to develop a feeling of competence and belief in their skills (Cherry, 2019a). Once again, social interaction plays a fundamental role in this developmental stage to provide social support. The development of a sense of worth should also be facilitated.

To pave the way to the next stage, Intimacy vs Isolation, it is important to place emphasis on social interaction and developing a strong personal identity in stage five, for learners to be able to successfully develop close, committed relationships during stage six (Cherry, 2019a).

Erikson's theory supports the theoretical informants mentioned in the Wheel of Wellness, discussed in Chapter 2_Unfolding Theory. Social support and a sense of worth are not only contributing factors to general wellness but are vital for adolescent well-being as it assists with the development of relationships and an ego-identity, which are integral to this phase of development.

Emphasis should be placed on the role of the project to critically consider the social aspect of the everyday life and not only the psychological or moral effects thereof, but also how the physical environment can affect this social interaction. Designing an intervention that is conscious of these aspects and strives to facilitate the social and 'personal self', becomes critical for the social and psychological well-being of adolescents.

5.4 CONCLUSION

Chapter five provides an additional enquiry which grounds the observations made on site regarding both the effect of the portable classrooms on the learning environments as well as the social and psychological behaviour of learners in theoretical texts. The latter is through providing a better understanding of the cognitive and psychosocial development of the primary user group, being the learners in their adolescent stage of development.

CHAPTER 06 : STUDYING PRECEDENTS

CHAPTER 07 : CONCEPTUALISING A RESPONSE

Architects have the opportunity to promote the well-being of the youth through the design of learning environments. It is, however, critical to pay close attention to not only the needs and functioning of adolescent learners but also the educational approaches and physical environment in which learners find themselves. The physical, social and psychological layers play a part, and would ultimately inform the future designs of schools.
As the physical environment in a South African context, portable classes prove to be problematic in both their individual capacity and their collective configuration on site. An argument is made for more flexible and deployable classrooms, which combat the physical issues associated with the existing, while further facilitating social interaction and addressing the concerns for thresholds and spatial hierarchy.

Theoretical, typological and contextual informants are derived from *Part B*, ultimately formulating the argument to be taken forward in *Part C*.

PART C _ ADJUST

STUDYING PRECEDENTS 06

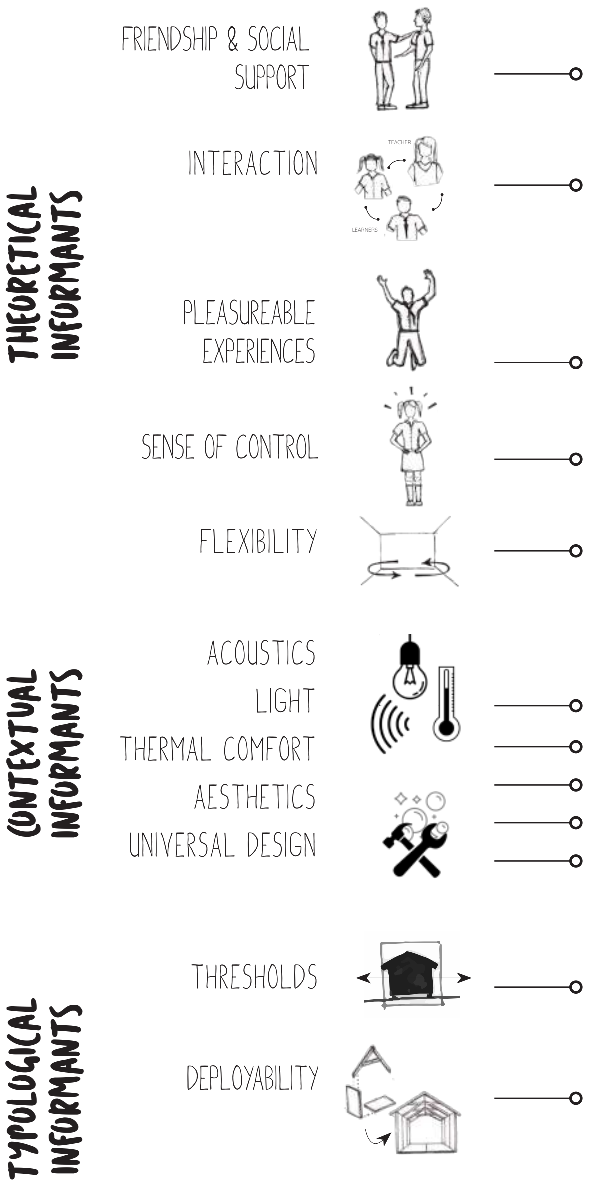
6.1 INTRODUCTION

Part A of the investigation provided an introduction to the project. An argument was framed within *Part B,* constituted by *Chapter 2* to *Chapter 5,* to examine the real-life scenario relating to the well-being of adolescents in their learning environments. This part sought to identify the issues currently present in South African secondary schools, hindering learners to flourish in terms of well-being. It ultimately concluded with several key points to take into consideration for the future design of schools, framed as theoretical, typological and contextual informants. Some of these require precedents to inform the design process towards addressing these fundamental concerns.

Now, *Chapter 6* makes use of an assessment criteria, based on these aforementioned key points, to analyse a variety of precedents in order to provide a better understanding as to how they can be achieved. It thus forms the basis for *Part C,* to adjust the approach to school design as a precursor to the design process.

6.2 ANALYSIS CRITERIA

The selection and assessment of precedents are based on the concerns identified within the chapters of inquiry and framed as informants within each of the previous chapters. These informants are now more boradly categorised for the precedent investigation in order to select precedents and extract a holistic understanding of each.



I.

Firstly, precedents are concerned with the idea of facilitating social interaction between young people. Through the site analysis and psychology report it became evident that **social interaction is of utmost importance.** This notion of interaction is further supported by the theory regarding the psychosocial and cognitive development of learners. It is, therefore, necessary to **consider the different interactions that potentially take place between adolescents** and how either the physical environment or the programmatic activities could affect this.

II.

The second consideration includes flexibility in space and **accommodating various modes of learning**. With regards to wellness, this further links to a **sense of control** and personalisation. Precedents are thus necessary to investigate how spaces could **adapt** to individual needs and attain a sense of flexibility, while successfully fulfilling a **core function**. It is also necessary to investigate how individuals could **find a sense of belonging** and personalisation within a public, communal space.

III.

A third aspect is the idea of sustainability and well-being in schools, further relating to the **spatial qualities** such as light, acoustics, thermal properties and aesthetics. Similarly, universal design plays a role with regard to the user experience. This aspect includes the investigation into the design of 'green-schools', to better understand their functioning and the consideration given to the user impact.

IV.

The last point to look at would be portable architecture and **systems of deployability** as this would not only address the issue of flexibility and rapid construction but could also investigate the concern for threshold and spatial hierarchy when designing the **individual and collective configuration** of the units on site

Figure 79: Precedent analysis criteria unpacked

For visual presentation and easy comparison, an analysis tool was formulated with the level of achievement indicated by the diameter of the circle.

FOUR CATEGORIES OF INVESTIGATION::

FACILITATING SOCIAL INTERACTION

user interaction

_considering the interactions between people and different activity levels that take place.

FLEXIBILITY IN SPACE

user-space appropriation

_relating to the appropriation of space and the control of the user over the physical environment.

SUSTAINABILITY & WELL-BEING

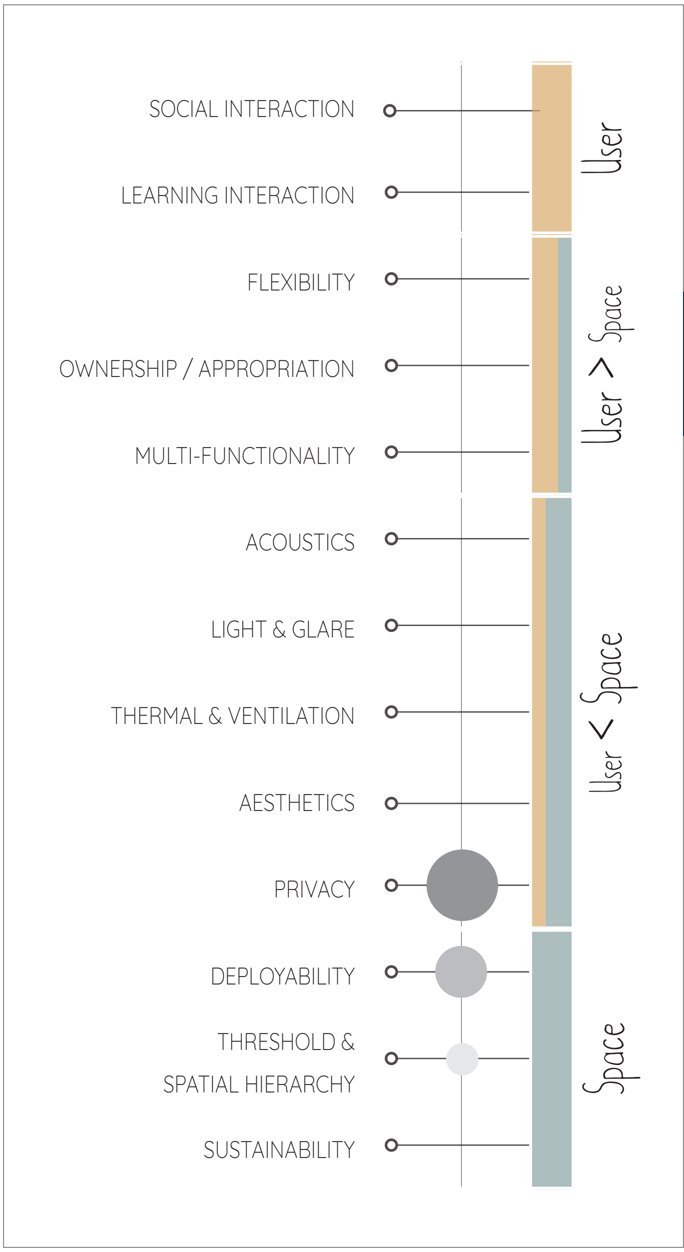
space-user impact

_taking the effect of the building, in terms of the physical environment and spatial qualities, on the user, into account

PORTABLE ARCHITECTURE

spatial connection

_examine the connection between buildings, with regards to spatial hierarchy and thresholds, as well as the functioning of the buildings themselves.



6.3 PRECEDENT ANALYSIS

6.3.1 MICRO HUTONG RENEWAL PROJECT


Figure 81: Zang Mingming, 2015 [1]

Figure 83: Su Shengliang, 2015 [1]

tree as visual centre of the courtyard

masonry staircase embraces tree & provides platform for social gathering & vantage points

plywood insertion as a children's library with plywood interior finishing

Figure 82: Wang Ziling, Su Shengliang, Zhang Mingming, 2015 [2]

niches for individual / group gathering & study

new intervention & insertion adopts shape of the existing

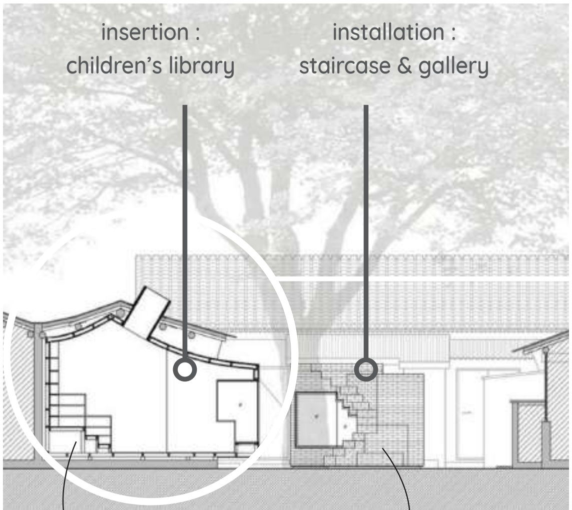
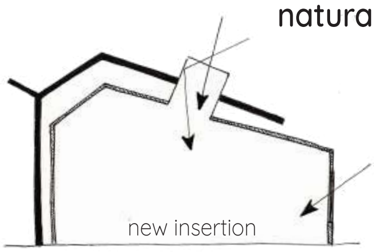


Figure 84: Section 2-2, ZAO/standardarchitecture, 2015 [1]

interior & exterior stepped surfaces

natural daylight



extrude slightly into courtyard, emphasised as new entity - contrast in material

Figure 80: Precedent analysis_1. Micro Hutong Renewal Project

Social encounters

Modes of interaction

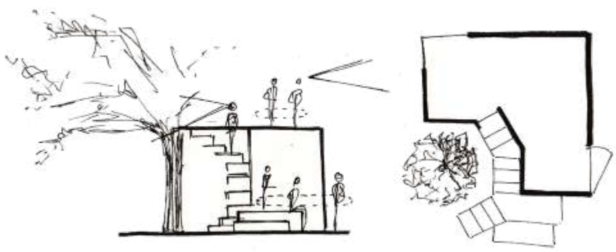
Spatial hierarchy

Multi-functional

Micro Hutong
Renewal Project

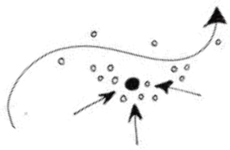
1.

Architect:	Zhang Ke (ZAO / Standard Architecture)
Location:	Beijing, China
Year:	completed 2014
Aims:	Highlight existing Hutong courtyard's potential to act as **catalyst of social interaction and generator of communal space**[1]**;** showing adaptive re-use to create resources for local community.
Description:	New structures added to existing built fabric: outdoor staircase which provides viewpoints & raised podiums for socialization; and insertion under existing roof canopy as a plywood & concrete children's library with minimal intervention to the historic fabric.

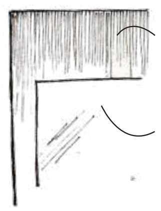


Social interaction strengthens community bonds.

Create gathering point in centre of space, allowing for circulation and a pause area.



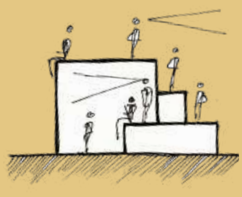
Visual access and permeability soften effect of intervention to prevent being perceived as a boulder within the space. Further connects interior and exterior spaces Balance between physical and visual barriers.



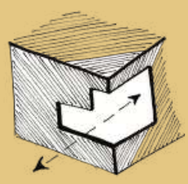
Material language : Old vs New.

Plywood used for new intervention, bringing haptic warmth and a sense of temporality. Concrete and bricks to respond to the existing, traditional materials.

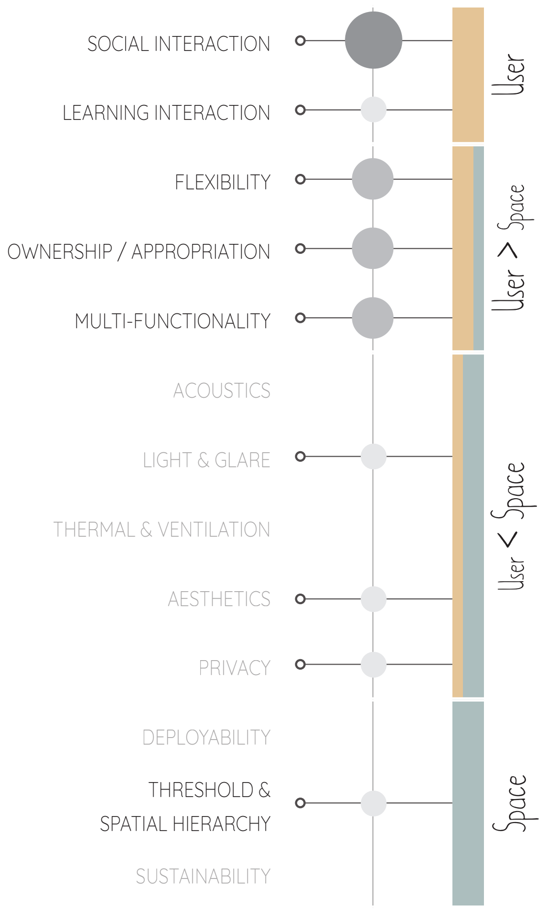
Level differences creates spatial zones



Visual connections



1 : (ArchDaily, 2015)
2: (Architonic, 2015)



06

6.3.2 KAVEL K


Figure 89: Marleen Beek, 2014 [1]

Spaces melt together to create unity in planes connecting to one another


Figure 88: Marleen Beek, 2014 [1]

Lower walkway, no interference with the play and social interaction

Pops of colour highlighting flexible objects


Figure 86: Marleen Beek, 2014 [1]


Figure 87: Marleen Beek, 2014 [1]

Building forms a central hub to differentiate the zones

Visual access and aesthetic character optimised

Graffiti facade with Braille indents. Over time, layers of paint will gather in the indents and create a narrative of use

Boundary fence becomes interactive as part of the play experience

Aesthetic wall also instils ownership, identity and sense of belonging

Figure 85: Precedent analysis_2. Kavel K

Social encounters

Modes of interaction

Spatial hierarchy

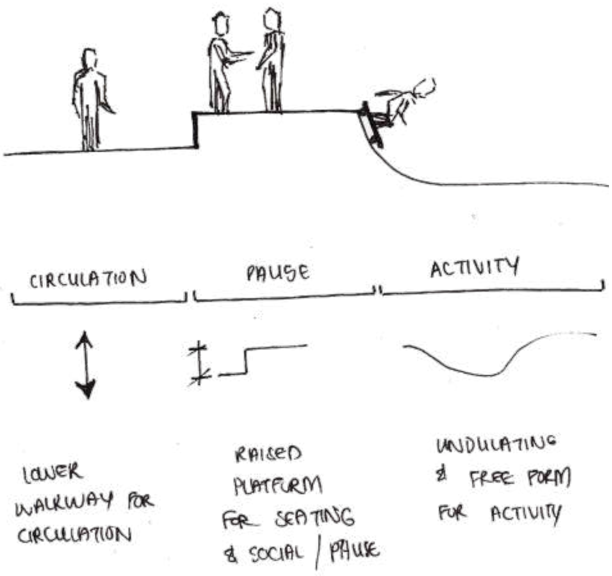
Multi-functional

Kavel K

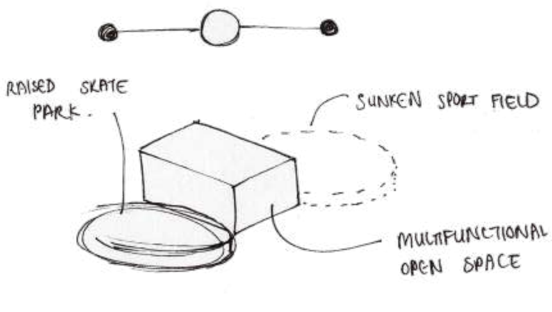
Youth Facility

2.

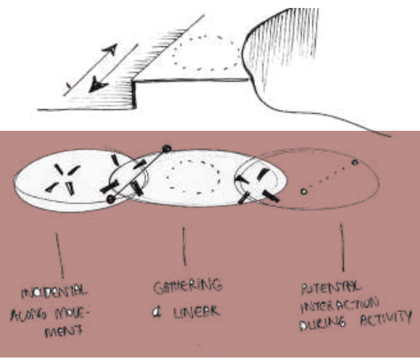
Architect:	Carve
Location:	The Hague, The Netherlands
Year:	2014
Aims:	Seeks to provide **safe public environment** for the youth, including a skating, sports- & youth facility to attracts a wide range of user groups[1].
Description:	Three zones are created: the multi-functional youth centre as central zone; a skating zone to the front with various **raised platforms** which **enable different activities & modes of interaction;** and the sports zone to the back. A graffiti wall with a braille pattern also forms part of the building, potentially **capturing the layers** of paint applied over the years.

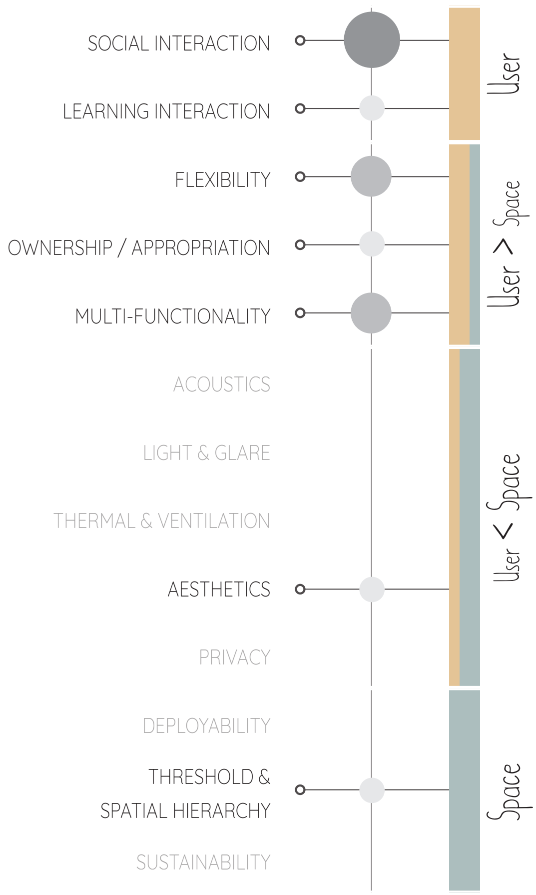


Modes of interaction



Spontaneous interaction where zones meet and the promotion of social interaction





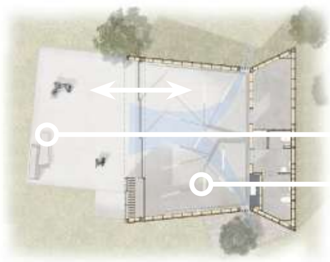
1 : (ArchDaily, 2014)

6.3.3 AULA K

Contribute to education of biodiversity and respect for the environment.

Introduce natural daylighting

Figure 93: (above & below): BCQ Arquitectura, 2019 [1]



Transition form exterior to interior

Social node

Multifunctional Classroom

Figure 91: (above): Marcela Grassi, 2019 [1]

Multiple layer front facade, levels of privacy & flexibility

Natural materials blending in with the environment

Include green infrastructure

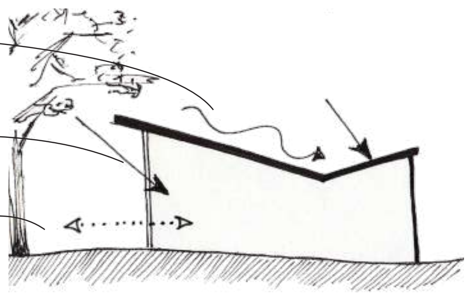
Space opens to the outside, allowing to experience the climate, light and natural environment

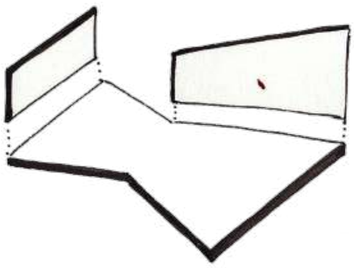
Figure 92: (left and above): Marcela Grassi, 2019 [1]

Slopes for solar and water harvesting to irrigate vegetation

Natural daylighting

Interior and Exterior threshold





Rapid construction on site

Figure 90: Precedent analysis_3. Aula K

Module

Multi-functional

Adaptable

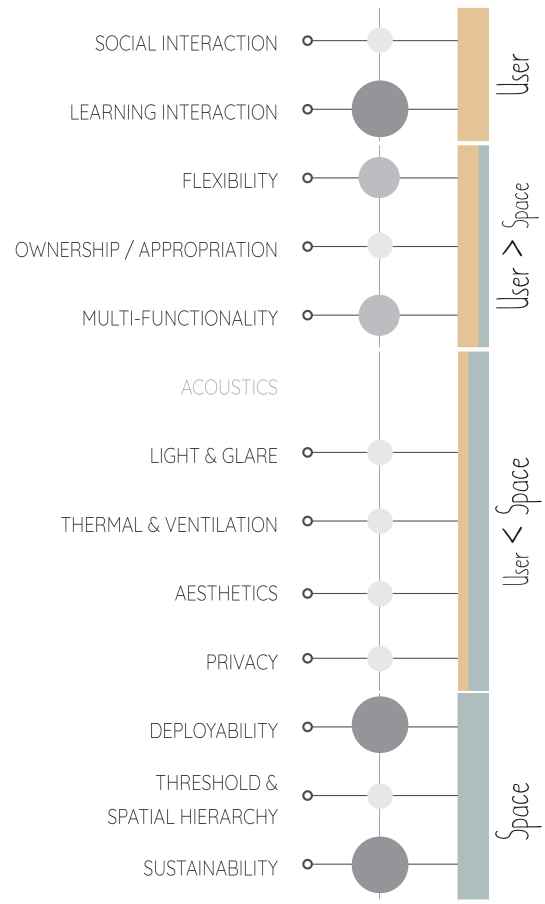
Sustainable

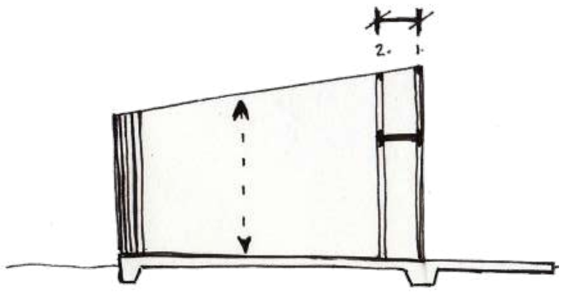
Aula K

Environmental Classroom

3.

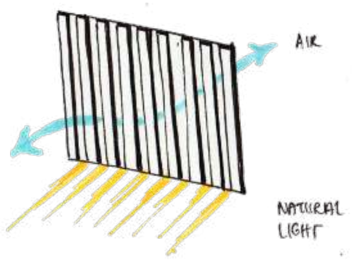
Architect:	BCQ Arquitectura
Location:	Barcelone, Spain (multiple sites possible)
Year:	2018
Aims:	Creating **prototype model** for environmental education classroom where design intervention functions as **learning & discovery space** and becomes educational in itself. [1]
Description:	A **three part prefabricated module,** delivered to site and installed in any which way to accommodate the needs of specific site. An open space allows for **flexibility,** while consideration is given to **light & natural ventilation,** to **experience nature** first hand, even within the interior space.





Volume opens up sit on landscape

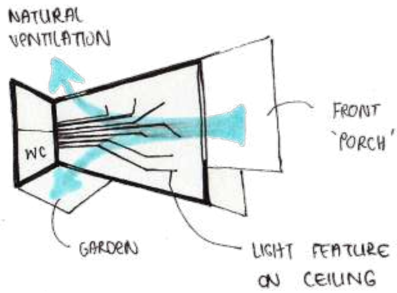
Large thresholds
1. Wooden slats facade opening up
2. Glass sliding doors- levels of privacy and balance between physical and visual barriers



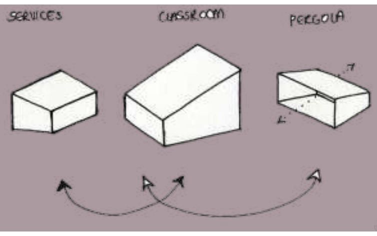
Visual connections

Lighting layout becomes a feature on the ceiling

Include natural ventilation



Modules
Configure according to needs

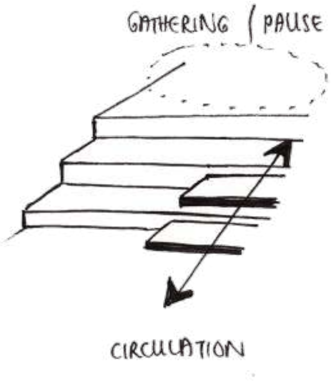


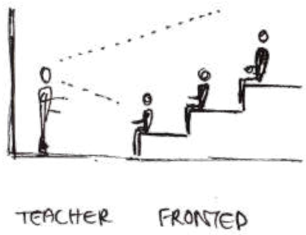
1 : *(ArchDaily, 2019)*

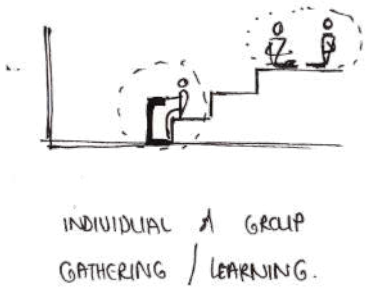
06

6.3.4 ALTSCHOOL

Figure 95: (left and below):
Magda Biernat, 2018 [1]







Semi-private,
soundproof boxes
allowing visual
access
Multi-functional
learning space

Spatial hierarchy
by the use
of colours to
indicate function

Modes of activity indicated by
the variation in physical space

Figure 94: Precedent analysis_4. Alt School

Learning spaces

Multi-functional

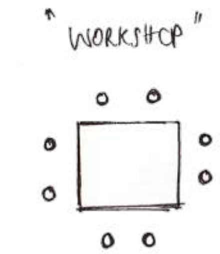
Colour coding for spatial hierarchy

In-between spaces

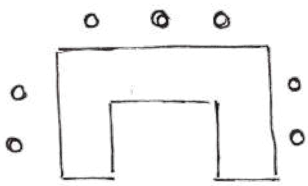
AltSchool

4.

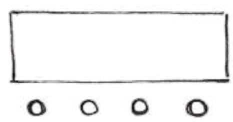
Architect:	Architecture + Information (A+I) Designs
Location:	Manhattan, New York
Year:	2017
Aims:	Create safe spaces where children experience **sense of safety & autonomy** through **student-centred** design[1]; accommodate individual needs & different learning styles, resulting in **multiple** types of spaces & **flexibility** within the interior articulation.
Description:	Staircase for assembly and **gatherings/ teachings**, work-stations for **collaborative** work & mealtimes, **individual** workbench-es as focus zone and computer facilities, and smaller glass boxes with a higher level of **privacy**.



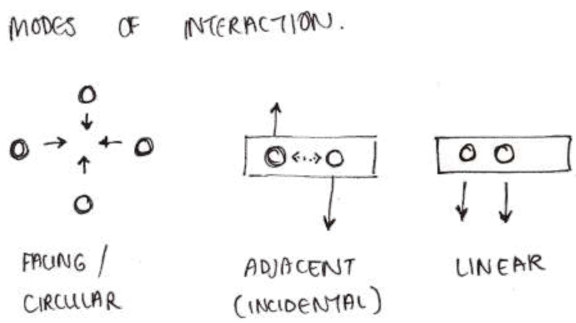
Group / inward facing interaction and peer-learning

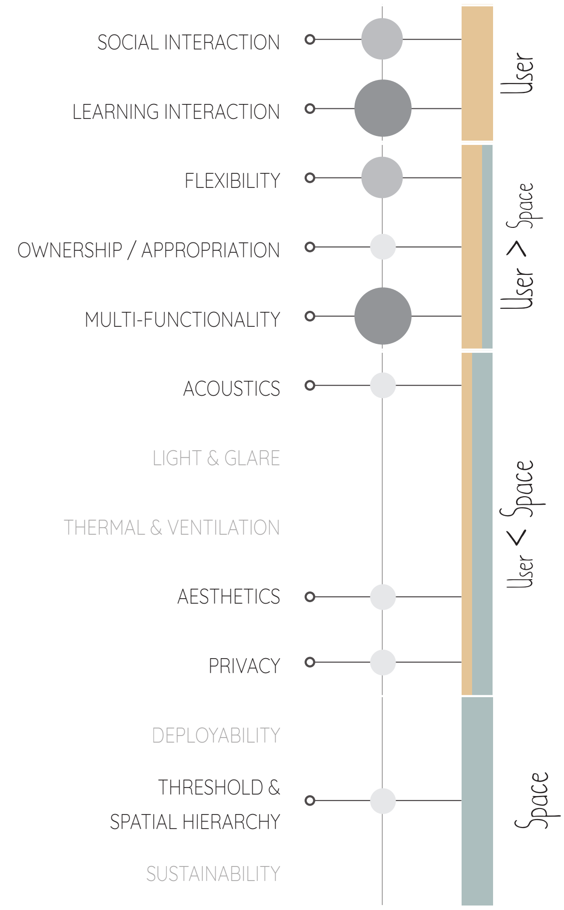


Larger group settings, less secluded from the surrounding environment

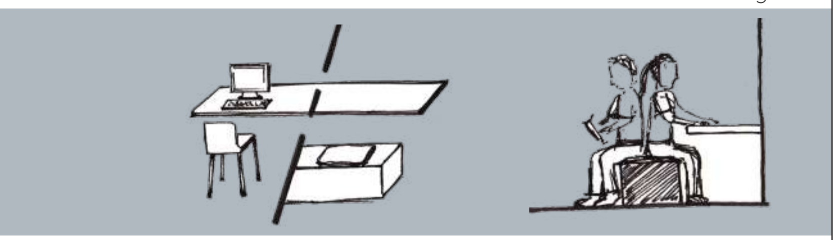


Linear learning, could evoke spontaneous interaction as individuals are prompted to engage in their shared space





Modes of Learning



1 : (Brillon, 2018)

6.3.5 STREETLIGHT SCHOOLS : JEPPE PARK PRIMARY

Incorporate branding / school identity as an aesthetic feature within the space

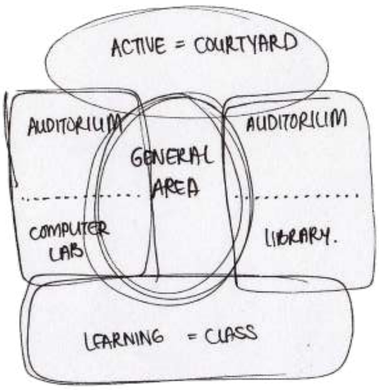
Indoor play & levels of privacy. Different zones created with an interior installation

Figure 97: (left and below): Streetlight Schools, n.d [2]

Polycarbonate for acoustic & privacy value added, also allows light transmittance

Multiple activities possible

reuse materials & innovative design



Spatial zoning according to requirements, overlaps and relationships.

The inherent spatial qualities available also act as informant

Figure 96: Precedent analysis_5. Streetlight Schools Jeppe Park Primary

Learning spaces / Ways of learning

Branding / Identity

Spatial Zoning

Sustainability

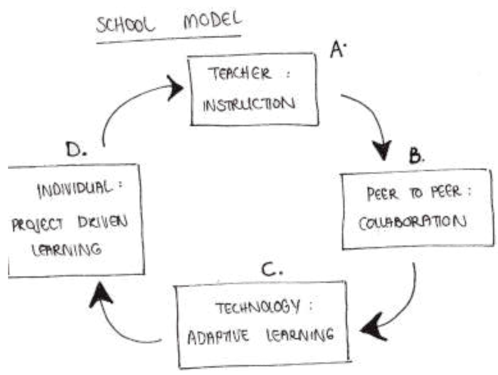
Streetlight Schools

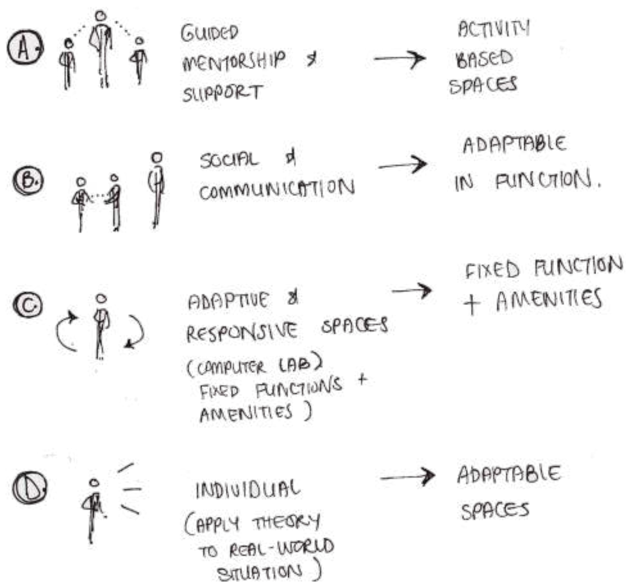
Jeppe Park Primary

5.

Architect:	Fieldworks Design Group
Location:	Jeppestown, Johannesburg
Year:	2016
Aims:	Low cost and up-cycled materials as part of an **innovative material** pallet, with little to no material wastage. Indigenous planting with low water requirements were incorporated, while the play towers and surface treatment complies with playground safety regulations[1]. The school provides new and exciting education opportunities to children in the area.
Description:	Jeppe Park Primary School as an **inner-city school** employing adaptive reuse. Receiving a Green Star rating, with sustainable material use. Finding **creative ways for teaching and learning.**

Considering the school model and different ways of learning

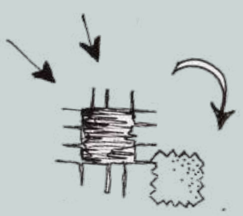


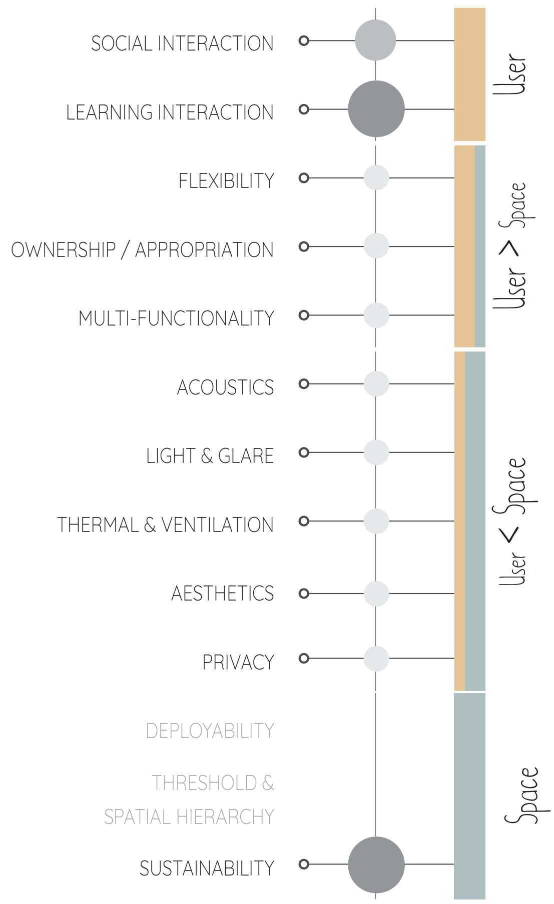


Levels of interaction between learners and between teachers and learners - using various facilities / equipment.

Space takes on multiple forms / ways of learning

Locally sourced & reused/recycled materials





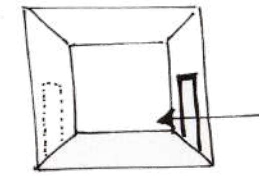
1 : (Donnelly, n.d.)
2: (Streetlight Schools, n.d.)

06

6.3.6 SAGE CLASSROOM

Natural light through clerestory windows

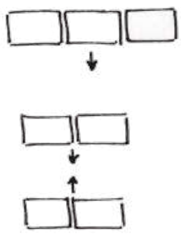
Pops of colour on exterior, giving identity to classroom



doorway access x 2 (flexible in size)

Figure 99: (above and right) SAGE Classroom[1]

Water harvesting



linear placement of clusters

Slanted / angled ceiling brings light in deeper and increased perception of site

Roof overhang blocks unwanted source of heat gain, promotes natural ventilation and natural day-lighting

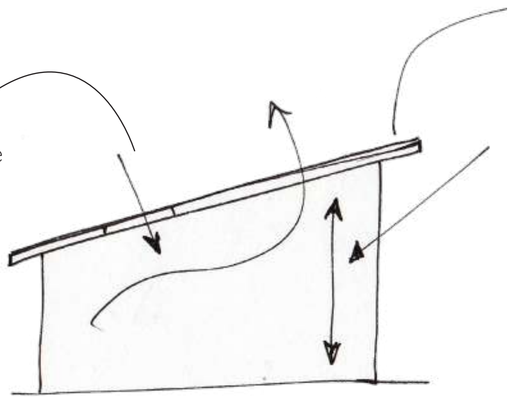


Figure 98: Precedent analysis_6. Sage Classroom

Learning spaces

Sustainability

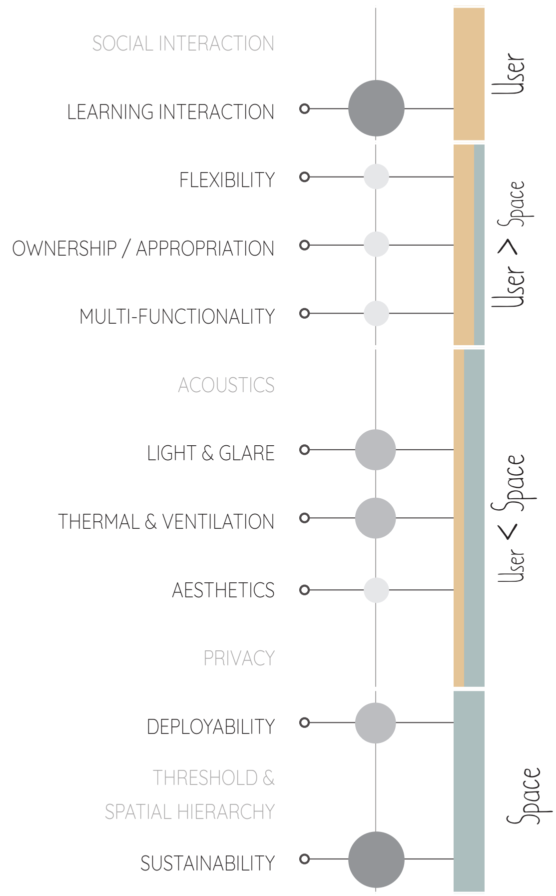
Portable Architecture

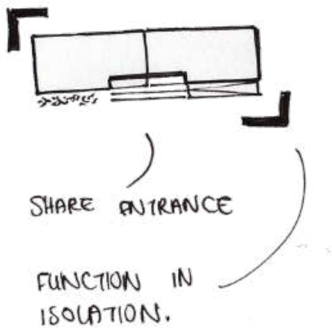
SAGE Classroom

6.

(Smart Academic Green Environment)

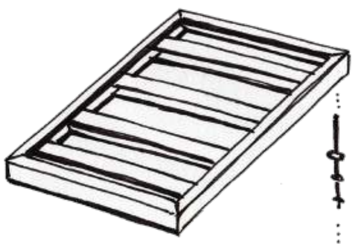
Architect:	Portland State University's faculty of Architecture and Engineering, and students with Blazer Industries & Pacific Mobile Structures
Location:	Pacific Northwest, United States
Year:	2011
Aims:	Set out to design & build an **affordable, green modular** classroom that accommodates the contemporary conditions & role of modular classrooms.
Description:	Using principles of **sustainability**, the classroom provides an improved alternative to existing portable. These units incorporate **natural daylight**, and **water harvesting**, further having better **ventilation** systems. Some flexibility is afforded as the doorway could be placed on either side.



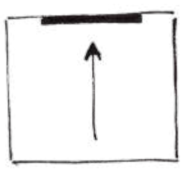


Reusable metal ramp

Steel frame increase permeability

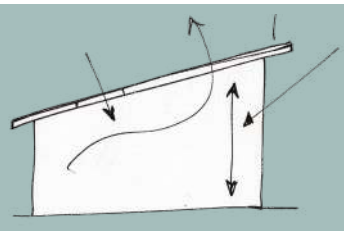


Helical pier foundation- leaves minimal site impact



One direction teaching _ teacher fronted approach but large enough to accommodate multiple interior layouts

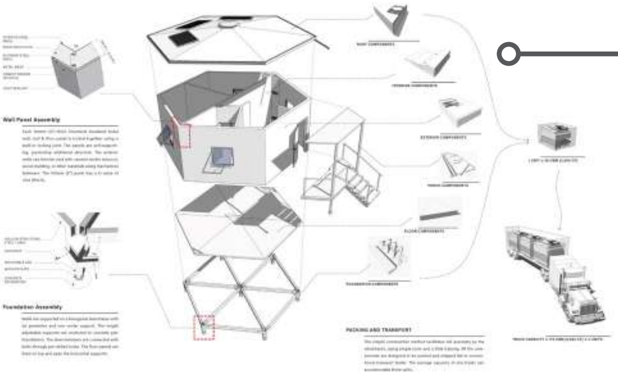
Once again creates the existing problem of isolated placement on site and lack of consideration for the in-between



Climatic response

1: (Center for Public Interest Design. n.d)

6.3.7 HEX HOUSE



Self supporting structure, promoting responsive strategies and adaptability

Roof facilitates rainwater harvesting and solar panels

Figure 101: Hex House Images, Dezeen, 2016[1]

Height adjustable support structure

Lower interior walls to allow for ventilation

Transition from interior to exterior

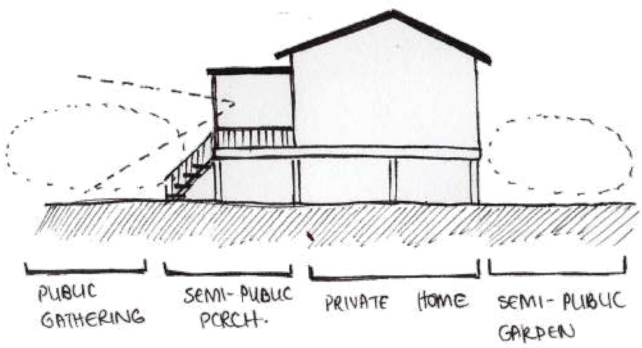


Figure 100: Precedent analysis_7. Hex House

Flexibility

Threshold

Sustainability

Deployability

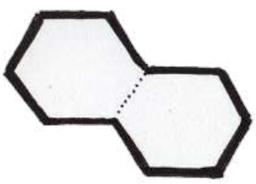
Hex House

Conceptual Project

7.

Architect:	Amro Sallam & Architects For Society
Location:	(Conceptual project)
Year:	n.d.
Aims:	To conceptualise a low-cost, off-grid, rapidly deployable home, which could be shipped in pieces & assembled on-site by the users themselves.
Description:	Using a hexagonal shape, it can be configured in linear or radial clusters on site, which could also enclose a central garden space. Incorporates two bedrooms and amenities for small family; considering passive cooling, solar energy & water harvesting.

