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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Study Leader: Anika van Aswegen

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
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.

Project Description:

Programme:

Site Description:

Site Address:

Environmental Potential (EP) – Well-being
Human Settlements and Urbanism (HSU)

Research Field(s):

Key Words:

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

Architectural Approach:

Theoretical Premise:

Investigating the role of design to enable wellness and promote well-being within learning environments

Interior Architecture promoting the well-being of learners and teachers through the design of deployable schooling infrastructure
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 prefabrication 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 triangulation 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
Acknowledgements:

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.

To my Boukunde friends and fellow students: it has been five years of hard work, blood, sweat and tears, but we made it! Thank you for the help and support, the shared knowledge and many memories.

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.

Many thanks and love to all.
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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.
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).
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
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):**


**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.
scene a : problem outline

Figure 06: Project Background
1.3 BACKGROUND

A shift in the focus of sustainability occurred due to the ‘Sick Building Syndrome’ (SBS), 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) 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 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

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?
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

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.

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

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*: 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.
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.

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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.
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.

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.
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’ (Hanington and Martin, 2012:138) and ‘scenarios’ (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 at 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.
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.

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.
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.
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, after which 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.
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

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.

Figure 09: Defining Wellness
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.

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, focusing 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)](image)
Figure 13: ‘Wheel of Wellness’ defining five main life tasks. Information sourced from (Myers et al., 2000:252-257)
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.

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.

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.

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

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

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 multidimensional 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 ‘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.).

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.).

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.

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).

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.

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.
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.
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.

![Physical Attributes](image_url)
THEORETICAL INFORMANTS:
WELLNESS & WELL-BEING

Figure 20: Theoretical Informants_Wellness & Well-being

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 INDIVIDUAL AND GROUP FORM, FOR THE SOCIAL, PSYCHOLOGICAL AND PHYSICAL WELL-BEING OF LEARNERS.

PLEASUREABLE EXPERIENCES

THEORETICAL INFORMANTS:
WELLNESS & WELL-BEING
2.3 ADOLESCENT WELL-BEING

Worldwide, a concern for the well-being of adolescents\(^2\) 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

\(^2\) South Africans suffer from anxiety, depression or substance-use problems

\(^3\) One in six South Africans suffer from anxiety, depression or substance-use problems

\(^4\) Youth feel hopeless and sad
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.

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, 2012:1659). 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, 2012:16, 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).
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 pre-fabricated 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.

Figure 23: Teacher-fronted plan layout

Figure 24: Flexible & Convertible plan layout
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.

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).

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).

Figure 25: Timeline of the Development of Educational Approaches
‘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)**

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 motivational 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).
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).

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 Gansmeier-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.

Figure 26: Social and Emotional Learning (SEL)
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).

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 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).

**21st CENTURY LEARNING**

Figure 27: Active Learning Classroom (ALC)

Figure 28: 21st Century Learning

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.
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 Kadhiran, 2017:406).

Figure 29: Key concepts derived from recent educational approaches

- 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)
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 improved 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).
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 co-operation 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, 2012:283). 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.
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.
*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.
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](image)
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 African schools, 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 Schools, 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.

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**Figure 33: ‘The Check-Up’ example segment**
Figure 34: Theoretical Informants_Complete summary

Social Interaction, a Sense of Worth and Belonging

Friendship & Social Support

Flexibility

Control over Emotions & Environment

Sense of Control

Interaction

Variety of Activities for Individuals and Groups

Pleasureable Experiences

Theoretical Informants
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.
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.

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
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 underwent great scrutiny (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 wellbeing (Nelson, 2014). This was applied to schools, and later resulted in the Smart Academic Green Environment (SAGE) portable classroom.

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.
1800s: Stately Neo-Classic

1870-1920s: Prefabrication techniques in school construction

1900-1940s: 'Open-Air' Schools

1940-1950s: Post-War Schools

1960-1970s: 'Open-Design' Schools

1970s: Baubiology Movement, or building biology concept: In response to post-World War II increase in illnesses due to faulty construction practices

1980-1990s: Experimental Schools

2000s: Green Schools

2006: Living Building Challenge

2014: WELL Building Standard

2019: Today

Educational Approaches

1900-1940s: 'Open-Air' Schools

1970s: Sick Building Syndrome (SBS)

1990s: LEED

2000: Wheel of Wellness

2006: WELL Building Standard

2014: WELL Building Standard

2019: Today

Sustainability / Health & Well-Being

Schooling Infrastructure

Prior to 19th C

1784: 1st Industrial Revolution

1870: 2nd Industrial Revolution

1969: 3rd Industrial Revolution

Prefabrication techniques in school construction

Baubiology Movement, or building biology concept

Shopping mall-like building
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.

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

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.

*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).

![Three portable systems, as defined by Kronenburg](image)

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 (specifically) acknowledges single story, prefabricated classrooms in the form of panelised 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 panelised 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.
Figure 40: Panellised and Portable classrooms distinguished

**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 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.

**PORTABLE ARCHITECTURE**

- Prefabricated (elements)
  - Panellised buildings
  - Portable classrooms

- Deployable (structure)
  1. Flat packed
  2. Pantograph
  3. Membrane systems
  4. Pneumatic
  5. Tensegrity structures
  6. Pods or capsules

Figure 41: Portable architecture
Kronenburg argues for efficiency in form, lightweight 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.

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**Figure 42: Typological Informant**

- Efficient Form
- Lightweight materials
- Flexibility in purpose
- Non-conventional construction methods

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**LEVEL OF FLEXIBILITY**

**III. Modular Parts**

Deployable (structure)
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 panelised 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.
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

Site: Tshwane Secondary School

Scene b: meso study

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.

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 Hammanskraal, 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 matriculation 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.

Figure 46: Feeder Zones to Tshwane Secondary 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.
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.
Well-being Architecture

URBAN TRIANGULATION OF WELL-BEING IN SYNNSIDE

**Well-being** Architecture

**CONNECTION**
- Qualitative - Quantitative
- Social connections
- Walking | Linger

**KEEP ACTIVE**
- Physical activity
- (exercise, circulation)
- Running | Cycling

**TAKE NOTICE**
- Mindfulness - Tranquility
- Mindful

**KEEP LEARNING**
- Inspirational / Communal
- Workshops | Talks

**GIVING**
- Volunteer / Participate
- Connect | Reconnect

**VISION & INTENTION**

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**PHYSICAL**
- Health
- Fitness | Durability
- Robust & Good condition

**PSYCHOLOGICAL**
- Education
- Useful | Function well

**SOCIAL**
- Creativity
- Venues (Beauty)
- Delight & raise spirits

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**PROXIMITY**
- To resources & facilities
- Walkable

**ARCHITECTURAL TYPOLOGY**
- Sport fields | Blocks | Equipment Level
- Attractive things on circulation routes
- Art | Lighting | Greenery
- Open art | Greenery
- Wildlife | Seating to observe
- Diverse public spaces and/or enclosures
- Hard and soft landscaping
- Open and safe homes, schools, Circular spaces
- Combines well in Art | Music (soundproof)
- Open workspace

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Figure 47: Urban & Black 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](image)
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.
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.
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.
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.).
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.
4.10.3 BUILDING LAYOUT

Figure 54: Tshwane Secondary School Floor plan
Buildings on site consist of two systems of prefabrication, namely panelised 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. Panelised 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, panelised 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.
Portable classrooms clustered together
- facing inwards towards one another
- creates ‘courtyard’ space in center
- underutilised as a garden with walkways all round

Portable classrooms in single row
- no interaction with surrounding buildings
- creates barrier to classroom cluster behind

Clear separation of Staff & Scholar facilities as buildings face opposite directions with no interaction between buildings
- indicates hierarchy of space & user
- defines intangible boundary between users & facilities

Slight interaction between buildings facing one another
- creates main circulation corridor
- classes ordered along parallel lines

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.
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.

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.

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.
Figure 57: Portable Classrooms Analysis
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.
As single-storey buildings, the prefabricated infrastructure provides the site with a domestic scale. Both the panelised 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.
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

**Underutilised street interface and public response**

**Active pedestrian walkway**

‘Lost’ entrance

Figure 60: Street Approach
4.10.6 CIRCULATION

The learner and staff movement on the school grounds is mostly directed by the paved walkways between buildings, and concrete corridors along the panelised 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 panelised buildings which create a step from the natural ground level to the floor level of the walkway and panelised 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.