06

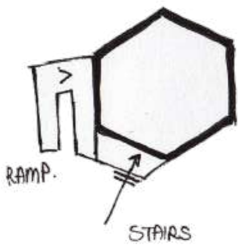


Combine 2 Units for a larger unit (Bigger Family)

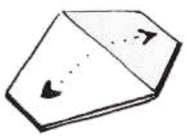
Structural integrity of hex form

Multiple configuration to create an communal garden and different layout for the larger community

From concept to actual product:

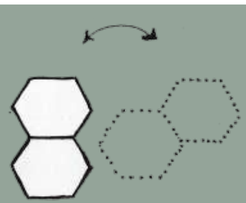


ramp added



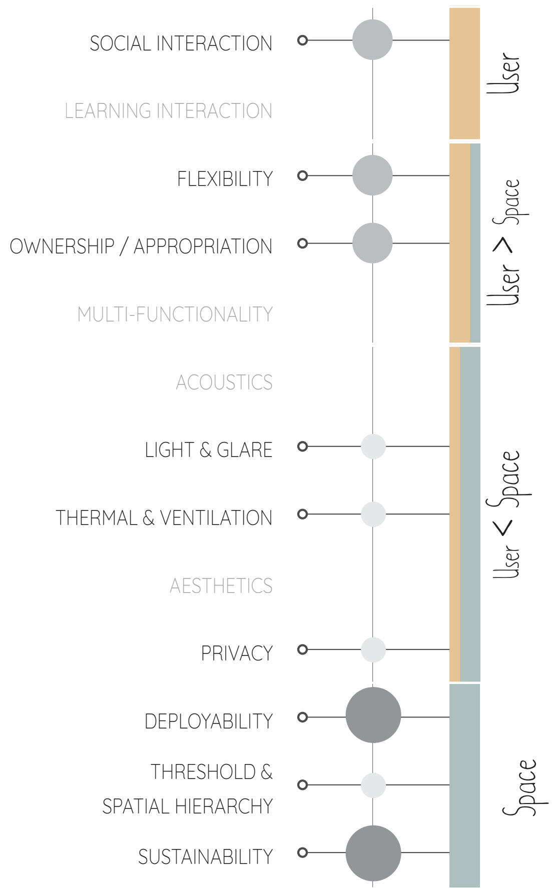
roof simplified

Promote social interaction through the consideration of the in-between spaces



Flexibility in configuration

1 : (McKnight, 2016)



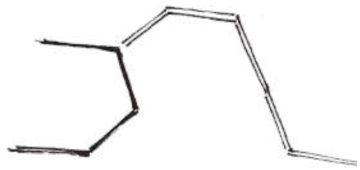
6.3.8 FLEX: FLEXIBLE LEARNING ENVIRONMENT

Figure 103: View from second floor balcony, HMC Arcitects, 2011[1]

Self-taught instruction
with teacher as facilitator

Figure 104: View inside learning environment, HMC Arcitects, 2011[1]

Same shape followed to create gardens and pathways, thus having a design language throughout the site



Open up facade

Interactive facade, multi-functional

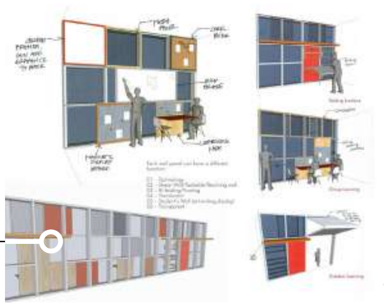
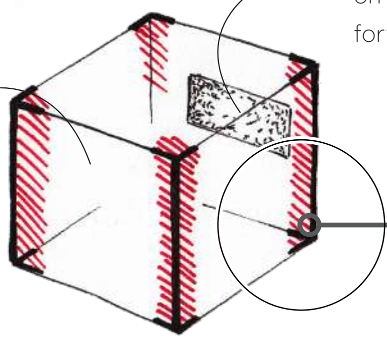


Figure 106: Architizer, n.d.[2]

Figure 105: Aerial view, HMC Arcitects, 2011[1]

Teaching inwards centered on one wall- students facing forward

Act of socialization informing appropriate behaviors and promotes team building



Corners are unused for instruction due to difficult sightliness from opposite side of the room

Figure 102: Precedent analysis_6. Flex: Flexible Learning Environment

Social encounters

Spatial hierarchy

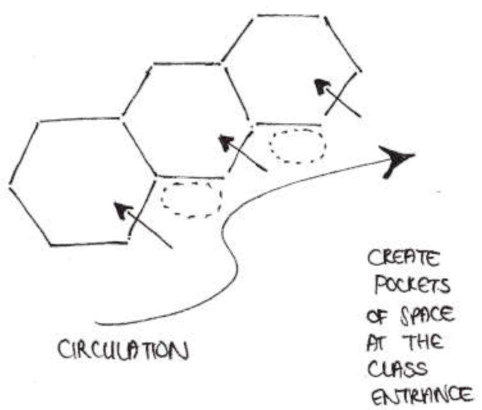
Modes of interaction

Multi-functional

Flex :
Flexible Learning Environmnets

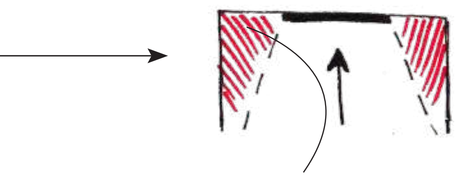
8.

Architect:	HMC Architects
Location:	Virtual site in Los Angeles
Year:	2010 (competition)
Aims:	Competition sought **flexible** solution to replace existing portable classrooms. Strategies were employed to ensure **sustainability** & **easy assembly/ disassembly.**
Description:	A **hexagonal**, uniform unit is created as **kit of parts**, with **interchangeable** wall panels that allow for flexibility and customization. Consider **natural light, rainwater harvesting & configuration of multiple units**. Each unit can also function as classroom, library, indoor dining, administrative or multi-purpose space.

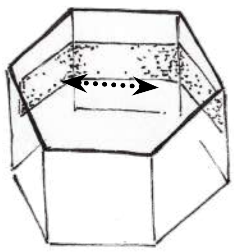


Multiple configurations possible, potentially combining multiple units.

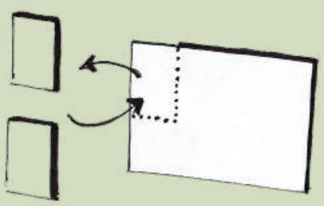
Three teaching walls allows three connecting walls to adjacent classes



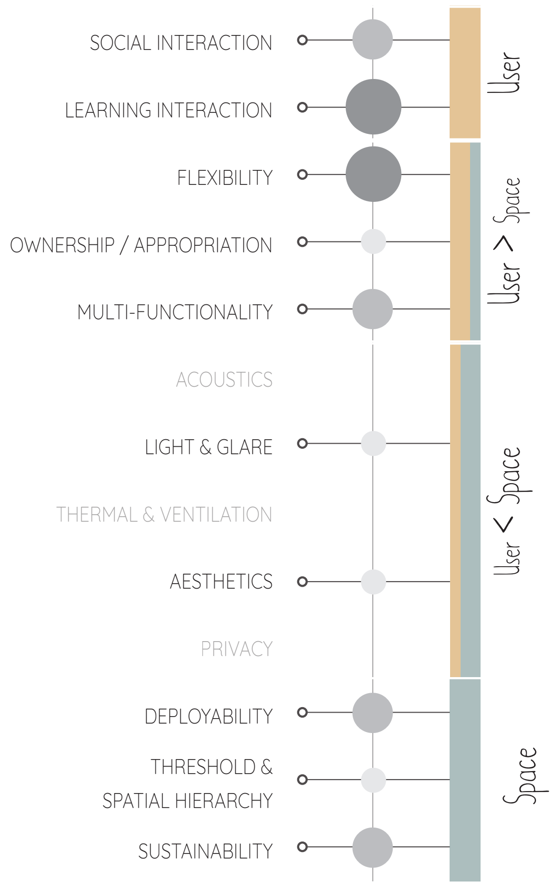
Each wall centrally focused back to students providing a panoramic view



Hexagon shape allows for three sides of teaching / learning



Flexibility in wall composition



1 : (Furuto, 2011)
2 : (Architizer, n.d.)

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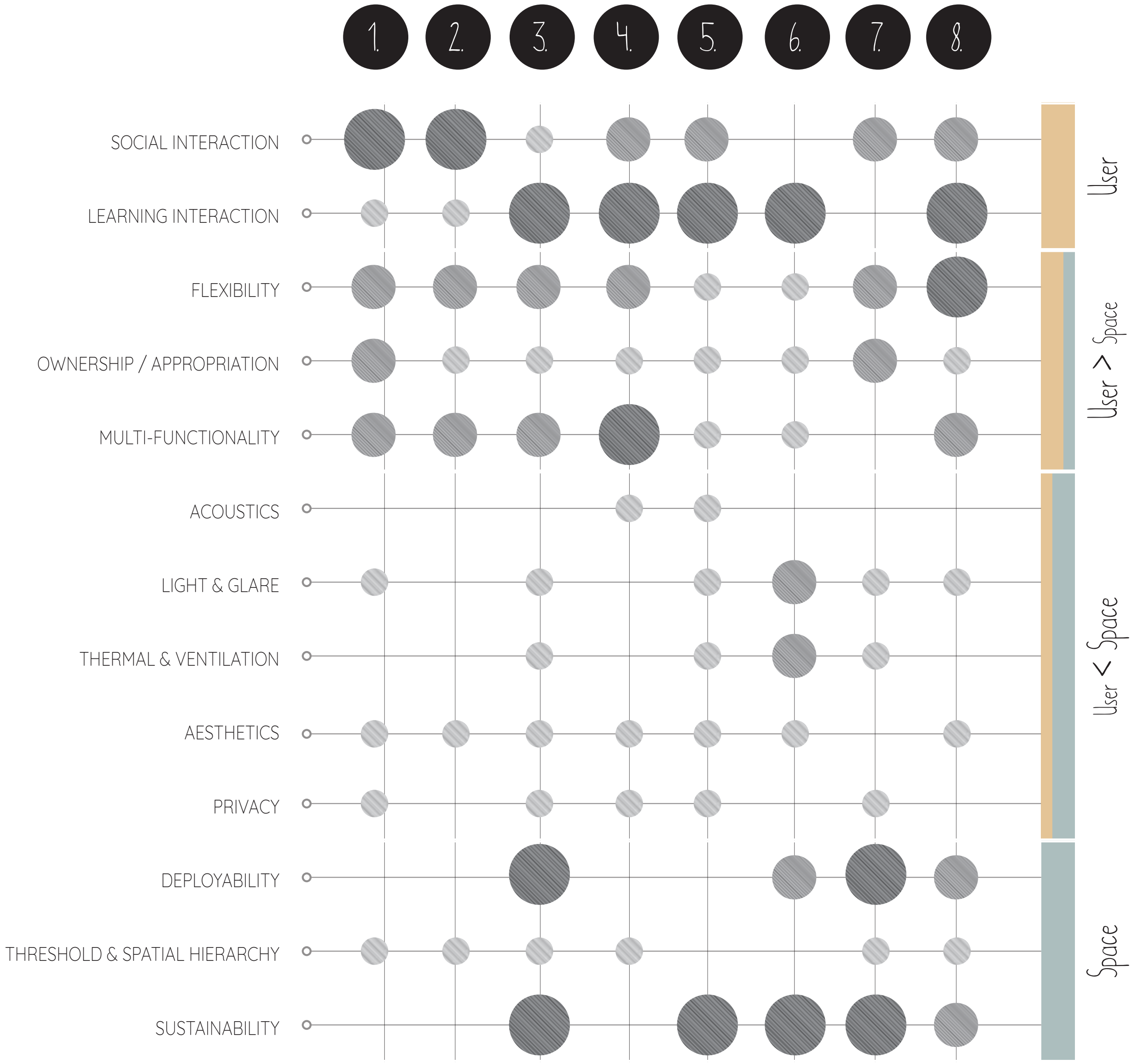


Figure 107: Precedent analysis_Assesment compilation

6.4 CONCLUSION

The precedent study presented in this chapter provides cases where the key considerations necessary for the project, have been addressed in one way or another. Through the analysis of each precedent, certain principles were identified, potentially informing the design process to follow. This chapter serves as a reference to look at existing projects for inspiration and guidance when designing a response to the fundamental concerns raised throughout *Chapters 2 to 5.*

CONCEPTUALISING A RESPONSE 07

7.1 INTRODUCTION

As the argument is made for more flexible learning environments that enable learners to flourish in both the physical, social and psychological realms of being, this chapter looks at a new approach towards achieving this. It is necessary to firstly explore conceptual ideas in response to the necessary considerations, until eventually reaching a final conceptual approach. By clearly defining a concept, direction can be given to the future design process.

7.2 CONCEPTUAL DEVELOPMENT

The chapters prior to the precedent study discussed in Chapter 6, identifies several issues on site and with regards to the well-being of adolescents in learning environments in general. The idea of creating a safe environment, that integrates nature and promotes relationships with people for support and socialisation stood out most. In addition to this, it recognises the need to create a schooling infrastructure that can expand and consist of smaller parts.

This resulted in a design vision for the project:

The school as **incubator*** for the physical, social and psychological well-being of learners.

*The term 'incubator' is used as it envisions the school as a safe and protected environment, controlled or maintained and enclosed within its boundaries; fostering growth and the development of well-being by providing suitable environmental conditions.

As initial responses to these ideals, four concepts were explored. These look at nature as a driving force, the idea of creating the school as a home away from home, or seeing it as a beacon within the community; and lastly exploring the idea of a building system. The initial four conceptual ideas are discussed hereafter. Each places emphasis on specific aspects and seeks to explore a different approach towards a possible design.

FOUR INITIAL CONCEPTS

The first conceptual approach places nature at the core of the design. This considers the current lack of green infrastructure and incorporating natural elements and greenery within the design, especially to provide shade and aesthetic elements. Consideration is given to the integration of the infrastructure with the natural topography of the site, making use of green slopes and outdoor spaces. By further blurring the boundaries between interior and exterior, different and more enriching teaching environments can be created, while allowing for social experiences. Day-lighting, passive ventilation and natural materials find particular relevance within this concept, therefore further exploring how the existing infrastructure could open up and allow for these natural systems to take place.

As a sense of self, control and belonging is found vital for well-being, this concept explores the idea of 'home' as a place with levels of privacy, personal space, friends and family that provide a support structure, comfort and safety, as well as spaces for interaction and personalisation / adaptation. It considers shelter and individual needs as main informants. The idea is to create a safe space centred around the user and their personal needs.

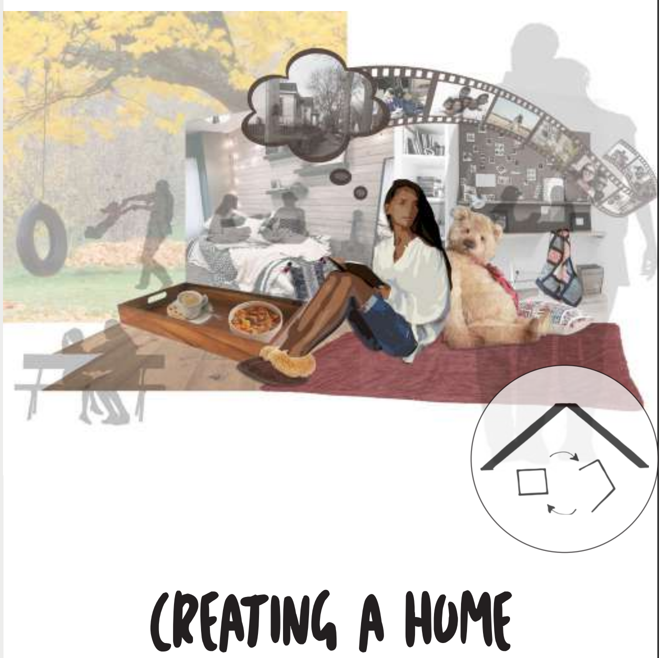


Figure 108: Four initial conceptual ideas

A COMMUNITY WELL

The Community Well is seen as a gathering space, a central point where different individuals congregate for an enriching and uplifting experience. In this instance, it considers a communal space within the school, with all classrooms and secondary spaces connected to create the whole. Furthermore, it considers this core space as a point of interaction and a beacon of hope. In terms of design, it has the potential of being a multi-functional space with both first and second order meaning, where each individual finds their place while allowing for the functioning of the whole.

BUILDING BLOCKS

Lastly, the concept of building blocks investigates the idea of stackable, modular units where the whole is comprised of similar but individual parts. To allow for future change and adaptation to take place, this concept explores the adaptability and flexibility of buildings and spaces, and the connections between these individual components.

Using the same criteria employed for the precedent study in the previous chapter, each of the initial four conceptual ideas were assessed. It sought to evaluate their response to the pressing issues which needed to be addressed through the design approach.

Figure 109: Conceptual Development

7.3 FINAL CONCEPTUAL APPROACH

By prioritising these initial conceptual ideas, a final concept could be derived:

A **Safe Haven and thriving village** that considers the individual self and fosters interaction

_ focussing on the comfort and flourishing of the individual learner, while considering the idea of a collective whole of which constituent parts work together in harmony

This concept aims to not only address aspects of well-being within the isolated context of a classroom, but also within the in-between spaces and the connection between these buildings / spaces.
On a more intangible level, it seeks to facilitate the well-being and individual needs of users, while allowing for the social interaction and communal activities to take place.
The final concept places the idea of 'home' at the core with 'nature' and 'community' serving as additional layers to address the concerns. The idea of 'building blocks' becomes a tool with which to achieve this.

Ultimately, a design concept sees the development of a deployable teaching-learning unit which addresses the concept of a safe haven as it promotes the well-being of learners on an individual and collective level, while creating a thriving village through the configuration on site. More simply put, it considers a comfortable environment where learning can take place on both the interior and exterior, allowing for more formal and informal activities, as well as the collective and personal appropriation of space.

7.4 CONCEPTUAL DRIVERS

To achieve the design concept mentioned above, six conceptual drivers were compiled as a guide to take forward and inform the design process.

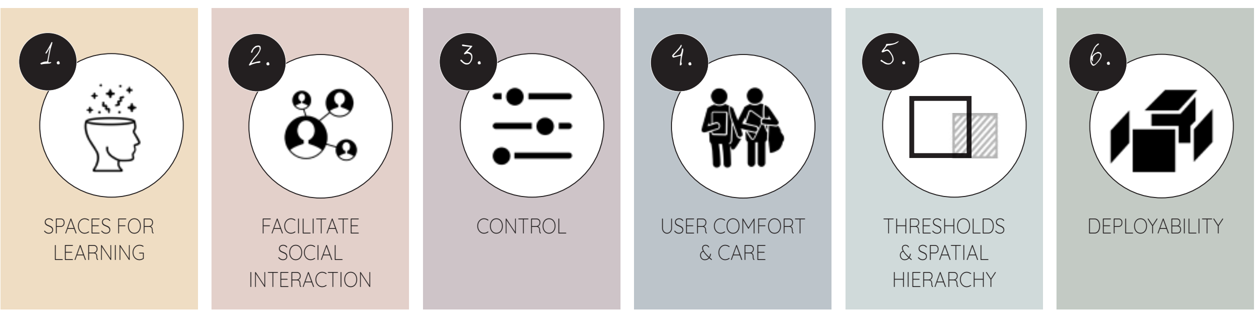


Figure 110: Conceptual Drivers

7.5 CONCLUSION

Chapter 7 explored four initial conceptual ideas which each sought to address some of the issues identified prior to this chapter. These culminated in a final conceptual approach for a deployable learning unit that promotes learner well-being in both its individual and collective configuration on site. Six conceptual drivers are formulated to drive the design process of the project.

CHAPTER 08 : FORMULATING A DESIGN RESPONSE

CHAPTER 09 : DESIGNING THE TECHNICAL

CHAPTER 10 : ENVISIONING THE POTENTIAL

CHAPTER 11 : CONCLUDING A RESPONSE

With *Part C_Adjust* as a means for change, *Part D_Articulate* presents an **alternative to the existing learning environment scenario** and seeks to refine a potential design solution to the main issues identified and explored in the preceding parts.

Chapter 8 elaborates on the conceptual response by assigning design informants to the conceptual drivers; further exploring the various strategies undertaken by the author to reach the overall **design concept** and **technical approach** for an a-contextual teaching-learning unit.
Subsequently, *Chapter 9* seeks to refine this design response into a **final proposal** for the **technification** of the unit, as well as the **application to site**.
As the project uses a testing site, *Chapter 10* **envisions the potential** of the design proposal to have a greater impact on schooling infrastructure beyond Tshwane Secondary School.
Lastly, *Chapter 11* concludes the project by revisiting the research questions, set out in *Part A_Approach*, and articulating the **contribution** made.

PART D _ ARTICULATE

FORMULATING A DESIGN RESPONSE 08

8.1 INTRODUCTION

Chapter 8 firstly investigates how the conceptual drivers, established in the previous chapter, could direct the design process with the help of design informants. In doing so, several strategies are laid out to guide the design and technical response. This chapter further includes an iterative design process of prototyping and drawings to establish the physical parameters and overall functioning of an a-contextual teaching-learning unit. As the design and technical resolution of such a unit are integral, this chapter explores a design concept and technical approach to be taken forward. Chapter 9 will follow with more detailed design investigations and technical refinement.

8.2 DESIGN INFORMANTS

Within *Chapter 7_Conceptualising a Response,* six conceptual drivers were formulated to inform the design process. Each of these conceptual drivers encompass multiple design informants, which provide more specific and measurable benchmarks to achieve throughout the iterative design process. Some entail certain design principles as an additional layer of criteria. Figure 111 to the right illustrates these drivers with their subsequent informants and principles take into account.

Throughout the theoretical and contextual inquiry, The aspect of accommodating **multiple learning experiences** and **facilitating social interaction** proved to be vital for the physical and social well-being of learners. Their psychological well-being can be promoted by enhancing their sense of worth, and a sense of control. **Control** as informant, therefore, proves to be a third critical aspect and the linchpin. Considering the typology of portable architecture and the potential to create an alternative to the current portable classrooms, which can be deployed to various contexts, the aspect of **deployability** stands as the final high priority design informant. User comfort and care, and thresholds and spatial hierarchy remain to be credible informants, but are placed as secondary considerations throughout the design process.

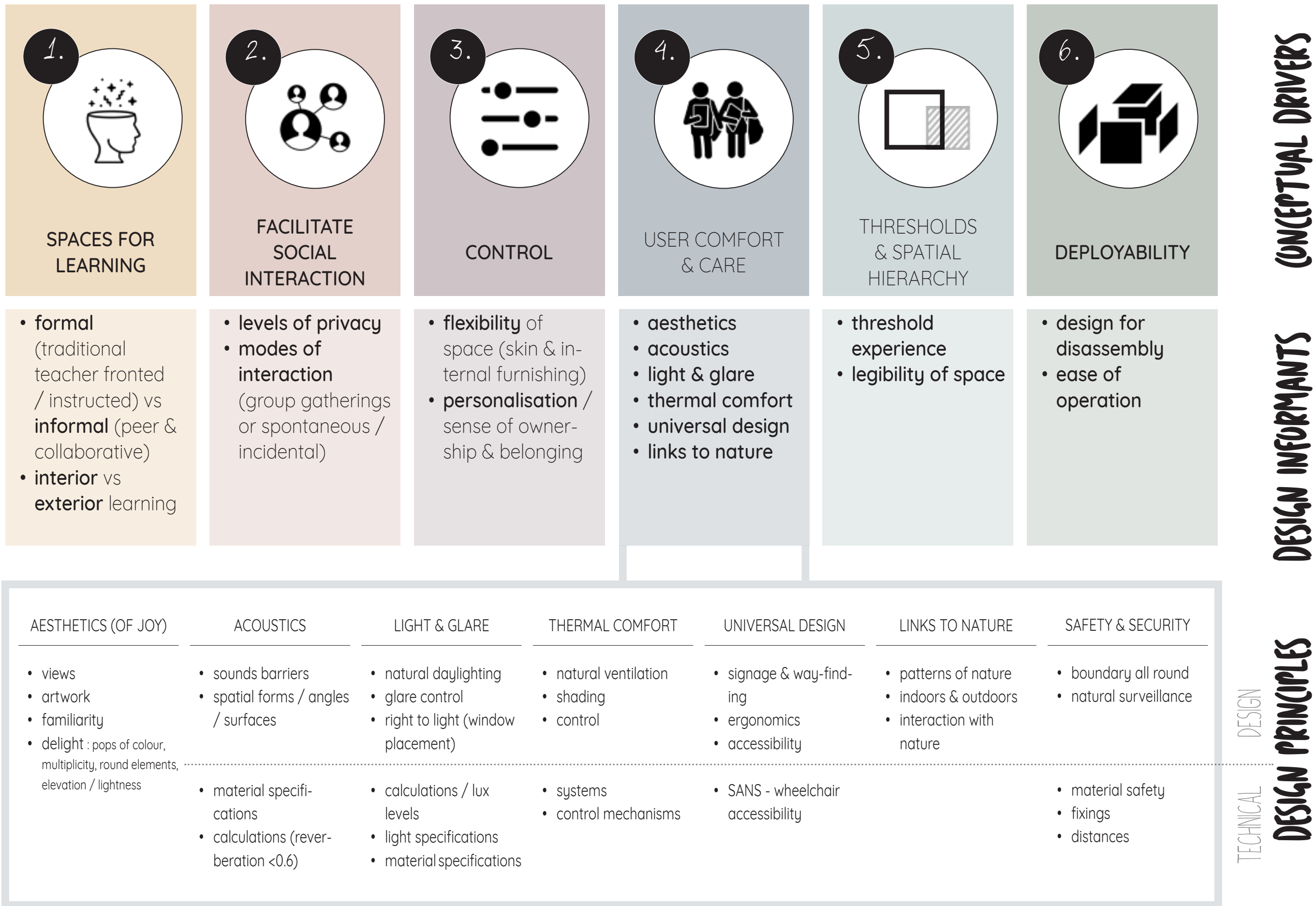


Figure 111: Design Informants

08

8.2.1 ASSESSMENT TOOL

These conceptual drivers with their subsequent design informants were formulated to create an assessment tool to use during the iterative design process. This allows for critical reflection and a visual representation of the success of each design response in achieving the set outcome concerned with the well-being of learners within learning environments.

Spaces for learning, Facilitate Social Interaction, Control and Deployability are the four conceptual drivers that were prioritised within this project due to their recurring relevance throughout the theoretical, typological and contextual inquiry. It is therefore vital to achieve a high level of success for these drivers specifically. The success level is indicated by the shade of grey used on the tool. Lower priority aspects are less crucial to optimise, but should be addressed to some degree within the design in order to ensure the overall success of the design response. Arguably, a sufficient design response would be achieved once the drivers of the highest priority are optimally addressed whilst achieving some level of success in the remaining, lower priority drivers.

After assessing the maquettes, models and drawings of an iteration, each stage necessitates a critical reflection to advise the next iteration, enabling a learning curve which allows for appropriate alterations towards the final design response.

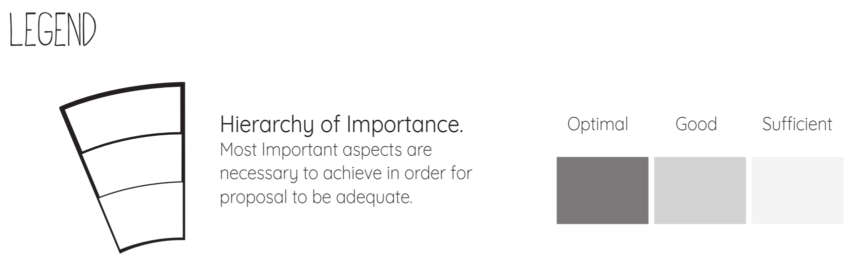


Figure 112: Assessment tool _ Legend

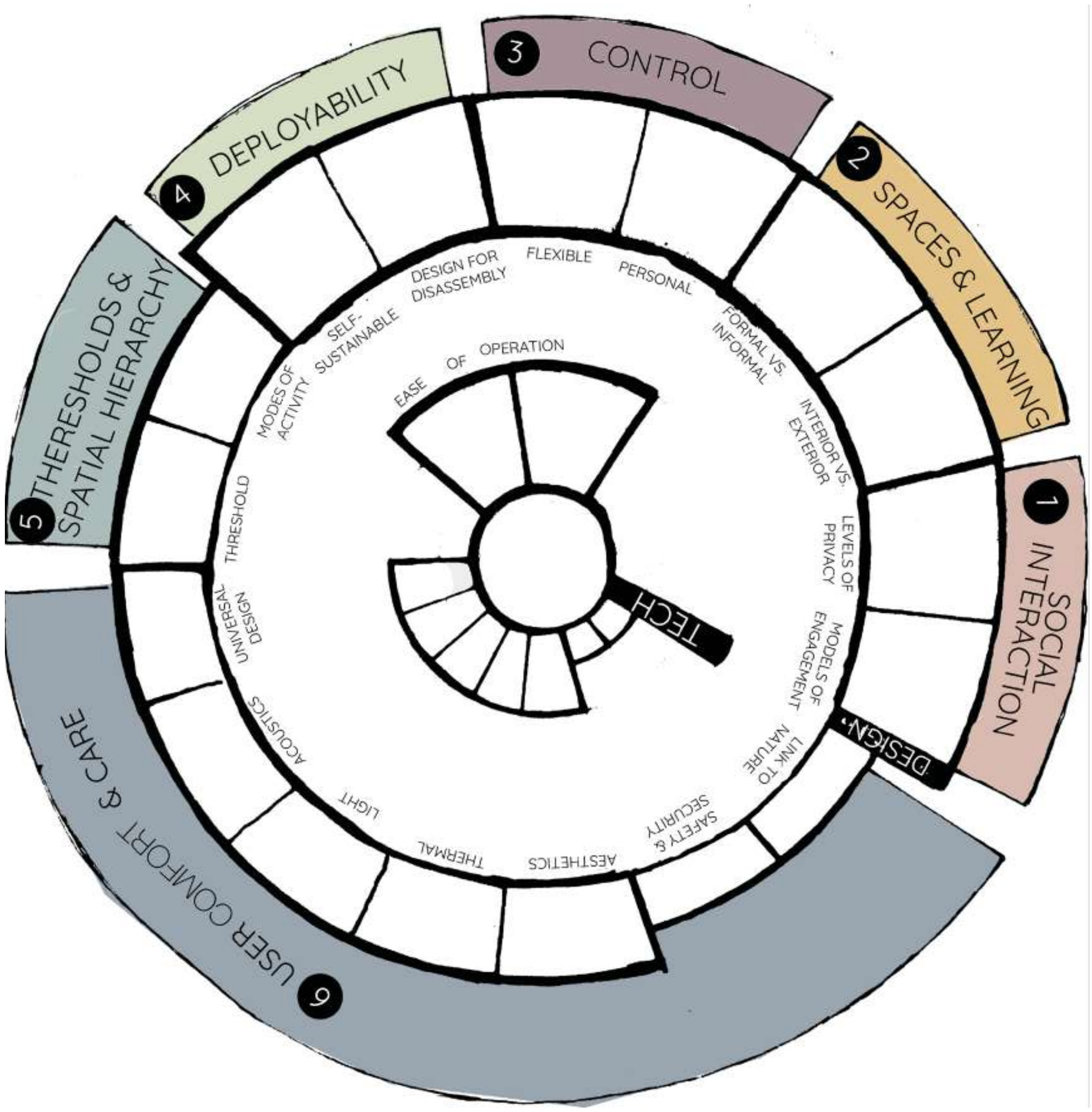


Figure 113: Assessment tool

08

8.3 UNIT DESIGN CONCEPT

Using the four main conceptual drivers and their design informants, as previously prioritised, several strategies were derived to guide the iterative design process. This contributed to the overall form and functioning of the unit, clearly identifiable within the design approach, as indicated below.

8.3.1 'FORM' STRATEGY

FORM

Spaces for learning :

Learning from the history and development of educational approaches, the conceptual driver pertaining to spaces for learning acted as form generator for the unit, on plan. Both the **teacher-fronted and the collaborative or peer learning** methods should be accommodated. This requires investigating alternative classroom shapes to the traditional rectangular form. By creating more than four wall surfaces, one provides opportunities to utilize the walls for different purposes, allowing multiple teaching possibilities and increased flexibility of space.

Facilitate Social Interaction :

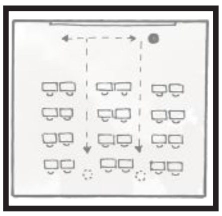
From a conceptual point of view, the entrance is envisioned to be set back or deviating from the circulation space. This would create a pause area on either side of the entryway and allows a threshold space that transitions from an exterior area of lingering and socialisation, to a similar interior area. A social zone is thus provided.

User Comfort & Care :

Although regarded as a lower priority conceptual driver, the acoustic, thermal and lighting informants allowed for the volumetric exploration of the unit. The remaining informants regarding aesthetics, universal design, security and safety, and nature would be considered within the later stages of the design.

Figure 114: Form strategy and design application

DESIGN APPLICATION

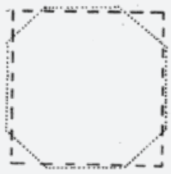


TEACHER-FRONTED

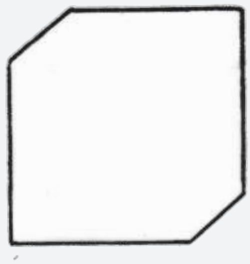
+

FLEXIBLE & CONVERTIBLE

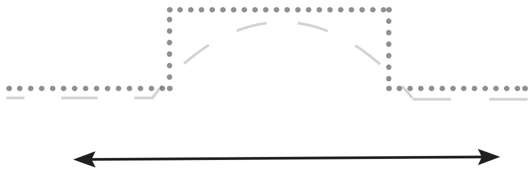
=



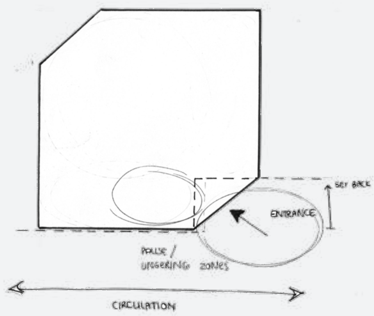
HEXAGONAL SHAPE TO ACCOMMODATE MULTIPLE APPROACHES



ENTRANCE



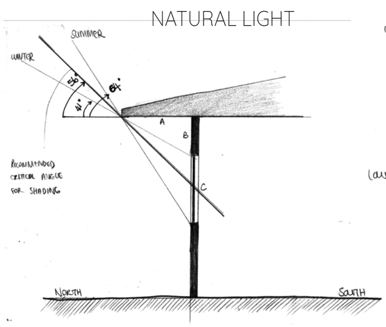
CIRCULATION ROUTE

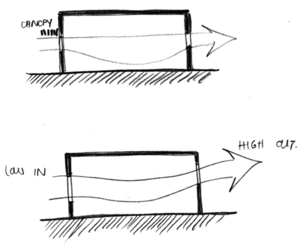


ENTRANCE ON A DIAGONAL, CORNER WALL, DEVIATING FROM CIRCULATION ROUTE ALONG EITHER SIDE

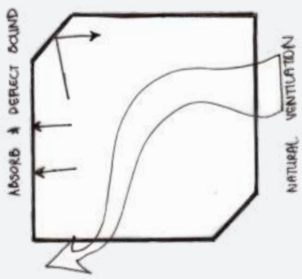
08

NATURAL LIGHT

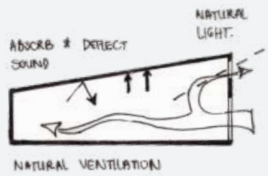




NATURAL VENTILATION



NATURAL LIGHT & VENTILATION, AND ACOUSTIC CONSIDERATION



8.3.2 'FUNCTION' STRATEGY

FUNCTION

Spaces for Learning & Social Interaction :

Five learning scenarios were conceptualised from the investigation into more recent educational approaches in Chapter 2_Unfolding Theory, as well as a brief, intuitive exploration by the author of what each subject could potentially entail. For the latter, the subjects were limited to the academic curriculum currently offered by the Tshwane Secondary School, as seen in figure 115 below.

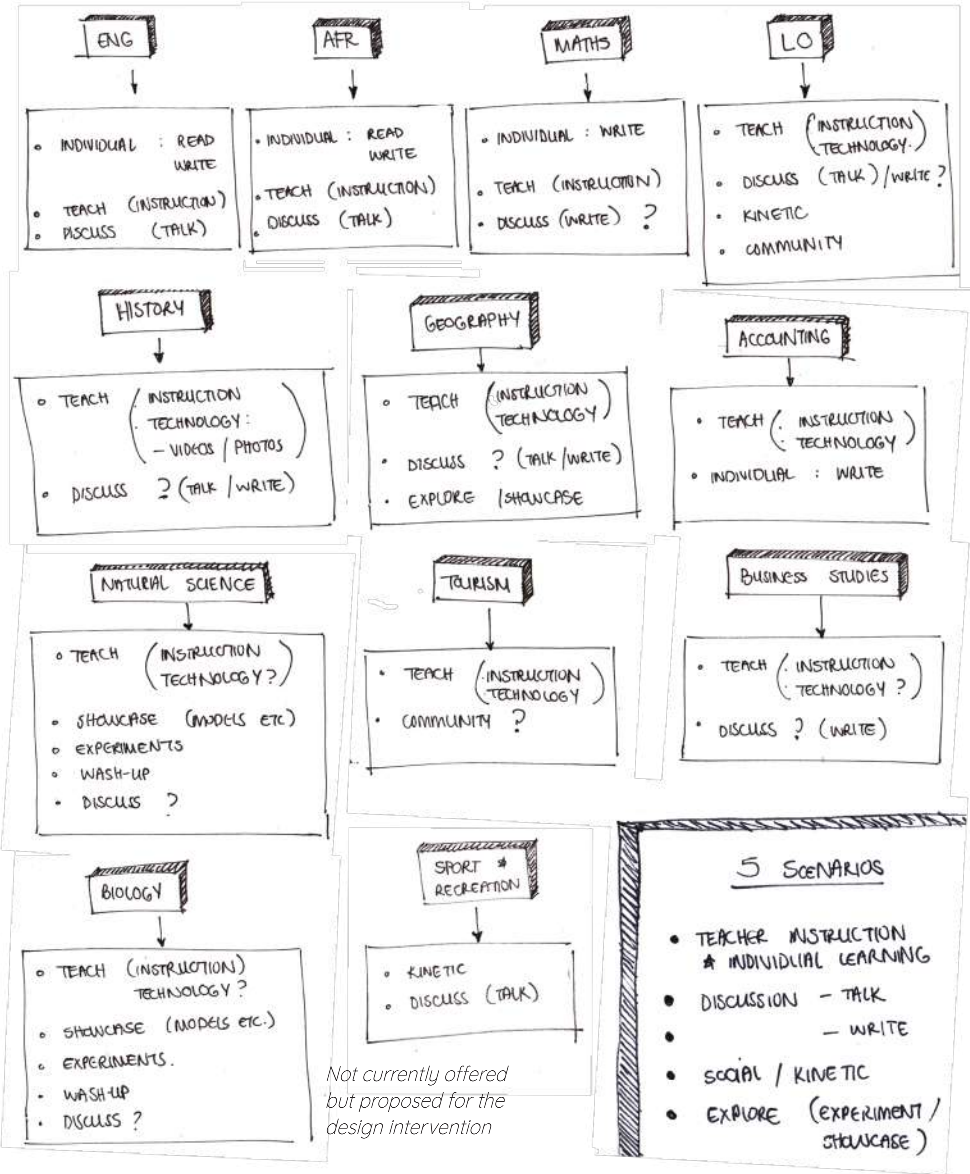
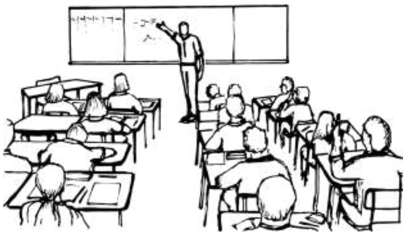


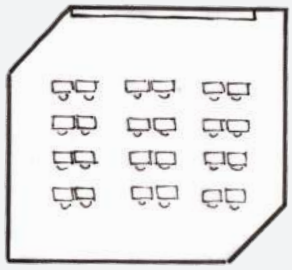
Figure 115: 'Function' strategy _ Subject Scenarios

DESIGN APPLICATION

1. TEACHER FRONTED

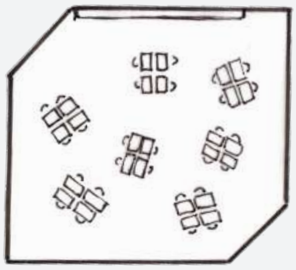
The traditional teacher fronted for teacher instructed learning, potentially including technology for presentations and / or projection.





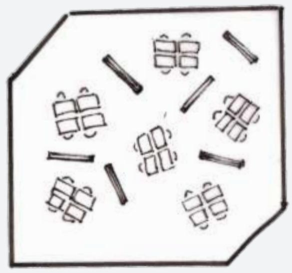
2. HYBRID LAYOUT

A hybrid layout that allows both teacher instructions, as mentioned above, and collaborative work in a single setting.



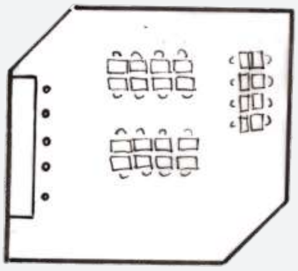
3. PEER LEARNING

The peer-learning scenario making use of partitions / screening devices to create some separation between groups of learners.



4. EXPLORATION

Individual or group learning which allows for self-directed exploration and discovery. This could take place either in a more focused work-zone, potentially incorporating computers, or throughout the classroom.



5. SOCIAL / KINETIC

Social and kinetic learning in both interior and exterior spaces. This includes skill exchange between learners, sport activities and classroom activities which employ play, dance, scenario acting or any other physical learning.

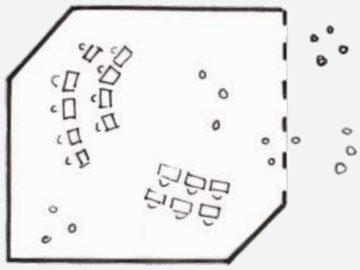


Figure 116: 'Function' strategy _ Five scenarios and their design application

The use of space not only affects the physical parameters of the unit, once again impacting the form, but furthermore offers a degree of flexibility and control to the user. Both *Spaces for Learning* and *Social Interaction* influence the concept of control, and vis versa.

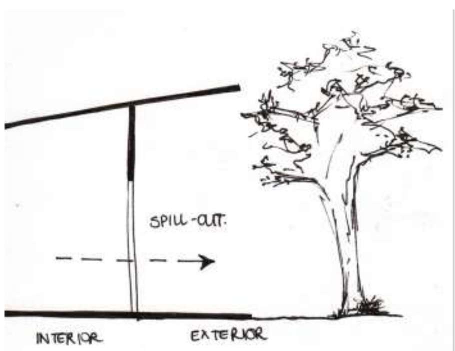
FUNCTION

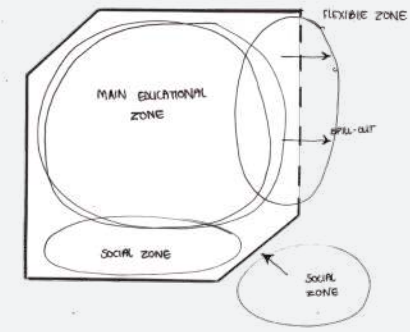
Although the first four scenarios discussed above typically take placed indoors, the fifth introduces a consideration for outdoor learning experiences. Different zones within the classroom could be assigned to the different scenarios, with the majority taking place within a main educational zone. As previously mentioned, a social zone can be provided. To allow for both interior and exterior learning experiences, the spill-out zone, extending from the main educational zone requires exploration.

Control :

These different zones address learning and social interaction, with each zone encompassing specific functional requirements, demanding for certain objects or design features. By creating a unit that can adapt to various educational approaches, and learning and social scenarios, control is awarded to the user. This becomes relevant on two scales; giving a sense of flexibility with regard to the built skin of the unit, and the interior furnishing. User control will no longer be limited to the use of space, but include the composition of the unit and its physical parameters.

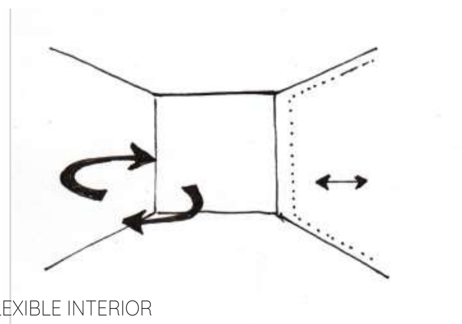
DESIGN APPLICATION



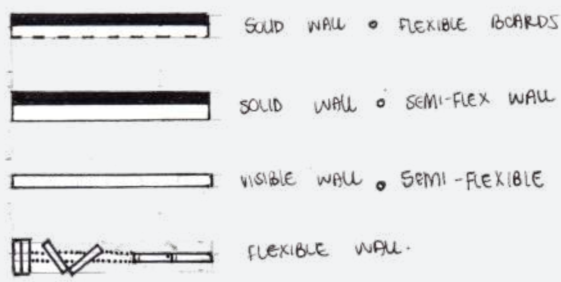


SOCIAL ZONE AND AN EDUCATIONAL ZONE ON BOTH THE INTERIOR AND EXTERIOR

FLEXIBLE BOUNDARY



FLEXIBLE INTERIOR FURNITURE & FIXTURES



DIFFERENT, INTERCHANGEABLE FACADES ALLOWING VARIOUS LEVELS OF FLEXIBILITY AND OPENNESS

08

Figure 117: 'Function' strategy _ Spatial zones & control, with design application

8.3.3 SIZE STRATEGY

SIZE

In terms of the size of classrooms, Guideline A_WELL Building Standard requires 4m^2 per learner, whereas Guideline B_Norms and Standards for South African School Infrastructure stipulates 1m^2 per learner and 7m^2 per teacher, with a maximum of 40 learners per classroom. Considering the cost implication of too large units and the site restrictions to which the project is subjected, a median should be found. This means that units should be larger than the existing 56m^2, which has proven to be restricted in use, while making optimal use of space in order to create a compact unit that efficiently utilises the available space.

During the contextual analysis it was found that only grade 8 and 9 classes serve such high numbers, due to subjects being compulsory. The same applies for the compulsory subjects taken by Grade 10-12 learners, even though these groups are smaller. However, the classes for elective subjects taken by Grade 10-12 learners are significantly smaller and accommodate anything between 10 and 30 learners.
The decision was thus made to design a standard unit large enough for approximately 36 learners, with the potential to enlarge or combine units should there be a need for more space.

Deployability :

To settle on a median, the size limitation of the unit was guided by the aspect of deployability. A modular system would enable incremental control over the size of the unit. Considering material properties and minimizing waste, the standard 1220 x 2440 panel size was refined to 1200 x 2400, and used to determine the size increments of the unit. Factors of these would also be used throughout the design, corresponding with the functional and ergonomic requirements. As a result, the median of roughly 88 m^2 is found.

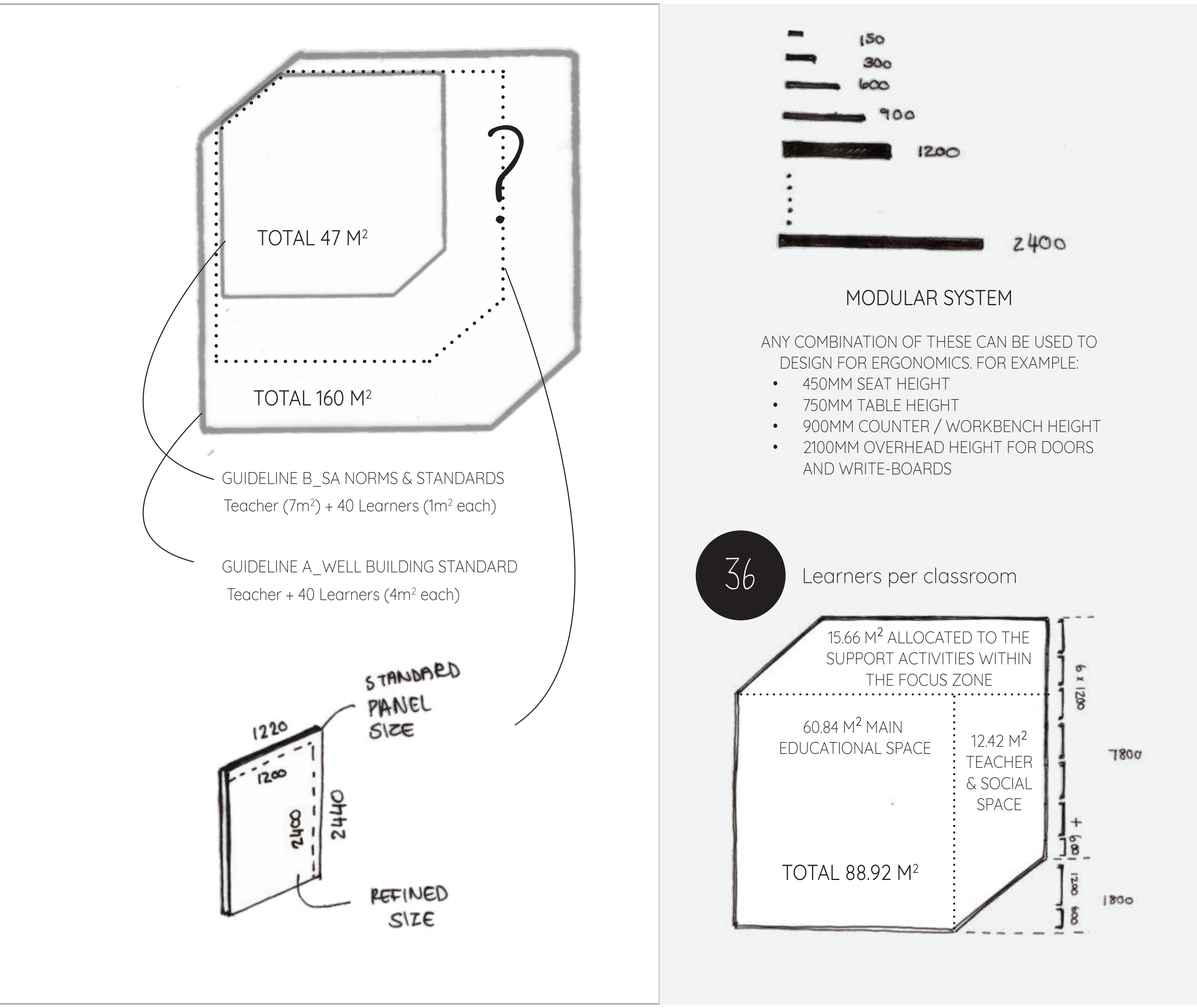


Figure 118: Size strategy and design application

8.4 TECHNICAL APPROACH

FINAL ITERATION

From the strategies and through the iterative process involving maquette prototyping and drawing explorations, the result sees a hexagonal unit, able to accommodate a variety of interior layouts for different learning scenarios. A modular system of prefabricated elements will be used to construct the unit, ultimately delivered to site as a kit of parts.