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
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 rainwater 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.

The hard surfaces on site, such as the exposed soil and paved areas, absorb the radiant heat and would subsequently increase the temperature experienced 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.

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 buildings 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.
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 daylighting 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 illumination 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
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.

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**Acoustics**

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.

---

**Table 1:**

<table>
<thead>
<tr>
<th>Time</th>
<th>Temperature</th>
<th>Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00</td>
<td>27.3 °C</td>
<td>54.8 %</td>
</tr>
<tr>
<td>11:30</td>
<td>29.8 °C</td>
<td>45.4 %</td>
</tr>
</tbody>
</table>

**Figure 66:** Existing Noise level measurements

**Figure 67:** Existing Temperature and humidity measurements
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.

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.

Maintenance 3 / 10

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

Cleanliness 5 / 10

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

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

Universal Design

Concrete block used as step into old ladies WC unit

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
4.10.9 CONCLUDING SWOT ANALYSIS

**S**: Space
- Large windows on one side allow for natural light and views with lower windows on opposite side limiting distraction of circulation
- Pinboard: opportunity for display & personalisation
- Light wall & ceiling colour: increases perceptive volume
- Slanted ceiling: increases perception of space
- Concrete step into classroom: durable
- Light wall & ceiling colour: increases perceptive volume
- Poor acoustics: thermal insulation
- Small volume: Limited layout options
- Monotonous space: lack of colour & tactility
- No interaction with exterior (isolated on site) - threshold

**W**: Weakness
- Not easily adaptable (Delivered to site as unit)
- Low 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: thermal insulation
- Small volume: Limited layout options & dense furniture
- Monotonous: clinical look to space
- Lack of colour & tactility
- No interaction with exterior (isolated on site) - threshold

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

**T**: Threat
- Not easily adaptable (Delivered to site as unit)
- Low 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: thermal insulation
- Small volume: Limited layout options & dense furniture
- Monotonous: clinical look to space
- Lack of colour & tactility
- No interaction with exterior (isolated on site) - threshold

**SWOT**

**OLD PORTABLE CLASSROOMS**

**S**: Space
- Large windows on one side allow for natural light and views, with lower windows on opposite side limiting distraction of circulation
- Pinboard: opportunity for display & personalisation
- Light wall & ceiling colour: increases perceptive volume
- Slanted ceiling: increases perception of space
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- Lack of colour & tactility
- No interaction with exterior (isolated on site) - threshold

**NEW PORTABLE CLASSROOMS**

**S**: Space
- Large windows on one side allow for natural light and views, with lower windows on opposite side limiting distraction of circulation
- Pinboard: opportunity for display & personalisation
- Light wall & ceiling colour: increases perceptive volume
- Slanted ceiling: increases perception of space
- Concrete step into classroom: durable
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- Small volume: Limited layout options & dense furniture
- Monotonous: clinical look to space
- Lack of colour & tactility
- No interaction with exterior (isolated on site) - threshold

**SWOT**

**PANELLED BUILDINGS**

**S**: Space
- Large windows on one side allow for natural light and views, with lower windows on opposite side limiting distraction of circulation
- Pinboard: opportunity for display & personalisation
- Light wall & ceiling colour: increases perceptive volume
- Slanted ceiling: increases perception of space
- Concrete step into classroom: durable
- Light wall & ceiling colour: increases perceptive volume
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- No overhangs for protection from elements
- Poor acoustics: thermal insulation
- Small volume: Limited layout options & dense furniture
- Monotonous: clinical look to space
- Lack of colour & tactility
- No interaction with exterior (isolated on site) - threshold
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

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

• 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

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

INSIDER VOICE / LEARNER

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

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

• 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

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

INSIDER VOICE / LEARNER

OUTSIDER VOICE / DESIGNER & VISITOR
• ‘Stoep’ provides circulation space and step before entering classroom
• Exposed, public space in front

5.b

• 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

6.a

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

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

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

INSIDER VOICE / LEARNER

OUTSIDER VOICE / DESIGNER & VISITOR
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

- Scholars congregate around shade and indoor spaces
- Interior spaces offer protection from the environment
- Classroom temperatures are uncomfortable for prolonged duration, which negatively impacts learning experiences
- Uniforms assist in gender identity by identifying with being either male or female
- A need for personalisation/sense of control to enhance mental health & emotional well-being, coping & success
- Lack of spiritual support
- As surrounding townships act as feeder zones, similar cultural backgrounds exist
- Could benefit mental health & motivate psychological well-being and life-satisfaction
- No additional attempt to create a collective school culture
Improved facilitation of social interaction is necessary for a sense of humour.

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.

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

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.
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 (Pattersson 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 CO₂ 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 CO₂ 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.
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
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.

**Encouragement & reinforcement:**
necessary for strong sense of self & control.
Otherwise insecure & unsure of beliefs, confused about self & future

**Ego-Identity:**
a conscious sense of self, developed through social interaction
influence behaviour & further development

**STAGE 5: IDENTITY VS ROLE CONFUSION**

Could lead to fidelity (ability to live by society's standards & expectations)
New challenges either help / hinder development
Constant flux due to new experiences & information gained

---

**Stage 3: Initiative vs Guilt**
Stage 2: Autonomy vs Shame & Doubt
Stage 1: Trust vs Mistrust

Begin to develop sense of pride in accomplishments & abilities, feeling of competence & belief in skills.

School Age (5 - 13 yrs)

Stage 4: Industry vs Inferiority

Young Adulthood (21-39yrs)

Stage 6: Intimacy vs Isolation

Adolescence (13 - 21 yrs)

Stage 7: Generativity vs Stagnation
Stage 8: Ego Integrity vs Despair

**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 discussing 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 further 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 encouragement 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.
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.

5.4 CONCLUSION
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.
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 broadly categorised for the precedent investigation in order to select precedents and extract a holistic understanding of each.

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.

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.

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.

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
Facilitating Social Interaction

User Interaction

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

User-space Appropriation

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

Space-user Impact

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

Spatial Connection

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

Four categories of investigation:

- Social Interaction
- Learning Interaction
- Flexibility
- Ownership/Appropriation
- Multi-functionality
- Acoustics
- Light & Glare
- Thermal & Ventilation
- Aesthetics
- Privacy
- Deployability
- Threshold & Spatial Hierarchy
- Sustainability

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

6.3.1 MICRO HUTONG RENEWAL PROJECT

- **Figure 80**: Precedent analysis of Micro Hutong Renewal Project
- **Figure 81**: Zang Mingming, 2015
- **Figure 82**: Wang Ziling, Su Shengliang, Zhang Mingming, 2015
- **Figure 83**: Su Shengliang, 2015
- **Figure 84**: Section 2-2, ZAO/standardarchitecture, 2015

- **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**
- **Niches for individual / group gathering & study**
- **New intervention & insertion adopts shape of the existing**
- **Extrude slightly into courtyard, emphasised as new entity - contrast in material**

**Social encounters**

**Spatial hierarchy**

**Modes of interaction**

**Multi-functional**
Micro Hutong Renewal Project

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; 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.

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

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.

Grey brick
Plywood
Glass

SOCIAL INTERACTION
LEARNING INTERACTION
FLEXIBILITY
OWNERSHIP / APPROPRIATION
MULTI-FUNCTIONALITY
ACOUSTICS
LIGHT & GLARE
THERMAL & VENTILATION
AESTHETICS
PRIVACY
DEPLOYABILITY
THRESHOLD & SPATIAL HIERARCHY
SUSTAINABILITY

1: (ArchDaily, 2015)
2: (Architonic, 2015)
6.3.2 KAVEL K

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

Lower walkway, no interference with the play and social interaction.

Building forms a central hub to differentiate the zones.

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

Visual access and aesthetic character optimised.

Boundary fence becomes interactive as part of the play experience.

Aesthetic wall also instills ownership, identity and sense of belonging.

Pops of colour highlighting flexible objects.

Social encounters

Spatial hierarchy

Modes of interaction

Multi-functional
Kavel K
Youth Facility

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 attract a wide range of user groups.

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

1: (ArchDaily, 2014)
6.3.3 AULA K

Contribute to education of biodiversity and respect for the environment.
Introduce natural daylighting

Transition form exterior to interior
Social node
Multifunctional Classroom

Natural materials blending in with the environment
Include green infrastructure

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

Rapid construction on site

Module
Adaptable
Multi-functional
Sustainable
Aula K
Environmental Classroom

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.