Each of the four main facades have unique properties and are interchangeable. Among these, a operable facade facilitates the potential to open up, thus blurring the boundaries between the interior and exterior spaces for both learning and social experiences. A support wall offers services and additional fixtures which would assist the functioning of the space, such as water and electricity, storage and workbenches. The teaching wall is equipped with moveable write-board to allow for both the teacher fronted instruction, and peer learning.

Volumetrically, consideration is given to natural daylighting and ventilation through the slanting roof and clerestory windows. Further ventilation can take place through the louvre panels, regardless of the unit orientation or composition. Universal access is taken into account by providing a ramp component. As a means to be self-sufficient and sustainable, a water storage tank is incorporated, further accommodating the support wall services.

8.4.1 TECHNICAL QUESTION

When looking at the high priority design informants the aspect of control becomes particularly important as it not only allows for the adaptation of space in its own right, but furthermore supports the social and learning experiences. Multiple learning methods and social interactions can be accommodated by providing control over both the physical boundaries and interior furnishing of the unit, to be responsive towards the collective and individual needs of users. Keeping design for disassembly and the ease of operation in mind, the construction of a deployable unit requires critical consideration for well-being. The technical investigation therefore questions the following:

How can the **assembly design enable deployability and user control,** to allow for both flexibility and appropriation of space?

A material, colour and construction strategy could assist in discovering the answer to this question and guide the design resolution and technification process.

8.4.2 MATERIAL STRATEGY

Material specifications aim to be **dual in use**, while allowing for user control and deployability through its weight properties and potential application. For example, bringing haptic and acoustic value to the space, or for its light and visual properties. Exterior surfaces should be weather resistant, with a slip-resistant floor finish creating continuity between the interior and exterior spaces. Material finishes on the interior wall faces and ceiling should achieve levels of privacy, allow for writeable and pin-able surfaces, and contribute to acoustic control, respectively. Most importantly, the material properties and potential application should consider **ease of operation and deployability**, in order to allow for control. In addition to this, the **sustainability** and **safety** of materials play a role in the final selection thereof.

Material family	Material name	Characteristics	Functional / Structural Properties	Possible Application	Malleability / workability / customization potential	Supplier + Available size / colour	Sensorial qualities		
							acoustics	light reflectance / transmittance	transparent / translucent / opaque
Natural	Cork	good acoustic properties, biodegradable and antimicrobial, inexpensive, paper like malleability, varying thickness, waterproof, stable, closed cell foam, light & resilient, insulates against heat & sound	not structural; as surface / acoustic treatment & haptic quality	Interior application. Acoustic treatment, surface treatment / furniture. Wall & ceiling insulation. Pin-board	Available in sheets of different thicknesses, can be moulded in custom forms. Flexibility dependant on sheet thickness, can be brittle around the edges and fragile as a very thin sheet. Fairly flexible	Get Cork : Sheets of 915 x 610mm x 6 / 10 mm thick. Fine, medium, large, lare mixed and roasted density available. Roasted being a dark brown colour, and the large mixed density having a dark speckle; whereas the other densities (fine to large) are fairly uniform in a natural brown colour. (Get Cork, 2019)	Sound Absorber: three millimeters of cork can block up to 10 decibels of sound; NRC (Noise Reduction Coefficient usually reported as a percentage): 1-inch thick cork wall tiles have a rating of 0.7, which means 70% of the noise is absorbed and 30% is reflected (Better Soundproofing, 2019). Overall NRC 0.15 - 0.7 (dependant on thickness). 6mm can block up to 20 dBs (Soundproof Living, 2019).	no reflection in its natural finish	opaque
Wood	OSB (F2)	engineered wood-based panel material (typically three layers consisting of long strands of wood bonded together with synthetic resin adhesive, with the strands of the outer two layers orientated in a particular direction (Panel Guide, 2014:103). Durable, cost effective and versatile. Panels can vary in thickness and colour. Not as smooth on the surface when untreated. No grain, knotholes or core voids present. Stronger and more dense than plywood. Resists buckling. Better resistance to decay than Plywood.	Could be structural elements (load bearing) or panel objects / surfaces. Flooring, wall / ceiling cladding, decking	Interior application. Surface finishes (wall, floor/ ceiling), furniture, panelling	Limited. Use as sheets, can be cut in different shapes / sizes - using hand saw /power saw and machined (routed, spindled, planed and bored) with normal woodworking machinery (Panel Guide, 2014:106). Can not be bent, but can be scored at small intervals to achieve a curved effect, not resulting in a solid surface finish.	Citiwood : Panels 1220 x 2440mm x 6 / 8 / 12 / 18 / 21 mm thick. (Citiwood a, n.d.)	Dense wooden panels with a R-value of 0.9, will limit the transmission of sound through the panel. The hard surface will however not absorb sound, but reflect it, thus directing the sound back into the space. Can be engineered to have acoustic properties	Depending on finish / coatings applied. Will subtly reflect light with a glossy varnish or sealant finish, mostly no reflectivity otherwise.	opaque
	plywood (3 ply beech)	Versatile material with a high strength-to-weight ratio. Available in a range of wood species, including hard- and softwood species (and a combination of both), and a range of resin types for interior, high humidity and exterior conditions (Panel Guide, 2014:111). Smooth, constant wood grain, very strong, durable and stainable. Resistant to many common annoyances associated with natural, solid wood. It is quite versatile in use and can vary in thickness. Uniform & strong	Could be structural elements or panel objects / surfaces. Building & construction / furniture and furnishing. Interior or exterior application, depending on specific ply used	Interior application. Surface finishes (wall, floor/ ceiling), furniture, panelling	Available in standard sheet sizes, thus prescribing some limitation to the surface size. Plywood can be cut, using a hand-, circular or band saw. It can also be routed, and moulded (Panel Guide, 2014:117).	Citiwood : Panels 1220 x 2440mm x 6 / 9 / 12 / 15 / 18 / 21 mm thick. (Citiwood b, n.d.)	Panels can be perforated and used in conjunction with a more absorbent material such as cork or felt to improve its acoustic performance. The hard surface will reflect sound, with its density reducing the transmission of sound through the panel	laminated surface provides slight shine, reflecting light subtly, but with no impact on comfort.	opaque
	medium density fibreboard (dry process fibreboard) - MDF	engineered woodbased panel, consisting of wood fibres which are bonded together with a synthetic resin adhesive (Panel Guide, 2014: 119). Versatile in use for construction and furniture. MDF is strong, denser than plywood, cost effective, fungus / mold resistant and a good insulator; further having sound-proofing attributes and can be finished in various ways (Bloch, 2012).	Non-structural panel used for furnishing and surface finish.	Interior application : surface finish / furnishing and furniture	Available in standard sheet sizes, thus prescribing some limitation to the surface size. Can be machined, routed and moulded - sanding the surface to producea smooth finish.	Citiwood : Panels 2750mm x 1830mm or 3660mm x 1830mm x 3 / 6 / 9 / 12 / 16 / 18 / 22 / 30. (Citiwood c, n.d.). Melamine faced MDF available in 16mm thickness (Citiwood d, n.d.).	the density of panels reduces sound transmission to adjacent spaces, while the hard, level surface is considered reflective	Depending on the finish. In raw form, no light reflectance. Glossy or peen finished could have levels of reflectance.	opaque
	timber (pine)	wood grain, smooth, natural colour finish, versatile in use, structural. Various lengths and sizes available	Structural : roofing element (truss, rafters, perlins or battens). Can also be used for non-loadbearing elements, flooring and furnishing.	interior : roof trusses providing additional support for the roof	Timber beams typically come in lengths mentioned under available sizes. The timber can be cut on site to suit lengths that you require. They can also be spliced with another beam to create a longer section than readily avaiable on the market. Should it be required timber can also be curved or bowed if required. From a large section of timber a custom section can also be carved to the required shape for furniture as an example	Timber beams can come in lengths of up to 12m but can be spliced to make longer lengths. Different suppliers have different typical cross sections, for example, OT Joiners have the typical sections of 46x231, 46x300, 70x231, 70x300, 70x363, 106x231, 106x363 and sections like a 120x120 or a 140x140 can be made by request, Builders warehouse have other sections such as a 32x305 or when glued together a 32x610 can be created. Similarly pine sheets for flooring also come in various panel sizes and thickenesses.	reflect sound as a sense hard surface. As a truss, surface areas are small, will have little effect on acoustics.	no light reflectance	opaque
polymer	wood composite	Can be smooth or textures, plastic feel but can be made to resemble wood, versatile in use, can be extruded to shape, can be UV resistant and weatherproof, thus variety of use	Could be structural or smaller detailing items.	interior/ exterior : all structural extrusions, flooring (decking), balustrades, and furniture			Dense and hard surface, thus reflecting sound. Possible impact sound, counter with underlying infill	glossy finish might have a slight shine but mat finish will not reflect light	opaque
Glass	transparent, Laminated glass - Clear Safety Glazing	Transparent, Scratch and abrasion resistant, Transmits & reflects light, Aesthetic & Functional, Inherently strong, Good under compression, Chemical and corrosion resistant, Hard & brittle	Allows transmittance of natural light optimally. Allows clear views.	Facades / windows for views and natural light			Sufficiently eliminates environmental / ambient noise. Louder sounds transmitted through.	Allows natural light into interior. Glare possible with direct sunlight.	transparent. Can be made more translucent using methods of sandblasting, frosting or fritting and applied decals.
	Palram _ Palsun	flat solid polycarbonate sheet, virtually unbreakable, transparent as glass but less than half its weight, high impact resistance, high clarity and light transmission, weather and UV resistant, wide service temperature range, blocks harmful UV radiation, good acoustical insulation, lightweight, versatile, formable and machineable (Palram South Africa a, n.d.).	high impact resistance. tensile strength at yield: 62.5 MPa, tensile strenght at break: 65 MPa (Palsun Technical Guide, 2016:5). Can be used as permanent glazing when used within suitable support frame : steel or aluminium, wood or rigid PVC profiles (Palsun Technical Guide, 2016:41)	Skylights, roofing, transparent acoustic barrier (Palram South Africa a, n.d.), wall panel - as permanent glazing	Somewhat limited to panel size, even though custom sizes are available upon request. Can be cut with table mounted or portable saws (Palsun Technical Guide, 2016:24-29). Panels can also be routed along the edges and drilled - specifically required for fixing methods; edges can also be grinded to smoothen any rough or jagged edges that occur during cutting (Palsun Technical Guide, 2016:24-29). Sheets can be cold bent or curved to a minimum radius as a factor of 200 x sheet thickness; or alternatively suitable for various thermoforming procedures (Palsun Technical Guide, 2016:31-35).	Palram : panel width and length 1220 x 2440, 2050 x 3050, 2450 x 3050 subject to speciic surface finish. Available thickness also depending on surface finish: 1, 1.5, 2, 2.5, 4, 5, 6, 8, 9-12.7, 18. "Other dimensions and specifications are availble upon request, subject to a minimum order" (Palsun Technical Guide, 2016:3)	suitable as a see-through saound barrier as it has good sound insulation properties. Panels of 12mm thick have a sound reduction value of 31dB, whereas 15mm panels offer 33dB sound reduction. (Palsun Technical Guide, 2016:11)	depending on the specific choice of colour and transparency, little to up to 90% of natural light can be transmitted through the panel.	Variety of options available: clear, tranparent, translucent or opaque
	Palram_ SunLite XL	These sheets have a cellular polycarbonate structure that yields a lightweight sheet, high impact strength, superior thermal insulation; further having high light transmission, including heat-blocking SolarSmart technology; structural durability, weather and UV resistant, blocks UV and radiation, easy to handle and install, high fire rating, versatile (Palram South Africa c, n.d.).	High impact resistance, tensile strength at yield: 62 MPa; Elongation at break : >90 (Sunlite Technical Guide, 2015:3)	roofing, wall cladding, glazing, skylights and sidelights, illuminated signage and displays, decorative partitions	Due to their hollow core, preliminary preparation and additional care are required before the actual installation. Flat multiwall polycarbonate sheet with UV protective layer on one side.. X-lite available in sheets with thickness of 16, 25, 32, 35 and 40 mm and area weight of 2.5, 3.0, 3.2, 3.5 and 4.1 Kg/m2. Colours available in clear, bronze, white opal, white diffusr, green, blue or multi-layered.. For sheets installed in the flat, horizontal position, (roofs, overhead skylights), a minimum slope of 5 percent is	Palram : panel widths vary and are available in 4, 4.5, 6, 8, 10, 16, 20, 25, 32, 35, 40 mm. Several structures are also available, namely, thin wall, triple wall, X-Lite, V-structure and 7 walls. "Other structures, dimensions and weights are availble upon request" (Sunlite Technical Guide, 2016:1)			clear or vriety of colours

Figure 119: Material Matrix

					Additional properties			Maintenance
tactility / finish	aesthetic : colour etc.	Sourcing & manufacturing (Waste, renewable resources)	Reuse/ reduce/ recycle	Density (kg/m3) or Panel Weight (kg/m2)	Performance in fire	Thermal Properties	Weather / water resistance	
generally smooth with a slight texture depending on the density and manufacturing, soft	left unfinished to add a natural feel and haptic warmth to the space, speckled as it consists of small particles - not a single, solid colour finish	from tree bark, 100% renewable source. no need to destroy the tree in order to obtain the material, growth continues.	biodegradable, can be downcycled into smaller particles and create a lower density cork product, not recyclable	Density: 140 to 160 kg/m3 (Amorim Cork, n. d.)	self extinguishing, fire resistant	Good insulator. Thermal conductivity : 0,035-0,048 W/m.°C. Thermal conductivity: λ = 0.043 W / m ° C (Amorim Cork, n.d.)	waterproof	Keep clean by only using damp clean cloth, no cleaning products with abrasive ingredients or solvents. Keep the water or other liquid use to a minimum as it could seep into the cork and cause damage. Protect from direct sunlight as cork is natural product and may fade over time, if exposed to direct sunlight for long periods of time (Worldfloorsdirect.com, 2019)
textured / finished to be smooth by sanding down the surface. Natural finish visually adds sense of tactility due to varying wood strands. If not finished or sanded along the edges / edged : prone to splinter. can be painted with water or oil-based paint, varnished, stained or finished with a wood veneer (Panel Guide, 2014:73)	Colour variations depending on the wood species used, resin system adopted and presing conditions under which manufactured. Transparent coatings will provide a smoother and shinier surfaces. Flakes differ in colour. Possibly painted - irregular surface finish will prohibit a smooth finish; flakes could absorb paint differently, resulting in a irregular colour finish	Quick regeneration process, using a variety of fast growing species and sustainable self-regenerating forests or plantations. Environmentally responsible and safe to use. OSB needs high heat and pressure to be produced, just like plywood, particleboard and MDF.	recycled content but difficult to reuse after use. can be safely disposed. Short lifespan. Not recyclable, but can downcycle and is biodegradable.	Typical density : 600kg/m3 - 680kg/m3	highly flammable. Engineered to be fire-resistant - Flame Safe fire retardant coating can be applied to the surface. Equivalent or better fire performance for same thickness of plywood. Can be coated with a non-combustible, fiberglass reinforced, cementitious coating - bonded to either one/ both sides of the panel, covering the surface. Impregnation treatments available. If not treated, the panels are flammable, being a wood derivative.	Thermal conductivity : 0,3 - 0,35 W/m.°C. For a panel density of 650kg/m3 : 0.13 W/m.K (Panel Guide, 2014:105)	hygroscopic (absorbing moisture from the air). Higher grades of OSB are moisture resistant but not waterproof, thus wetting of OSB should always be avoided to prevent swelling and potential fungi attack. Water vapour resistance factor varies between the wet cup and dry cup, being 30 and 50 respectively for a density of 650 kg/m3. (Panel Guide, 2014: 105)	Not normally attacked by wood-boring insects, but could be susceptible to fungal attack - panels made from pine offer moderte resistance to attack, whereas those made from aspen and spruce could be more susceptible (Panel Guide, 2014:105). Fungi attacks can be avoided by protecting the OSB from environments that result in fungi growth, such as higher temperatures and certain relative humidities. Surfaces and edges can be coated for protection against moisture damage, thus requiring additional coatings with time. Edges need to be protected and sealed - prone to swelling. Must be protected from rain and accidental soaking (Panel Guide 2014:106)
wood grain, adding a sense of tactility. This can be felt slightly or smoothed out, depending on the finishing process. when sanded, the surface is smooth to touch. The tactilliy will also depend on the wood species used.	Natural finish would include a wood grain and darker knots over the otherwise fairly uniform natural colour. Potential applied finished include a range of paints, varnishes and stains - depending no the required outcome (Panel Guide, 2014:118). When used in changing environmental conditions, should make use of flexible coatings to accommodate the expansion or shrinkage (Panel Guide, 2014:118). Waxe and lacquer are also suitable - colourless or coloured.	Air pollution - emission of chemicals and fuels used in the industry, as well as drying the wood and applying the glue. Generators release hydrocarbon and particulate pollution, with the sawing of wood further contributing to the latter. Noise, soil, water and air pollution is caused by various factors of the industry. Secondly; deforestation, soil degradation, a high carbon footprint and disposal are all elements of concern. Need to source locally. High heat and pressure to be produced, particleboard and MDF.	Plywood panels can be reused if still intact, without a separation of adhesive from the veneer joints. Long life span, easy reuse, but energy intensive. Downcycle & biodegradable	Typical density : 340 kg/m3. could range between 400 kg/m3 and 700 kg/m3 (Panel Guide, 2014:113)	Highly Flammable. Fire rated or Flame resistant plywood can be used, preventing fire spread. Fire resistant chemical coatings can be applied and used in treatment processes. Alternatively, can be combined with non-combustible materials, such as plasterboard or fibrous cement, hiding the visual wood qualities.	Thermal conductivity : 0,3 - 0,35 W/m.°C. Dependent on the density, it can range from 0.09 to 0.24 W/m.K. (Panel Guide, 2014:116)	Hygroscopic (absorbing moisture from the air). Cross laminated nature of plywood result in minimal size differentiation as it shrink or expands; "1% change in moisture content increases or decreases the length and width of plywood by about 0.15mm per metre run" (Panel Guide, 2014:115). Should be treated to avoid water damage. Specific resin types will also increase the resistance to water. Water vapour resistance : 50 - 110, depending on the density, species and structure.	Edges should be sealed properly with suitable sealing compounds in the form of either liquids, pastes and hot melts to prevent water damage, which could cause dimensional changes/swelling, staining, failure of the coating, decay, delamination and ultimately to premature failure of the plywood (Panel Guide, 2014:118). UV timber finish could be applied to avoid plywood tanning when exposed to direct sunlight over time (Onetwotree, 2019). A dusting cloth or slightly damp cloth should be used to remove dust and dirt as needed, wiping the surface dry afterward. Be wary of heat and moisture, as these could stain the surface; also avoid abrasive objects to prevent scratching - use adhesive felt pads etc. (Room & Board, n.d.).
Raw MDF : Smooth sanded finish, hard. Melamine faced MDF: can be slightly textured with a wood-like grain, or a slight bump finish where panels are used in their peen finish.	Pale straw colour (Panel Guide, 2014: 119); can have added finishing affording a variety of colours and textures. Sealed edges or edging. Opague paints, conventional water- or oil-based paints, lacquers and resins, as well as varnishes and stains can be applied. Melamine faced MDF is also available in various colour finished.	"typical process involves reducing wood down to small chips, which are then thermally softened and mechanically refined into fibres ... mixed with a synthetic resin binder. The resinated fibres are dried and then formed into a mattress ... (which is) pressed between heated polished press plates to the desired thickness" (Panel Guide, 20104:119). Uses less binders than particle board (Bloch, 2012).	Not fully sustainable due to the use of adhesives. Binders and resins may contain formaldehyde, a know carcinogen. Can be recycled, even though the process is new and scarce, resulting in disposal to landfills where chemical could leach out and contaminate groundwater (Bloch, 2012).	Densities can range from below 550 kg/m3 to up to 800 kg/m3 and above. Typical densities include the following: •Average density: 700 kg/m3 to 800 kg/m3 • Core density: 600 kg/m3 to 700 kg/m3 • Face density: 1000 kg/m3 to 1100 kg/m3. Weight is however not uniform accross		Range : 0.05 W/m.K @250 kg/m3 density to 0.14 W/m.K @800 kg/m3 density	Hygroscopic (absorbing moisture from the air). Moisture content change of 1% will typically result in a 0.4mm length and width change per metre run (Panel Guide, 2014: 120). Water vapour resistance factor : varies from 2 @ 250kg/m3 density, up to 20 @ 800kg/m2 density (Panel Guide, 2014:121)	Although "susceptible to fungal attack under prolonged wet conditions", the attack by wood-boring insects is less likely (Panel Guide, 2014:121). A dusting cloth or slightly damp cloth should be used to remove dust and dirt as needed, wiping the surface dry afterward. Be wary of heat and moisture, as these could stain the surface; also avoid abrasive objects to prevent scratching - use adhesive felt pads etc. (Room & Board, n.d.).
wood grain, adding a sense of tactility. This can be felt slightly or smoothed out, depending on the finishing process.	natural finish, clear treatments to retain natural colour. Can be painted	Laminating of pine consists of a number of manufacturing processes, including a glueing process. Glued planks is stacked in the laminating press where pneumatic pressure is applied to squeese the glued surfaces together. Beams are planed all round to smooth surface finish to required dimensions and laminated beams cut to required lenghts. Beams are inspected in accordance with the apperance grade as stipulated in SANS 1450	Solid wood aste has always been a problem to recycle, with the end uses of wood recovered from construction and demolition activities sometimes limited. This is because the wood is commingled with other materials and contaminants or is in such poor condition that the cost of processing and cleaning limits the economic viability of processing and reusing the material. Wood waste generated at residential and commercial wood frame construction sites offers a greater potential for reuse because of the ease of separating the wood during various stages of construction	Pine densities vary widely depending on which tree it comes from so to say, however, it averages around 500kg/m3	Due to its combustible nature there have been frequent doubts concerning its performance in case of fire but experience has shown that large size timber sections are capable of giving a good performance.	Thermal conductivity of pine in the direction of the grain is 0.22W/moC; perpendicular to the grain is 0.14 W/moC	Pine can be waterproofed by use of oil-based primer/stain and water sealant	Treated for potential bugs and moisture
artificial wood grain can be made smooth, or textured to provide grip for slip prevention	can be made in variety of colours, not finished or painted							no maintenance
smooth, hard, continuous surface. Depending on the applied finish to alter the transparency, a slight texture could be added.	transparent in its clear form. Frosted or sandblasted glass provides a grey-ish tinge which affects the transparency. Fritted glass could have a similar result. Colourful decals can also be applied to glass surfaces.	Although glass is easy to recycle the process can be very energy intensive. If able to reuse glass you'll end up with a more environmentally friendly decor	recyclable but energy intensive (22,7 - 25,1 MJ/kg with footprint of 1,17 - 1,29 kg/kg). Can also downcycle		Under great amount of heat: shatter. Small fire: retain its shape due to the ability to withstand extreme temperature fluctuation	Thermal conductivity : 0,625 - 1,11 W/m.°C		Cleaned regularly to remain aesthetic and prevent view restrictions - easy to clean. Long life span, should be replaced when cracked or chipped
Smooth, hard	Variety of optiona available : Clear; transparent in grey, bronze, blue, green or red (SolarSmart panels available in blue, green and blush); translucent in yellow, white opal or diffuser, mint green, red, and 'solar ice' (SolarSmart panels available in metalic grey and 'solar olmpic'); opaque in dark green, red brick, black, dark blue, cream, light grey, dark grey or brown (Palsun Technical Guide, 2016:4). Palsun sheets can also be printed (Palsun Technical Guide, 2016:30).			Density: 1.2 g/cm3 (Palsun Technical Guide, 2016:5). Thus panel weight: 120 x 240 x 1.2 cm = 41.47 kg	As a thermoplastic, it will melt and burn under intense heat of a fire, but will not propogate flames and solidifies and self-extinguishes as soon as the direct flame is removed; no toxic fumes or gases produced during this process (Palsun Technical Guide, 2016:12). "PALSUN FR is a fire retardant flat solid polycarbonate sheet with improved flammability ratings. The flame retardant additives make it virtually non-combustible. When flame licks the sheet, it will only get scorched and eventually melt, solidifying quickly when the direct heat source is removed. Drippings do not ignite other combustible	Thermal conductivity: 0.21 W/m.K (Palsun Technical Guide, 2016:5). SolarSmart Panels are also available in limited colours and transparency to block infra-red light, which reduces heat-build-up (Palsun Technical Guide, 2016:4).	manufactured with a co-extruded, UV protective layer on one or two sides to ensure long lifetime of service, retaining toughness and optical quality under intense UV exposure, with minimal reduction in properties (Palsun Technical Guide, 2016:7-12). A change in light transmission and yellowness index is minimal (Palsun Technical Guide, 2016:12).	Cleaning: Avoid abrasive or high alkaline cleaners, rinse immediately with clean, cold water; do not apply cleaners in direct sunlight. Never use sharp objects, wipers (squeegees) or razors. "Always test cleaners in a small inconspicuous area prior to cleaning entire panel to prevent adverse results. When using a pressure washer, do not allow the spray tip to come too close to the panel, as it could have enough pressure to penetrate or tear the panel. Avoid dry cleaning, as sand and dust particles clinging to the exterior of the panels may scratch the surface." (Palsun Technical Guide, 2016:30)
smooth, hard				Density: 1.2 g/cm3 (Sunlite Technical Guide, 2016:3). Thus panel weight: 120 x 240 x 1.2 cm = 41.47 kg	Flammability per methods and Classification* BS 476/7 Class 1 EN 13501 B, s1, d0 ASTM D-635 CC-1 (SUNLITE® FR) ASTM E-84 Class A	UV protective layer; Coefficient of linear thermal expansion in mm/mm °C with value of 6.5x10-5		

8.4.3 COLOUR STRATEGY

A colour strategy seeks to provide the interior space with visual cues to guide the use of space in accordance with the flexibility and sense of user control designed for. **Fixed, structural components** are made from a **black** wood polymer extrusion. The colour black suggests a sense of power and formality, thus ascribed to the more permanent elements. **Semi-permanent** features moving on tracks or pivoting in place, will make use of a **dark or saturated pop of colour**. A **brighter, less saturated pop of colour** will be applied to **free moving elements**. The **floor, walls and ceiling** surfaces generally pertain to a **neutral colour palette,** in the form of brown tones.

This ultimately sees fairly neutral surface areas, with the black, fixed elements outlining the structure, and furniture and flexible features introducing pops of colour to bring excitement and indicate a sense of flexibility.

The interaction between object and user becomes important, thus designing technemes to indicate where and how these objects should be interacted with, i.e. designing a universal language with regards to handles and fixings subjected to frequent touch. The **colour accents** will therefore highlight the technemes within the space, **communicating a sense of flexibility to the user and prompting their interaction with the object.**

To provide each classroom with an identity a single colour, in its different levels of saturation, can be used for these accents assigned to flexible elements. Different classrooms can then be identified according to their colour. For example, seeing the yellow class as the maths classroom, or knowing that the blue classroom is that of a specific teacher or grade group.

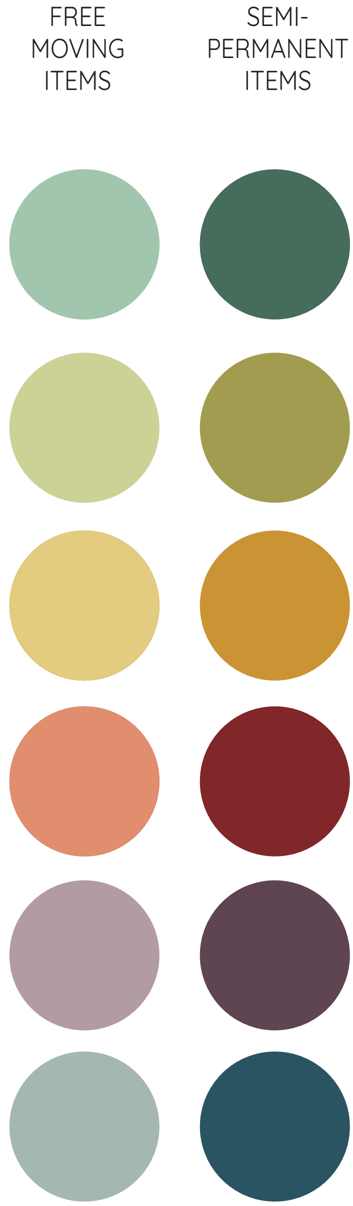


Figure 120: Colour Strategy & Palette

8.4.4 CONSTRUCTION STRATEGY

Different levels of flexibility call for particular connections and fixing methods.

_ Fixed, structural components use more permanent fixings such as screws and bolts, or clip-lock systems, for example tongue and groove. In the case of wall panels, a need for maintenance requires a less permanent but stable fixing method that would allow for easy repairs without compromising the structural or security properties of the unit.

_ Semi-permanent features make use of tracks and pivot joints to enable ease of use and enable a limited degree of flexibility.

_ Free-moving objects, such as the movable 'write'-boards and interior furniture provide the largest degree of flexibility. Although not fixed, these objects do take the temporary connections into account to aid in the use of the object. For example, adding rubber footings to furniture legs to prevent slipping and scratching the floor surface, as well as fitting movable 'write'-boards with castor wheels that are equipped with brakes.

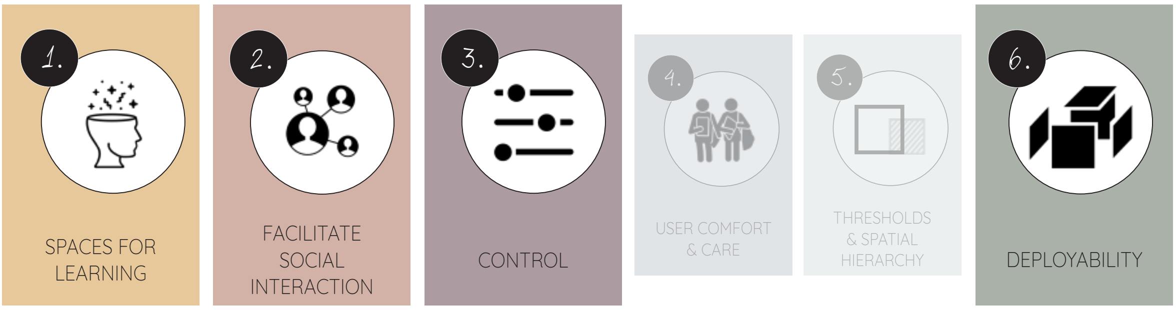
8.5 CONCLUSION

Starting off with the stipulation of design informants and an assessment tool for the iterative design process, this chapter continues to explain the different strategies undertaken, relating to the four informants of highest priority. These strategies guided the conceptual design of the deployable, teaching-learning unit, in terms of its form, size and overall functioning. As the further development of the design is integral to the technical resolution, a technical approach is outlined, with additional strategies regarding materials, colour and construction. A second process of iterations in pursuit of the design refinement and technical resolution will follow in Chapter 9, while employing the strategies discussed here.

9.1 INTRODUCTION

Following on the general unit design in *Chapter 8_Formulating a Design Response, Chapter 9_Designing the Technical* pursues the design refinement and technical resolution of the proposal previously made. The aforementioned design and technical strategies guide an iterative design process which makes use of prototyping and scenarios, to resolve the teaching-learning unit in its entirety, as well as the intervention on the Tshwane Secondary School testing site.

DESIGNING THE TECHNICAL 09



As *Spaces for Learning, Social Interaction, Control* and *Deployability* are prioritised, and provided the design strategies discussed in the previous chapter, these four categories are used to structure *Chapter 9*. Starting with *Deployability* and *Control*, to showcase the a-contextual, technical design resolution, followed by *Spaces for Learning* and *Social Interaction*, this chapter presents the final design proposal as a reinvisioned scenario of the existing, which promotes the well-being of learners.

scene a : deployability

design for disassembly
ease of operation

Starting with the overall composition of the unit, *scene a* introduces the different components, as would be assembled on-site. An on-site assembly process, however, requests several connection details between components, as part of the technical refinement. These are explored and presented as a conclusion to the deployability scene.

9.2 UNIT COMPOSITION

Figure 122 presents the twelve (12) main components of the unit, numbered according to the on-site assembly process. Each unit includes components 01 - 09, noting that the placement of the floor- and facade panels may differ from one unit to another. Component 10 - 12 serve as additions to the core components, with their quantity and placement subject to the unit composition and the configuration of multiple units on site. The off-site assembly and more detailed discription of each will be discussed in the section to follow, after which an on-site assembly manual and details will be provided.

FRONT VIEW

BACK VIEW

08. ROOF PANELS

07. ROOF STRUCTURE

06. FACADE PANELS

12. FLEXI PORCH

05. LOUVRE PANELS

11. RAMP

04. CORNER POSTS

10. ENTRANCE PORCH

03. FLOOR PANELS

09. WATER TANK

02. FLOOR STRUCTURE

01. ADJUSTABLE FOOTINGS

Figure 121: Unit Front and Back Views

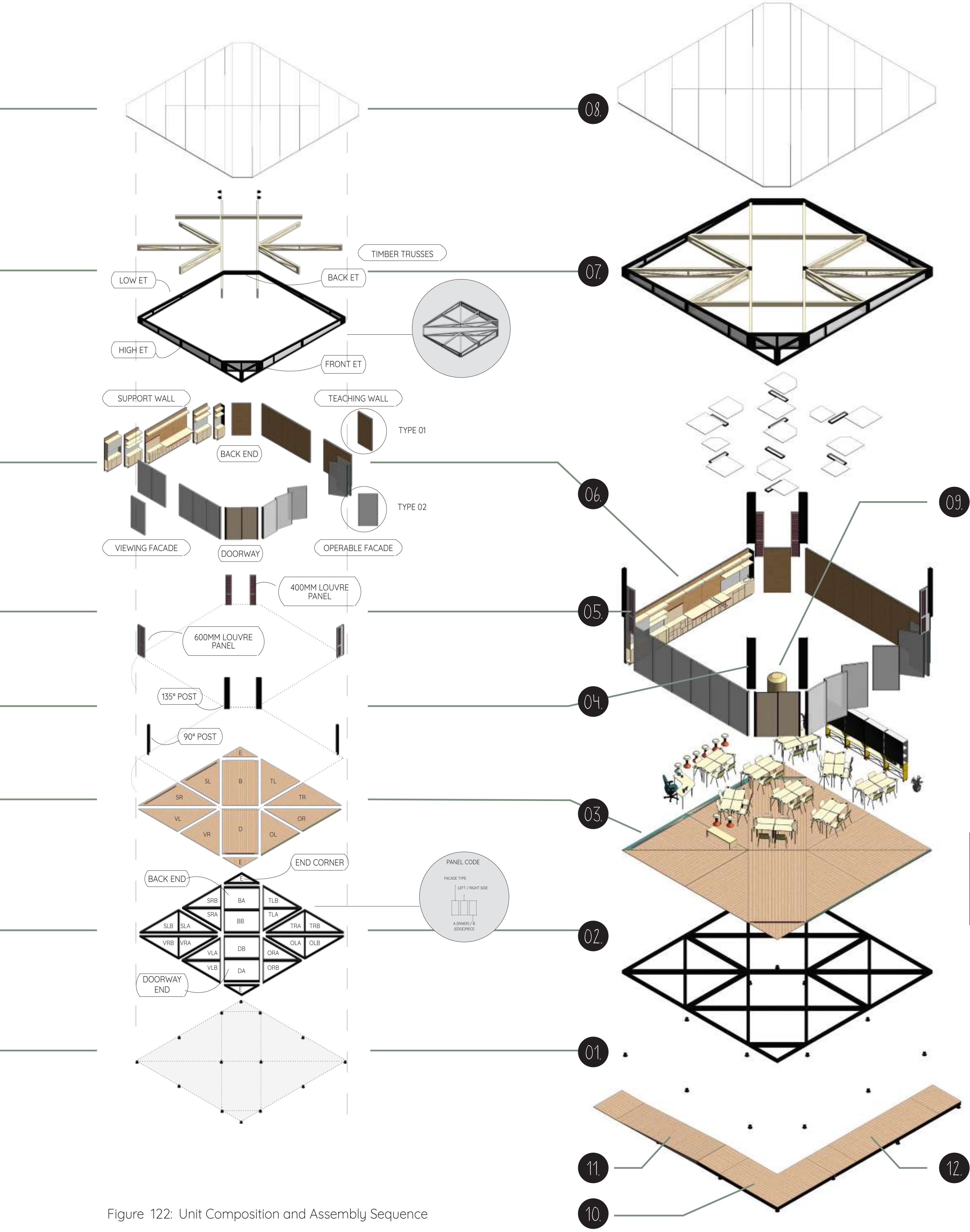
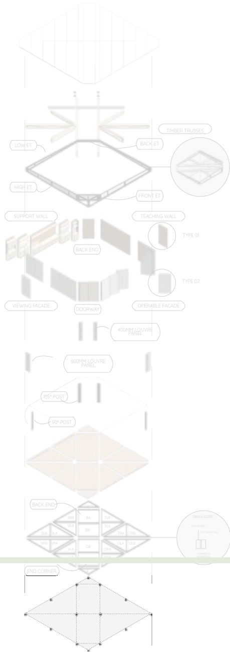


Figure 122: Unit Composition and Assembly Sequence

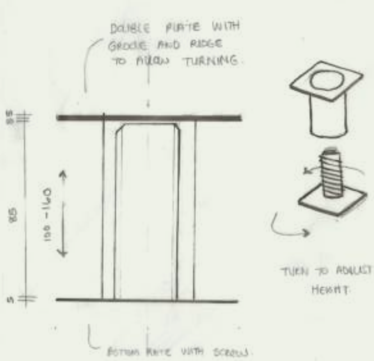
09

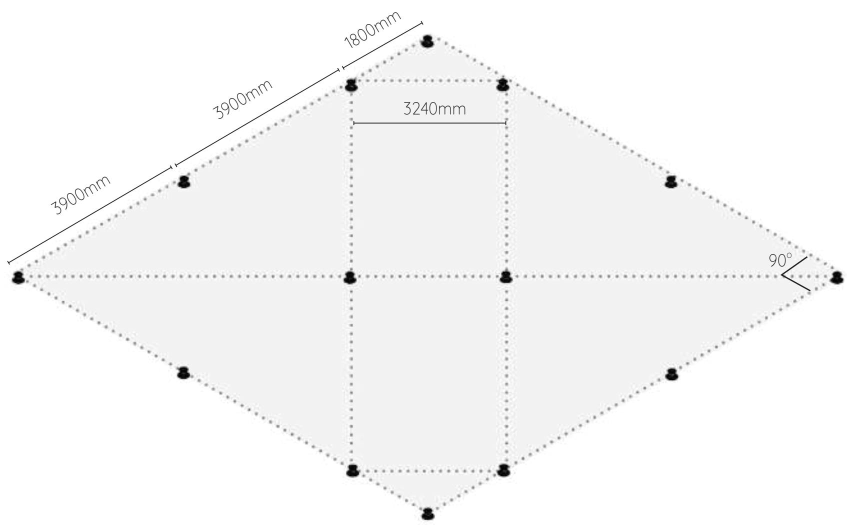


01. ADJUSTABLE FOOTINGS

Steel screw-type footings within a PVC housing, with a 200mm diameter and an adjustable height of 100-160mm are used to ensure a level placement of the unit on site. These footings are placed on the natural ground level, at the positions and intervals as indicated, and adjusted as the assembly process progresses.

Three head plate profiles are used, accommodating the corner, side and central placement. Head plates are black powder-coated steel plates with pre-drilled holes to allow for easy on-site assembly as the floor structure will be bolted to these head plates.



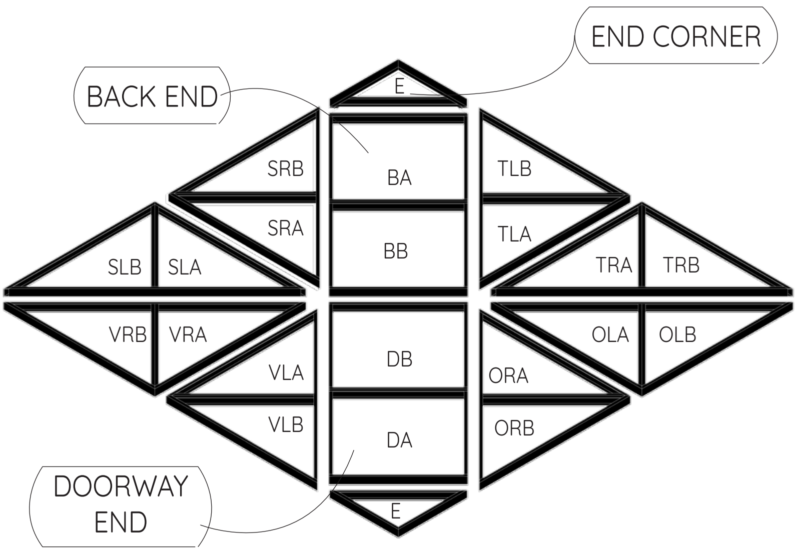


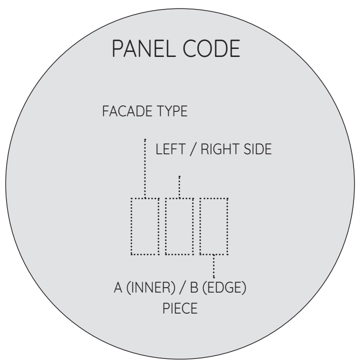
FINAL ITERATION

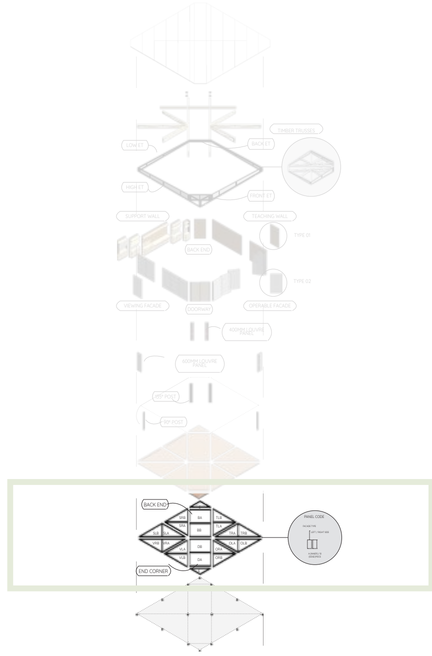
Figure 123: Adjustable footings _ Final iteration

02. FLOOR STRUCTURE

Several 180 x 70 x 10mm Parallel Flange steel channels, cut at a 45° angle and to the required length, are welded together to create the smaller frame structures. These are bolted together and to the adjustable footings on-site through pre-drilled holes, providing the underlying floor structure for each facade type, including the central and end corner floor area. Finish : Black powder-coating.







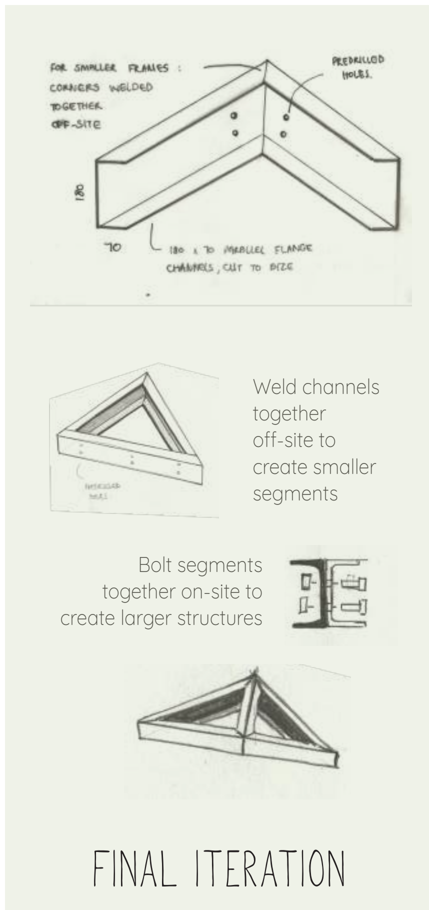
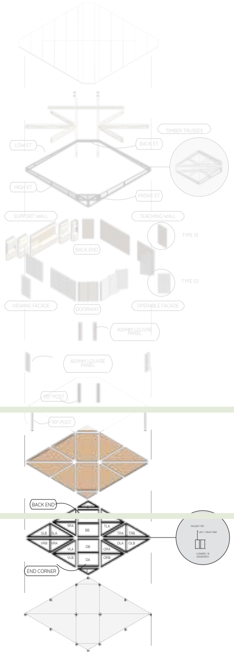


Figure 124: Floor structure _ Final iteration

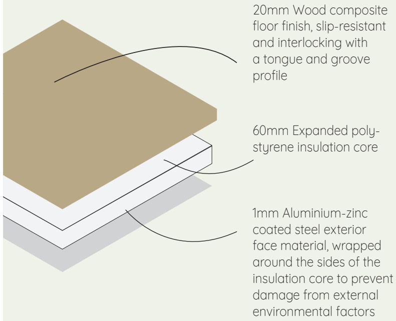
03. FLOOR PANELS

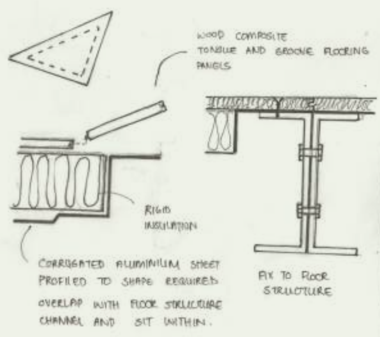


Custom shaped structural insulated panels are manufactured off-site, with an aluminium-sink exterior finish, expanded polystyrene insulation core and slip-resistant wood composite floor finish.

Each of the four interchangeable facades, as well as the doorway and back end, require a unique floor-wall connection, resulting in a particular placement of floor panels, depending on the specific unit composition. Each facade type thus has a left and right side, with the outer edge of each introducing these unique floor connections.

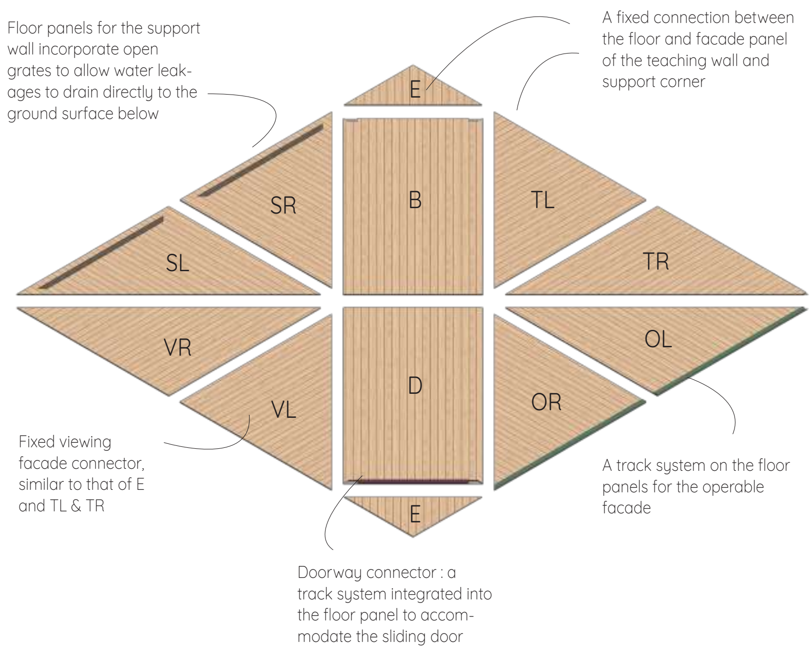
Sandwich Panel Construction





FINAL ITERATION

Figure 125: Floor panels _ Final Iteration



From the centre looking out:

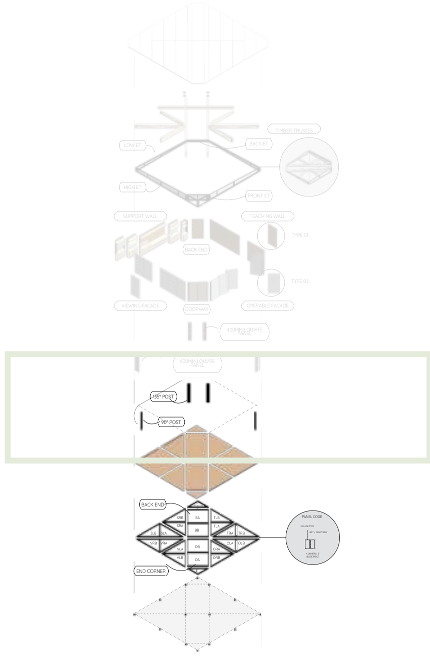
L Left side segment

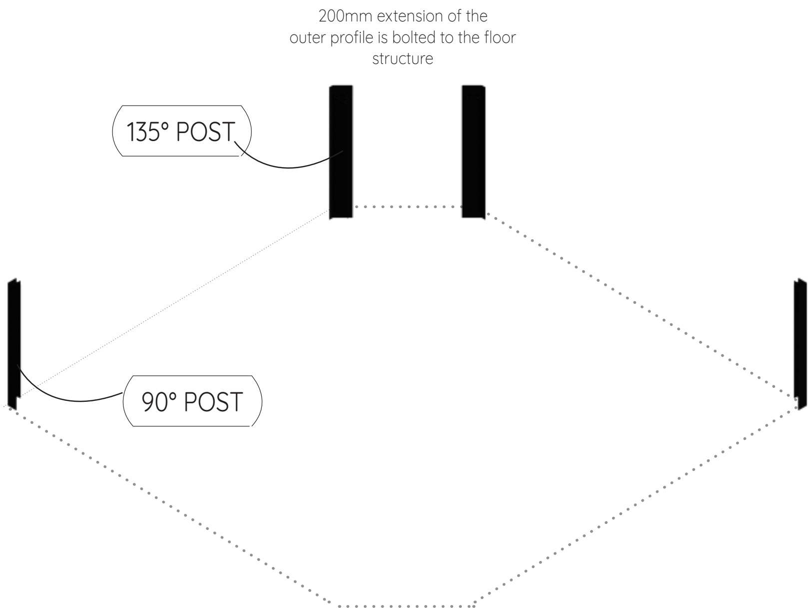
R Right side segment

Wood composite tongue and groove panels are applied off-site as the final floor finish of both interior and exterior spaces, providing a continuous slip resistant floor finish.
The expanded polystyrene insulation core and aluminium-zinc exterior face are slightly recessed to create an overhang for on-site assembly where floor panels and placed within the floor structure and secured through the wood composite overhang.

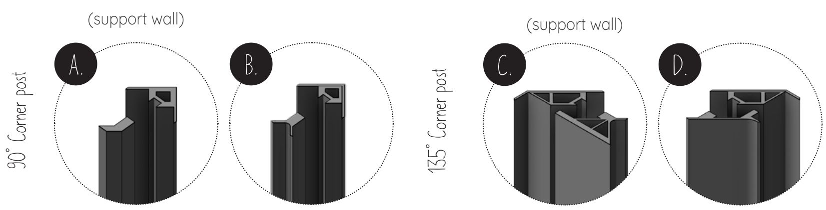
04. CORNER POSTS

Custom composite wood polymer extrusions are used as corner posts, allowing for either 90° or 135°. Corner posts are extruded with the necessary connecting profiles to adjoin to wall panels and both the extruded and timber roof trusses.
Each of these consist of two parts, the first being the outer, more permanent connection to which trusses join. The second sees an interlocking profile to the first to secure the wall-panels in place



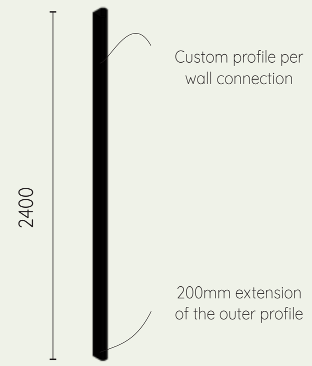


Four Profiles



2600mm Custom profile composite wood polymer extrusions as corner posts, black colour finish.
Boundary trusses slot within the void of these to create an interlocking joint.

Profile accommodates a connection to the facade panels with an additional lock-in profile to keep facade panels in place



FINAL ITERATION

Figure 126: Corner posts _ Final Iteration

09

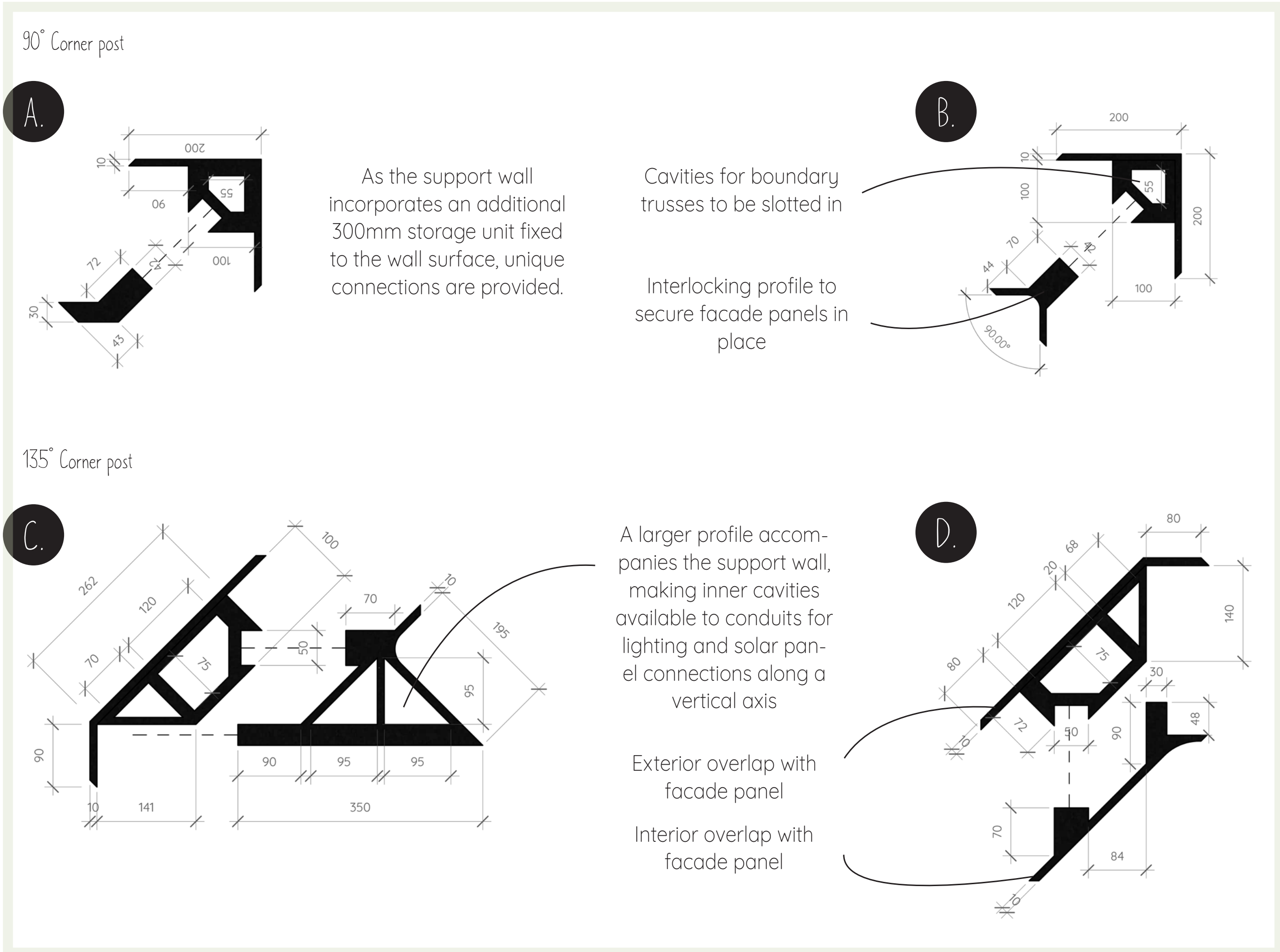
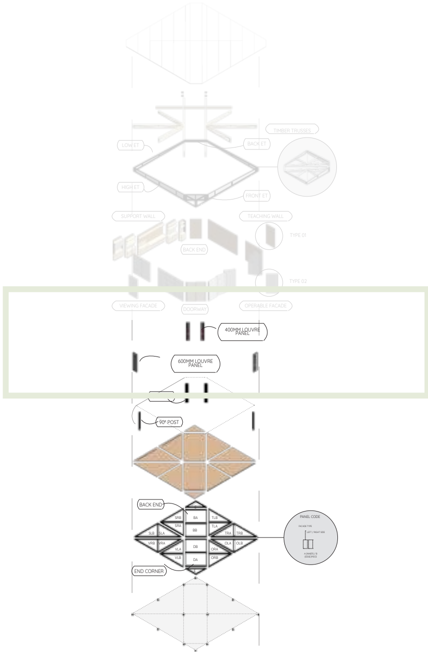
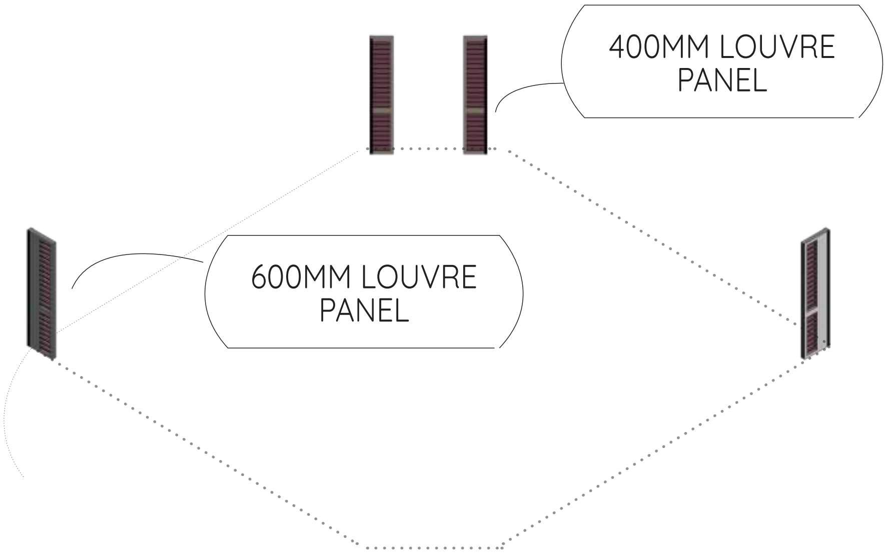


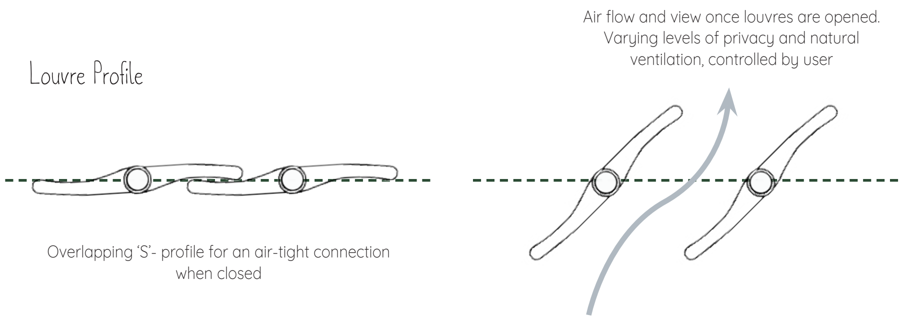
Figure 127: Corner posts _ Profile A-D

05. LOUVRE PANELS

The back-end wall includes two 400 x 2400 louvre panels, with an additional 600 x 2400 louvre panel on opposite corners of the units, providing a source of natural ventilation which can be controlled by the user.







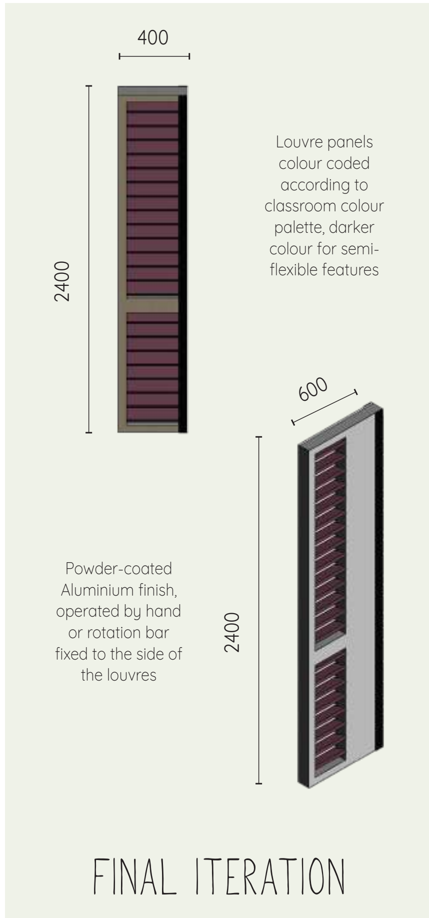


Figure 128: Louvre Panels _ Final iteration

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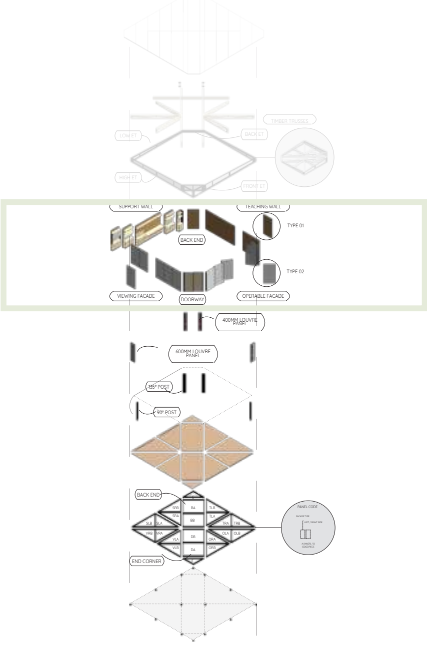


06. FACADE PANELS

Two types of custom facade sandwich panels are manufactured to accommodate the four interchangeable facades, as well as the door-way and back end.
Each facade employs a unique application of the panel to provide the necessary level of flexibility. This calls for the unique floor panel as-signed to each wall. Both panels consist of a sandwich system which is constructed off-site, leaving the on-site assembly of panels as a rapid, infill process.
Panels clip-lock into one another for rapid assembly on-site. Profiles create an angled connection to allow for a pivoting motion, necessary for operable facades and ease of replacement. A neoprene seal lines the profile connection to prevent air leakage.

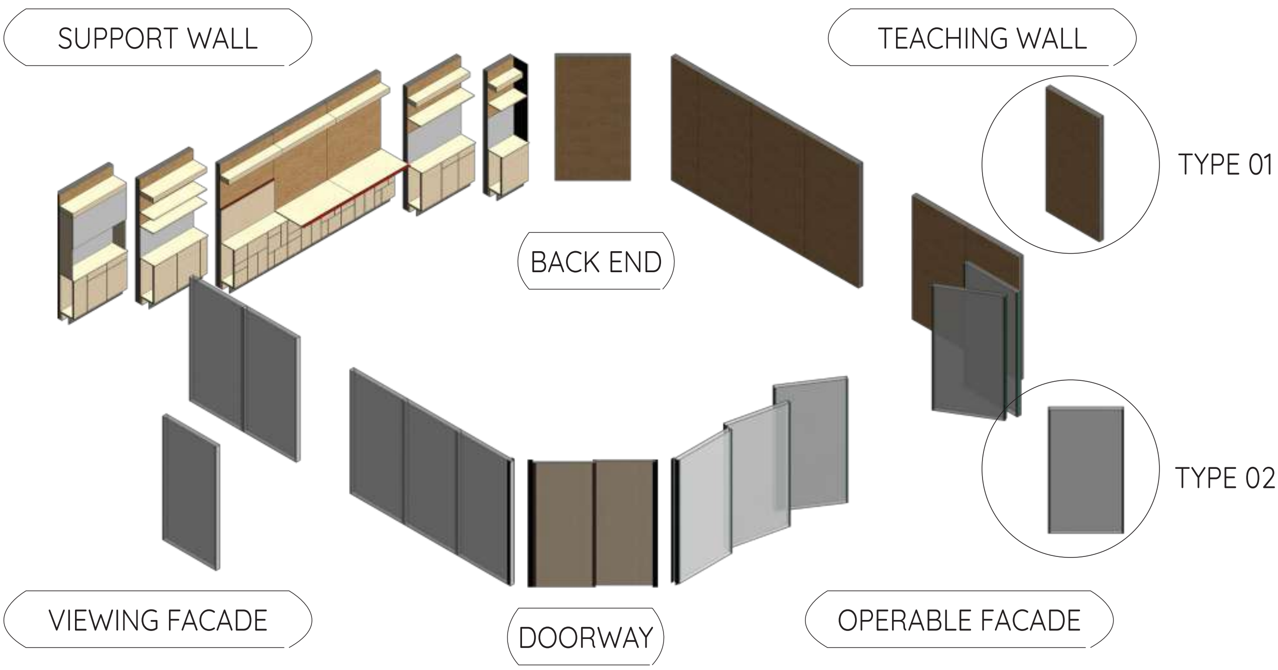


Figure 129: Facade panels _Exploded axonometric

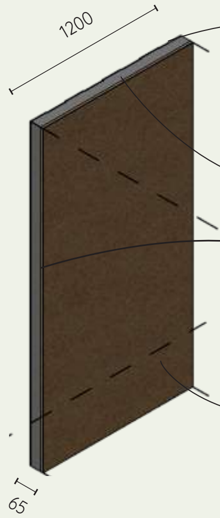
Type 01 _ Structural insulated panel

DOORWAY

TEACHING WALL

SUPPORT WALL

BACK END



1200 x 2400 x 1mm Aluminium-zinc coated steel exterior face shaped in custom profile, finished with white colour coating.

1200 x 2400 x 75mm Expanded polystyrene insulation core, fit into aluminium-zinc profile.

1200 x 2400 x 16mm Plywood sheet fixed to the aluminium-zinc sheet profile as the interior face of the structurally insulated wall panel.

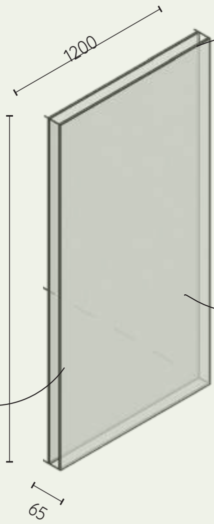
1200 x 2400 x 10mm Cork sheet applied to the plywood as a pin-board and acoustic wall treatment.

Type 02 _ Polycarbonate sandwich panel

OPERABLE FACADE

VIEWING FACADE

Designed for acoustic and thermal properties and dressed with a decal to control privacy and views.



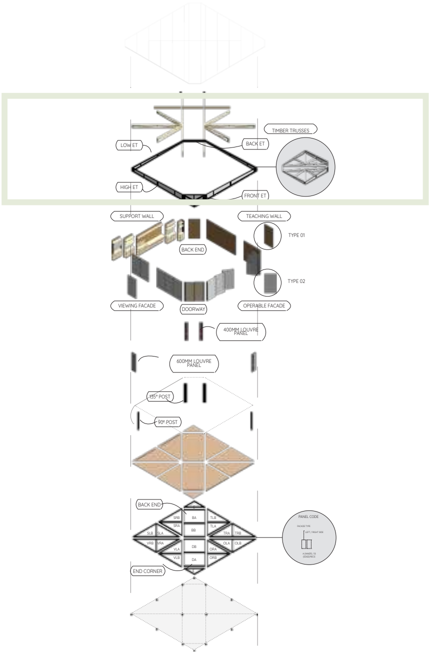
1200 x 2400 x 12mm Palsun Polycarbonate sheeting with decal on interior face, fitted into aluminium frame with neoprene seal around edges

1200 x 2400 x 25mm Sunlite XL Multi-wall polycarbonate sheeting with solar control for thermal properties, fitted into aluminium frame with neoprene seal around edges

Custom Aluminium frame all round to create panel sandwich with central air cavity, interlocking to with a neoprene seal on either side of the panel

FINAL ITERATION

Figure 130: Facade panels _ Final iteration



07. ROOF STRUCTURE

Custom made wood polymer composite truss extrusions (ET) for the boundaries of the unit. To accommodate the slope of the roof, a 'back', 'low', 'high' and 'front' truss is used. Each truss is extruded with the connecting profile for the corresponding timber trusses, as well as an integrated gutter. Colour: Black.

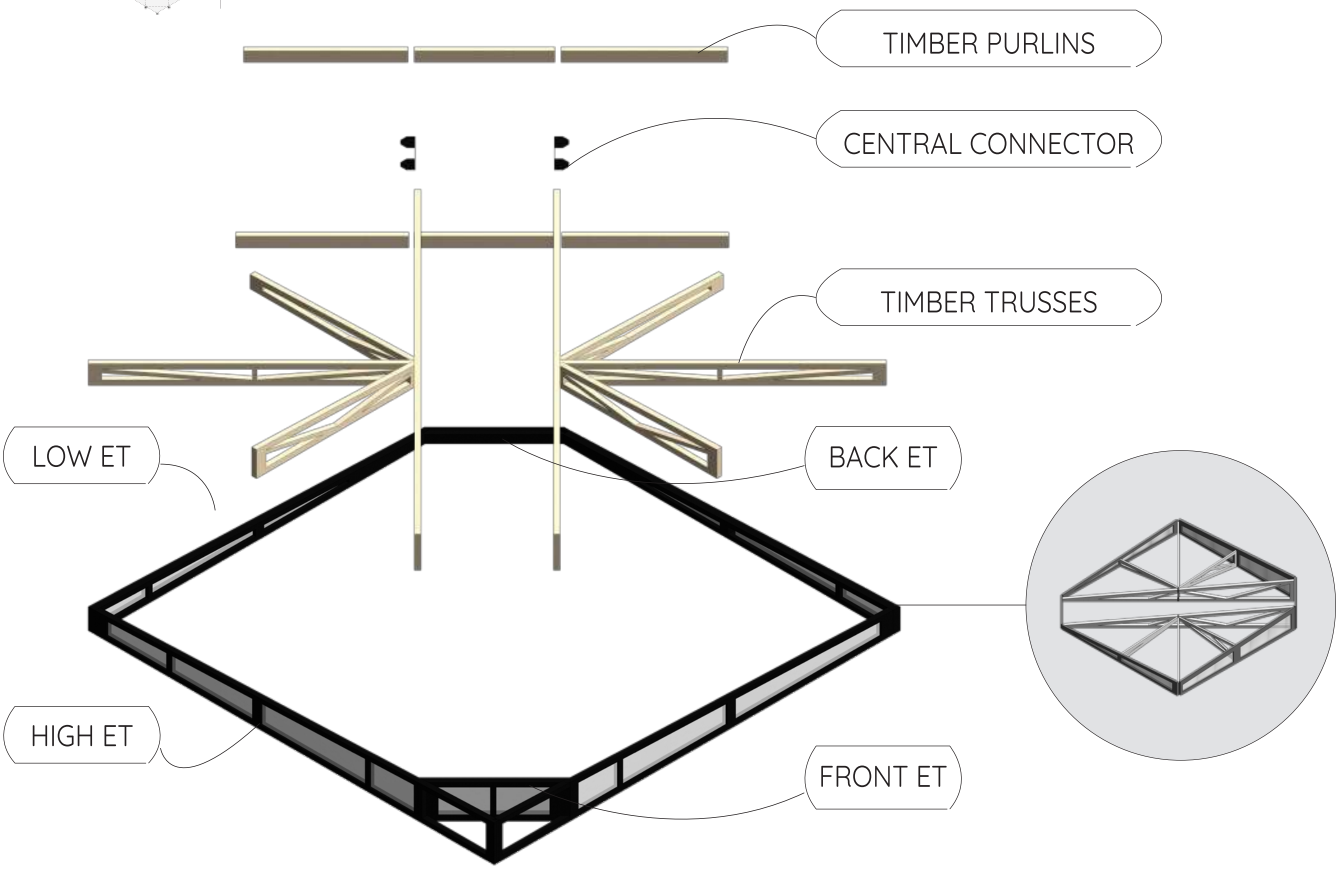
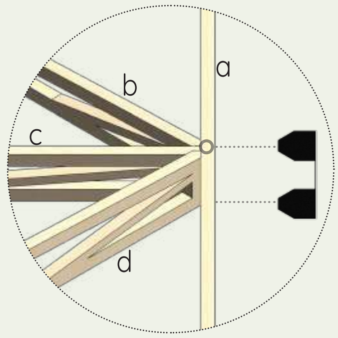


Figure 131: Roof Structure _ Final Iteration

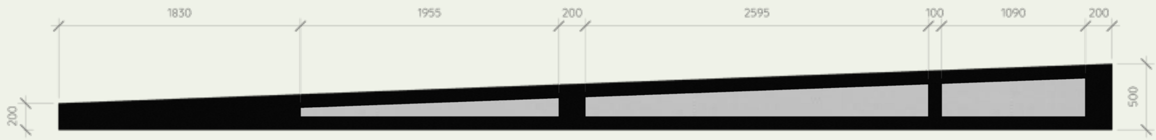
Interior Timber trusses

Timber trusses (a-d) are made to span on the interior, between the wood polymer extruded boundary trusses, to support the roof panelling. Connected to boundary extruded trusses by sliding into connecting profile. Connected to one another with a black powder-coated aluminium 'central connector' with a top and bottom plate, into which each truss is screwed.



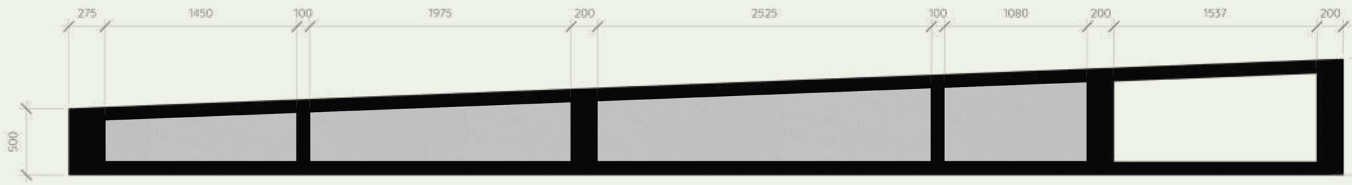
Composite Wood Polymer extruded boundary trusses (ET)

LOW ET



Integrated gutter, extruded with the truss, covered with a fine grain metal mesh.

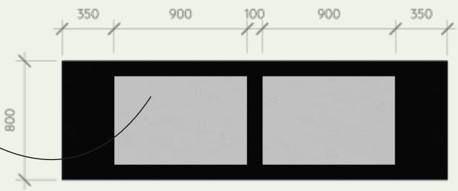
HIGH ET



BACK ET

Solid composite wood extrusion

Open-able polycarbonate windows for natural ventilation



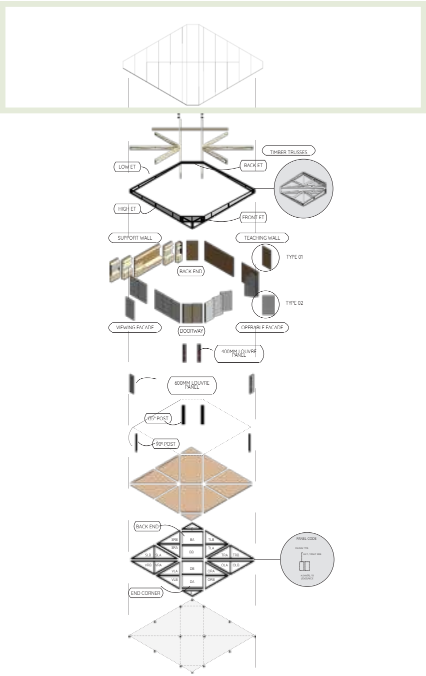
Palram SunLite XL Multi-wall polycarbonate infill panel to allow diffused natural daylighting, with Solar Smart coating to prevent heat build-up by blocking out infra-red light

FRONT ET

FINAL ITERATION

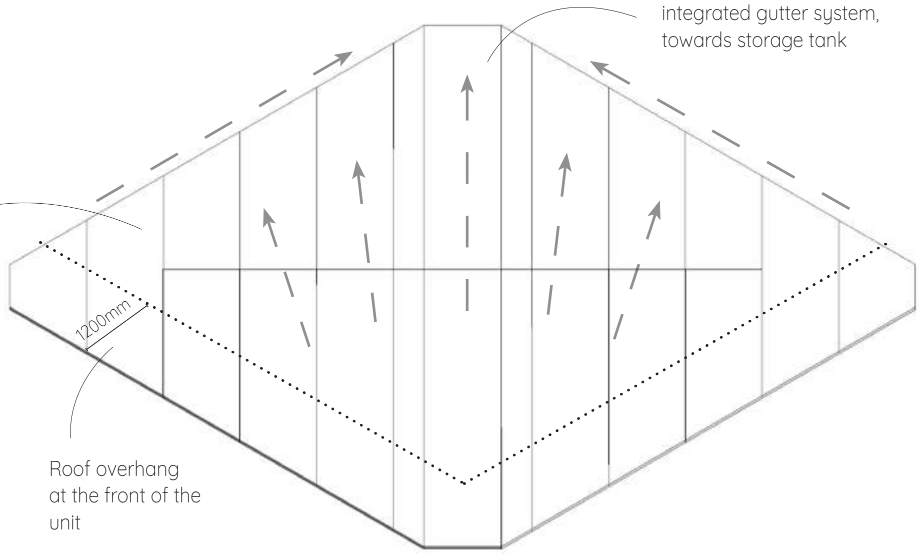
Figure 132: Roof Structure _ Extruded trusses

09



08. ROOF PANELS

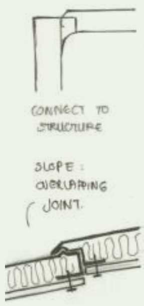
Custom roof structural insulated panels, with an aluminium-zinc exterior face material, expanded polystyrene insulation core and plywood interior finish. Manufactured as a sandwich panel off-site, these panels are connected to one another and the supporting roof structure during the on-site assembly process.



Panel profile allows interlocking with the composite wood extruded boundary truss and a 250mm edge overlap between adjacent panels

Panels for the roof overhang include an aluminium-zinc sheet extension, limiting the plywood face to the portion of the panel situated on the interior of the unit.

FINAL ITERATION



Sandwich Panel Construction

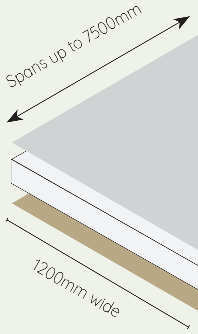


Figure 133: Roof panels _ Final iteration

09. WATER TANK

Piping to the water storage tank connects to the integrated gutters within the boundary trusses, with water supply pipes connecting to the support wall. A municipal supply can also be connected, and the tank filled with a hosepipe as needed.

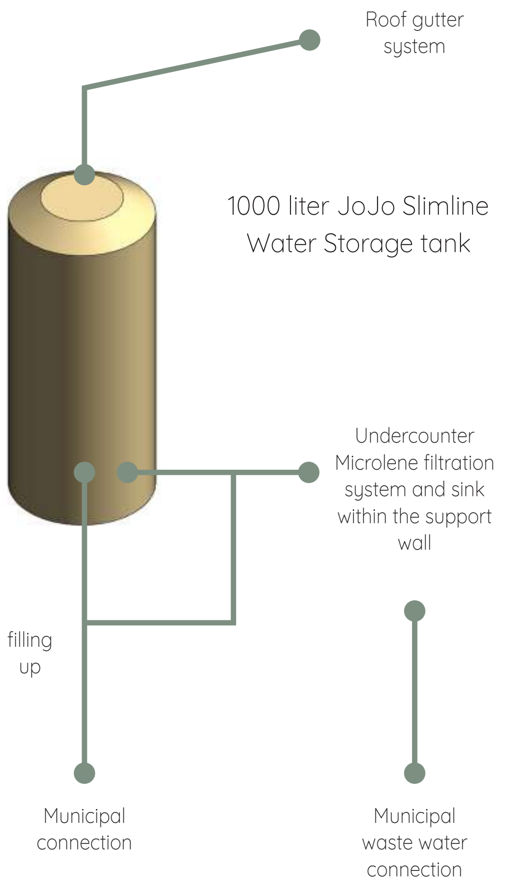


Figure 134: Water Tank Connection

10. ENTRANCE PORCH

Completing the entryway, a square porch is added to the front of the unit, level with the unit floor structure.

11. RAMP

As main access route to the unit entrance, while ensuring universal design, a ramp component can be added alongside the unit, leading up to the front corner.

12. FLEXI PORCH

An additional component, the length and floor level heigh of the unit, can be added to any side. This provides a spill-out space, or circulation route.

Both the off- and on-site assembly processes of the three additional components align with that of the base structure of the unit and should be followed simultaneously. This includes the adjustable footings, the floor structure and floor sandwich panels. A continuous floor surface results between the unit and the additions.

9.2.1 ON-SITE ASSEMBLY MANUAL

STEP 01.

Place adjustable footings on site, as per spacing and their correct head plating. At first, keep on the lowest setting.

STEP 02.

Fix the smaller triangular frames together (TLA + TLB), (TRA + TRB), (OLA + OLB), (ORA + ORB), (VLA + VLB), (VRA + VRB), (SLA + SLB), (SRA + SRB), (BA & BB), and (DA & DB) with bolts through pre-drilled holes to create the larger triangles that need to span between the footings on the boundary.

STEP 03.

Starting with the central floor framed structures (back- and door-end), place the structure on the corresponding footings. Continue with the large triangular frames assembled in Step 02 (TL & TR, OL & OR, VL & VR, and SL & SR).

With each placement, ensure that the frames are level and adjust the footings as needed. Once the entire structure in levelled, fix the corners and flat plate footings to there corresponding framed structure.

STEP 04.

Install the exterior segment of the corner posts by placing them on the corresponding corner structure with the extension bolted to the floor structure, through pre-drilled holes.

STEP 05.

Slot the floor panel sandwiches within the corresponding frame, and screw to the frame. Ensure that the floor panels are installed according to the unit composition as each facade would require specific floor panels

STEP 06.

Connect the composite wood extruded boundary trusses to the exterior segment of corner posts by slotting them into the voids.

STEP 07.

Using the aluminium plate central connector, connect the halves of the main timber trusses and slot the entire truss into the corner posts at the back- and door-end. Fix the remaining timber trusses into the corresponding extruded truss along the boundary and screw to the central connector on the main timber truss.

STEP 08.

Fix the purlins between the trussess where needed, using black powdercoated channels. First bolt the channel to the main trusses, through the channel web. Then bolt the purlins to the channels through the flanges.

STEP 09.

Install the roof sandwich panels. Starting with the panels along the lower extruded boundary trusses with the integrated gut-ters, lastly installing those with the overhang.

STEP 10.

According to the unit composition, install the facade panels on the appropriate floor panels. This is done by placing the first panel between the up-stands created by the composite wood segment or onto the tack system (see Detail B & C.), after-which the panel is slid to the corner post. Followed by the placement of the next panel, slide the panel towards the first, and ensure that the panel profiles interlock. Continue until all facade panels are installed. Louvre panels are installed using the same process.

STEP 11.

Once all the facade panels are in place, slot the interlocking segment of the corner posts in, securing the facade in place. For maintenance, to replace a panel, remove the interlocking segment and slide the facade panels to the side, to undo the interlocking, and remove panels as needed.

STEP 12.

Hang the acoustic panels by hooking the wire hoops on the open-eye hooks pre-installed on the plywood ceiling panels. Further install the light fittings to the trusses, or the pre-installed canopies by screwing in the stems where light fittings suspend from the ceiling panels along the central part of the unit.

STEP 13.

Connect the water tank to the basin in the support wall, with piping located in the service box. In addition to this, connect the light fittings and LED Downlights to the electrical source (being municipal or solar panels). The void within the interlocking segment of the corner post, unique to the support wall, can be used to house a conduit for wiring , connecting the different light fittings and the electrical sockets, thus creating a vertical path of connection between the different components which require electricity at different heights.

STEP 14.

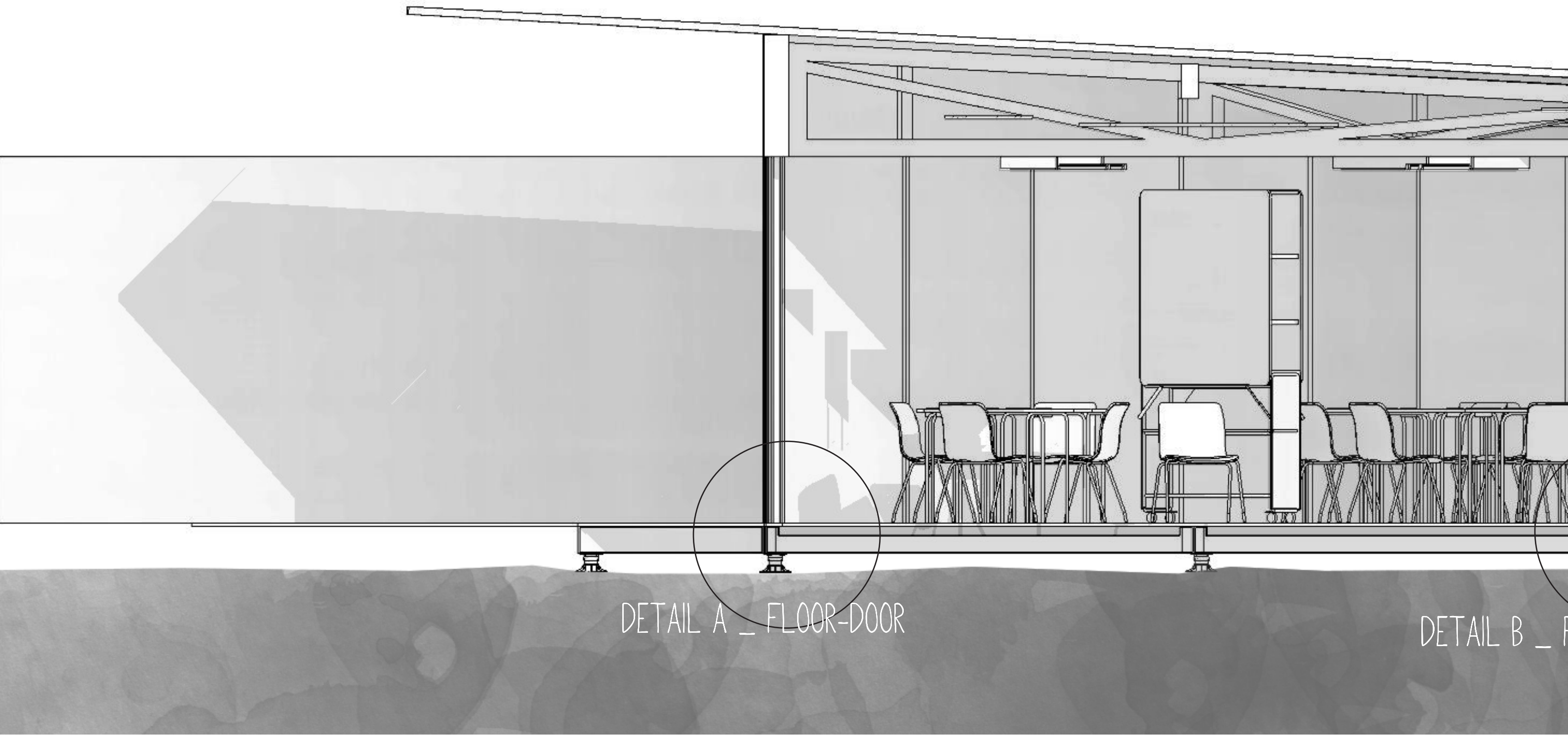
Depending on the configuration of units on site, place the adjustable footings for the ramp, entrance and flexi-porches along the unit where needed.
Referring to Steps 01 - 03, construct the floor structures for the unit and bolt them to one another.
Similar to Step 05, place the floor panels on the structure and screw it to the underlying floor structure.

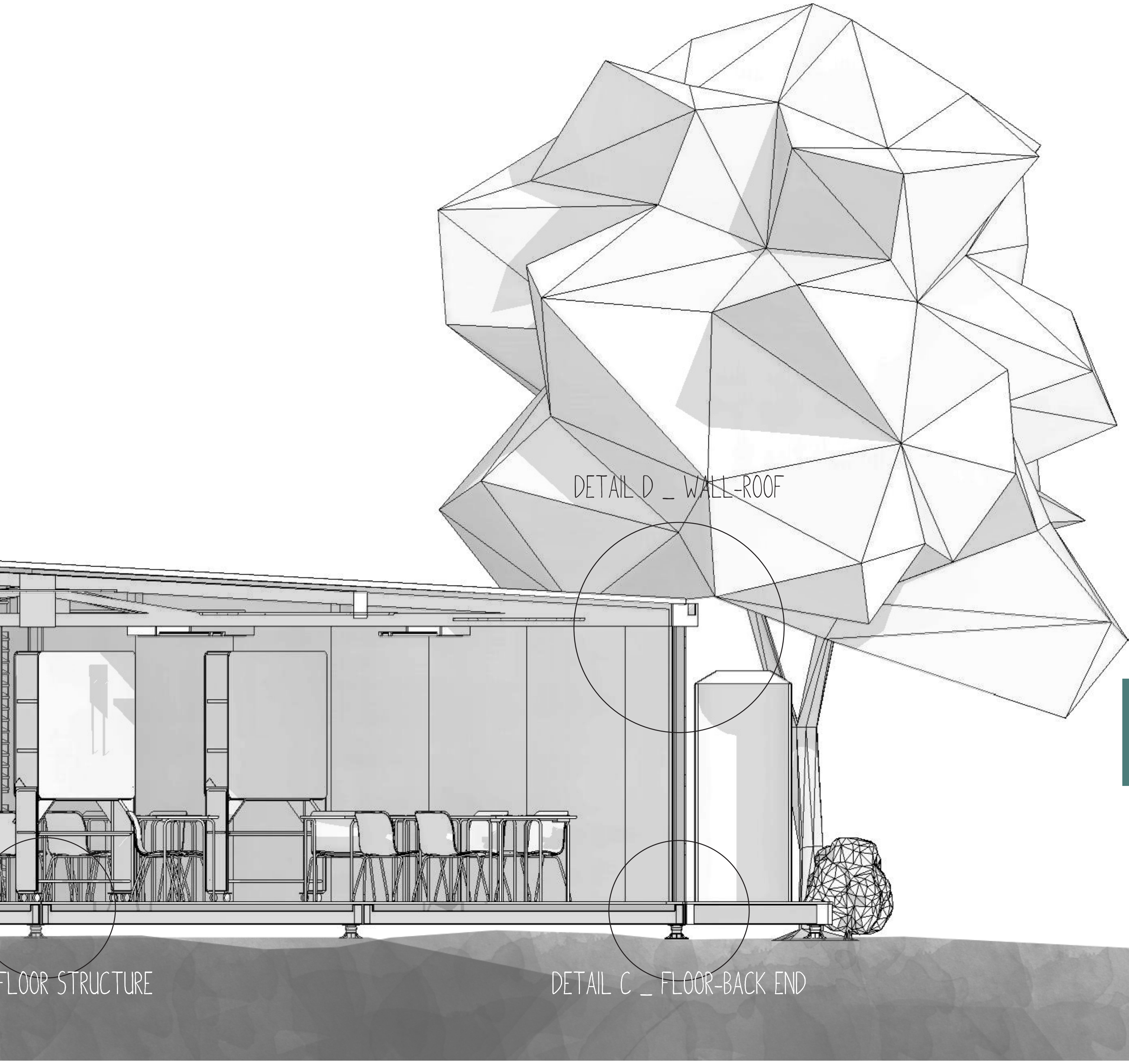
STEP 09.

Place the wobble stools, learner desks and chairs, teacher desk and chair, and the bench, as well as the four 'write'-boards where required.

09

9.2.2 SECTION AND DETAILS





09

DETAIL A _ FLOOR - DOOR CONNECTION

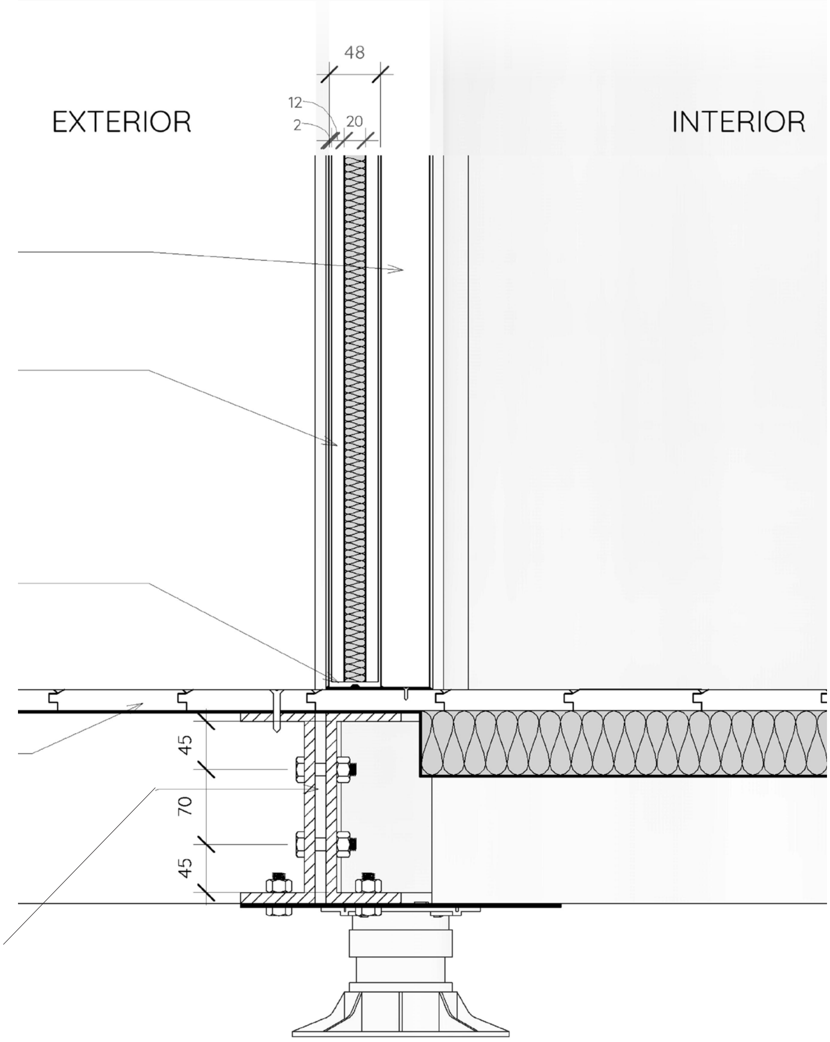
Frame end cap fitted within the composite wood extruded corner post, including a locking mechanism for the door panel.

1200 x 2400 x 48mm door sandwich panel comprised of two 12mm plywood panels and a 20mm expanded polystyrene insulation core, fitted within a 2mm aluminium frame, powdercoated with the dark colour within the classroom colour palette.