Description: A three part prefabricated module, delivered to site and installed in any 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

Lighting layout becomes a feature on the ceiling
Include natural ventilation

Visual connections

Modules
Configure according to needs

1: (ArchDaily, 2019)
6.3.4 ALTSCHOOL

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

Learning spaces
- Colour coding for spatial hierarchy

Multi-functional
- In-between spaces
AltSchool

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; accommodate individual needs & different learning styles, resulting in multiple types of spaces & flexibility within the interior articulation.

Description: Staircase for assembly and gatherings/teachings, workstations for collaborative work & mealtimes, individual workbenches 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

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

More of Interaction:

Facing / Circumferential

Adjacent (Unidentified)

Linear

1: (Brillon, 2018)
6.3.5 STREETLIGHT SCHOOLS : JEPPE PARK PRIMARY

Spatial zoning according to requirements, overlaps and relationships.

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

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

The inherent spatial qualities available also act as informant

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

Multiple activities possible

reuse materials & innovative design

Learning spaces / Ways of learning

Spatial Zoning

Branding / Identity

Sustainability

Figure 96: Precedent analysis_5. Streetlight Schools Jeppe Park Primary

Figure 97: (left and below): Streetlight Schools, n.d
Considering the school model and different ways of learning:

User > Space

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.)

Streetlight Schools
Jeppe Park Primary

Architect: Fieldworks Design Group
Location: Jeppesown, 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. The school provides new and exciting education opportunities to children in the area. 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.

Description:

Description:

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

Figure 98: Precedent analysis_6. Sage Classroom

- Natural light through clerestory windows
- 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 daylighting
- Pops of colour on exterior, giving identity to classroom
- Doorway access x 2 (flexible in size)
- Linear placement of clusters

Learning spaces
Portable Architecture

Sustainability
SAGE Classroom
(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

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

Height adjustable support structure

Lower interior walls to allow for ventilation

Transition from interior to exterior

Flexibility
Sustainability
Threshold
Deployability
Hex House
Conceptual Project

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.

**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

Self-taught instruction with teacher as facilitator

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

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

Teaching inwards centered on one wall–students facing forward

Act of socialization informing appropriate behaviors and promotes team building

Open up facade

Interactive facade, multi-functional

Classroom identity

Figure 102: Precedent analysis_6, Flex: Flexible Learning Environment

Figure 103: View from second floor balcony, HMC Architects, 2011

Figure 104: View inside learning environment, HMC Architects, 2011

Figure 105: Aerial view, HMC Architects, 2011

Figure 106: Architizer, n.d.

Social encounters

Modes of interaction

Spatial hierarchy

Multi-functional
Flex : Flexible Learning Environments

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.

1 : (Furuto, 2011)
2 : (Architizer, n.d.)
Figure 107: Precedent analysis_Assessment 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.
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.
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
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.

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.

![Conceptual Drivers](image)

Figure 110: Conceptual Drivers
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.
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.
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 taken 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.
### Design Informants

<table>
<thead>
<tr>
<th>Conceptual Drivers</th>
<th>Design Informants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spaces for Learning</td>
<td>• formal (traditional teacher fronted / instructed) vs informal (peer &amp; collaborative) • interior vs exterior learning</td>
</tr>
<tr>
<td>Facilitate Social Interaction</td>
<td>• levels of privacy • modes of interaction (group gatherings or spontaneous / incidental)</td>
</tr>
<tr>
<td>Control</td>
<td>• flexibility of space (skin &amp; internal furnishing) • personalisation / sense of ownership &amp; belonging</td>
</tr>
<tr>
<td>User Comfort &amp; Care</td>
<td>• aesthetics • acoustics • light &amp; glare • thermal comfort • universal design • links to nature</td>
</tr>
<tr>
<td>Thresholds &amp; Spatial Hierarchy</td>
<td>• threshold experience • legibility of space</td>
</tr>
<tr>
<td>Deployability</td>
<td>• design for disassembly • ease of operation</td>
</tr>
</tbody>
</table>