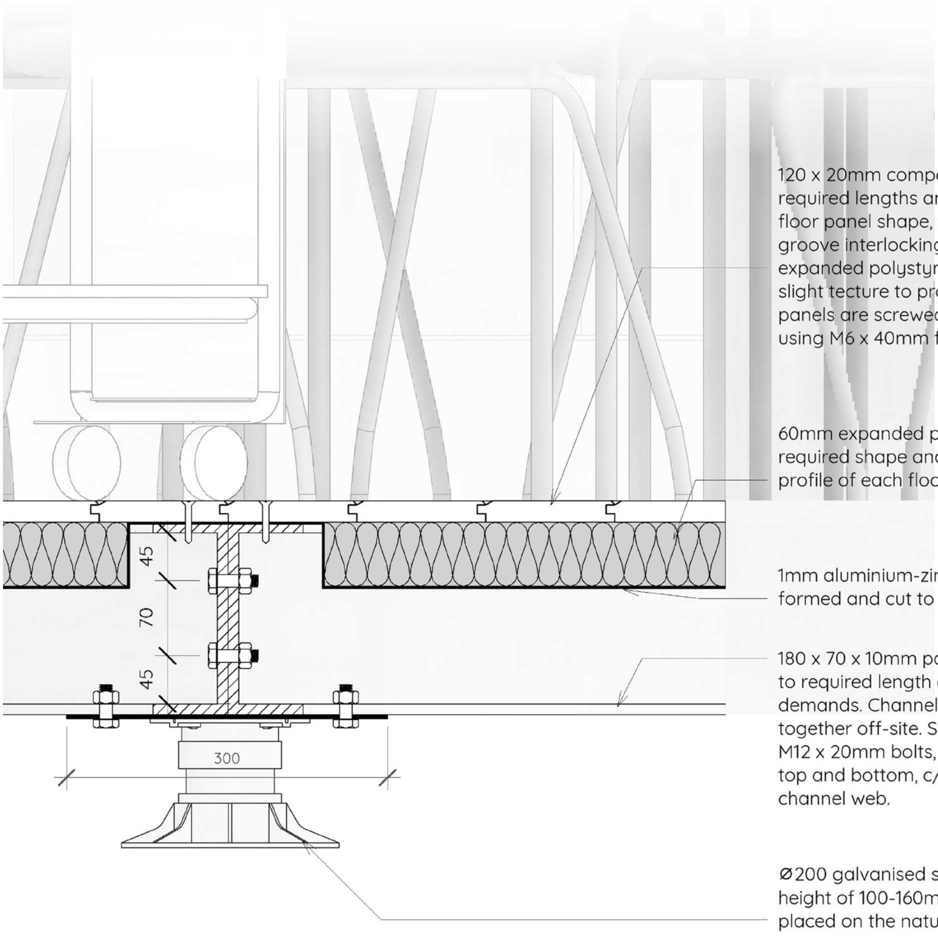
Door panel frame created with a profile to accommodate the floor guide, which is pre-fitted to the composite wood floor edge on the applicable floor panel, with M3 x 10mm flat countersink head screws @ 300mm intervals

120 x 20mm composite wood floor planks, cut to required lengths and to specific angles as required by floor panel shape, fitted together with a tongue and groove interlocking system, and glued to the expanded polystyrene insulation core. Extruded with a slight tecture to provide a non-slip surface. Floor panels are screwed to the underlying steel structure using M6 x 40mm flat countersunk head screws.

2600 x 10mm custom profile extruded composite wood corner post, fitted to the steel floor frame structure with M20 x 20mm bolts before adding the exterior front segment at the entrance.



DETAIL B _ FLOOR - STRUCTURE CONNECTION



120 x 20mm composite wood floor planks, cut to required lengths and to specific angles as required by floor panel shape, fitted together with a tongue and groove interlocking system, and glued to the expanded polystyrene insulation core. Extruded with a slight tecture to provide a non-slip surface. Floor panels are screwed to the underlying steel structure using M6 x 40mm flat countersunk head screws.

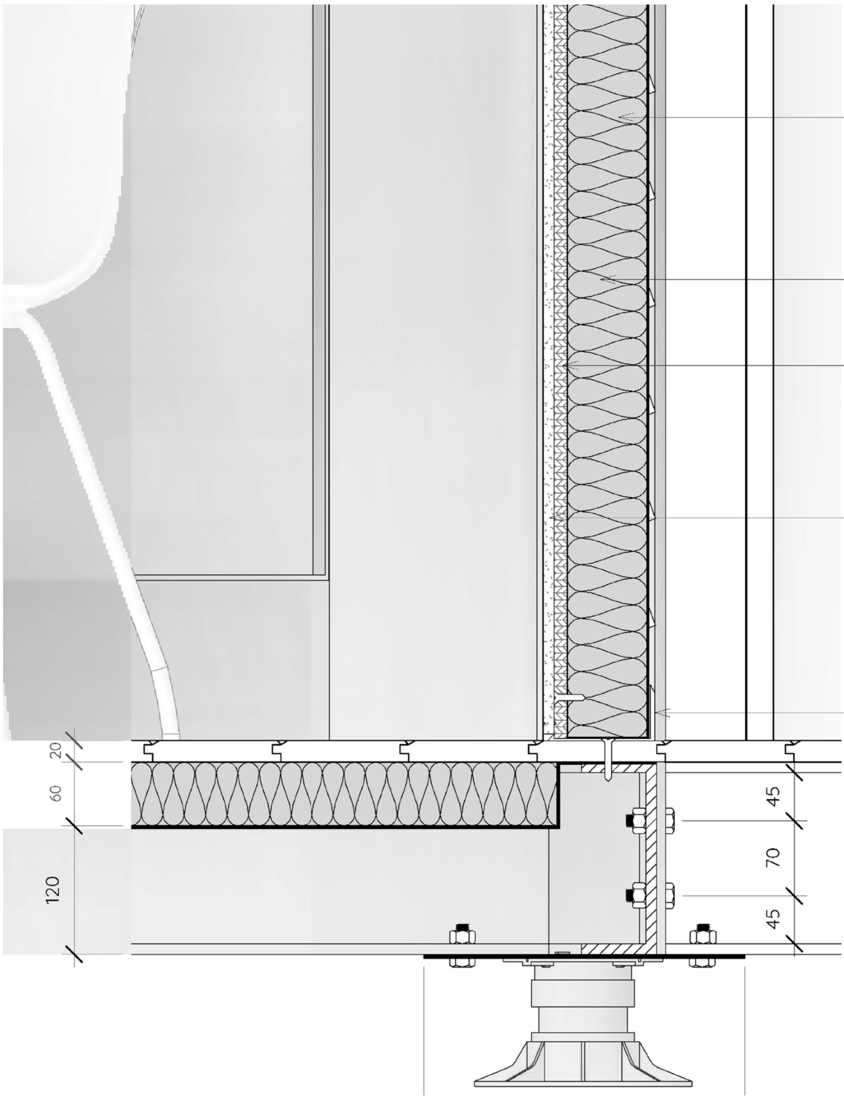
60mm expanded polystyrene insulation core, cut to the required shape and fitted within the aluminium-zinc sheet profile of each floor panel.

1mm aluminium-zinc sheet profile as exterior face, custom formed and cut to required floor panel size and shape.

180 x 70 x 10mm parallel flange galvanised steel channel, cut to required length and 45° angle as floor panel size and shape demands. Channels for each structure segment are welded together off-site. Segments are bolted together on-site with an M12 x 20mm bolts, through pre-drilled holes, 45mm from the top and bottom, c/c 70mm and 1500mm intervals along the channel web.

Ø200 galvanised steel screw-type footing with an adjustable height of 100-160mm, housed within a PVC plastic moulding and placed on the natural ground level, bolted to the galvanised steel channel floor frame structure with M12 x 14mm bolts through pre-drilled holes in the galvanised steel headplate and channel flange.

DETAIL C _ FLOOR - BACK-END CONNECTION



1 x 2400 x 1200mm aluminium-zinc sheet as exterior face of structurally insulated panel, custom formed with an interlocking profile between panels and a bottom fold-over of 50mm on the interior face, white powdercoating finish.

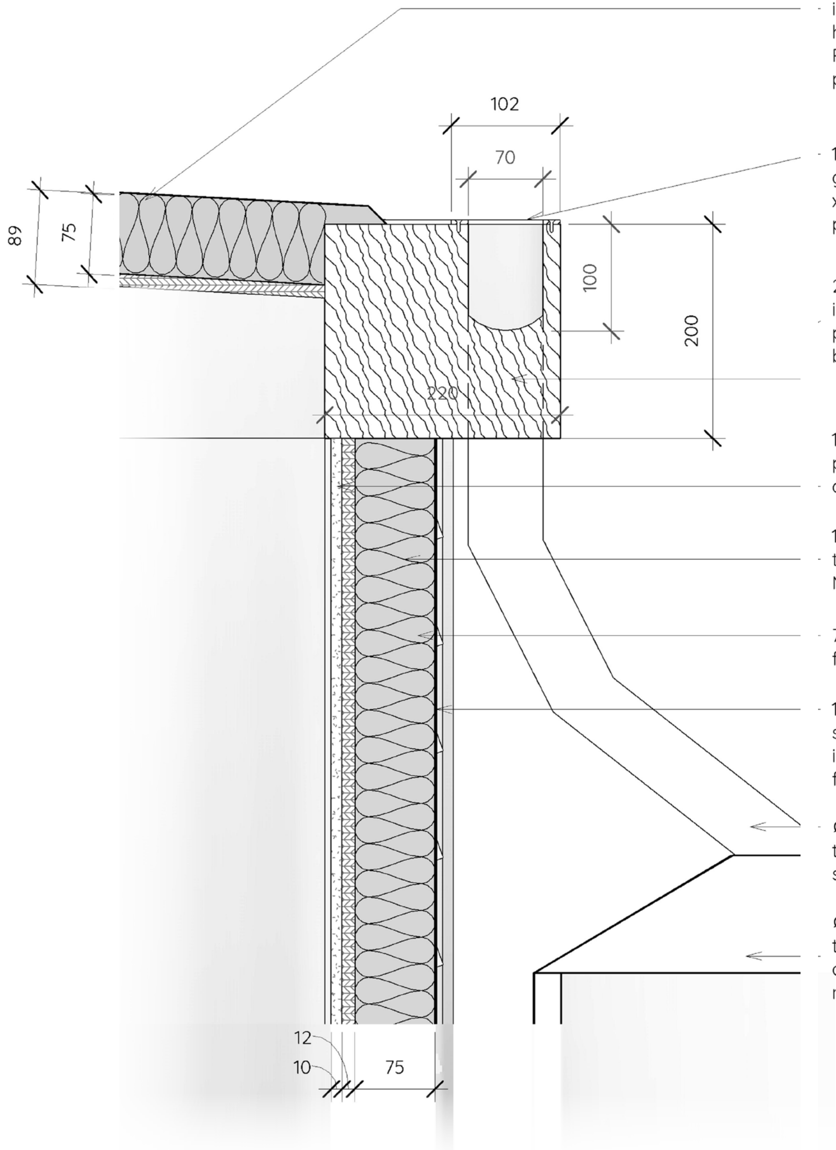
75 x 2400 x 1200mm expanded polystyrene insulation core, fitted within aluminium-zinc sheet profile.

12 x 2400 x 1200mm plywood interior face, screwed through the aluminium fold-over 40mm from the edge, with M3 x 20mm flat countersink head screws at 300 c/c spacing.

10 x 2400 x 1200mm cork wall finish screwed to the plywood interior face with M6 x 16mm flat countersink head screws, along the edge at 400mm intervals

4mm custom composite wood extrusion adhered to the edge flooring panel, allowing the wall sandwich panel to be fitted in with a 50mm upstand and 2mm neoprene seal ensuring an air and water tight wall-floor connection.

DETAIL D _ WALL - ROOF CONNECTION



1200 x 89 x 7500mm structurally insulated roof panels with an interlocking profile to overlap with composite wood extruded boundary trusses, leading water run-off to the integrated gutter. Supported by the 114mm x varying heights timber interior trusses and 114 x 228mm purlins. Roof panel edging overlap of 250mm between adjacent panels, joined with pop-rivets at 500mm c/c intervals.

102 x 4 x 2600mm galvanised steel fine grain grate as gutter filter, fixed to the composite wood extrusion with M3 x 15mm screws at 300mm c/c intervals. Black powdercoating.

220 x 200 x 2600mm wood composite extrusion with an integrated gutter, fixed to the composite wood extruded corner post with an vertical interlocking connection within the void, black finish.

10 x 2400 x 1200mm cork wall finish screwed to the plywood with M6 x 16mm flat countersink head screws, along the edge at 400mm intervals.

12 x 2400 x 1200mm plywood interior face, screwed through the aluminium-zinc sheet fold-over 40mm from the edge, with M3 x 20mm flat countersink head screws at 300 c/c spacing.

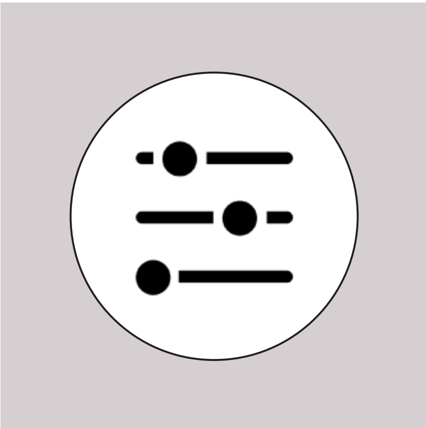
75 x 2400 x 1200mm expanded polystyrene insulation core, fitted within the aluminium-zinc sheet profile.

1 x 2400 x 1200mm aluminium-zinc sheet as exterior face of structutrally insulated wall panel, custom formed with an interlocking profile between panels, white powdercoating finish.

ø70mm PVC downpipe connected to the gutter with a threaded connector, further connected to the water storage tank.

ø840 x 2100mm 1000liter JoJo Slimline water storage tank, connected to the integrated gutter system. Bottom connection to the support wall, supplying rainwater or municipal water to the basin, 'winter grass' colour finish.

scene b : control



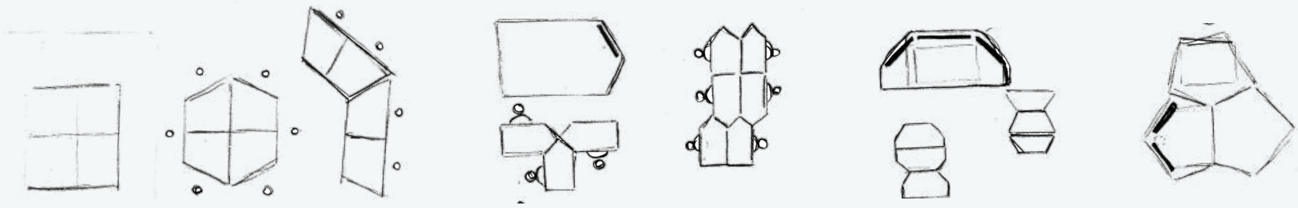
flexibility & appropriation / personalisation

Several attributes consider flexibility and appropriation of space. This can be seen with regards to both the form and functioning of the unit. Users have the ability to control interior layouts, as a result of flexible facade interfaces, as well as furniture and fixtures, while exercising a larger sense of control over the unit composition and configuration on site.
Scene b explores these different scales of control, exercised by groups or individuals, teachers or learners.

9.3 FURNITURE & FIXTURES

Furniture is seen as mobile features within the space, large contributing to the overall flexibility in the functioning of a learning environment on a daily, or short term basis. Within the design proposal, several furniture items are designed to not only allow flexibility, but consider the potential needs of individuals and groups, thus providing opportunity for a sense of personalisation and ownership.

9.3.1 LEARNER DESKS



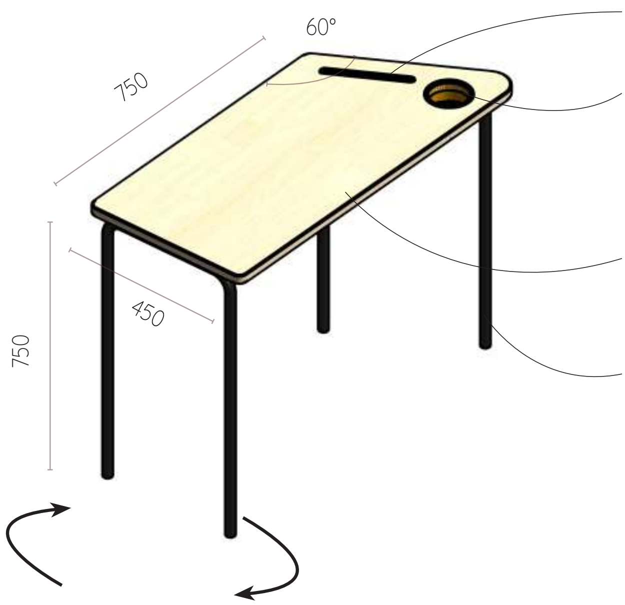
Could result in unused corners on individual desks

Pointed end creates obstruction for passers-by, with a loss of space for the user

More rounded edges are safer for the user and soften the perception of corners. Ensure that edges are functional.

Figure 136: Learner desks_Iterative Process

ITERATIVE PROCESS



'Groove' functioning as a docking station for electronic devices such as phones or tablets, envisioned within the 21st Century learning concept

100mm diameter custom formed polypropylene cup, slotted into plywood perforation, colour coordinated with the classroom colour palette. 'Cup' as a water-bottle or stationary holder, depending on user needs

450 x 20mm custom shape Plywood worktop with perforations for 'Cup' and 'Groove'.

15mm diameter x 750mm brushed stainless steel tubing, formed to the required 'U'-shape and screwed to the plywood at 200mm c/c spacing. Footings are capped with a rubber housing to prevent scratching the floor and for ease of movement

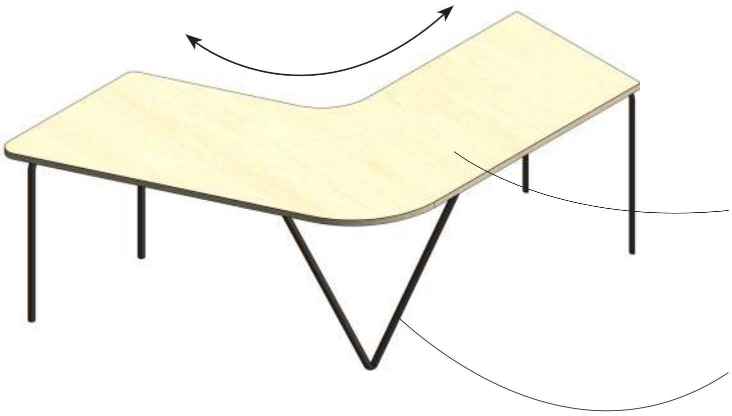
Various modes of use, and group configurations possible

FINAL ITERATION

Figure 135: Learner desks _ Final Iteration

09

9.3.2 TEACHER DESKS



Allows for various angles of use and increases the orientation potential in the classroom, further providing ample worktop space for working and temporary storage such as learner work for marking or teaching material.

450 x 20mm custom shape Plywood worktop with perforations for 'Cup' and 'Groove'.

15mm diameter brushed stainless steel tubing, formed to the required 'U'- and 'V'-shape and screwed to the plywood at 300mm c/c spacing. Footings are capped with a rubber housing to prevent scratching the floor and for ease of movement

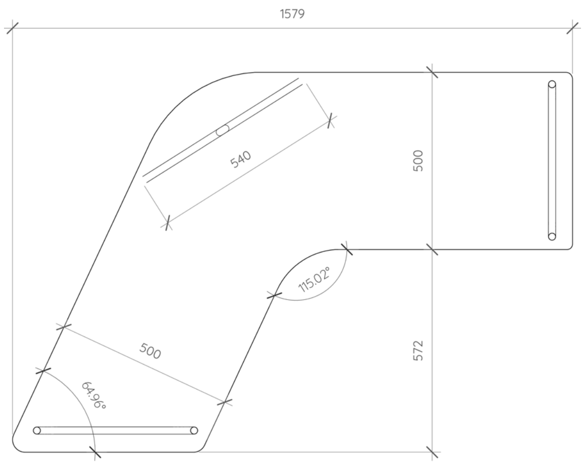


Figure 137: Teacher desks_Final Iteration

9.3.3 ADDITIONAL FURNITURE AND FITTINGS

Learner chairs adapted from the Gardena' chair by R&D Leyform:

520 x 505 x 815mm stackable chair with 15mm diameter brushed stainless steel legs, capped with rubber footings. A 16mm Custom shaped plywood seat with a coloured laminate applied to the backrest, corresponding with the light colour pop of the classroom colour palette.

Light fittings:

1200 x 80 x 200 38W LED Parabolic Louvre pendant light fitting, with Chromawerx Duo White control, tunable white from 2700K to 6500K, suspended from plywood ceiling with 12mm diameter threaded steel tube, white powder-coated stem to be 2400mm above the final floor level, or fixed to the bottom of timber trusses with a mounting clip

Wobble stools adapted from the Grow stool by 'Hierarchy':

80mm diameter x 500-680mm brushed stainless steel height adjustable stem, with a coloured polypropylene base corresponding to the light colour pop of the class-room colour palette, with a 330mm diameter x 20mm plywood seat, screwed to the stem fitting.

Social bench adapted from the Johann bench supplied by 'Deskstand':

450 x 1300 x 300mm plywood bench

Figure 138: Furniture & Fittings palette

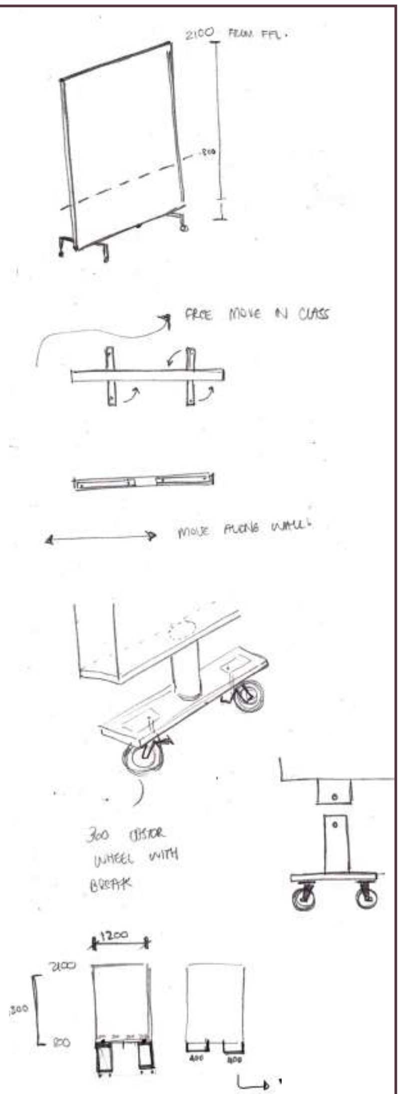
09

9.4 TEACHING WALL

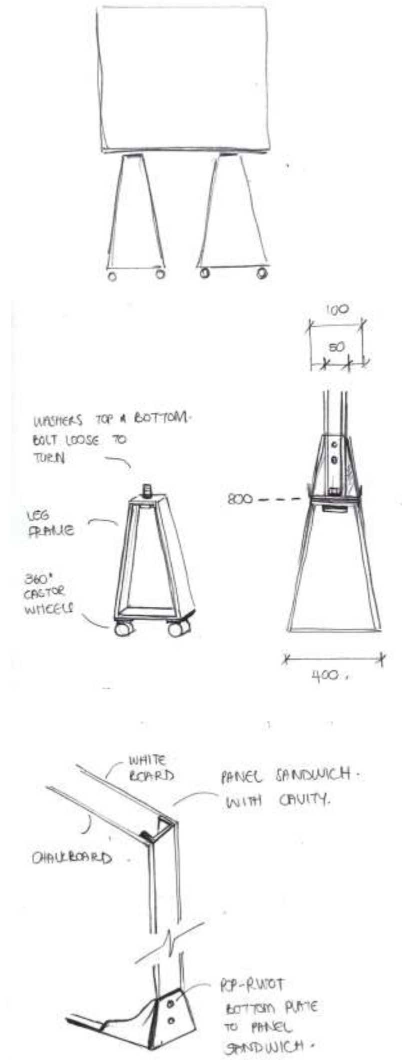
The teaching wall is regarded as the interior facade most likely to be used for the teacher instruction as a solid, pin-able wall surface is provided. This allows teachers to pin up any graphic or informative material relevant to their subjects and necessary for their teaching approach. Student work could potentially also be pinned on these walls, enstilling a sense of pride and belonging. Traditionally, teachers make use of blackboards or whiteboards to communicate information and explain the content. For this design proposal, a different approach was taken, leading to the design of moveable 'write'-boards.

9.4.1 MOVEABLE 'WRITE'-BOARDS

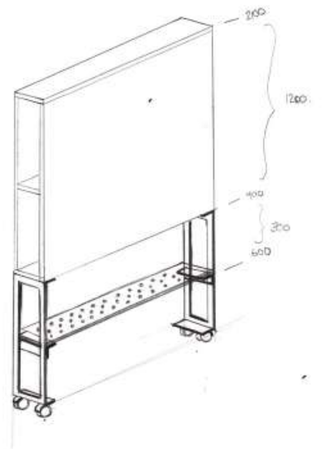
The moveable 'write'-boards are designed as a learning tool within the space. The front and back faces are finished with a whiteboard coating on the one side and a chalkboard finish on the other, affording teachers and learners to use their preferred surface finish, or in some cases both. These components are also fitted with 360° castor wheels, including a brake plate, to allow for easy movement throughout the space. This not only accommodates a shift in learner desk orientation during teacher instruction, but also encourages collaborative learning as it can be used as screening devices with a writeable surface to share ideas and work together.



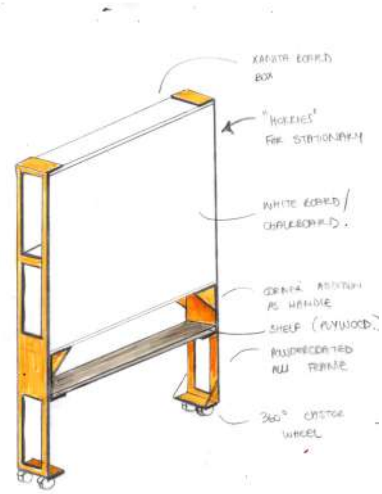
Swivel legs to adjust from flush placement against the teaching wall to a balanced placement as screening device.



Sandwich panel structure with cavity to increase stability



Increased width to allow stability and flush placemnet against the teaching wall without having to swivel legs. Include a shelf and storage boxes.

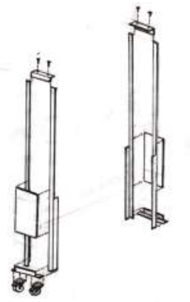


Incorporate side and front handles for ease of operation

ITERATIVE PROCESS

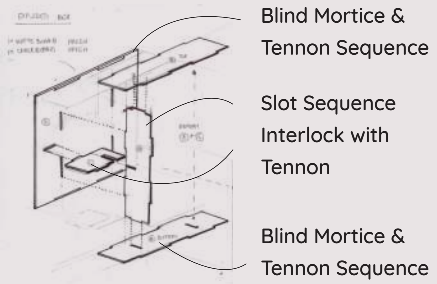
Figure 139: 'Write'-boards _ Initial Iterative Process

09

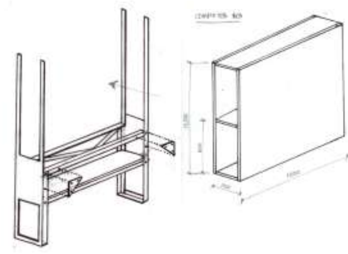


Structure, wheels and side panels

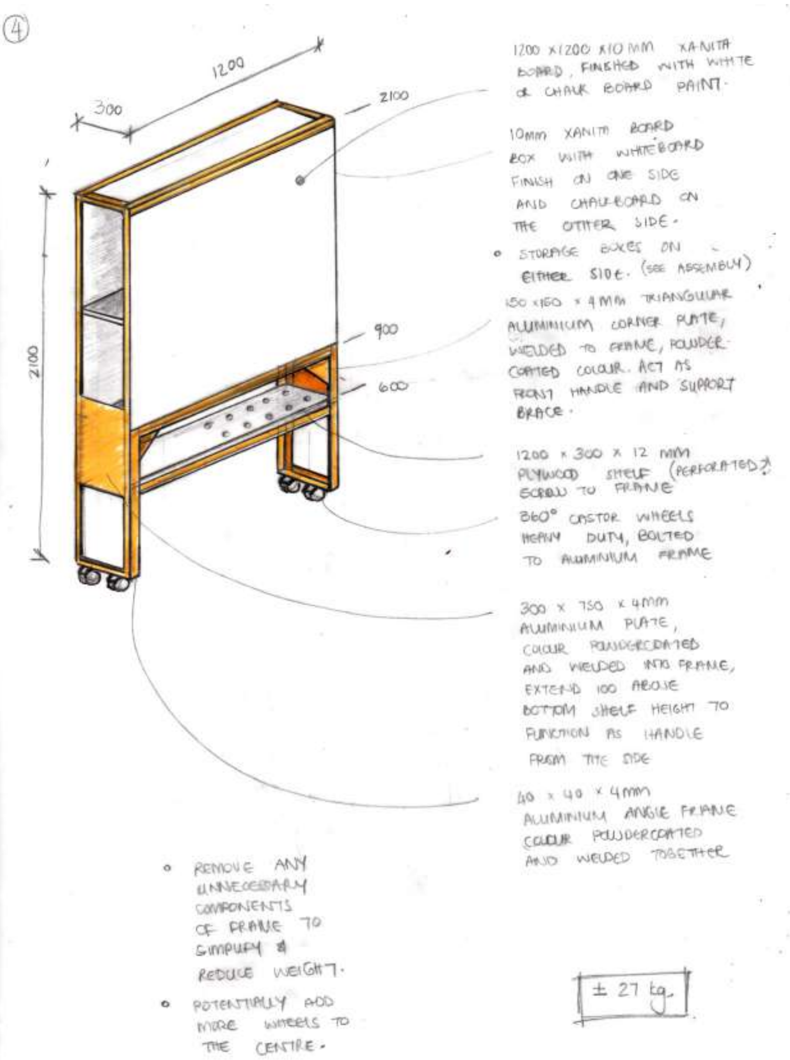
Shelf structure and plywood shelf

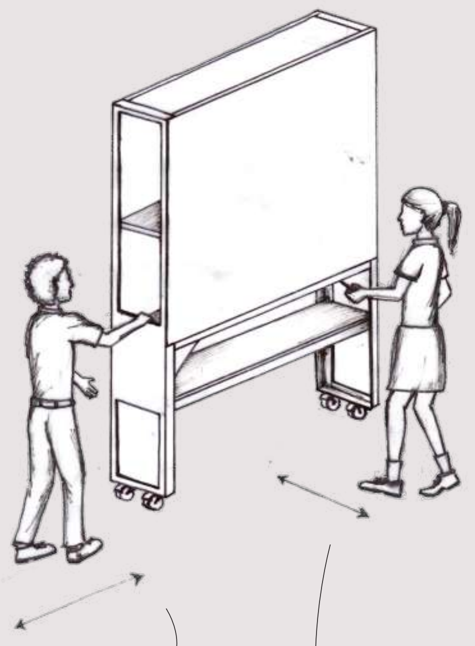


Xanita board box with white- and chalkboard finish on the front and back face



Box slotted in.
Front handles / cross-bracing added.



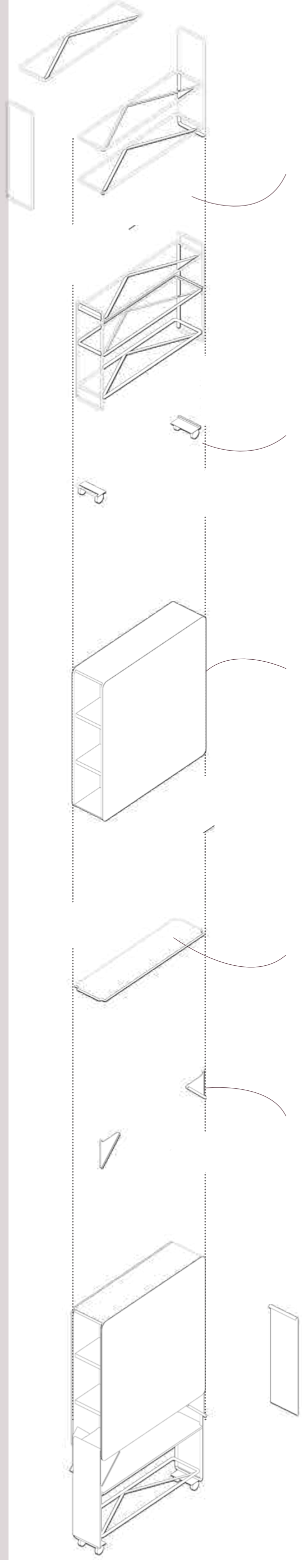


Side panel extending beyond the storage cavity to create a handle on the side, assisting with the movement of the 'write'-board within the space

Cross-bracing creates a front handle with which to move the board to the front and back, especially considering the ease of operation when panels are placed adjacent to one another along the teaching wall.

Figure 140: 'Write'-boards _Iterative Process Finalisation

ITERATIVE PROCESS



20mm diameter brushed stainless steel legs, formed to the required shape. Additional 4mm cross-bracing added to the shelf structures. Components welded together to create trolley frame structure.

100 x 300 x 4mm powdercoated aluminium bottom plate with 20mm diameter semi-circle edge curve, placed around and screwed to the bottom bar of the trolley frame structure. 360° Castor wheels fixed to the bottom plate with pop-rivets, ensuring easy movement.

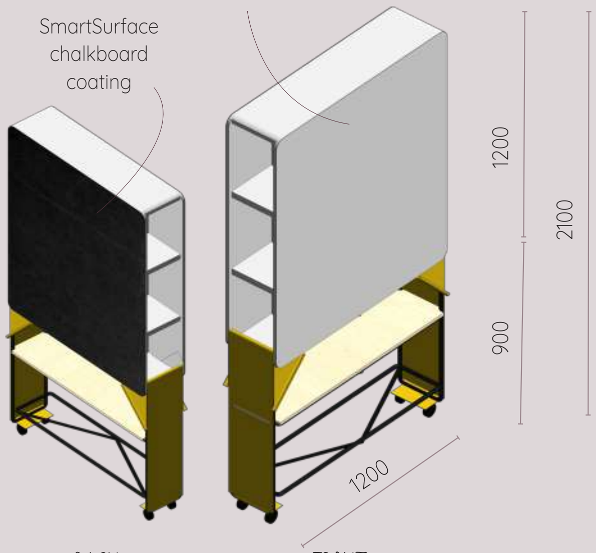
16mm Xanita board box put together with blind mortice & tennon, as well as slot interlock and tennon interlocking joints. Exposed Xanita edges are finished with white PVC flexible "C" section edge band. The front and back faces are finished with white- and chalkboard coatings respectively.

1200 x 300 x 20mm plywood shelf, with 30 diameter corner cut-outs for shelves to be placed on the trolley shelf structures.

200 x 200 x 4mm triangular front plate, powdercoated aluminium according to the classroom colour palette, fixed to the trolly frame structure with pop-rivets, functionaing as front handles and cross-bracing.

900 x 300 x 4mm side panels with 20mm diameter semi-circle edge profile as the side handles, powdercoated aluminium corresponding with the classroom colour palette, fixed to the trolley frame structure with pop-rivets.

Figure 141: 'Write'-boards _Final Iteration Composition



Storage boxes and a shelf for writing utensils, drawing equip-ment, books and teaching materials.

Figure 143: 'Write'-board_Final Iteration

ADDITIONAL FEATURE : TROLLEY

Trolleys are equipped with three shelves as opposed to the one shelf and Xanita storage box accompanying the 'write'-boards.

Figure 142: Trolley

FINAL ITERATION

09

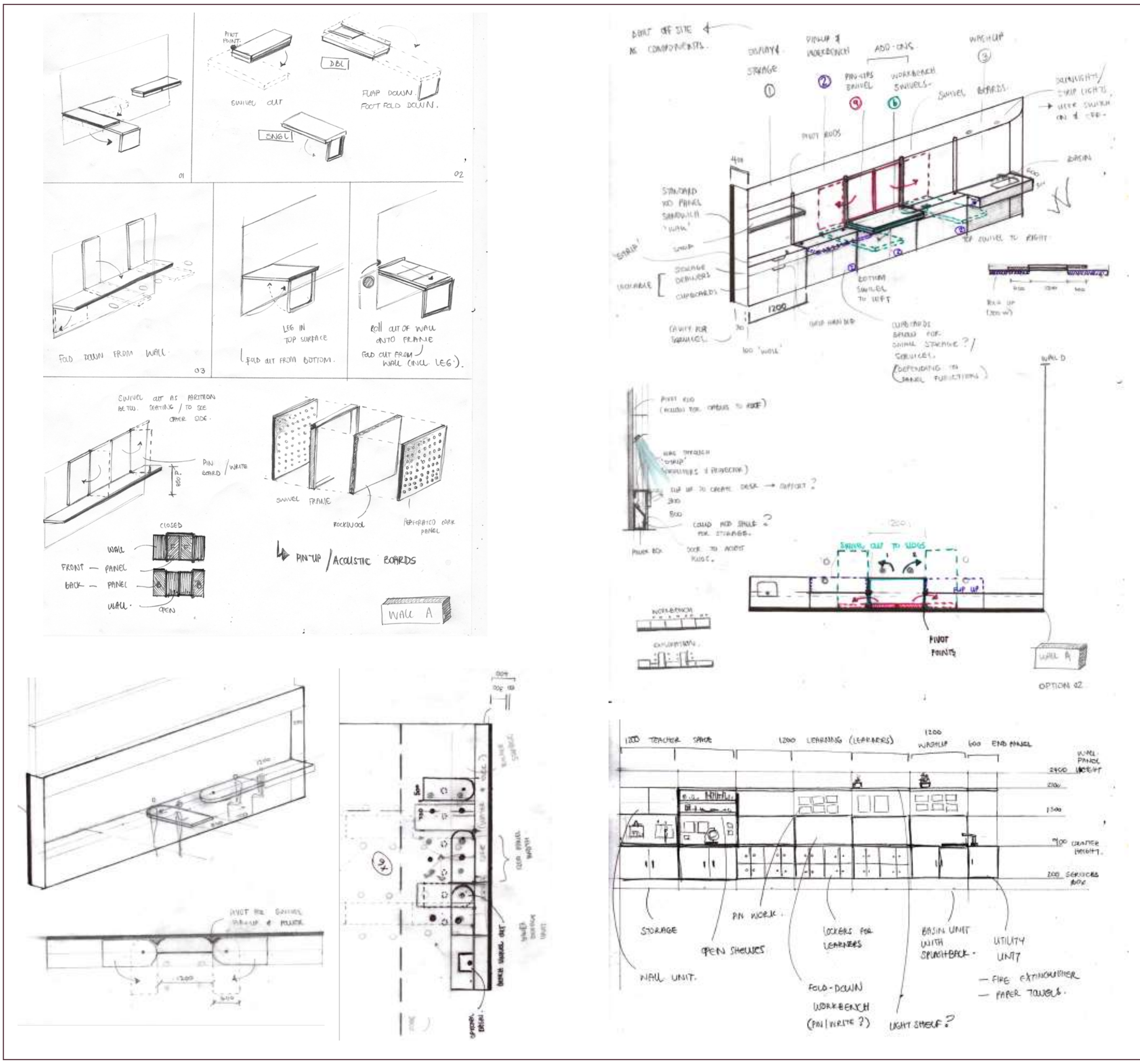
9.5 SUPPORT WALL

Housing a workbench, storage units, services and pin-able surfaces, the support wall is designed to assist a multitude of activities within the classroom. It primarily caters for the 'focus zone' or explorative learning scenario.

The wall consist of seven panels, constituting three different sections. Primarily making provision for the education of learners, the middle section sees the standard panel features. A 300mm counter serves as a display shelf or alternatively could support the optional 600mm worktop, which would cantilever the remaining 300mm and provide a large enough overhang for knee space. In such a scenario, stool seating is provided to accommodate computers, for a library scenario, as well as a workstation for individual or group learning beyond the curricular routine. Storage lockers for the learners can be found below the counter, with the bottom services box housing the electrical conduit and water piping. These standard features are present on all three segments, with the outer two having unique features for additional functions.

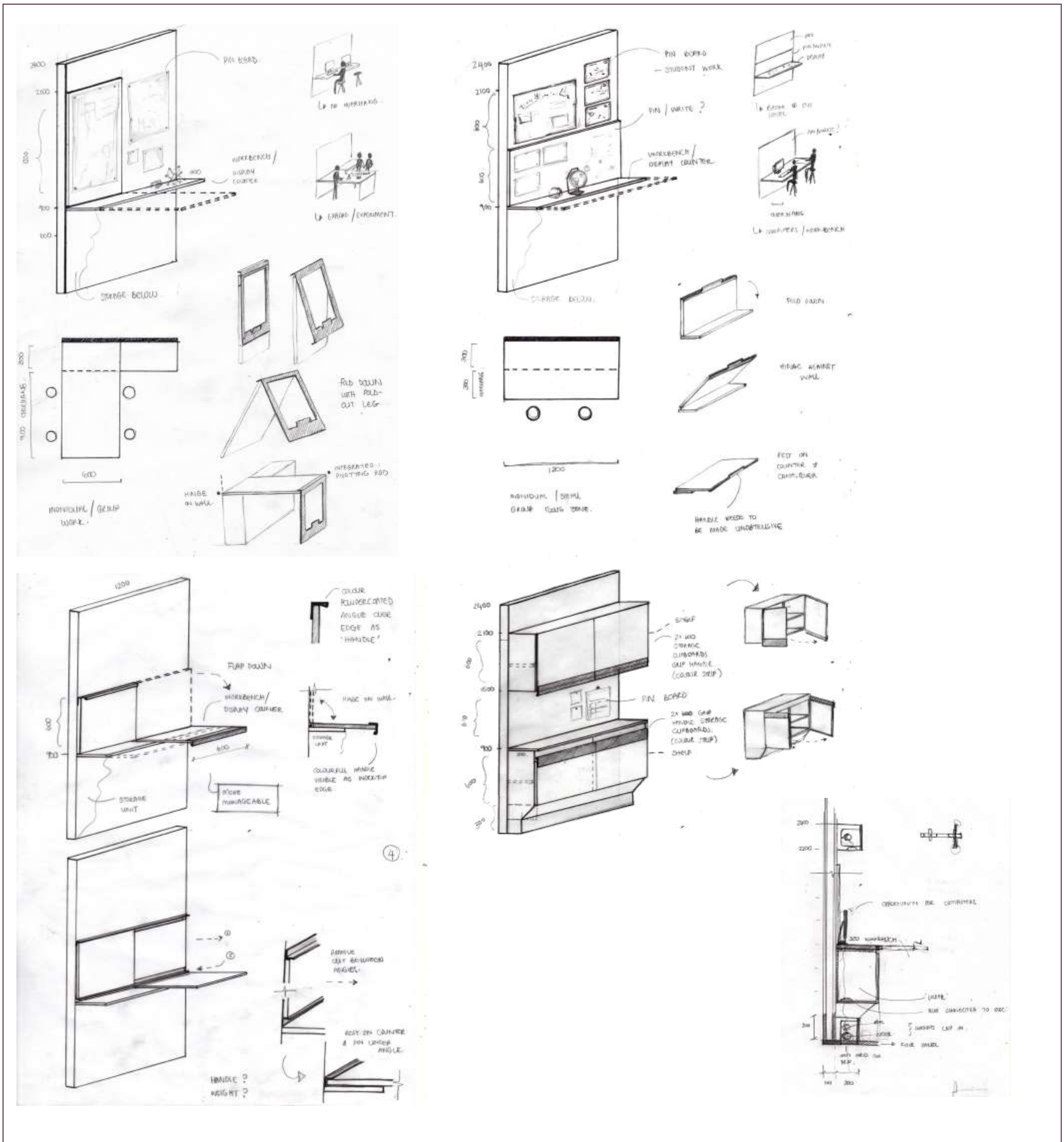
The second segment incorporates a wash-up area as unique feature, with water supply from the water storage tank, to facilitate a laboratory scenario and any learning activities where hand- or object washing will be needed. This would be situated on the end closest to the water tank corner. An under-counter filtration system allowss each classroom to provide learners with potable water.

The final segment largely considers the teacher. Lockable storage and display shelves are integrated, with a roller-shutter door asigning flexibility to the wall-unit with reagrds to the level of display.



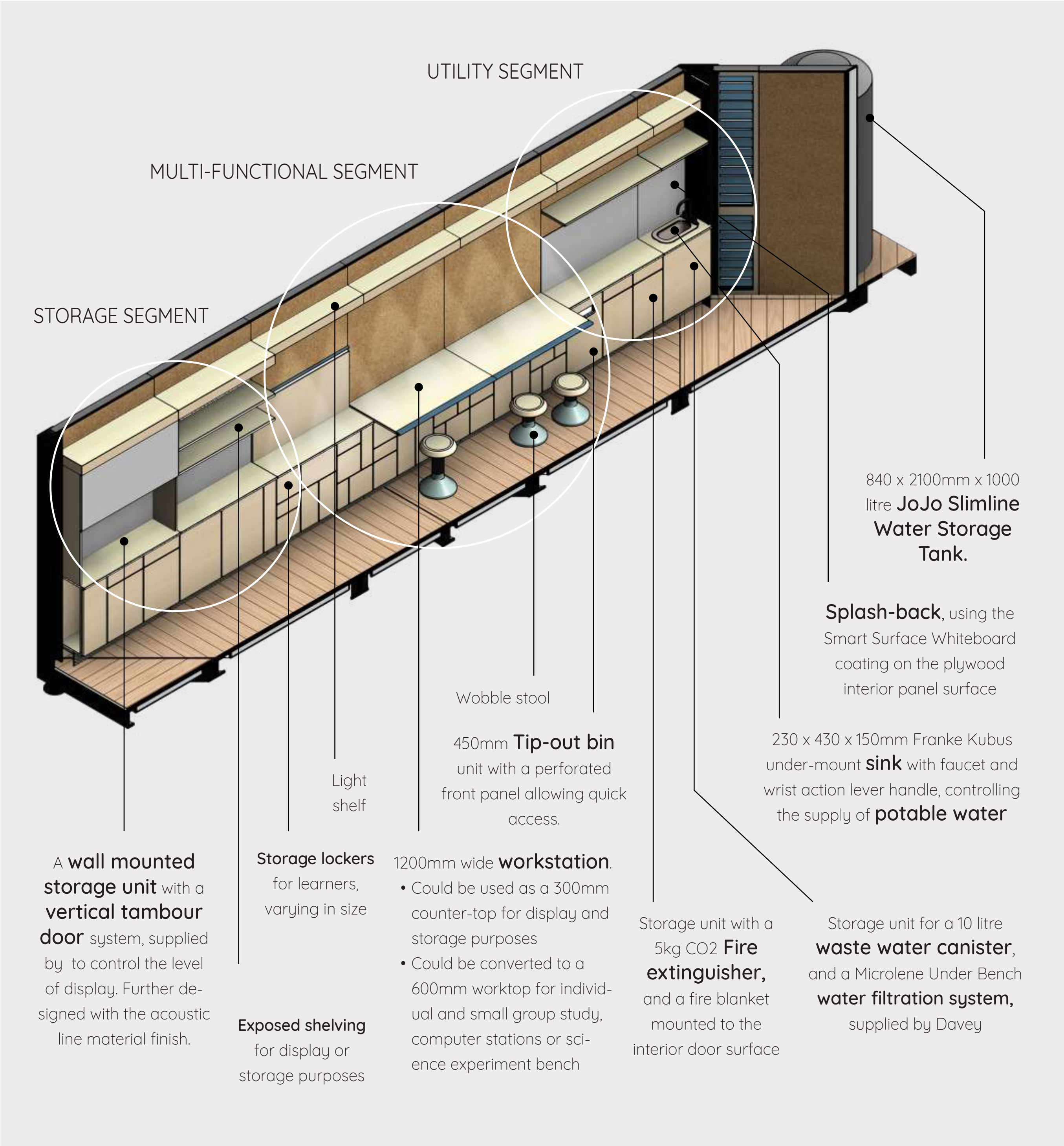
ITERATIVE PROCESS

Figure 144: Support Wall _ Iterative Process 01



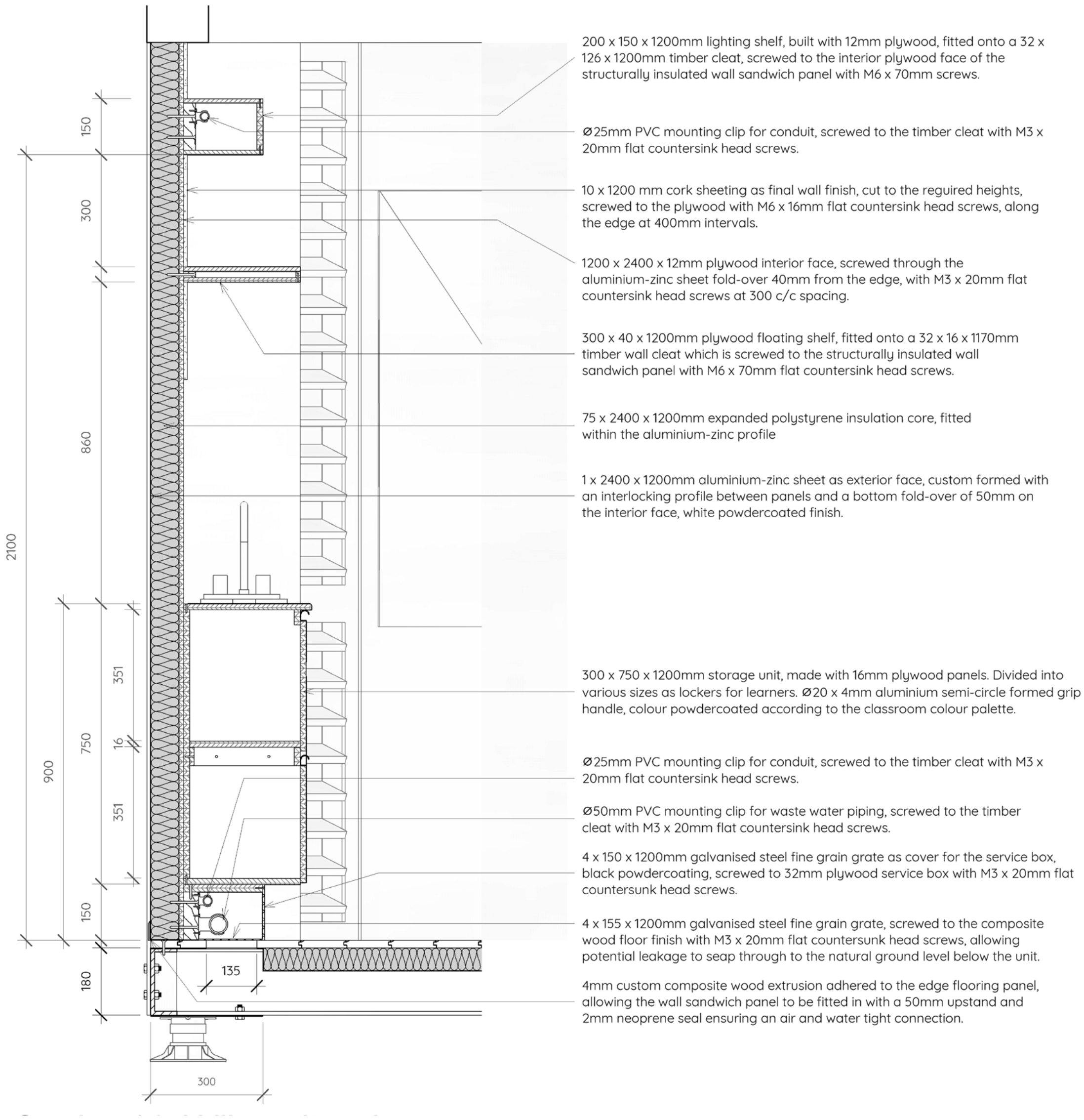
ITERATIVE PROCESS

Figure 145: Support Wall _ Iterative Process 02



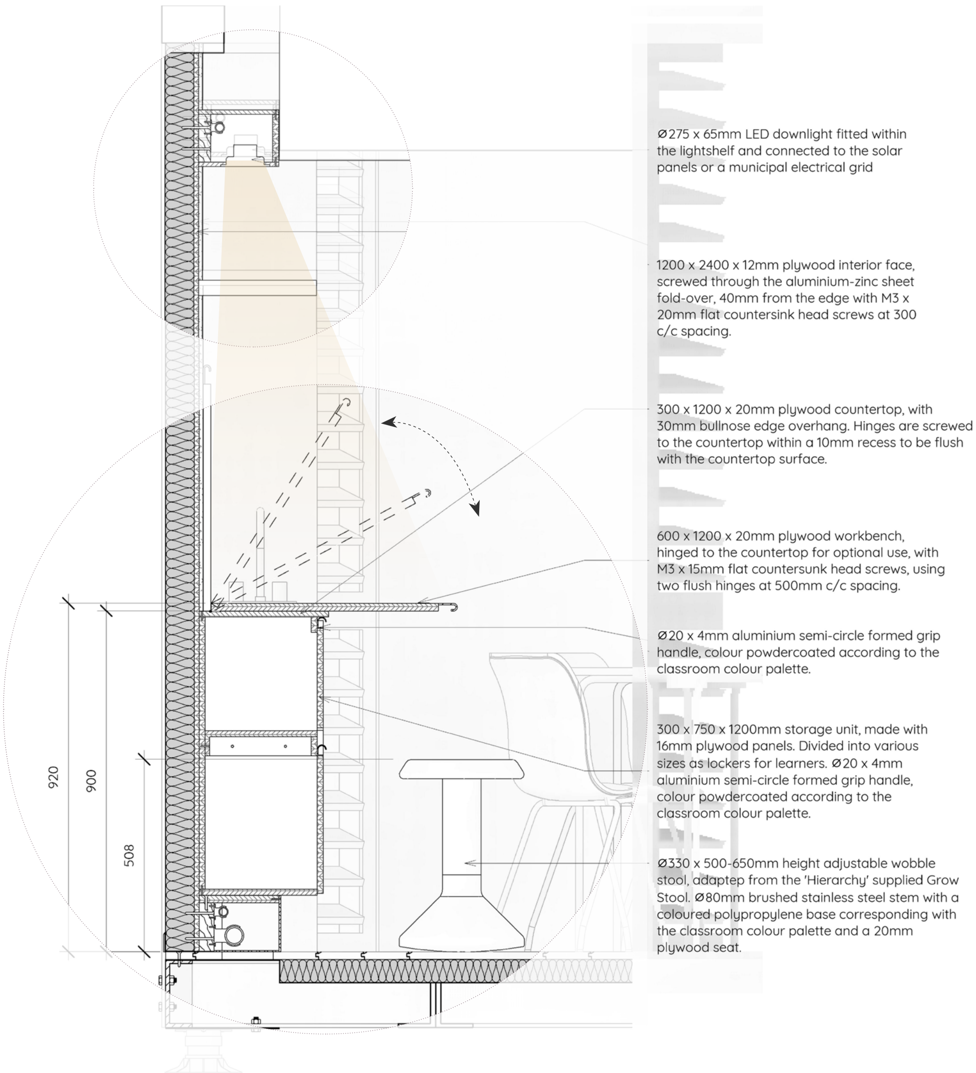
FINAL ITERATION

Figure 146: Support Wall _ Final Iteration



SECTION _ UTILITY SEGMENT

Figure 147: Support Wall _ Section: Utility Segment



SECTION _ MULTI-FUNCTIONAL SEGMENT

Figure 148: Support Wall _ Section: Multi-Functional Segment

9.6 UNIT COMPOSITION SCENARIOS

9.6.1 RULES TO FOLLOW

The four interchangeable facades permits flexibility with regards to the physical parameters of the unit. This means that the unit composition can adapt according to the needs of the user and the site requirements, and not be limited to a specific orientation within the given context.

However, to ensure the efficient functioning of the unit, in terms of service provision, natural ventilation, social zoning and overall configuration on site, three rules should be followed (See figure 149 & 150). Consequently, eight composition scenarios are available for single units, as shown in figure 151. Figure 151 also illustrates possible, but not limited, scenarios for adjacent units which function separately, and the combination of two units to create larger spaces. These configurations of multiple units can be further explored as needed, provided that the rules are adhered to.

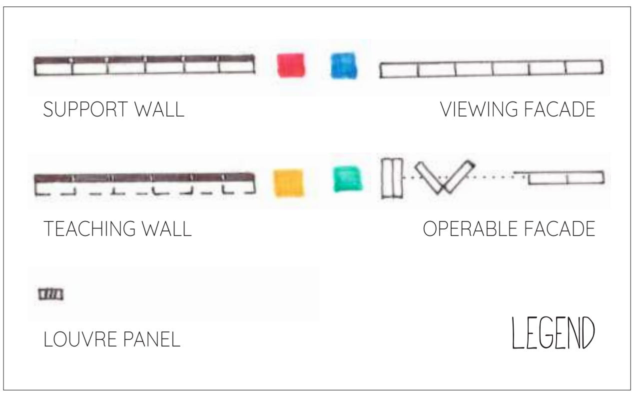


Figure 150: Unit composition legend

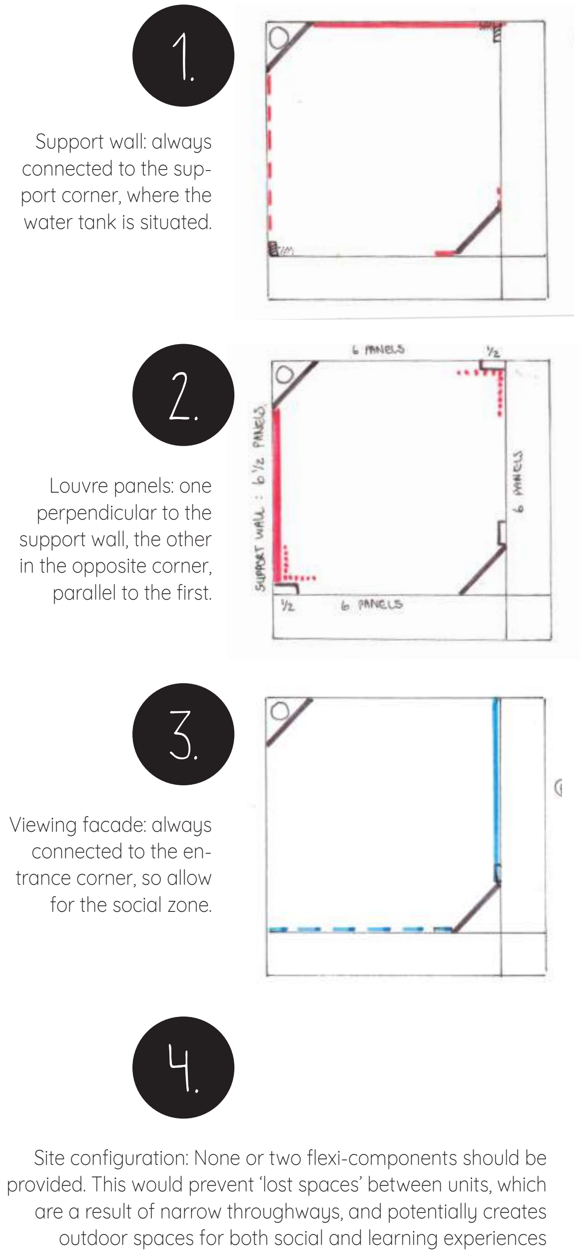
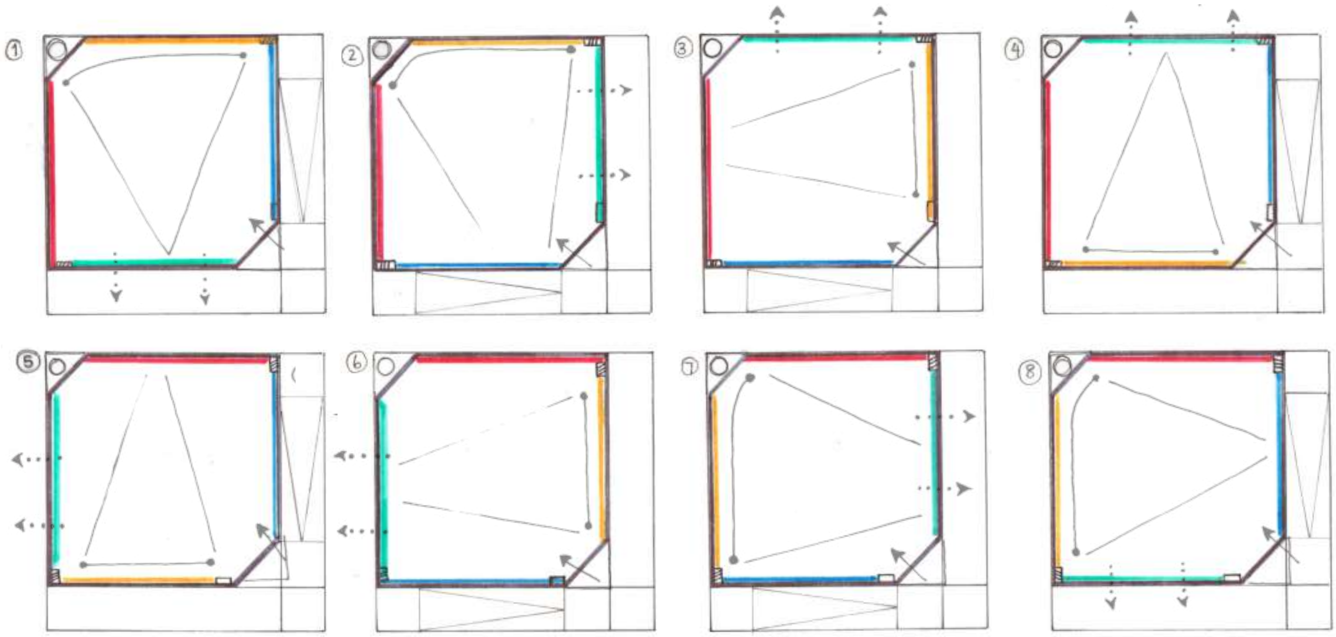
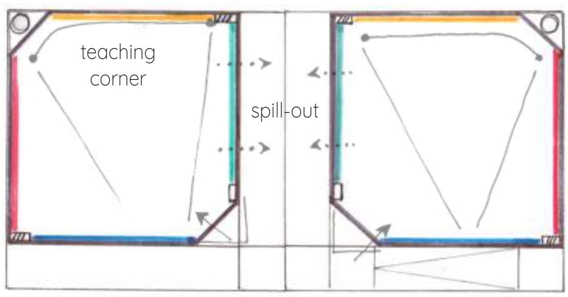


Figure 149: Unit composition rules to follow

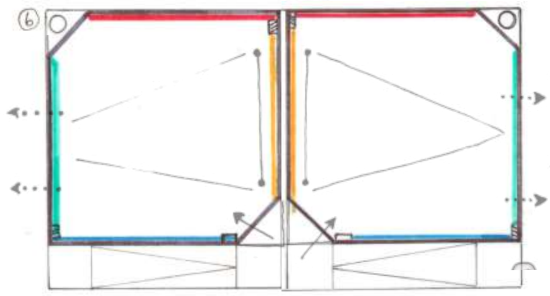
SINGLE UNIT



ADJACENT UNITS

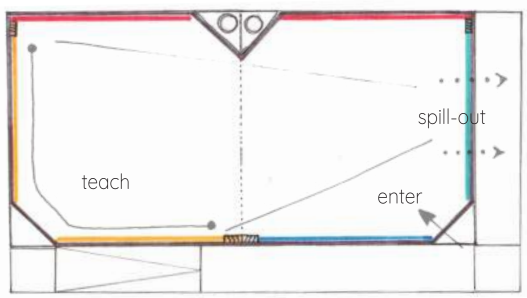


communal spill-out / exterior learning space



Back to back with shared circulation space

COMBINED UNITS



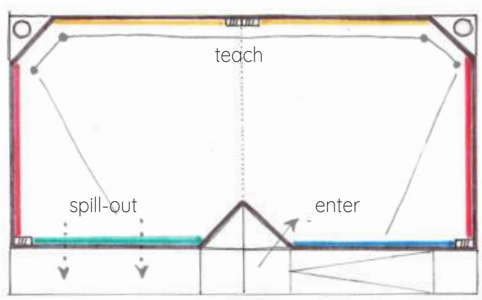


Figure 151: Unit composition scenarios

scene c : spaces for learning

formal & informal
interior & exterior

As the aspect of control is designed for in various ways, the resulting flexibility accommodates an array of learning experiences.

Scene c presents the different teaching and learning scenarios affiliated with both the interior space of the unit, and the exterior, in-between spaces once the units are configured on site.

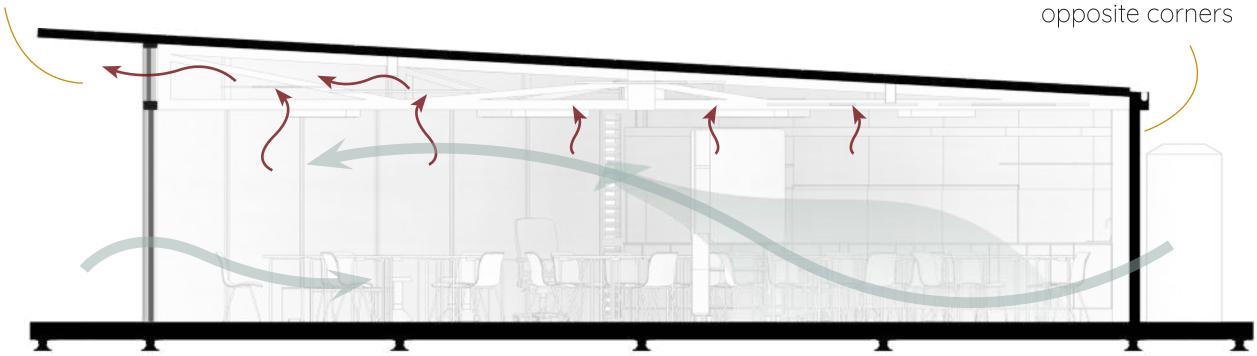
9.7 PHYSICAL COMFORT & EXPERIENCE

In order to ensure user comfort and care, the natural ventilation, acoustic performance and lighting quality within the unit were all critical factors to consider. These are addressed through the design of the unit components as well as the material selection. In doing so, an environment condusive to learning was created.

NATURAL VENTILATION

Operable clerestory windows

Louvre panels at the back end wall and opposite corners



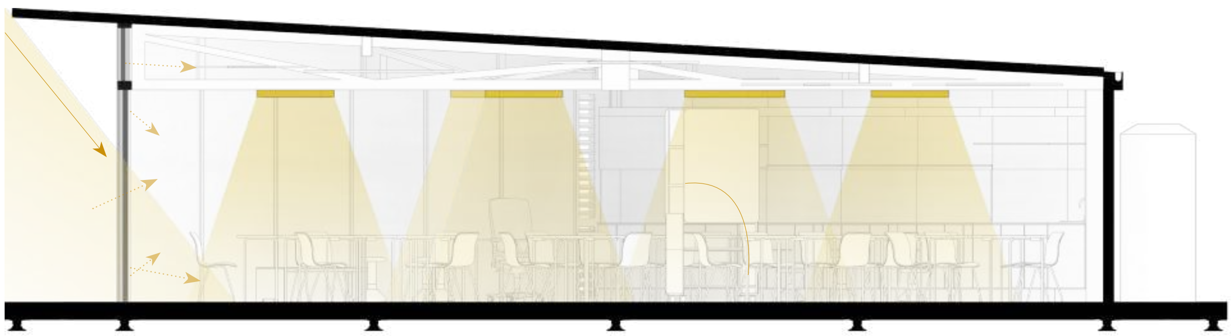
Cross ventilation through the louvre panels and the operable clerestory windows

Figure 152: Natural Ventilation

LIGHTING

Natural daylighting

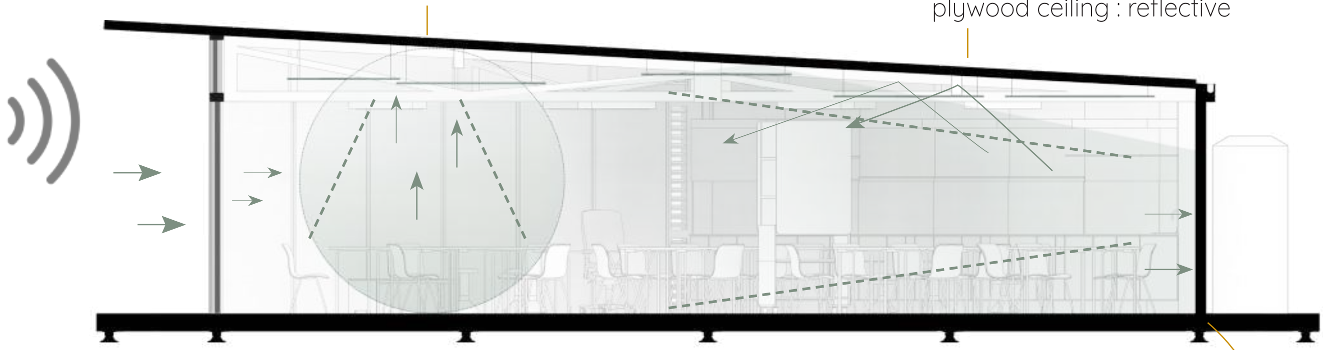
Artificial lighting



Natural daylighting through clerestory windows and polycarbonate facades.
Multi-wall polycarbonates ensure indirect light to avoide glare and a more even distribution of lighting
Artificial lighting : Parabolic LED light fixture as general pendant lighting.
LED downlights as additional task lighting above the workbench

Figure 153: Lighting

ACOUSTICS



Ecophon Solo, custom shape, acoustic panels supended from the ceiling
to control the noise generated by learners.
Cork wall surfaces further absorb sound.
Hard plywood ceiling surface reflects and distributes sound into the space.
Palsun Polycarbonate panels create acoustic barrier

Figure 154: Acoustics

SPATIAL QUALITY

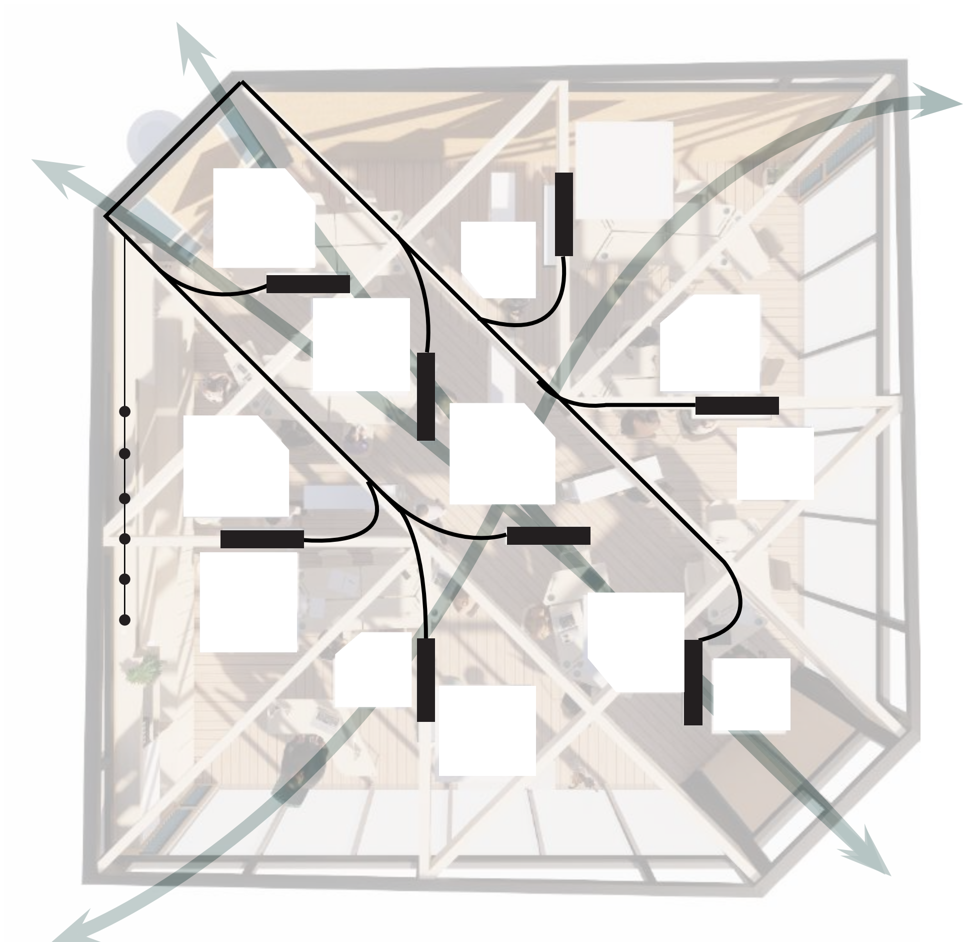


Figure 155: Spatial Quality

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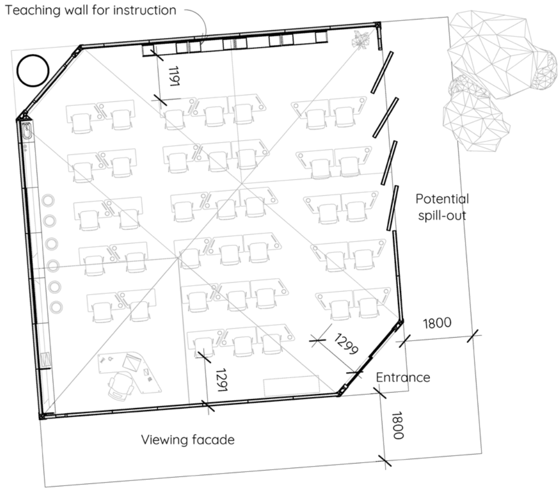
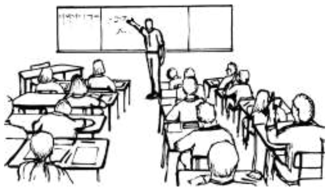
9.8 TEACHING-LEARNING SCENARIOS

Referring back to the 'function' strategy previously established in *Chapter 8 _ Formulating a Design Response*, the **five scenarios concerning educational approaches,** necessary to be accommodated, are presented within the design proposal. These primarily address the 'formal & informal' design informant of Spaces for learning..

1. TEACHER FRONTED

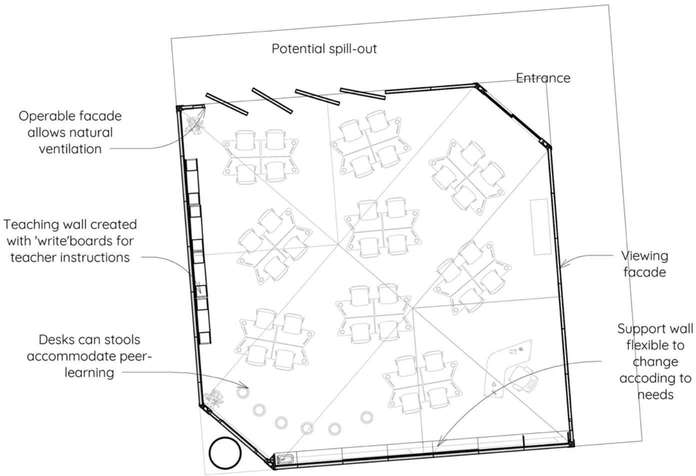




A teaching wall with 'write'-boards is provided for traditional **teacher-fronted instruction.** Learners have views to the exterior through the operable facade. As the viewing facade alongside the circulation space is to the back of learners, distraction from passers-by are limited.

Figure 156: Teaching-learning scenarios _ Teacher fronted

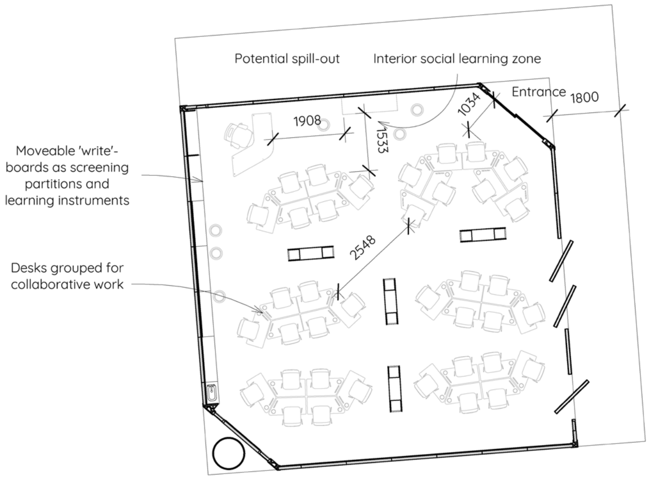
2. HYBRID LAYOUT



Teacher instruction and collaborative learning between learners taking place.
The learner desks can be configured in multiple group sizes and shapes. Furthermore, the write-boards can be moved along the teaching wall to alter the orientation of instruction. Consideration is given to the acoustics in order to allow for both teacher projection and noise control.

Figure 157: Teaching-learning scenarios _ Hybrid layout

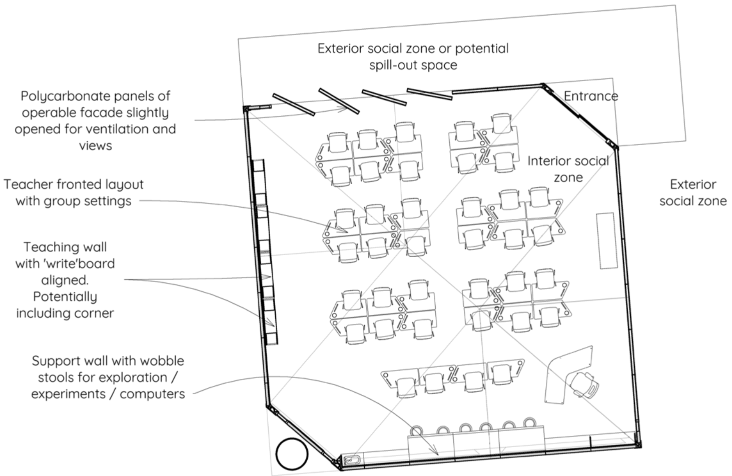
3. PEER LEARNING



Within this scenario, **pure collaborative and peer-learning** takes place. This sees the movement of write-boards into the space, as **screening partitions** between groups of learners sharing ideas and engaging in both individual and peer learning. The group sizes and desk layouts can be altered as required for the specific activities, with teacher acting as facilitator among the groups. Acoustic ceiling islands would assist in suggesting group layouts and the noise control associated with the learning experience.

Figure 158: Teaching-learning scenarios _ Peer learning

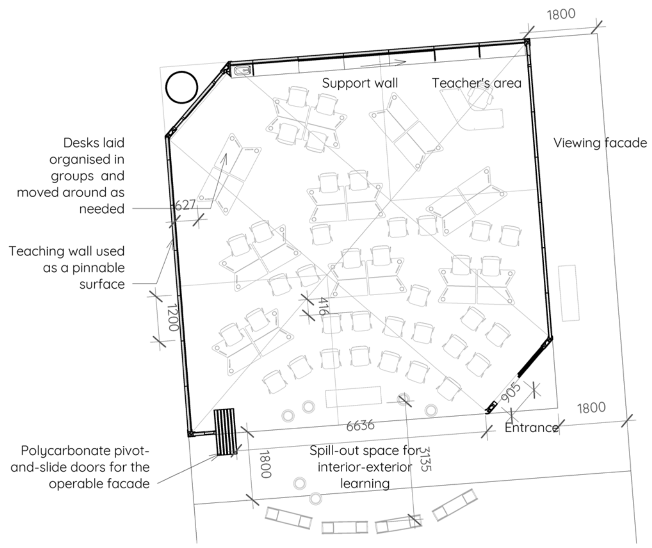
4. EXPLORATION



As the unit is comprised of a kit of parts, each classroom will be equipped with a support wall. This flexible wall surface makes provision for exploration in the form of **computer studies** or laboratory work as a workbench, wash-up area and electrical points are provided. In addition to these, the workbench further enables **individual or small group studies** before or after the academic schedule.

Figure 159: Teaching-learning scenarios _ Exploration

5. SOCIAL / KINETIC



The social and kinetic learning experience finds particular relevance with the idea of the **operable facade**, and can take place in conjunction with any of the other four scenarios discussed. It is here where the traditional desk learning becomes less important and learners are encouraged to **engage in physical activities,** such as dancing, role-playing etc., in both the **interior and exterior spaces.**

Figure 160: Teaching-learning scenarios _ Social / Kinetic

9.9 A LEARNING ENVIRONMENT

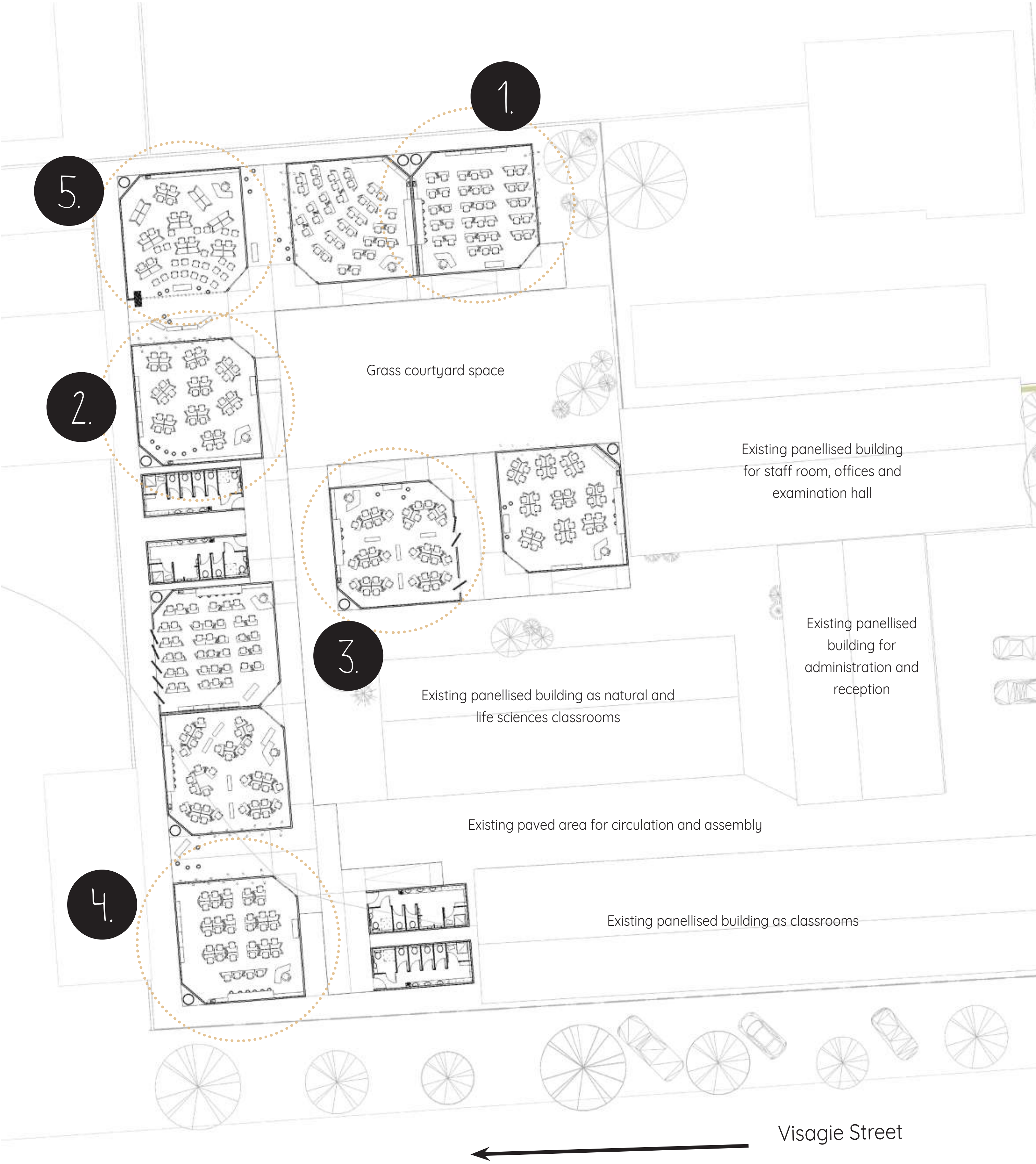
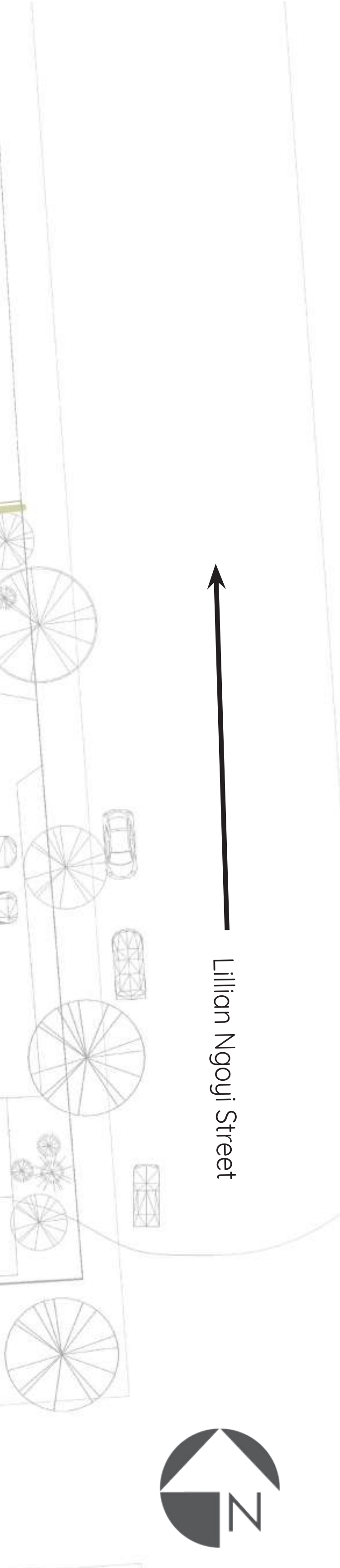


Figure 161: A Learning Environment _ Potential scenario



Extending from the potential learning scenarios found within the classrooms, figure 161 presents the school scenario where a combination of teaching and learning experiences take place through both indoor and outdoor activities. As seen with the potential school scenario proposed, the five scenarios can be configured on site in multiple ways, allowing teachers and learners to adjust the learning environment according to their needs - no longer being limited to the traditional teacher-fronted classroom layout. Furthermore, the educational experience is not merely limited to the interior of a classroom, but sees social learning taking place beyond the boundaries of a unit, making use of a grassy courtyard and green infrastructure, as well as the flexi-porches and circulation spaces provided between units. This allows the learners and teachers to utilise the in-between spaces as part of the school experience.

The various subjects offered by Tshwane Secondary School would require specific interior layouts and respond differently to the outdoor space and surrounding classrooms. The composition of each unit thus becomes important. Likewise, the configuration of multiple units are vital to consider, as this would create the exterior and in-between spaces in which learners find themselves. Instead of being lost and under-utilised, these spaces become part of the overall learning experience. This further addresses the concern for threshold and spatial hierarchy.

Ultimately, the design proposal optimises the informant relating to interior and exterior spaces for learning.

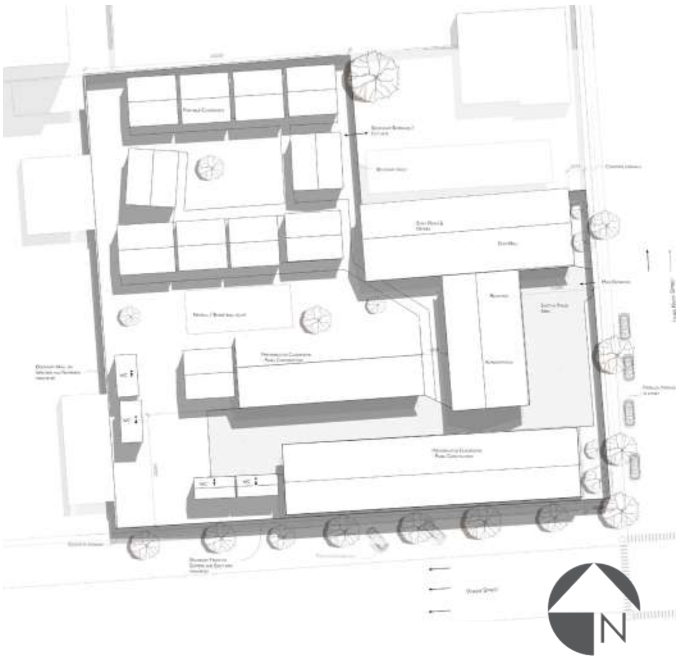
scene d : social interaction

levels of privacy
modes of interaction

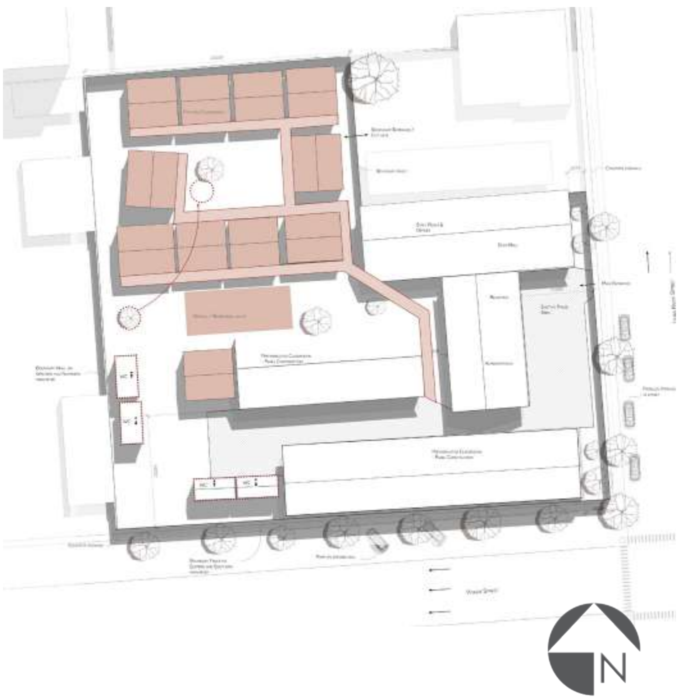
In order to promote the well-being of adolescents, the facilitation of social interaction for friendship and support networks proved vital through the theoretical inquiry and psychosocial layer of investigation. Although evident within the current site condition, social encounters happen haphazardly without special provision being made. It could be vastly improved as a critical component to educational environments.

9.10 SITE SCENARIO

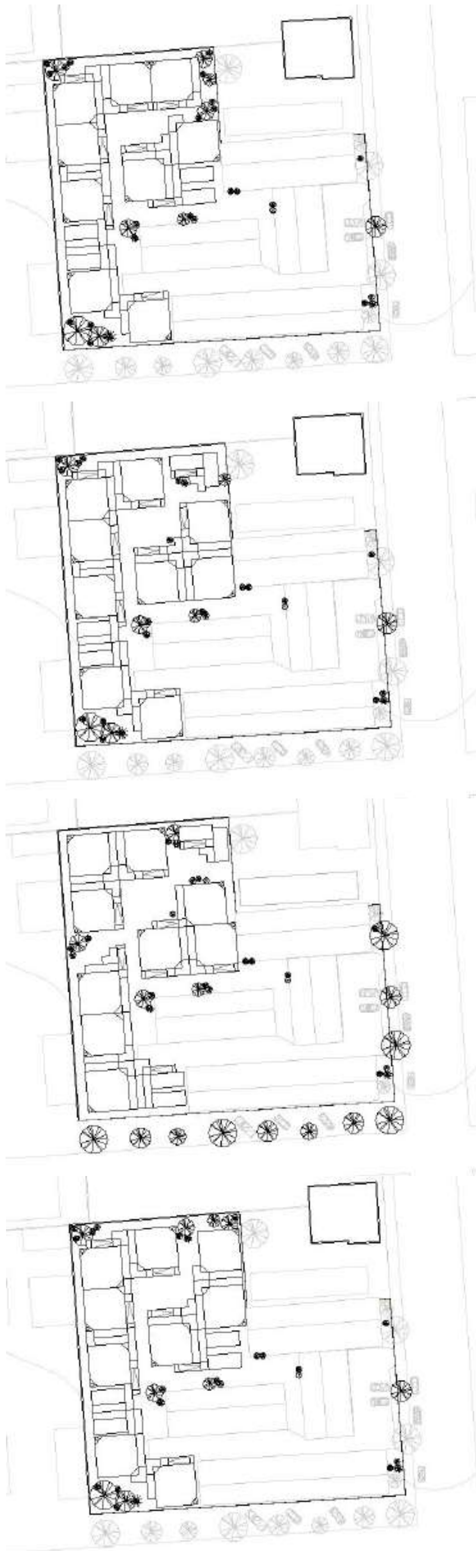
Social interaction often happens spontaneously, or forms part of the educational approach, as previously discussed. The design proposal seeks to facilitate social encounters between learners throughout the site. The unit composition includes the allocation of a social zone on both the interior and exterior of the entryway, allowing for lingering and socialisation between learners and teachers in and around the classroom. Consideration is further given to the landscaping and outdoor spaces, to extend the social encounters beyond the boundaries of the teaching-learning unit, and utilise the entire site.



EXISTING CONDITION



REMOVAL OF EXISTING INFRASTRUCTURE



ALTERNATIVE SITE SCENARIOS

Figure 162: Site Transformation

Figure 163: Alternative Site Scenarios

09

9.10.1 SOCIAL ENCOUNTERS

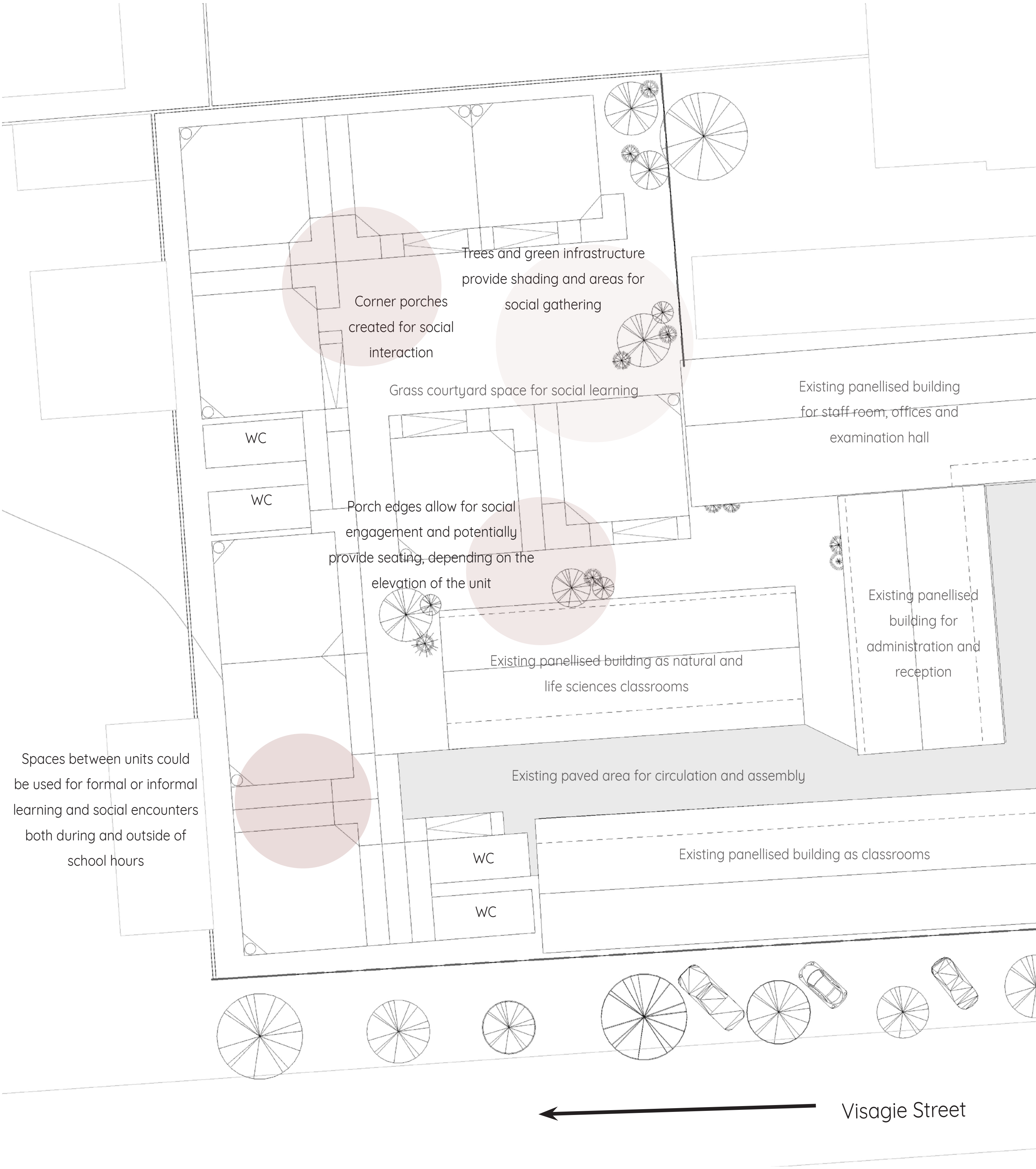
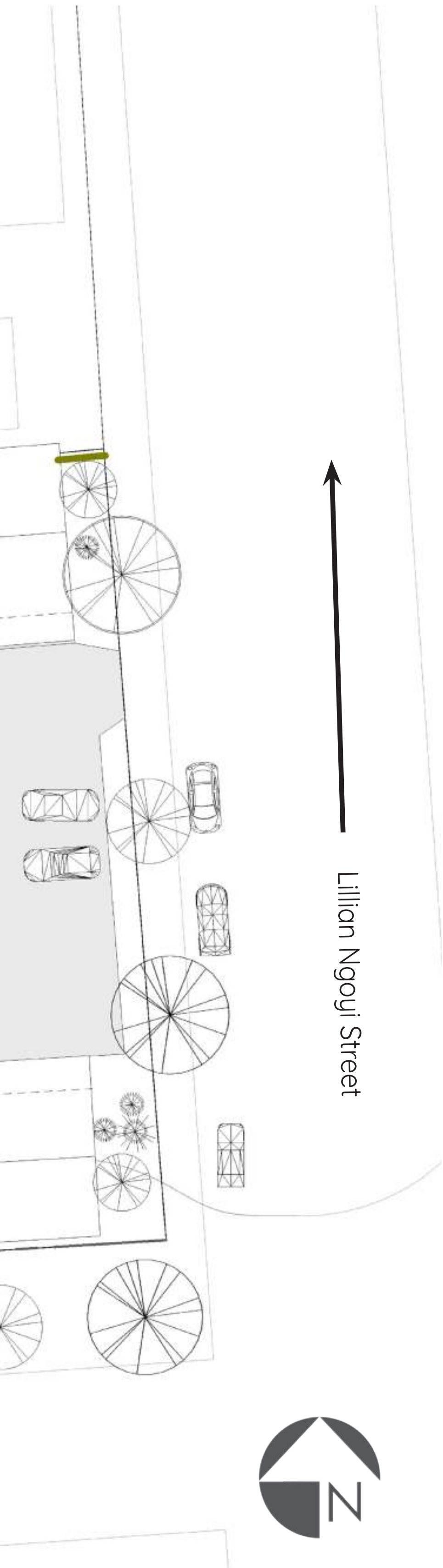


Figure 164: Social encounters



The educational experience is not merely limited to the interior of a classroom. Through the contextual inquiry in *Chapter 4*, it was found that the portable classrooms currently acting as the Tshwane Secondary School infrastructure, are problematic due to their isolated existence on site. As a result, lost in-between spaces contribute to the negative impact of the learning environment.