### Design Principles

<table>
<thead>
<tr>
<th>Aesthetics (of Joy)</th>
<th>Acoustics</th>
<th>Lighting &amp; Glare</th>
<th>Thermal Comfort</th>
<th>Universal Design</th>
<th>Links to Nature</th>
<th>Safety &amp; Security</th>
</tr>
</thead>
<tbody>
<tr>
<td>• views • artwork • familiarity • delight (pops of colour, multiplicity, natural elements, elevation / lightness)</td>
<td>• sounds barriers • spatial forms / angles / surfaces</td>
<td>• natural daylighting • glare control • right to light (window placement)</td>
<td>• natural ventilation • shading • control</td>
<td>• signage &amp; way-finding • ergonomics • accessibility</td>
<td>• patterns of nature • indoors &amp; outdoors • interaction with nature</td>
<td>• boundary all round • natural surveillance</td>
</tr>
<tr>
<td></td>
<td>• material specifications • calculations (reverberation &lt;0.6)</td>
<td>• calculations / lux levels • light specifications • material specifications</td>
<td>• systems • control mechanisms</td>
<td>• SANS - wheelchair accessibility</td>
<td></td>
<td>• material safety • fixings • distances</td>
</tr>
</tbody>
</table>

Figure 111: Design Informants
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.

---

**LEGEND**

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

- Optimal
- Good
- Sufficient

Figure 112: Assessment tool _ Legend
Figure 113: Assessment tool
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

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
TEACHER-FRONTED + FLEXIBLE & CONVERTIBLE = HEXAGONAL SHAPE TO ACCOMMODATE MULTIPLE APPROACHES

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

NATURAL LIGHT & VENTILATION, AND ACOUSTIC CONSIDERATION

CIRCULATION ROUTE

NATURAL LIGHT

NATURAL VENTILATION
8.3.2 ‘FUNCTION’ STRATEGY

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

Not currently offered but proposed for the design intervention
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.

Although the first four scenarios discussed above typically take place 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 ZOney AND AN EDUCATIONAL ZONE ON BOTH THE INTERIOR AND EXTERIOR

FLEXIBLE INTERIOR FURNITURE & FIXTURES

DIFFERENT, INTERCHANGEABLE FACADES ALLOWING VARIOUS LEVELS OF FLEXIBILITY AND OPENNESS

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

In terms of the size of classrooms, Guideline A – WELL Building Standard requires 4 m² per learner, whereas Guideline B – Norms and Standards for South African School Infrastructure stipulates 1 m² per learner and 7 m² 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 56 m², 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 m² is found.
**DESIGN APPLICATION**

---

**MODULAR SYSTEM**

Any combination of these can be used to design for ergonomics. For example:
- 450mm seat height
- 750mm table height
- 900mm counter / workbench height
- 2100mm overhead height for doors and write-boards

---

GUIDELINE B_SA NORMS & STANDARDS

Teacher (7m²) + 40 Learners (1m² each)

GUIDELINE A_WELL BUILDING STANDARD

Teacher + 40 Learners (4m² each)

---

**Figure 118: Size strategy and design application**

---

15.66 m² allocated to the support activities within the focus zone

60.84 m² main educational space

12.42 m² teacher & social space

TOTAL 88.92 m²
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.
**Natural Cork:**
- Non-slip surface.
- Acoustic properties, biodegradable and renewable.
- Good acoustical properties, biodegradable and renewable. Cork is a natural flexible material, varying thickness, weight, and density. Cork is an excellent insulator and can be finished in various ways.

**Wood:**
- Corkboard and Chipboard are available in various thicknesses and colours.
- Solid timber or engineered wood can be used in structural applications, but some are more suitable for non-structural applications.
- Plywood is used in furniture, flooring, and furnishing.

**Engineered Wood:**
- MDF is strong, denser than plywood, cost-effective, fungus/mold resistant, and a synthetic resin adhesive with the strands of colour.
- Not as smooth on the surface when formable and machineable (Palram South Africa, 2014).

**Fascades/Windows for High Humidity and Suitable Panel Specifications:**
- Could be structural, acoustic, transparent, and support frame: steel or other materials.

**Interior Application:**
- Structural, acoustic, transparent, and support frame: steel or other materials.
- Non-structural panel used for funnelling and furnishing.