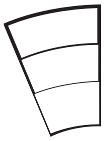
A site intervention sees the removal of existing portable classrooms, to be replaced by the proposed teaching-learning unit (see figure 162). Several scenarios for the site layout are possible, and explored (see figure 163). The author ultimately presents one of these potential scenarios in greater detail (see figure 164).

'Levels of privacy' served as a design informant to prompt degrees of interaction. Semi-private areas, as seen within classrooms and more secluded outdoor spaces, accommodate supportive encounters and deeper friendships. The landscape design created semi-public spaces and points of gathering for friend groups and the spontaneous interactions between acquaintances. The spontaneity further arises among the circulation spaces as learners pass one another between academic periods.

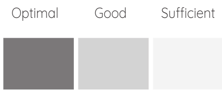
Similar to privacy levels, different seating options give way to varying modes of interaction. With the unit being raised from the natural ground level, the entrance and flexi porch offers a seating edge around the classroom. This is seen as an extension of the social zone originally allocated within the 'form' strategy and unit composition. Throughout the site, linear and centrally focussed encounters between learners could take place, supporting established and new friendships.

9.11 ASSESSMENT

LEGEND



Hierarchy of Importance.
Most Important aspects are necessary to achieve in order for proposal to be adequate.



The existing scenario poses several **threatens to the physical, social and psychological well-being** of learners. Not only does it **limit** the educational approach and **disregard user control**, but furthermore performs poorly in terms of user comfort and care

EXISITNG CONDITION

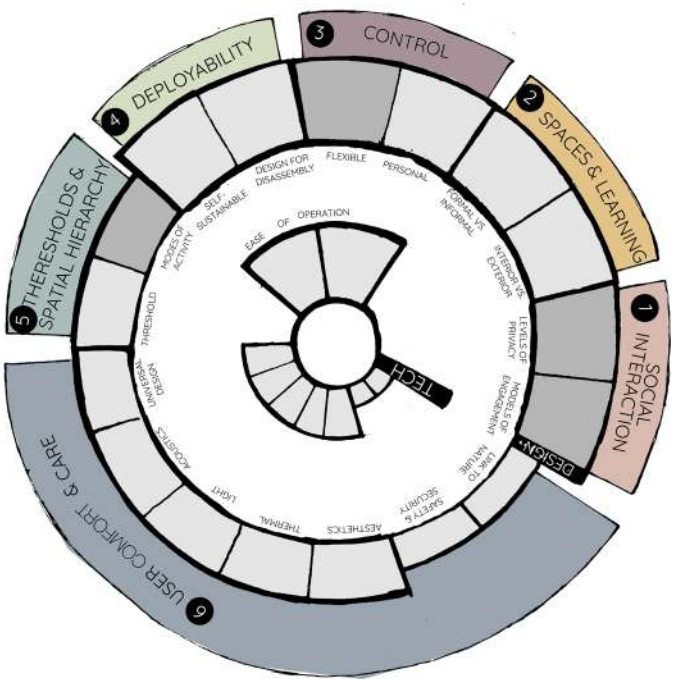


Figure 165: Existing Scenario Assessment

Overall, the design proposal receives a rating of **success** as it manages to address all of the aspects to their required level of optimisation.

In doing so, the proposed teaching-learning unit serves as an alternative to the current portable classrooms, and a model of **deployable schooling infrastructure** that not only facilitates their education, but also **promotes the physical, social and psychological well-being of learners.**

PROPOSED DESIGN SCENARIO

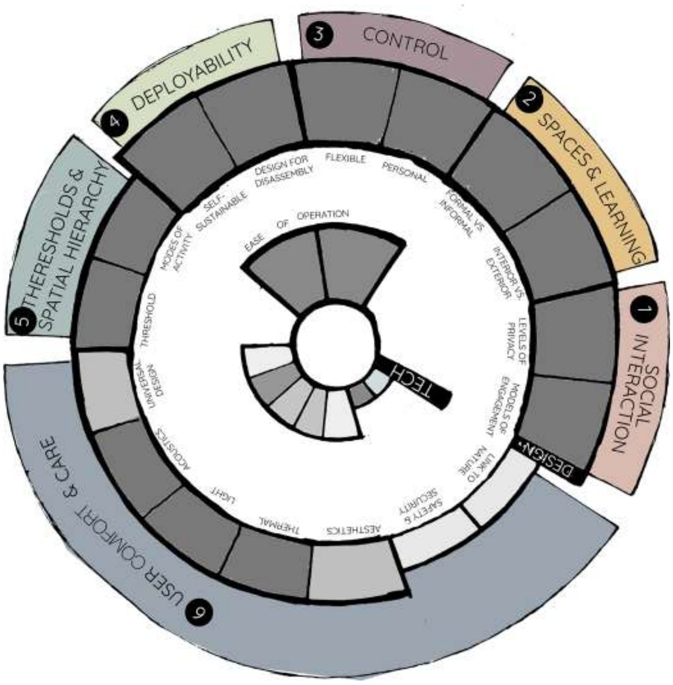


Figure 166: Design Proposal Assessment

As presented in *scene a - d,* the aspects of ***Deployability, Control, Social Interaction*** **and** ***Spaces for Learning*** are optimised within the design proposal and technical resolution. In doing so, these high-priority attributes enable a learning environment which promotes the well-being of teachers and learners alike.

Of second priority, *Thresholds and Spatial Hierarchy* was indirectly addressed through the unit composition and configuration rules, as well as the final intervention on site. Furthermore, the technical approach incorporates a material & colour strategy which implement spatial cues.

Several other factors pertaining to *User Comfort and Control,* such as universal design, acoustics, light, ventilation and aesthetics are also carefully considered. The circulation spaces, along with accessible ablution facilities accommodate users with physical impairments related to mobility. Specific attention has been given to the acoustic performance of the interior space, in order to facilitate the variety of learning scenarios. The unit composition also makes provision for natural ventilation and daylighting, regardless of the orientation on site. Lastly, the colour and material palette, along with the facade decal contribute to the aesthetic value.

9.12 CONCLUSION

Through this chapter, prototypes and various scenarios were explored and assessed in detail, to ultimately propose a final design solution for a deployable teaching-learning unit that could promote the well-being of learners as a unit, and as a whole on site. A kit of parts for the unit and interior furnishing, as well as their configuration and the intervention on the testing site, Tshwane Secondary School is designed and technically resolved. The design proposal can now be tested in different contexts to showcase the broader potential and implications for South African schools.

ENVISIONING THE POTENTIAL 10

The design proposal of a flexible, deployable teaching-learning unit envisions intervention within a multitude of contexts, not limited to the testing site used within this project.

_By creating a self-sustaining unit which merely sits on site and can adjust to sloping landscapes, the unit is **not limited to levelled surfaces**. It can thus be installed on paved areas, or in rural areas with soil grounds.

_The flexibility encompassed in the wall configurations further allows for the unit to be configured in various ways, thus **not restricting the orientation** on site, but rather allowing for the **unit to be assembled in response to context.**

_The project and its testing site, Tshwane Secondary School, investigates a public school scenario within the South African context and aims to provide an alternative to the portable classrooms currently neglecting learner well-being. It is assumed that such a project would be government funded, thus subjected to budget constraints.
To attract public investors and appeal to the private schooling sector as well, a unique **commercial brand** could be created for the new deployable, teaching-learning unit. This would bestow a marketability to the unit, potentially attracting private investors. This could result in mass production, which further supports the feasibility of employing such a unit. With the help of a branding strategy and potential investments, the **roll-out potential** of this design proposal is thus envisioned.

_As used in this case, these units can **replace the existing portable classrooms** found across South Africa, and perhaps globally.

_Lastly, the proposed units could function as additions to other schooling infrastructure, as seen with the Tshwane Secondary School. More generally, this becomes where portable classrooms are installed to accommodate the influx of students not fully supported by the brick-and-mortar school buildings initially built on site. It thus **functions as additional schooling infrastructure** to increase the capacity of schools. Alternatively, it could be used as **founding infrastructure** for new schools in a **variety of contexts,** as explained in the points above.

10 ENVISIONING THE POTENTIAL

11 CONCLUDING A RESPONSE

Within *Part A*, the author provided a project outline and brief which set out certain research and design outcomes to be achieved. The research questions, firstly looking at the sub-questions, were answered in the following ways :

SUB-QUESTIONS:

Theory

A general concern for well-being presents the need to extend available theories and design guidelines regarding wellness and well-being, into the education sector.

How can available theories and design guidelines pertaining to wellness and well-being, be translated to address learning environments?

The Wheel of Wellness (Myers et al., 2000) is used as the main theoretical base,alongside additional sources to gain insight into the concepts of wellness and well-being. Two existing guidelines provide further insight. The first being the WELL Building Standard, Education Pilot (International WELL Building Institute, 2018) which assists in the translation of wellness design into learning environments. The second guideline is used to contextualise this within the South African context, by adopting the Norms and Standards for South African School Infrastructure (add reference). These sources are ultimately triangulated into an audit document, called 'The Check-Up'. This audit ultimately serves as a translation from theory into design, programme, policy and technical terms relating to learning environments in South Africa.

As a contribution to the education sector and discipline of interior architecture, 'The Check-Up' can now be used to evaluate how successfully existing schools are promoting the well-being of learners and highlighting the shortcomings of each school. Informed improvements can be made to alleviate the current negative impacts, using the audit as a guideline.

Context

What are the physical, social and psychological implications of existing schooling infrastructure, specifically considering the portable building systems found at Tshwane Secondary School?

Schooling infrastructure is firstly understood by unpacking the different typologies commonly found. As the testing site makes use of prefabricated building systems in the form of panelised buildings and portable classrooms, a more general concern for the effect of portable classrooms came about. A contextual study analysed the existing site in general, with additional sources being consulted to investigate the impact of portable classrooms on the health and well-being of learners. The physical implications were primarily supported by these sources and the noise, temperature and light level measurements taken on site. The social and psychological implications were investigated through the lenses of empathy mapping and a psychology report conducted on site. Multiple unobtrusive methods employed within the contextual study thus provided the answer for this question, along with additional sources as theoretical grounding. The answer is thus that these portable building systems, and more specifically the portable classrooms are not sufficiently fulfilling programmatic requirements or the aspects of well-being, resulting in a lack of aesthetic appeal, comfort, and pleasurable experiences. As a result, learners find themselves in a dreary environment, threatening their sense of worth and control, ultimately negatively affecting their psychological well-being.

Value lies within the multi-layered typological and contextual inquiry of the project, as the issues related to the current condition of schooling infrastructure and learner well-being is exposed. A real-life scenario is presented. The analysis criteria used for the precedent studies, distill these concerns and could be used to prompt a response.

Design

How can the design of deployable schooling infrastructure promote the physical, social and psychological well-being of learners, in both its individual capacity and collective configuration?

The design informants provide an answer for this question. By accommodating multiple learning methods, facilitating social interaction and offering a sense of control to the user, schooling infrastructure could promote the well-being of learners. Although these are the three informants prioritised within the project, the aesthetics, acoustics, light, noise, thermal comfort, as well as the thresholds and spatial hierarchy could contribute to this promotion of well-being. Furthermore, the assembly design refines the facilitation of user control through flexibility of space and a sense of personalisation,as explained in Chapter 9_Designing the Technical. The assessment tool developed in Chapter 8_Formulating a Design Response, showcases the success in answering this question.

The project ultimately makes an architectural contribution through the design proposal and technical resolution of a deployable teaching-learning unit. The intervention on Tshwane Secondary School testing site serves as a prototype for the future design of schools and potential roll-out of such a design solution, both in South Africa and globally.

MAIN QUESTION:

By successfully answering the sub-questions as discussed above, the main research question is answered.

How can interior architecture enable schooling infrastructure to facilitate the well-being of learners?

Interior architecture could facilitate the well-being of learners by designing a flexible and deployable teaching-learning unit, that not only considers the variety of uses within, but also the configuration of multiple uses and the in-between spaces. Primarily, schooling infrastructure should allow for multiple ways of learning, while facilitating social interaction and user control to enable a sense of worth. The overall well-being of learners can be affected by considering each of the three domains, namely the physical, social and psychological.

11 CONCLUDING A RESPONSE

CHAPTER 12 : STATING REFERENCES

CHAPTER 13 : PROVIDING APPENDICES

PART E _ ASSIST

STATING REFERENCES 12

REFERENCE LIST

ArchDaily. (2014). *Kavel K / Carve*. [online] Available at: https://www.archdaily.com/493306/kavel-k-carve/?ad_source=myarchdaily&ad_medium=bookmark-show&ad_content=current-user [Accessed 5 Dec. 2019].

ArchDaily. (2015). *Micro-Yuan'er / ZAO/ standardarchitecture*. [online] Available at: https://www.archdaily.com/775172/micro-yuaner-zao-standardarchitecture/561baea5e58ece94b8000324-micro-yuaner-zao-standardarchitecture-photo?next_project=no [Accessed 5 Dec. 2019].

ArchDaily. (2019). *AULA K / BCQ Arquitectura*. [online] Available at: https://www.archdaily.com/910917/aula-k-bcq-arquitectura/?ad_source=myarchdaily&ad_medium=bookmark-show&ad_content=current-user [Accessed 5 Dec. 2019].

Architectmagazine.com., 2016. *The Hex House - A Rapid Deployment, Dignified Disaster Shelter.* [online] Available at: https://www.architectmagazine.com/project-gallery/the-hex-house-a-rapid-deployment-dignified-disaster-shelter [Accessed 8 September 2019].

Architizer. (n.d.). *LAUSD Modular Classroom of the Future Competition*. [online] Available at: https://architizer.com/projects/lausd-modular-classroom-of-the-future-competition/ [Accessed 9 Dec. 2019].

Architonic. (2015). *Micro-Yuan'er by ZAO/standardarchitecture | Semi-detached houses*. [online] Available at: https://www.architonic.com/en/project/zao-standardarchitecture-micro-yuaner/5102914 [Accessed 5 Dec. 2019].

Assana, S., Wongsa, L. and Poonsri, R. (2017). Quality of Life, Mental Health and Educational Stress of High School Students in the Northeast of Thailand. *Journal of Clinical and Diagnostic Research*, [online] 11(8), pp.1-6. Available at: https://www.jcdr.net/article_fulltext.asp?issn=0973-709x&year=2017&volume=11&issue=8&page=VC01&issn=0973-709x&id=10429 [Accessed 8 Jul. 2019].

Babatsikou, F. P. (2011). The Sick Building Syndrome (SBS). *Health Science Journal* 5(2): 72-73.

Barrett, P., Davies, F., Zhang, Y. & Barrett, L. 2015. The impact of classroom design on pupils' learning: Final results of a holistic, multi-level analysis. *Building and Environment*, 89, 118-133. [online] Available at: https://www.researchgate.net/publication/272625202_The_impact_of_classroom_design_on_pupils'_learning_Final_results_of_a_holistic_multi-level_analysis.

Barry, M., Clarke, A. and Dowling, K. (2017). Promoting social and emotional well-being in schools. *Health Education,* 117(5), pp.434-451.

Brillon, J. (2018). *A+I designs New York City school with colourful panels and tiered seating*. [online] Dezeen. Available at: https://www.dezeen.com/2018/04/29/architecture-plus-information-designs-atl-school-new-york-city-colourful-panels-tiered-seating/ [Accessed 5 Dec. 2019].

Brooks, A. 1998. *Standardisation in Portable Architecture*. In: R. Kronenburg, Transportable Environments Theory, Context, Design and Technology, 1st ed. London: E & FN Spon.

Buildingcentre.co.uk. 2019. *Wellbeing, wellness and health: what are the differences?*. [online] Available at: https://www.buildingcentre.co.uk/news/wellbeing-wellness-and-health-what-are-the-differences [Accessed 10 June 2019].

Burge, P. S. (2004). Sick building syndrome. *Occupational and Environmental Medicine* 61(2): 185.

Cambridge Dictionary, 2019a. *Meaning of prefabricated in English.* [online] Available at: https://dictionary.cambridge.org/dictionary/english/portable [Accessed 1 September 2019].

Buthelezi, S. (2017). *Imagining a decolonised 21st Century education.* [online] The M&G Online. Available at: https://mg.co.za/article/2017-10-06-00-imagining-a-decolonised-21st-century-education [Accessed 12 Jul. 2019].

Cambridge Dictionary, 2019b. *Meaning of deploy in English.* [online] Available at: https://dictionary.cambridge.org/dictionary/english/deploy [Accessed 30 September 2019].

Cambridge Dictionary, 2019c. *Meaning of portable in English.* [online] Available at: https://dictionary.cambridge.org/dictionary/english/deploy [Accessed 30 September 2019].

Capolongo, S., Buffoli, M., Oppio, A. & Rizzitiello, S. 2013. Measuring hygiene and health performance of buildings: A multidimensional approach. *Annali di igiene: medicina preventiva e di comunità,* 25, 151-157. DOI: 10.7416/ai.2013.1917. [online] Available at: https://www.researchgate.net/publication/235885762_Measuring_hygiene_and_health_perfomance_of_buildings_a_multidimensional_approach.

Capolongo, S. 2014. Architecture as a Generator of Health and Well-being. *Journal of public health research,* 3, 276. DOI: 10.4081/jphr.2014.276. [online] Available at: https://www.researchgate.net/publication/265175938_Architecture_as_a_Generator_of_Health_and_Well-being.

Center for Public Interest Design. (n.d). *SAGE Classroom.* [online] Available at: http://www.centerforpublicinterestdesign.org/sage-classroom [Accessed 8 September 2019].

Cherry, K. 2019a. *Erik Erikson's Stages of Psychosocial Development.* Verywell Mind. [online] Available: https://www.verywellmind.com/erik-eriksons-stages-of-psychosocial-development-2795740#what-is-psychosocial-development [Accessed 1 May 2019].

Cherry, K. 2019b. *What Are Piaget's Four Stages of Development?*. Verywell Mind. [online] Available at: https://www.verywellmind.com/piagets-stages-of-cognitive-development-2795457 [Accessed 1 October 2019].

Choi, A., 2018. *Why schools should pay more attention to students' mental health and well-being.* [online] Available at: http://oecdeducationtoday.blogspot.com/2018/03/mental-health-students-school.html. [Accessed 19 January 2019].

Community Organisers Toolbox, n.d. *School Governing Bodies.* [online] Available at: http://etu.org.za/toolbox/docs/government/sgb.html [Accessed 5 September 2019].

Cooper, D., De Lannoy, A. and Rule, C. (2015). Youth health and well-being: why it matters?. In: A. De Lannoy, S. Swartz, L. Lake and C. Smith, *South African child gauge 2015.* [online] Cape Town: Children's Institute, University of Cape Town, pp.60-68. Available at: http://www.ci.uct.ac.za/sites/default/files/image_tool/images/367/Child_Gauge/South_African_Child_Gauge_2015/Child_Gauge_2015-Health.pdf [Accessed 17 Jul. 2019].Department of Basic Education (2019). School Realities 2018, EMIS18/2/014. [online] Available at: https://www.education.gov.za/Programmes/EMIS/StatisticalPublications.aspx. ISBN: 978-1-4315-3280-3. [Accessed 8 Jul. 2019].

Dam, R. and Siang, T. 2019. *Empathy Map – Why and How to Use It.* The Interaction Design Foundation. [online] Available at: https://www.interaction-design.org/literature/article/empathy-map-why-and-how-to-use-it. [Accessed 1 October 2019].

Department of Basic Education. 2013. *South African Schools Act (84/1996): Regulations relating to minimum uniform norms and standards for public school infrastructure.* Published under Government Notice R920 in Government Gazette 37081 of 29 November 2013. [online] Available at: https://discover-sabinet-co-za.uplib.idm.oclc.org/webx/access/ggaz_pdf/2013/jul/gg37081_nn920.pdf. [Accessed 1 March 2019].

Donnelly, D., n.d. Project 04: Top of the Class. [ebook] Online: Earthworks Magazine, pp.92-98. Available at: https://static1.squarespace.com/static/569e28325a56686dfb3b641a/t/5b3220d2352f53ec816753ba/1530011971457/Streetlight+Schools+Earthworks+Article.pdf [Accessed 5 Dec. 2019].

Drury, K. and McClure, R. (2014). *'They Have To Go': The Environmental and Health Costs of Portable Classrooms.* [online] InvestigateWest. Available at: http://www.invw.org/2014/05/07/portables/ [Accessed 17 Jul. 2019].

Furuto, A. (2011). *Flex: Flexible Learning Environments / HMC Architects.* ArchDaily. [online] Available at: https://www.archdaily.com/128504/flex-flexible-learning-environments-hmc-architects [Accessed 8 September 2019].

Hanington, B. and Martin, B. 2012. *Universal methods of design 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions.* Beverly, MA: Rockport Publishers..

Hazen, E., Schlozman, S. & Beresin, E. 2008. Adolescent Psychological Development: A Review. *Pediatrics in Review,* 29, 161-7.

Horton, B. W. & Snyder, C. S. 2009. Wellness: Its Impact on Student Grades and Implications for Business. *Journal of Human Resources in Hospitality & Tourism,* 8, 215-233. [online] Available at: https://www.tandfonline.com/doi/full/10.1080/15332840802269858.

International WELL Building Institute. 2015. *The WELL Education Facilities Pilot Addendum.* Delos Living LLC. [online] Available at: https://a.storyblok.com/f/52232/x/ab682473ab/educational-facilities-pilot-with-q2-2019-addenda_final.pdf.

International WELL Building Institute. 2018. *The WELL Building Standard.* New York: International WELL Building Institute pbc and Delos Living LLC. [online] Available at: https://a.storyblok.com/f/52232/x/a966fd0d94/well-v1-with-q3-2019-addenda_final.pdf.

Johnston, G. D. (2012). *The Effect of Meaning and Purpose in Life on Wellness and Life Satisfaction.* Doctor of Philosophy. Texas Tech University. Kang, M. (2003). Sustainable Design for the Built Environment. *Implications* 01(06): 1-3.

Kirsten, T.G.J.C., Van der Walt, H.J.L. & Viljoen, C.T. 2009. Health, wellbeing and wellness: An anthropological eco-systemic approach. *Health SA Gesondheid* 14(1), Art. #407, 7 pages. DOI: 10.4102/hsag.v14i1.407. [online] Available at: https://hsag.co.za/index.php/hsag/article/view/407.

Kronenburg, R. 1998. *Transportable Environments*. London: E. & F. N. Spon.
Kronenburg, R. 2008. *Portable Architecture*. 4th ed. Berlin: Birkhäuser.
Kubheka, T. 2019. *Gauteng Education Dept concerned about overcrowding at some schools*. Eyewitness News. [online] Available at: https://ewn.co.za/2019/01/22/gauteng-education-dept-concerned-about-overcrowding-at-some-schools [Accessed 4 September 2019].
Lexico Dictionaries. 2019. *Portable Classroom*. [online] Available at: https://www.lexico.com/en/definition/portable_classroom [Accessed 1 October 2019].
Marais, P. 2016. "We can't believe what we see": Overcrowded classrooms through the eyes of student teachers. *South African Journal of Education*, 36(2), 1-10. [online] Available at: http://scielo.org.za/scielo.php?script=sci_arttext&pid=S0256-01002016000200005 [Accessed 4 September 2019].
Martin, D. S. (2012). *Are schools making kids sick?*. [online] CNN. Available at: https://edition.cnn.com/2012/01/14/health/school-indoor-air-pollution/index.html [Accessed 15 Jul. 2019].
Matimela, G. 2019. 'Tshwane Secondary School history and basic information'. Interviewed by Twané van der Merwe, 5 March 2019 at Tshwane Secondary School, Pretoria.
McGuire, J. 2016. *Why a classroom that's too warm tires you out, and the best study temperature*. South China Morning Post. [online] Available at: https://www.scmp.com/lifestyle/families/article/1928625/why-classroom-thats-too-warm-tires-you-out-and-best-study [Accessed 3 April 2019].
McKnight, J. (2016). *Architects for Society creates low-cost hexagon refugee houses*. [online] Dezeen. Available at: https://www.dezeen.com/2016/04/14/architects-for-society-low-cost-hexagonal-shelter-housing-refugees-crisis-humanitarian-architecture/ [Accessed 9 Dec. 2019].
McMahon, A., et al. (2010). Reviewing the meanings of wellness and well-being and their implications for food choice. *Perspectives in Public Health* 130(6): 282-286.
Mehta, M. & Lokhandwala, A. S. 2017. Indoor environment quality: A crucial aspect for designing sustainable interiors. *International Journal of Applied Home Science*, 4, 1003-1011.
Muhammad, S., et al. (2014). Academic Buildings and Their Influence on Students' Wellbeing in Higher Education Institutions. *Social Indicators Research : An International and Interdisciplinary Journal for Quality-of-Life Measurement* 115(3): 1159-1178.
Myers, J. E., Sweeney, T. J. & Witmer, M. 2000. The Wheel of Wellness Counseling for Wellness: A Holistic Model for Treatment Planning. *Journal of Counseling and Development*, 78, 251-266.
National Wellness Institute. n.d. *The Six Dimensions of Wellness Model 1976 by Bill Hettler*. National Wellness Institute. [online] Available: https://www.nationalwellness.org/page/Six_Dimensions. [Accessed 1 May 2019].
Nelson, B. 2014. *School design through the decades: A visual history of school design*. Mosaic. [online] Available at: https://mosaicscience.com/story/school-design-through-decades/. [Accessed 5 September 2019].

Neuman, W. 2014. *Social Research Methods: Qualitative and Quantitative Approaches.* 7th ed. Harlow, England: Pearson Education Limited.

Niall, M. (2018). *Are South African schools ready for the 4th Industrial Revolution?.* [online] Niall McNulty. Available at: https://www.niallmcnulty.com/2018/07/are-south-african-schools-ready-for-the-4th-industrial-revolution/ [Accessed 12 Jul. 2019].

Nichols, J.R. (2019). *4 Essential Rules Of 21st Century Learning.* [online] TeachThought We grow teachers. Available at: https://www.teachthought.com/learning/4-essential-rules-of-21st-century-learning/ [Accessed 9 Jul. 2019].

Norris, K. (2010). *Finding balance: 6 dimensions of wellness.* Washington Blade: America's LGBT News Source. [online] Available at: https://www.washingtonblade.com/2010/06/10/finding-balance-6-dimensions-of-wellness/. [Accessed 2 May 2019].

O'Brien, M. 2010. Unobtrusive Research Methods – An Interpretative Essay. Practising Media Research. [online] Available at: http://www.michelleobrien.net/wp-content/uploads/2011/10/Michelle_OBrien_Unobtrusive_Research_Methods.pdf. [Accessed 1 October 2019].

Ohsrep.org.au. 2019. *Offices: Temperature and humidity - what are the 'rules'?* - OHS Reps. [online] Available at: http://www.ohsrep.org.au/hazards/call-centres/offices-temperature-and-humidity-what-are-the-rules. [Accessed 3 April 2019].

O'Neil, E. 2009. Grace under pressure, Investigating a design response in event of disaster. Magister of Interior Architecture (Professional). University of Pretoria, Pretoria.

Patterson, J., Chandler, M., Jiang, B. and Chan, T. (2009). Portable Classrooms: Immediate Solutions to a "Growing" Problem. *School Business Affairs,* [online] 75(6), pp.23-25. Available at: https://eric.ed.gov/?id=EJ919341 [Accessed 16 Jul. 2019].

Park, J. 2017. *Temperature, Test Scores, and Human Capital Production.* Cambridge: Harvard University. [online] Available at: http://scholar.harvard.edu/files/jisungpark/files/temperature_test_scores_and_human_capital_production_-_j_park_-_2-26-17.pdf [Accessed 3 Apr. 2019].

Perez, C. M. 2017. *What is the Difference Between Wellness and Wellbeing. Wellbeing Messenger.* [online] Available at: https://wellbeingmessenger.com/difference-between-wellness-and-wellbeing/. [Accessed 25 June 2019].

Pretoria Secondary School. 2015. Pretoria Secondary School History. [online] Available at: http://pretoria-secondary-school.co.za/our-school.html. [Accessed 4 September 2019].

Puteh, M., et al. (2012). Thermal Comfort in Classroom: Constraints and Issues. *Procedia - Social and Behavioral Sciences* 46: 1834-1838.

Rands, M. L. and Gansemer-Topf, A. M. (2017). The Room Itself Is Active: How Classroom Design Impacts Student Engagement. *Journal of Learning Spaces,* [online] 6(1), pp.26-33. Available at: https://lib.dr.iastate.edu/edu_pubs/49 [Accessed 15 Jul. 2019].

SACAP. (2019). *The shocking state of mental health in South Africa in 2018*. [online] Available at: https://www.sacap.edu.za/blog/counselling/mental-health-south-africa/ [Accessed 16 Jul. 2019].

Sanoff, H. and Walden, R. 2012. School Environments. In: H. Sanoff, School Design. Van Nostrand Reinhold. [online] Available at: https://www.researchgate.net/publication/234625948_School_Design. [Accessed 2 October 2019].

Seetha, P., et al. (2008). Effects to teaching environment of noise level in school classrooms. *Journal of Scientific & Industrial Research* 67: 659-664.

Shernoff, D., et al. (2016). The influence of the high school classroom environment on learning as mediated by student engagement. *School Psychology International* 38(2): 201-218.

Singh, P. and R. Arora (2014). *Classroom Illuminance: Its impact on Students' Health Exposure & Concentration Performance*. International Ergonomics Conference HWWE 2014. Guwahati, India.

Smith, A. and M. Pitt (2011). Sustainable workplaces and building user comfort and satisfaction. *Journal of Corporate Real Estate* 13(3): 144-156.

Steemers, K. 2015. Architecture for Well-being and Health. 6th Velux Daylight Symposium. London. [online] Available at: http://thedaylightsite.com/architecture-for-well-being-and-health/.

Stoewen, D. 2015. Health and wellness. The Canadian Veterinary Journal, 56(9), 983–984. [online] Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4535518/. [Accessed 10 June 2019].

Streetlight Schools. (n.d.). HOW OUR FACILITY IS DIFFERENT. [online] Available at: https://www.streetlightschools.org/facility# [Accessed 5 Dec. 2019].

Subramani, C. and D. S. Kadhiravan (2017). Academic Stress and Mental Health Among High School Students. *Indian Journal of Applied Research* 7(5): 404-406.

Visser, L. (2016). *Shift College - Shifting the perspective of Mathematics, Science and Technology Education in South Africa.* Department of Architecture. Pretoria, University of Pretoria. Masters in Interior Architecture (Professional).

Wagoner, J. and Haarlow, W. 2002. *Common School Movement*. Encyclopedia.com. [online] Available at: https://www.encyclopedia.com/history/united-states-and-canada/us-history/common-school-movement. [Accessed 19 August 2019].

Wallendorf, W. (2019). Tshwane Secondary School Wellness.

Wood, M. (2012). *Portable classrooms, despite heat and noise, find permanent homes here.* [online] The Escondido Grapevine. Available at: https://escondidograpevine.com/2016/04/25/portable-classrooms-despite-heat-and-noise-find-permanent-home/ [Accessed 15 Jul. 2019].

STATING REFERENCES 12

13 PROVIDING APPENDICES

13.1 THE ‘CHECK-UP AUDIT’

ANNEXURE A _ 'The Check-up' Wellness Audit

Reference framework

WELL-BUILDING STANDARD

_ International WELL-Building Institute (2014)

Design metrics and strategies regarding Air, Water, Nourishment, Light, Fitness, Comfort and Mind

SA NORMS AND STANDARDS

_ South African Department of Basic Education (2013)

Requirements and specifications (sizes, materials, light, acoustics etc.) in terms of the facilities (education, education support and admin/ management areas) and services (water, electricity, connectivity) provided by Schools in South Africa

'WHEEL OF WELLNESS' THEORY

_ J.E. Myers, T.J. Sweeney & J.M Witmer (2000)

Requirements and specifications (sizes, materials, light, acoustics etc.) in terms of the facilities (education, education support and admin/ management areas) and services (water, electricity, connectivity) provided by Schools in South Africa

Contribution

WELL-BEING

PROGRAMME

Relating the programme on site, and the function of the space, therefor informing the specific activities that would / should take place within the space.

social

GENERAL DESIGN

Spatial layout and overall design informed by these stipulations, considering spatial quality requirements & other properties that need to be addressed through the design intervention. (eg. : services, views, thermal/ acoustic / lighting quality, dimensions etc.)

psychological

TECHNIFICATION / SPECIFICATION

These aspects have less of an impact on the overall design, but relate more to the technical detailing / specification in terms of sizes, materials etc, as well as the systems to be employed on site.

POLICY

Not relating to the spatial design or technical specifications, but rather proposing certain changes or implimentations to the policies, rules and regulations employed on site.

physical

	Aspect	Description	Implication		Source	
PROGRAMME	Fitness / Exercise	PART 1: FITNESS PROGRAMS Onsite fitness or training programs offered from a qualified professional at least once a month	• exterior education space / sport and recreation facilities		WELL-Building Standard : *Fitness_66* *(Precondition)*	
		PART 2: FITNESS EDUCATION Classes from qualified professional offered at least once every 3 months to cover the following: a. Different modes of exercise b. Safe fitness techniques c. Comprehensive exercise regimens.	• exterior education space / sport and recreation facilities • lecture hall / multifunctional class			
		PART 3: PHYSICAL ACTIVITY BREAKS Early education and primary schools: a. Minimum of 30 minutes daily of moderate to vigorous exercise. b. Removal / reduction in physical activity breaks may not be used as a form of punishment. c. Physical activity breaks are taken before lunch.				
	Stress & Addiction Treatment	PART 2: STRESS MANAGEMENT Qualified counselor offering group / private workshops and referrals, made available	• private & multiunctional spaces for counseling		WELL-Building Standard : *Mind_95* *(Precondition)*	
		PART 3: MIND & BEHAVIOR SUPPORT FOR STUDENTS Program that addresses psychological & behavioral distress available to students : a. Access to short term treatment & referrals to qualified professionals for depression, anxiety, substance use, smoking cessation, addiction and co-occurring mental health issues. b. Qualified professionals such as nurses / guidance counselors available on-site for consultations on depression, anxiety, substance use, smoking cessation, addiction and co-occurring mental health issues.	• private & multiunctional spaces for counseling • personal / private areas to deal with anxiety and to relax			

GENERAL DESIGN

Aspect	Description	Implication	Source
Universal Access	Universal design accommodating the needs of a diversity of users, both fully able and impaired. It allows for all students and staff members to use the space, including new schools as well as additions, alterations & improvements to existing schools.	• access • circulation • signage & way-finding • facilities (indoor & outdoor) • communication • safety measures • ergonomics	Dept of Basic Education : SA Norms & Standards for schools
	PART 1: ACCESSIBILITY AND USABILITY Compliance with one of the following: a. Current ADA Standards for Accessible Design or comparable local code or standards. b. ISO 21542:2011 - Building Construction - Accessibility and Usability of the Built Environment	• SANS 10400 Part S	WELL-Building Standard : *Comfort_72* *(Precondition)*
Lighting	Natural daylighting - reduces artificial lighting.	• natural daylighting	Dept of Basic Education : SA Norms & Standards for schools
	Minimise glare from both natural daylighting and artificial lighting.	• shading • building orientation • window size & placement • material specifications	
	PART 1: VISUAL ACUITY FOR FOCUS Workstation / desk requirements: a. Ambient lighting system able to maintain an average light intensity of 215 lux [20 fc] or more, measured on horizontal plane, 0.76m above finished floor. Lights may be dimmed in presence of daylight, but able to independently achieve these levels. b. Ambient lighting system is zoned in independently controlled banks no larger than 46.5 m^2 or 20% of open floor area of the room (whichever is larger). c. If ambient light is below 300 lux [28 fc], task lights providing 300 to 500 lux [28 to 46 fc] at work surface are available upon request.	• lighting design & spesification	WELL-Building Standard : *Light_53* *(Precondition)*

	Aspect	Description	Implication		Source	
GENERAL DESIGN	Right to light	PART 1: LEASE DEPTH 75% of the area of all regularly occupied spaces is within 7.5 m of view windows.	• room dimensions • window placement & views		WELL-Building Standard : *Light_61* *(Optimisation)*	
		PART 2: WINDOW ACCESS a. 75% of all workstations are within 7.5 m of atrium / window with views to exterior. b. 95% of all workstations are within 12.5 m of atrium / window with views to the exterior.	• room dimensions • spatial layout of furniture • window placement & views			
	Windows	Easy operation while considering safety measures & natural ventilation	• window placement & specification		Dept of Basic Education : SA Norms & Standards for schools	
		Every regularly occupied space has operable windows that provide access to outdoor air and daylight.	• specification of openable windows • placement for daylight & ventilation		WELL-Building Standard : *Air_19* *(Optimisation)*	
	Ventilation	Incorporate natural ventilation through openable windows and permanent wall vents in compliance with the relevant laws & regulations.	• windows placement & specification • wall vents		Dept of Basic Education : SA Norms & Standards for schoo	

GENERAL DESIGN

Aspect	Description	Implication		Source	
Interior Circulation	PART 1: STAIR ACCESSIBILITY AND PROMOTION In projects of 2-4 floors, at least one common staircase meets the following requirements: a. Accessible to regular building occupants during all regular business hours. b. Throughout the space, wayfinding signage and point-of-decision prompts are present to encourage stair use (at least one sign per elevator bank).	• stairs : placement & access • signage		WELL-Building Standard : *Fitness_ 64* *(Precondition)*	
	PART 2: STAIRCASE DESIGN In projects of 2-4 floors, at least one common staircase meets following requirements: a. Located within 7.5m of building's main entrance, main entry check-point (e.g., welcome/reception desk), edge of its main lobby, or edge of main welcome area. b. Clearly visible from building's main entrance, main entry check-point (e.g., welcome/reception desk), edge of main lobby, or edge of main welcome area, or are located visually before any elevators present upon entering from main entrance. c. Stair width set at minimum of 1.4 m between handrails, or width allowable by local code.	• stairs : placement & access • elevator placement • SANS 10400 Part M & Part S			
	PART 3: FACILITATIVE AESTHETICS In projects of 2-4 floors, both common stairs and paths of frequent travel display elements of aesthetic appeal by incorporating at least 2 of the following throughout: • Artwork • Music • Biophilic elements • Daylighting using windows or skylights of at least 1 m^2 in size • View windows to outdoors / building interior • Light levels of at least 215 lux [20 fc] when in use.	• sightlines & views • decoration / aesthetic detailing • window placement & sizes for appropriate views / daylighting • user experience			

GENERAL DESIGN

Aspect	Description	Implication	Source
Signage	A name board indicating school deails should be visible to public, including following information : 1. school name 2. contact details 3. GPS coordinates 4. National Education Management and Information System (EMIS) number	• signage • public views of school	Dept of Basic Education : SA Norms & Standards for schools
Innovative Design	Promote efficient & cost effective design to create enabling and inclusive teaching & learning environments	• overall design & detailing	Dept of Basic Education : SA Norms & Standards for schools
Administration areas*	Areas used by staff and management for the purposes of day to day runnig of the school. Include the following :	• required facilities / admin areas with minimum sizes • spatial layout & building / room dimentions	Dept of Basic Education : SA Norms & Standards for schools
	Principal's office	• $20m^2$	
	Deputy Principals office	• $15m^2$	
	Head of Department (HOD) office	• $15m^2$	
	Administration	• $20m^2$	
	Reception Area	• $15m^2$	
	Printing Room	• $15m^2$	
	Staff Kitchenette	• $12m^2$	
	Staff Room	• $60m^2$	
	Storage Area (for admin purposes)	• $15m^2$	
	Sick Room	• $15m^2$	

*Refer to original document (Annex E) for Administration area requirements per school type

GENERAL DESIGN

Aspect	Description	Implication		Source	
Education areas*	The minimum teaching and learning areas essential for functioning. Including the following:	• required facilities / learning areas with minimum sizes • spatial layout & room dimensions		Dept of Basic Education : SA Norms & Standards for schools	
	Classrooms (Grade 1-12) - maximum of 40 learners per class	• $1m^2$ per learner & $7m^2$ per educator • Minimum unit size $48m^2$			
	Part 1: Classroom Space Allocation: a. Early education, elementary, middle & high school; class: 4 m^2 per student overall. b. Adult education; seminar classroom: 2 m^2 per student overall. c. Adult education; lecture hall: 1.5 m^2 per student overall.	• 4 m^2 per student in classroom • classroom dimensions		WELL-Building Standard : Mind_*P6* *(Optimisation)*	
	Library : School library / media centre with adequate and suitable school library collection must be present with core collection regularly replenished according to requirements of particular school.	• School library / media centre (mobile library, cluster library, classroom library, centralised school library / school community library)		Dept of Basic Education : SA Norms & Standards for schools	
	Laboratory with necessary apparatus & consumables in accordance with specific curriculum needs of particular school to make possible to conduct experiments and scientific investigations - May be combined where practicable. Maintained in good working order. Lockable facility for apparatus & consumables in accordance with safety standards	• Options : lab / mobile lab / classroom / safe container • Maintenance • Lockable (security & safety) • Minimum unit size for science laboratory = $60m^2$			
	Sport & recreation: spaces allowing for physical education, sporting & recreational activities. May use facillities of another school / local community, if so consulted.	• Sport / recreational activities			
	Storage per classroom & teaching space	• MInimum size : $12m^2$			

*Refer to original document (Annex E) for Education area requirements per school type

GENERAL DESIGN

Aspect	Description	Implication	Source
Physical Activity Areas	One of the following requirements are met: a. Physical activity facilities in form of gymnasium / playing field must be provided on-site. b. Free, direct pedestrian access to gymnasiums, playing fields or swimming pools through a shared facilities agreement / similar arrangement.	• sport & recreational facilities • access and pedestrian movement to facilities	WELL-Building Standard : *Fitness_68* *(Optimisation)*
Active transportation support	PART 2: POST COMMUTE & WORKOUT FACILITIES _ Provided on site or within 200m of building's main entrance: a. One shower with changing facility for the first 100 regular building occupants & one additional shower for every 150 regular building occupants thereafter. b. One locker for every 5 regular building occupants, or evidence that the lockers provided exceed demand by at least 20%.	• ablution facilities : to include showers and lockers • water and sanitation layout	WELL-Building Standard : *Fitness_69* *(Optimisation)*
	PART 3: BICYCLE STORAGE FACILITIES Provided within 30m of building main entrance: a. Basic bicycle maintenance tools, including tire pumps, patch kits and hex keys available for use. b. Separate & secure storage for bicycles, sized at 5% or more of all building staff & students above grade level 3, calculated at peak occupancy.	• facilities provided for bicycles	
Surveilance	Natural surveilance incorporated in open areas & relationships between buildings as far as possible.	• building layout • sightlines / views	Dept of Basic Education : SA Norms & Standards for schools
Injury prevention	PART 1: SUFFICIENT LIGHTING Outdoor lighting meets the following requirements: a. Emit no light above the horizontal plane. b. Use shielding: viewing angle = not less than 80°. c. Able to produce a maintained average of at least 10 to 30 lux [1 to 3 fc] as measured on vertical surfaces 1.5 m above the ground.	• lighting layout & specification	WELL-Building Standard : *Fitness_P8* *(Precondition)*

GENERAL DESIGN

Aspect	Description	Implication		Source	
Injury prevention (continued)	PART 2: SIDEWALKS a. Located on both sides of the road. b. Minimum of 1.5 m in width. c. Minimum buffers of 1 m in width. d. Provide direct access from parking/loading areas to a building entrance. e. Schools must establish policies and procedures ensuring that sidewalks and parking areas are clear of snow, ice, leaves, or any other obstacle.	• site design • circulation routes & access • maintenance / cleanliness policy		WELL-Building Standard : *Fitness_ P8* *(Precondition)*	
	PART 3: CROSSWALKS a. Markings for crosswalks present at all stop signs, traffic signals, and major points of pedestrian concentration. b. Minimum of 1.8 m in width. c. Raised for enhanced visibility and vehicle speed reduction.	• signage • site design / circulation routes & access			
	PART 4: SAFE ROUTES TO SCHOOL A program modeled after Safe Routes to School is developed with parental support and implemented at the school with at least the following: a. Drop-off/pick-up lanes are differentiated from bus lanes. b. School crosswalk warning postings with arrows pointing to location of crosswalk are visible at all crosswalks. c. Curb extensions minimum of 1.8 m are present in locations of high pick-up/drop-off activity and low visibility areas and at crosswalks. d. Bicycle paths: minimum 1.5 m in width. e. Bicycle paths differentiated from pedestrian paths.	• site design / circulation & access • signage			

GENERAL DESIGN

Aspect	Description	Implication		Source	
Injury prevention (continued)	PART 5: PLAYGROUNDS, IF PRESENT: a. Surfaces around playground equipment have minimum of 30cm of wood chips, mulch, sand, or mats made of safety-tested rubber / rubber-like materials. b. Protective surfacing covers minimum of 1.8m in all directions from edge of any playground equipment. Under swings, the protective surface covers twice the height of suspending bar, in both directions. c. Openings in guardrails / between ladder rungs are not between 9 - 22cm d. Dangerous hardware such as open “S” hooks or protruding bolt ends are not present.	• spatial layout • material specification • construction & detailing / technification		WELL-Building Standard : *Fitness_ P8* *(Precondition)*	
Acoustics	Reduce background noise & reverberation time to allow for proper speech clarity between teacher and students, as well as between students	• acoustic materials • space shape & openings • placement / relation to noise sources		Dept of Basic Education : SA Norms & Standards for schools	
	PART 4: SOUND PRESSURE LEVEL IN SCHOOLS Each regularly occupied space meets following sound pressure level when the space and adjacent spaces are unoccupied: a. Spaces equal to or less than 1,900m^2: average sound pressure level from outside noise intrusion is less than or equal to 35 dBA. b. Spaces greater than 1,900 m^3: average sound pressure level from outside noise intrusion is less than or equal to 40 dBA.	• acoustic materials • space shape & openings • placement / relation to noise sources		WELL-Building Standard : *Comfort_ 74* *(Precondition)*	
	PART 1: ACOUSTIC PLANNING Develop acoustic plan that identifies the following spaces & potential sources of disruption: a. Loud and quiet zones. b. Noisy equipment in the space.	• spatial layout • placement / relation to noise sources • specification of equipment		WELL-Building Standard : *Comfort_ 75* *(Precondition)*	

GENERAL DESIGN

Aspect	Description	Implication		Source	
Acoustics (continued)	PART 2: MECHANICAL EQUIPMENT SOUND LEVELS _Mechanical equipment system meets the following requirements once interior build-out is complete in the following spaces: a. Open office spaces & lobbies regularly occupied and/or contain workstations: maximum noise criteria (NC) of 40. b. Enclosed offices: max noise criteria (NC) of 35. c. Conference rooms and breakout rooms: maximum noise criteria (NC) of 30 (25 recommended).	• spatial layout • placement / relation to noise sources • specification of equipment • acoustic materials		WELL-Building Standard : *Comfort_75* *(Precondition)*	
	PART 6: NOISE CRITERIA IN SCHOOLS While unoccupied & measured in geometric center of the room: Classrooms: less than 35.	• acoustic materials • space shape & openings • placement / relation to noise sources			
	PART 2: REVERBERATION TIME FOR LEARNING SPACES a. Spaces less than/ equal to 280m³ : <0.6 sec b. Spaces greater than 280m³ & equal to or less than 570m³ : <0.7 seconds	• acoustic materials • space shape & openings		WELL-Building Standard : *Comfort_78* *(Optimisation)*	
Pedestrian activity	Amenities : Sites in which the building takes up less than 75% of total lot size provide at least one of the following within highly-trafficked areas, such as building entrances, public transportation stops, walking paths and plazas: bench / cluster of movable chairs and tables / drinking fountain or water refilling station	• pedestrian walkway & furniture		WELL-Building Standard : *Fitness_67* *(Optimisation)*	
	To encourage more pedestrian activity, sites in which the building takes up less than 75% of the total lot size include at least two of the following in the outdoors a. A water fountain or other water feature b. A plaza or open air courtyard c. A garden or other landscaped elements. d. Public art	• pedestrian walkway • public space & communal area • aesthetic design			

GENERAL DESIGN

Aspect	Description	Implication		Source	
Security & Safety	Fencing all round : minimum height 1.8m. Additional safety measure : Burglar proofing for openable ground floor windows / security guard / alarm system linked to rapid response. All buildings and other facilities must comply with fire regulations	• boundary wall / fence • arrangement / policy for security or response company • Fire regulations : SANS 10400 Part T		Dept of Basic Education : SA Norms & Standards for schools	
Water	Available at all times for drinking, personal hygiene & food preparation (where appropriate). Sufficient water-collection points & water use facilities available to allow convenient access. Choice of apprpriate water technology is based on assessment & should be maintained in good working order.	• water supply points Options : municipal reticulaton network, rain water harvesting & tanker supply from municipalities when required, mobile tankers, borholes / local reservoire & dam • water & sanitation supply layout • drainage		Dept of Basic Education : SA Norms & Standards for schools	
	Encourage water consumption : At least one dis-penser located within 30m of all parts of regularly occupied floor space (minimum 1 per floor) / At least one dispenser with free, potable water pro-vided per 30 students in outdoor activity areas, if present, based on average outdoor occupancy	• water points (spatial layout and facilities) • water & sanitation supply layout • drainage		WELL-Building Standard : *Water_37 (Optimisation)*	
Sanitation	Sufficient number of sanitation facilities - easily accessible, provide privacy & security, promote health & hygiene standards, comply with all relevant laws & maintained in good working condition. Choice of appropriate technology based on assessment. Options : Water borne sanitation, small bore sewer reticulation, septic / conservancy tank systems, ventilated improved pit latrines / composting toi-lets - no plain pit / bucket latrines allowed	• obscure glazing must be used in both male and female toilet windows • boys and girls toilets must as far as possible be separate • *for enrolment range 201-400 (101-200 per gender) : Total of 17 toilets 6x Girls toilets, with 4 basins. 2x Boys toilets, 4x urinals and 2x basins. 1x Unisex disabled toilets & basins. 2x Female staff toilet and 1x basin. 1x Male staff toilet with 1x urinal and 1x basin. *Refer to original document (Annex G) for different school types		Dept of Basic Education : SA Norms & Standards for schools	

GENERAL DESIGN

Aspect	Description	Implication		Source	
Healthy Entrances	PART 1: ENTRYWAY WALK-OFF SYSTEM : To capture particulates from occupant shoes at all regularly used entrance(s), one of the following is installed & maintained on weekly basis: a. Permanent entryway system comprised of grilles, grates or slots, which allow for easy cleaning underneath, at least the width of the entrance and 3m long in the primary direction of travel (sum of indoor and outdoor length). b. Rollout mats, at least the width of the entrance and 3m long in the primary direction of travel (sum of indoor and outdoor length). c. Material manufactured as an entryway walk-off system, at least the width of the entrance and 3m long in the primary direction of travel (sum of indoor and outdoor length).	• entrances to buildings • material specification		WELL-Building Standard : *Air_08* *(Precondition)*	
	PART 3: PLAYING FIELD STAGING AREA: Must be present in all facilities adjacent to an exterior grass sports field, if present: A staging area and mud room separates the playing field from the changing room to capture mud and moisture.	• staging area & mud room • sport & recreational activities • spatial layout			
Eating spaces	PART 1: EATING SPACES FOR OCCUPANTS: Contain tables and chairs to accommodate at least 25% of total occupants at a given time	• eating space (size and furnishing) • spatial layout & amenities		WELL-Building Standard : *Nourishment_52* *(Optimisation)*	
	PART 2: BREAK AREA FURNISHINGS Contain all of the following: a. Refrigerator, device for reheating food (such as microwave or toaster oven), and sink. b. Amenities for dish washing. c. At least one cabinet or storage unit available for occupant use. d. Eating utensils, including spoons, forks, knives and microwave-safe plates and cups	• eating space (size and furnishing) • spatial layout & amenities • detailed design of programme & furnishing / furniture with provision for appliances			

GENERAL DESIGN

Aspect	Description	Implication		Source	
Beauty & Design	PART 1: BEAUTY AND MINDFUL DESIGN Contains features intended for all of following: a. Human delight. b. Celebration of culture. c. Celebration of spirit. d. Celebration of place. e. Meaningful integration of public art.	• aesthetic design & details		WELL-Building Standard : *Mind_87* *(Precondition)*	
	PART 1: CEILING HEIGHT (CH) _ Provides expansive, comfortable & open feel to interior space when proportional to room dimensions. a. Rooms of 9m width / less: CH = at least 2.7m b. Rooms of > 9m width : CH = at least 2.75m plus at least 0.15m for every 3m over 9m c. Rooms that provide full wall view to outdoors / atrium space (with at least twice the CH of room): minimum CH of 2.75m for a room width of 12m plus at least 0.15m for every 4.5m over 12m	• spatial dimensions - ceiling height		WELL-Building Standard : *Mind_99* *(Optimisation)*	
	PART 2: ARTWORK _ integrated into the space adds complexity to visual field. a. Entrances and lobbies. b. All regularly occupied space greater than 28 m²	• aesthetic design & details			
	PART 3: SPATIAL FAMILIARITY Design elements can be used to establish way-finding, aid in orientation & provide spatial familiarity. Project incorporates way-finding elements in projects with floor plates 929m² / larger through use of the following elements: a. Artwork that is distinct in shape and color b. Visually grouped zones / areas with unifying design components: (i) lighting, (ii) furniture color and (iii) flooring pattern/color. c. Corridors over 9m in length end in artwork / view window to exterior with sill height no taller than 0.9m from floor and with at least a 30m vista.	• aesthetic design & details • spatial layout & views / sightlines • way-finding			

	Aspect	Description	Implication		Source	
GENERAL DESIGN	Biophilia (i)_ Qualitative	PART 1: NATURE INCORPORATION Develop biophilia plan with description of how nature is incorporated through the following: a. Environmental elements. b. Lighting. c. Space layout.	• green infrastructure on site • natural daylighting • space layout - views and sightlines		WELL-Building Standard : *Mind_88* *(Precondition)*	
		PART 2: PATTERN INCORPORATION Biophilia plan with description of how project incorporates nature's patterns throughout design.	• aesthetic design & details • material specification			
		PART 3: NATURE INTERACTION Biophilia plan that provides sufficient opportunities for human-nature interactions: a. Within the building. b. Within project boundary, external to building.	• greenery (incorporate in interior & exterior) • boundaries between int. & ext. • interaction with landscape / nature			
	Biophilia (ii)_ Quantitative	PART 1: OUTDOOR BIOPHILIA At least 25% of project site area a. Features either landscaped grounds / rooftop gardens accessible to building occupants. b. Consists of, at minimum, 70% plantings including tree canopies (within the 25%).	• green infrastructure		WELL-Building Standard : *Mind_100* *(Optimisation)*	
		PART 2: INDOOR BIOPHILIA Incorporate into interior space: a. Potted plants / planted beds: cover at least 1% of floor area per floor. b. Plant wall per floor: covers wall area equal or >2% of floor area / covers largest of available walls, whichever is greater	• greenery within interior : potted plants and planted beds, or plant walls			
		PART 3: WATER FEATURE _ for every 9,290m² in projects larger than 9,290m² : a. At least 1.8 m in height / 4 m² in area. b. Ultraviolet sanitation or other technology to address water safety.				

GENERAL DESIGN

Aspect	Description	Implication		Source	
Flexibility of space	Creating a multi-functional space to allow for multiple education & support functions	• flexibility / adaptability / • multi-functional space • multi-functional furniture / furnishing		Dept of Basic Education : SA Norms & Standards for schools	
Olfactory Comfort	PART 1: SOURCE SEPARATION All restrooms, janitorial closets, kitchens, cafeterias & pantries prevent strong odors from migrating to workspaces through separation method (1+): a. Negative pressurization. b. Interstitial rooms. c. Vestibules. d. Hallways. e. Self-closing doors.	• spatial layout • material spesification • air movement		WELL-Building Standard : *Comfort_77* *(Optimisation)*	
Adaptable Spaces	PART 1: STIMULI MANAGEMENT Seating & spatial layouts: organized into separate workplace zones & provide differing degrees of sensory engagement. Regularly occupied spaces of 186m² / larger establish appropriate zones based on the below guidelines: a. Programing plan, using data from interviews, surveys, focus groups & observational research, to establish organization's culture, work patterns, work processes and space utilization. b. Annotated floor plans incorporate research data to establish work zones that support variety of work functions. c. Designated quiet zones: enclosable / semi-enclosable rooms with no more than 3 seats per room. d. Designated collaboration zones: enclosable / semi-enclosable rooms with no less than 3 seats & at least one visual vertical surface area for communicating ideas or work.	• spatial layout & amenities (informed by contextual analysis & research) • quiet zones • collaboration spaces with furnishing • design elements for display / expression & collaborative work		WELL-Building Standard : *Mind_89* *(Optimisation)*	

GENERAL DESIGN

Aspect	Description	Implication		Source	
Adaptable Spaces (continued)	PART 2: PRIVACY Projects with gross floor area greater than 1,860m² provide designated quiet space for focus, contemplation & relaxation: a. Space is at minimum 7m² plus 0.1m² per regular building occupant, up to maximum of 74m² b. Ambient lighting provides continuously dimmable light levels at 2,700K or less. c. Noise Criteria (NC) from mechanical systems is 30 or lower. d. Plan is developed that includes description of how project incorporates two of the following elements into the space: (i) plant wall and/or floor plantings, (ii) audio device with nature sounds, (iii) variety of seating arrangements.	• spatial layout • views & sightlines / spatial hierarchy for various levels of privacy • acoustic materials & control • furniture & furnishing • lighting design & specification		WELL-Building Standard : *Mind_89* *(Optimisation)*	

TECHNIFICATION / SPECIFICATION

Aspect	Description	Implication	Source
Solar Power	Incorporate natural cooling & address energy savings through solar design principles, in compliance with the relevant laws & regulations.	• solar power • energy usage • product / lighting specifications • natural daylighting	Dept of Basic Education : SA Norms & Standards for schools
Power Supply	Must have form of power supply which complies with relevant laws - sufficient for school demand - using most appropriate source (solar, generator, wind / grid)	• power supply & electrical layout	Dept of Basic Education : SA Norms & Standards for schools
Material use	No inappropriate materials, such as mud / asbestos	• material specification	Dept of Basic Education : SA Norms & Standards for schools
	Limit VOC emissions of all interior paints, coatings, adhesives & sealants, as well as flooring, insulation, furniture and furnishing Consider mold & microbe succeptibility	• spesification of materials & finishes • construction / fixing methods	WELL-Building Standard : *Air_04* *(Precondition)*
Electronic connectivity	Wired / wireless connectivity for purposes of communciation. (Includes : Telephone, fax, internet & intercom / public address system.) Must be maintained in good working order.	• maintenance • connectivity and approporiate equipment	Dept of Basic Education : SA Norms & Standards for schools
Humidity Control	PART 1: RELATIVE HUMIDITY At least one of the following is required: a. A ventilation system with capability to maintain relative humidity between 30% - 50% at all times by adding / removing moisture from the air. b. Modeled humidity levels in the space are within 30% - 50% for at least 95% of all business hours of the year. Buildings in climates with narrow humidity ranges are encouraged to pursue this option.	• regulating humidity • ventilation	WELL-Building Standard : *Air_16* *(Optimisation)*
	PART 2: SHOWER MOISTURE BARRIER If present, an airlock or ventilation barrier is required between showers and changing rooms	• Changing room / ablution design • construction / detailing for airlock system	

TECHNIFICATION / SPECIFICATION

Aspect	Description	Implication		Source	
Direct Source Ventilation	PART 1: POLLUTION ISOLATION AND EXHAUST All cleaning & chemical storage units, bathrooms and all rooms that contain printers & copiers (except those meeting low-emission criteria of Ecologo CCD 035, Blue Angel RAL-UZ 171, or Green Star) meet the following conditions: a. Are closed from adjacent spaces with self-closing doors. b. Air is exhausted so that all air is expelled rather than recirculated.	• spatial layout of rooms • techinification / specifying doors etc • equipment specification to be low-emission (printers & copiers) • ventilations systems		WELL-Building Standard : *Air_17* *(Optimisation)*	
	PART 5 : CHANGING ROOMS Changing rooms, if present, must be ventilated: a. Return air is vented outdoors & not recirculated. b. The ventilation rate is at least 1.33 Air Changes per Hour (ACH).	• ventilation systems			
Ergonomics : Visual & physical	PART 1: VISUAL ERGONOMICS All computer screens, including laptops, are adjustable in terms of height & distance from user.	• furniture & furnishing / equipment specification / detail design		WELL-Building Standard : *Comfort_73* *(Precondition)*	
	PART 3: SEAT FLEXIBILITY Furnishings adjustable in following ways: compliant with HFES 100 standard / BIFMA G1 guidelines a. Workstation chair height adjustability b. Workstation seat depth adjustability	• furniture & furnishing specification / detail design			
	PART 4: STANDING SUPPORT Workstations requiring users to stand for extended periods of time include following amenities: a. At least 10cm recessed toe space at base of workstation to allow decreased reaching requirements for occupants. b. A foot rest to allow occupants to alternate resting feet. c. Anti-fatigue mats or cushions.	• furniture & furnishing specification / detail design			

POLICY

Aspect	Description	Implication		Source	
Smoking ban	PART 1: INDOOR SMOKING BAN : Building policy or local code reflects that smoking and the use of e-cigarettes is prohibited inside the project.	• school rules / policy		WELL-Building Standard : *Air_02* *(Precondition)*	
	PART 3 SMOKE-FREE CAMPUS : Signage must be present at all major entrances to the school property to show: a. Smoking is prohibited on school property. b. The hazards of smoking.	• signage			
Mold & Microbe	PART 2: MOLD INSPECTIONS _ need to be implemented to ensure signs of discoloration and mold on ceilings, walls and floors as well as any water damage and pooling is not present	• inspections : Mold & microbe, water damage		WELL-Building Standard : *Air_06* *(Precondition)*	
Cleaning Protocol	A cleaning plan is created that includes: a. The Cleaning Equipment and Training section of Table A4 in Appendix C b. A list of approved product seals with which all cleaning, disinfection and hand hygiene products must comply in accordance with the Cleaning, Disinfection and Hand Hygiene Product section in Table A4 in Appendix C. c. A list of high-touch surfaces and schedule of sanitization or disinfection as specified in the Disinfection and Sanitization section in Table A4 in Appendix C. d. A cleaning schedule that specifies the extent and frequency of cleaning, including the Entryway Maintenance section of Table A4 in Appendix C e. Dated cleaning logs that are maintained and available to all occupants.	• cleaning & maintenance protocol • spesification of cleaning products		WELL-Building Standard : *Air_09* *(Precondition)*	

13.2 FINAL PROJECT PRESENTATION

Figure 167: Final Pin-up and Model

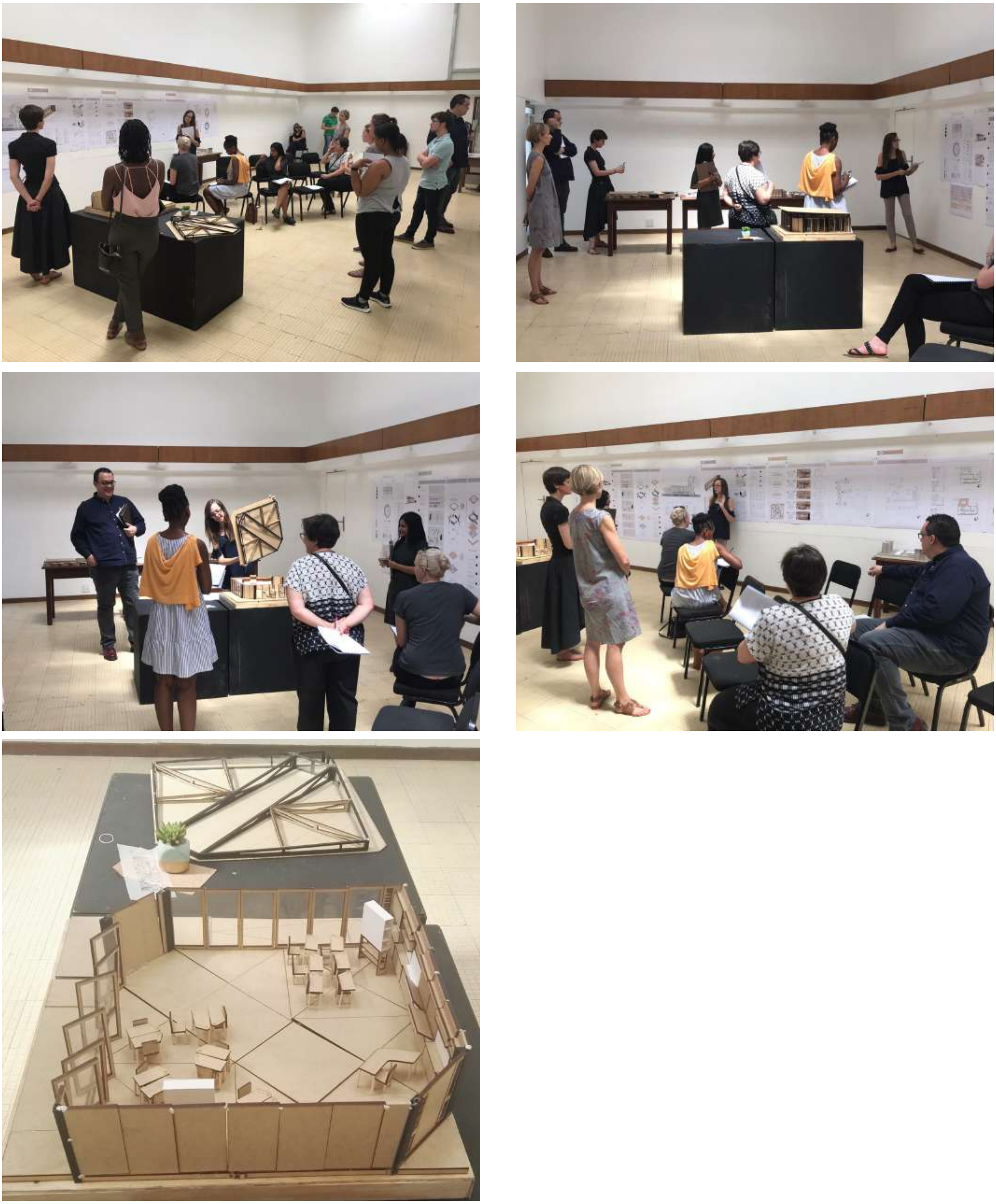


Figure 168: Final Exam Crit

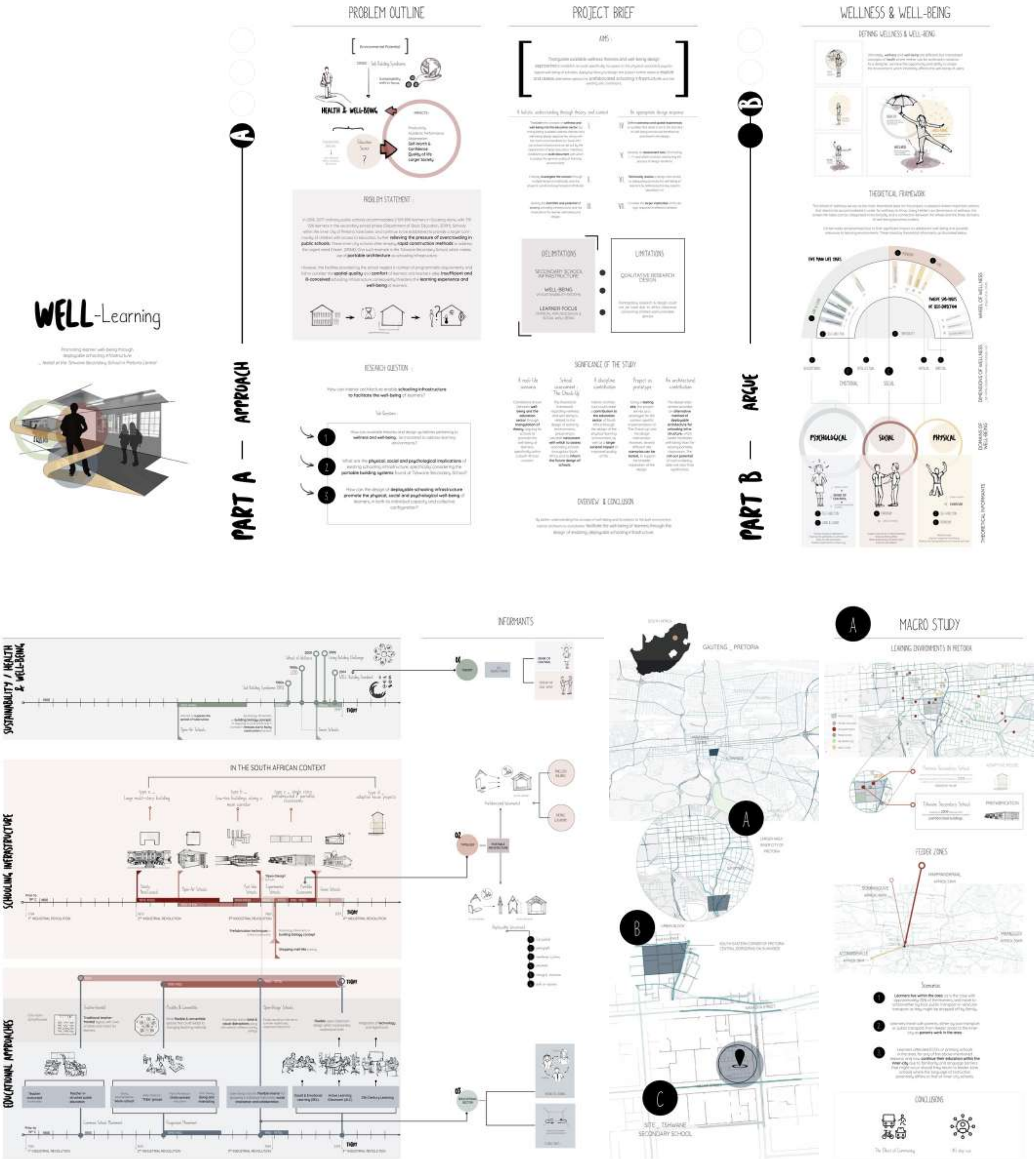


Figure 169: Presentation layout 01

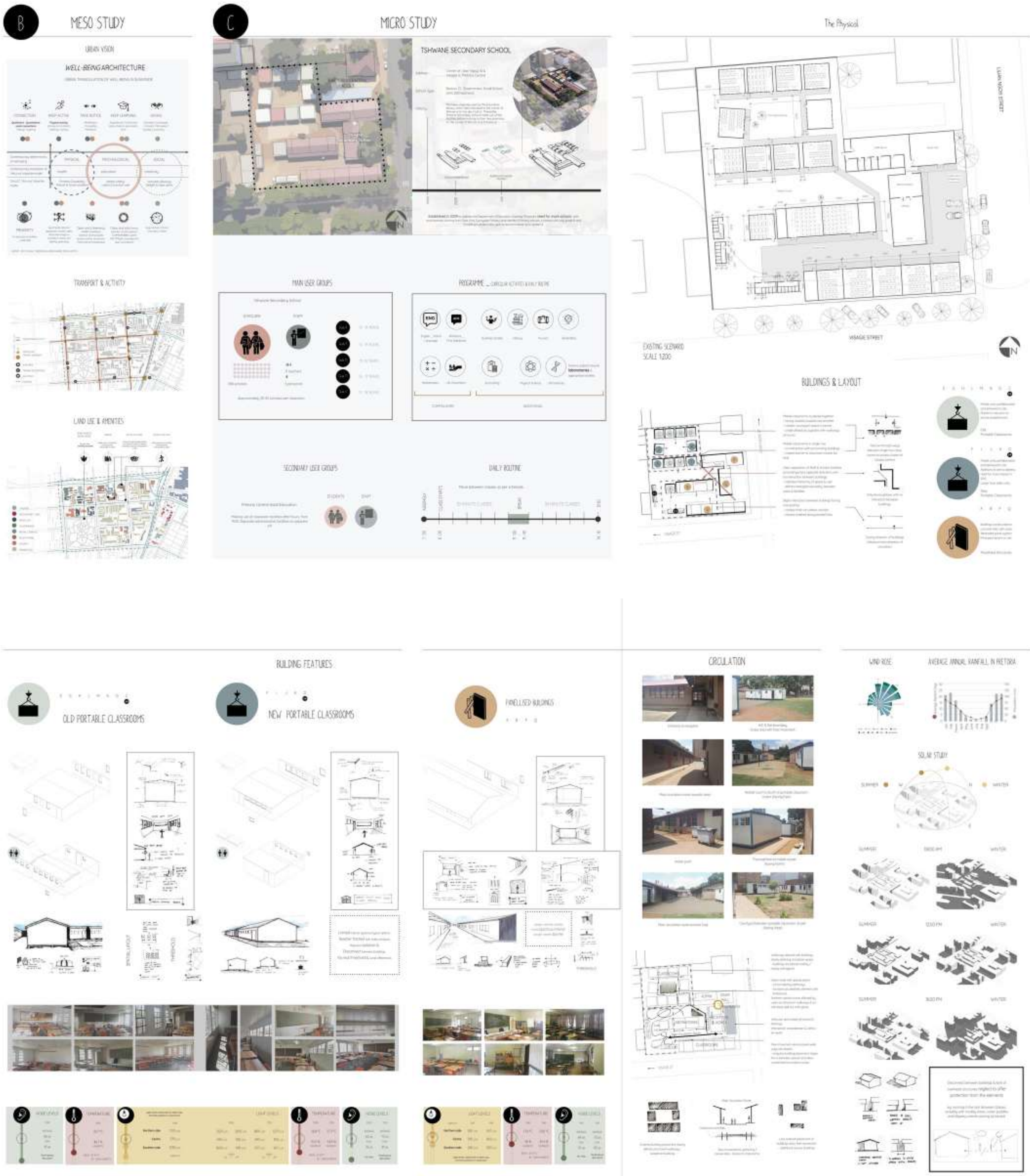


Figure 170: Presentation layout 02

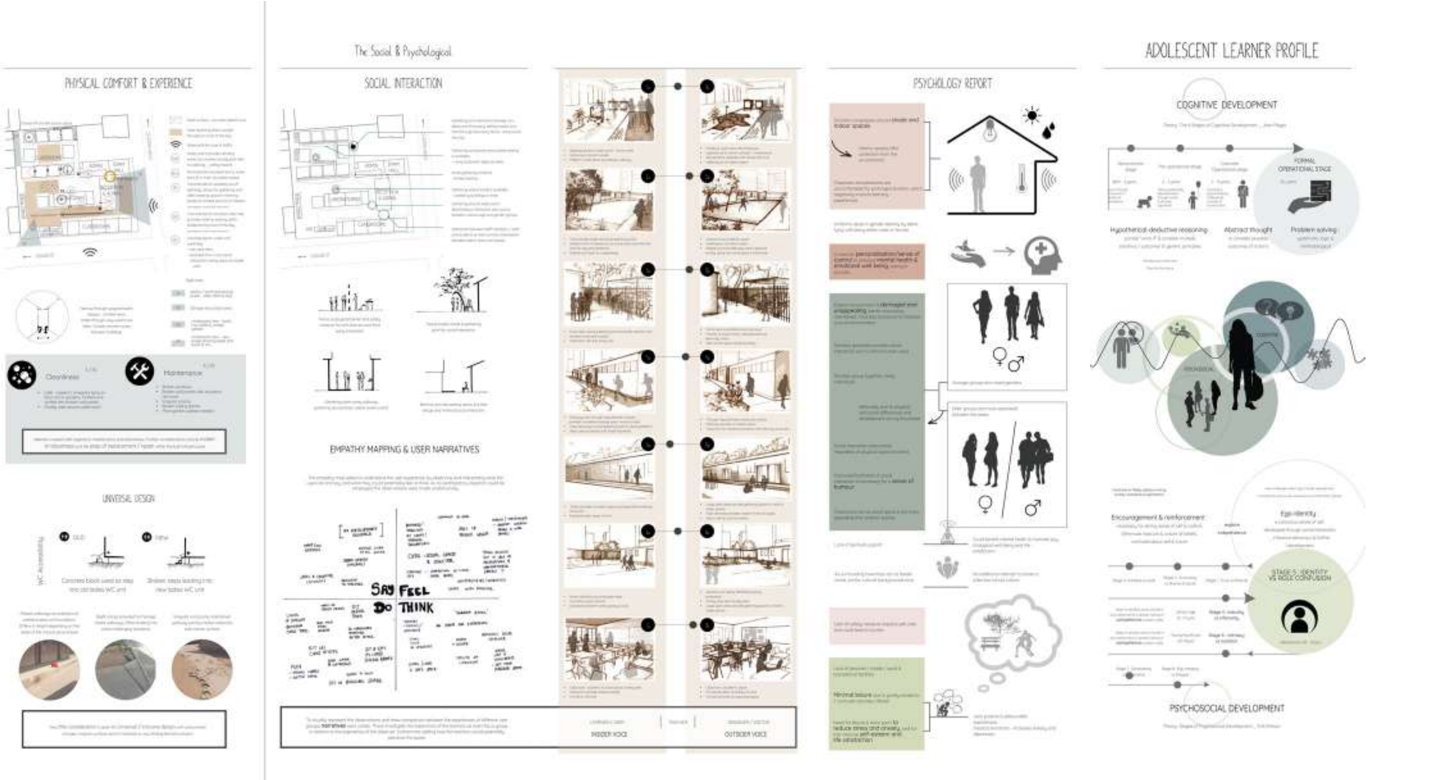
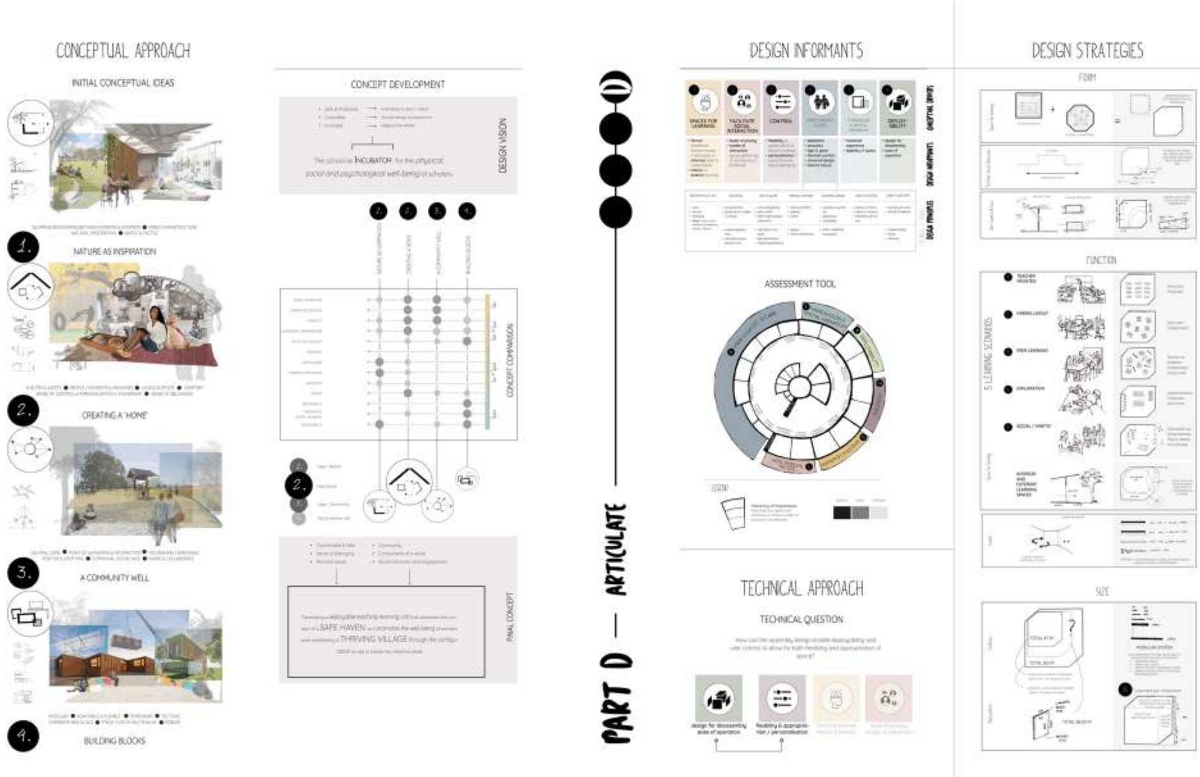
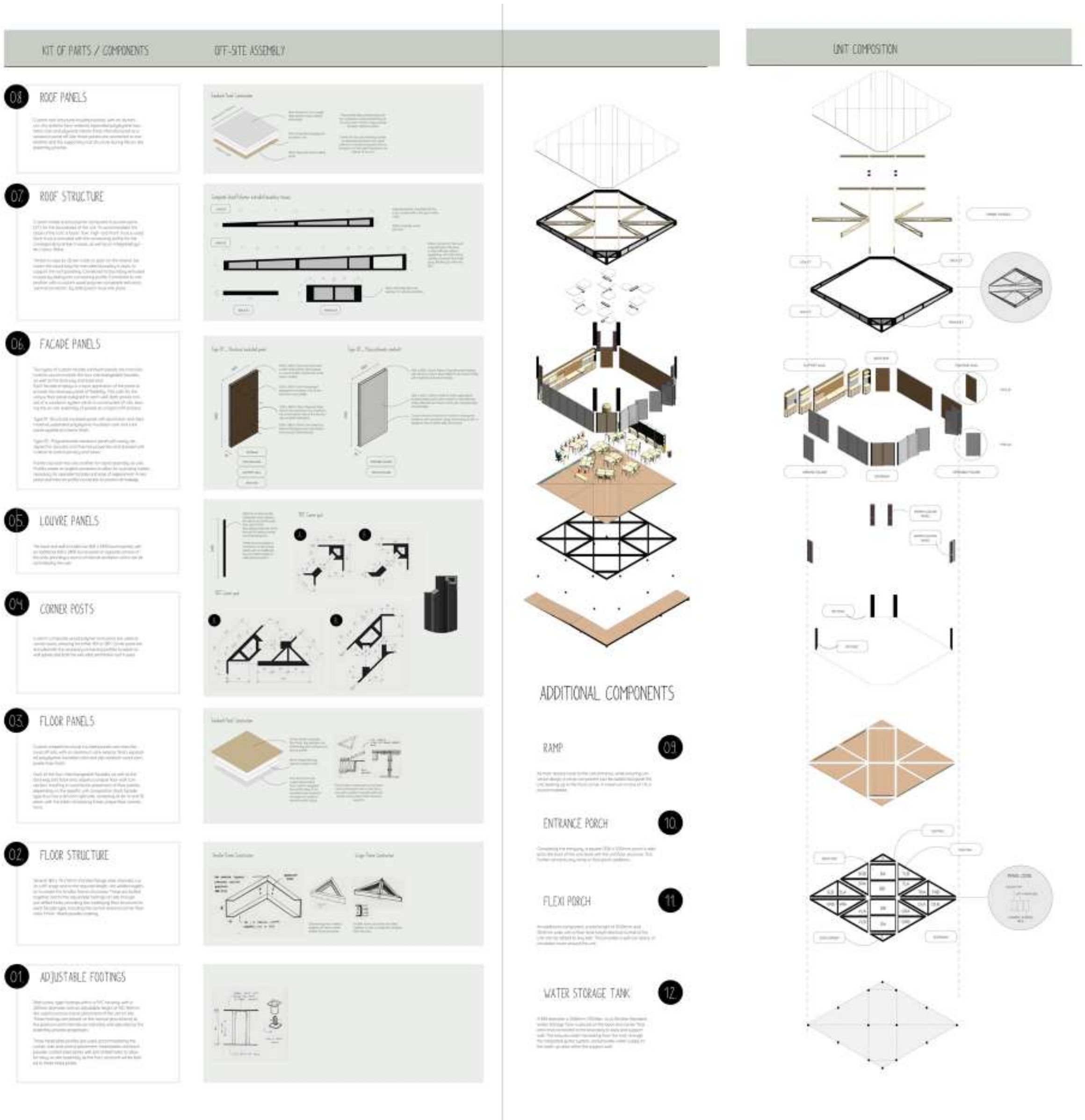


Figure 171: Presentation layout 03

Figure 172: Presentation layout 04 (to the right)


CONCEPTUAL APPROACH
INITIAL CONCEPTUAL IDEAS
1. NATURE AS INSPIRATION
2. CREATING A 'HOME'
3. A COMMUNITY WELL
4. BUILDING BLOCKS
CONCEPT DEVELOPMENT
DESIGN VISION
CONCEPT COMPARISON
FINAL CONCEPT
PART D — ARTICULATE
DESIGN INFORMANTS
ASSESSMENT TOOL
LEGEND
TECHNICAL APPROACH
TECHNICAL QUESTION
DESIGN STRATEGIES
FORM
FUNCTION
5 LEARNING SCENARIOS
SIZE


KIT OF PARTS / COMPONENTS
OFF-SITE ASSEMBLY
UNIT COMPOSITION
08 ROOF PANELS
07 ROOF STRUCTURE
06 FACADE PANELS
05 LOUVRE PANELS
04 CORNER POSTS
03 FLOOR PANELS
02 FLOOR STRUCTURE
01 ADJUSTABLE FOOTINGS
ADDITIONAL COMPONENTS
RAMP 09
ENTRANCE PORCH 10
FLEXI PORCH 11
WATER STORAGE TANK 12

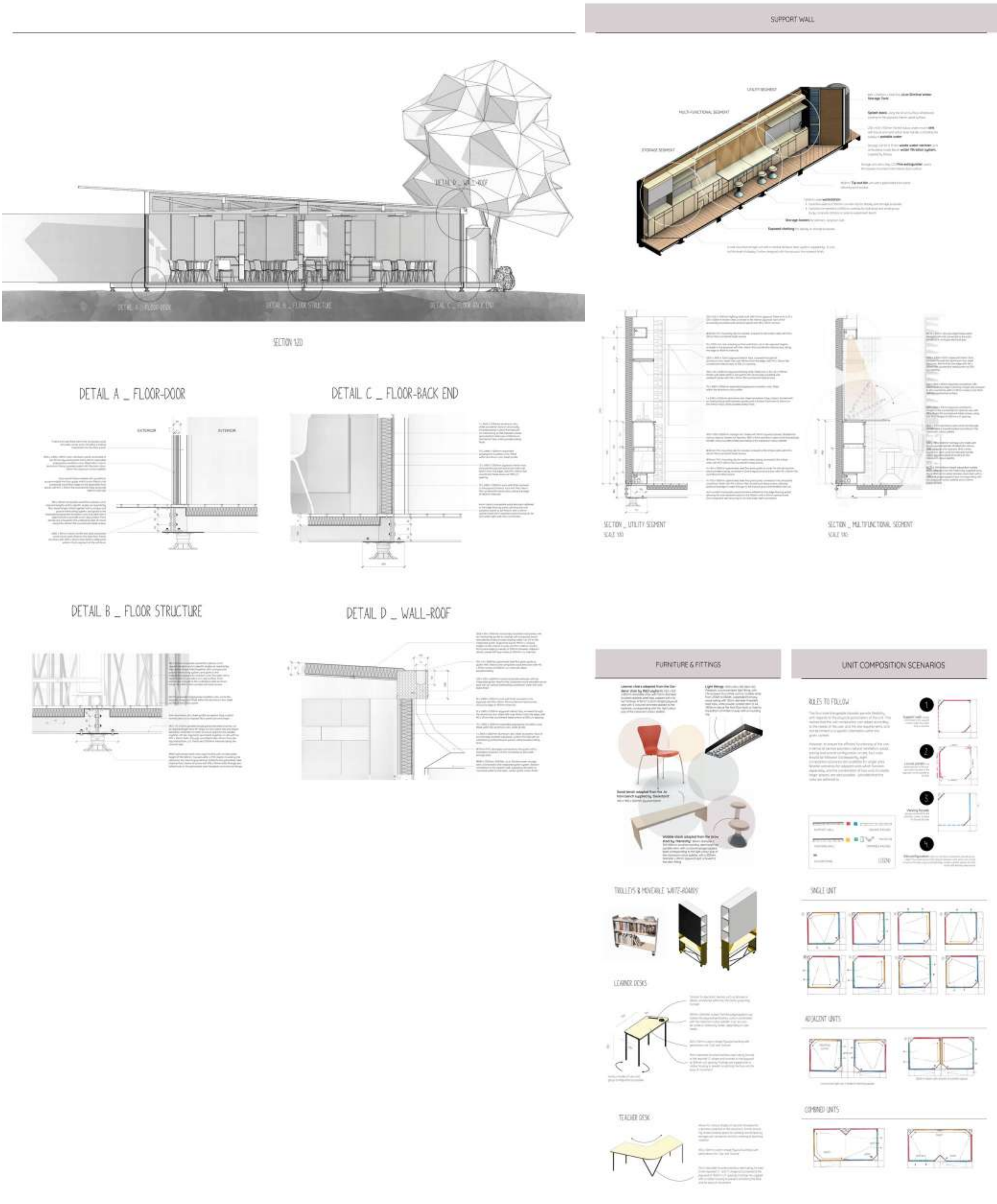


Figure 173: Presentation layout 05

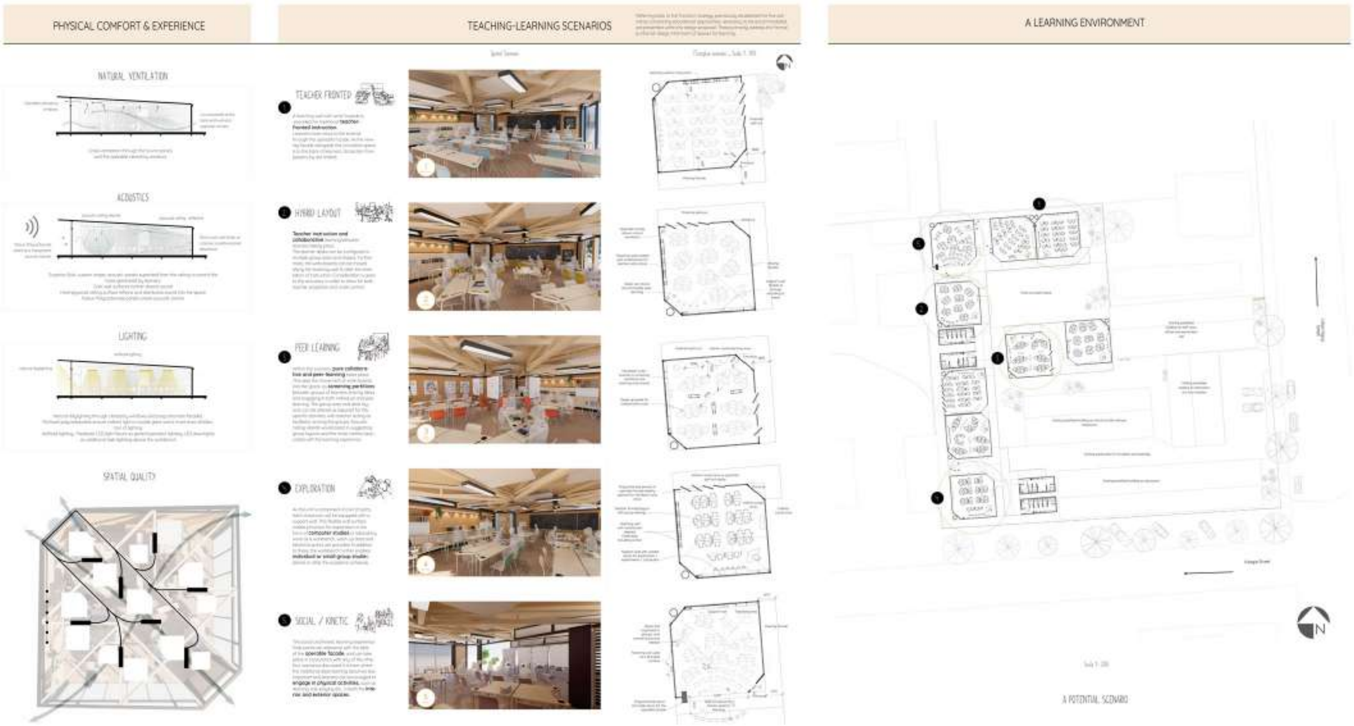


Figure 174: Presentation layout 06

ENVISIONING THE POTENTIAL

The design proposal of a flexible, deployable teaching-learning unit envisions intervention within a **multitude of contexts,** not limited to the testing site used within this project.

The **flexibility** encompassed in the wall configurations further allows for the unit to be configured in various ways, thus **not restricting the orientation on site**, but rather allowing for the unit to be assembled in response to context.

To attract public investors and appeal to the private schooling sector as well, a unique **commercial brand** could be created for the new deployable, teaching-learning unit. This would bestow a marketability to the unit, potentially attracting private investors. Resulting mass production will supports the feasibility of employing such a unit. With the help of a **branding strategy** and potential investments, the **roll-out potential** of this design proposal is thus envisioned.

Lastly, the proposed units could function as **additions** to existing schooling infrastructure, or alternatively be used as **founding infrastructure** for new schools in a variety of contexts.

PROVIDING APPENDICES 13

the end...