**Exterior Application:**
- Structural, acoustic, transparent, and support frame: steel or other materials.

**Ambient Temperature:**
- Structural, acoustic, transparent, and support frame: steel or other materials.

**Performance in Fire:**
- Structural, acoustic, transparent, and support frame: steel or other materials.
- Fire-resistant panels have improved flammability ratings.

**Thermal Properties:**
- Thermal transmission and yellowness index.

**Light Reflection and Transmittance:**
- Light reflection and transmittance.

**Sound Absorption:**
- Sound absorbing cork can block up to 10% of the sound, taking into account the density of the material.

**Sensorial Qualities:**
- Sensorial qualities.
**MDF**

<table>
<thead>
<tr>
<th>Material family</th>
<th>Material name</th>
<th>Characteristics</th>
<th>Functional / Structural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plywood (3 ply)</td>
<td></td>
<td></td>
<td>Durable, cost effective</td>
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<td>and stainable. Resistant</td>
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<td>to many wood grain,</td>
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- **Typical density:** 0.4 - 0.6 W/m.K (Panel Guide, 2014) | **Thermal Conductivity:** 0.027 W/m.K (Panel Guide, 2014) |

- **Thermal Conductivity:** 0.027 W/m.K (Panel Guide, 2014)

- **Sound transmission:** 35-40 dB (Panel Guide, 2014)

- **Potential Supplier:** Available size / colour

- **Maintenance:** No maintenance

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**MDF**

- **Density:** MDF is produced in a wide range of densities, from 700 kg/m³ to 1100 kg/m³, depending on the manufacturer.
- **Water Resistance:** MDF is water resistant, but should be protected from prolonged exposure to water to prevent warping.
- **Fire Resistance:** MDF is not flame retardant and can be damaged by fire.

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**Melamine Faced MDF**

- **Density:** MDF is produced in a wide range of densities, from 700 kg/m³ to 1100 kg/m³, depending on the manufacturer.
- **Water Resistance:** MDF is water resistant, but should be protected from prolonged exposure to water to prevent warping.
- **Fire Resistance:** MDF is not flame retardant and can be damaged by fire.

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**Laminate Faced MDF**

- **Density:** MDF is produced in a wide range of densities, from 700 kg/m³ to 1100 kg/m³, depending on the manufacturer.
- **Water Resistance:** MDF is water resistant, but should be protected from prolonged exposure to water to prevent warping.
- **Fire Resistance:** MDF is not flame retardant and can be damaged by fire.

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**Particleboard**

- **Density:** Particleboard is produced in a wide range of densities, from 700 kg/m³ to 1100 kg/m³, depending on the manufacturer.
- **Water Resistance:** Particleboard is water resistant, but should be protected from prolonged exposure to water to prevent warping.
- **Fire Resistance:** Particleboard is not flame retardant and can be damaged by fire.

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**Particleboard**

- **Density:** Particleboard is produced in a wide range of densities, from 700 kg/m³ to 1100 kg/m³, depending on the manufacturer.
- **Water Resistance:** Particleboard is water resistant, but should be protected from prolonged exposure to water to prevent warping.
- **Fire Resistance:** Particleboard is not flame retardant and can be damaged by fire.

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**Chipboard**

- **Density:** Chipboard is produced in a wide range of densities, from 700 kg/m³ to 1100 kg/m³, depending on the manufacturer.
- **Water Resistance:** Chipboard is water resistant, but should be protected from prolonged exposure to water to prevent warping.
- **Fire Resistance:** Chipboard is not flame retardant and can be damaged by fire.
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.
FORMULATING A DESIGN RESPONSE

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.
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.
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.

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 description of each will be discussed in the section to follow, after which an on-site assembly manual and details will be provided.
Figure 121: Unit Front and Back Views
Figure 12: Unit Composition and Assembly Sequence
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.

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.
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.

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.
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.

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.

Figure 126: Corner posts _ Final Iteration
As the support wall incorporates an additional 300mm storage unit fixed to the wall surface, unique connections are provided.

Cavities for boundary trusses to be slotted in

Interlocking profile to secure facade panels in place

A larger profile accompanies the support wall, making inner cavities available to conduits for lighting and solar panel connections along a vertical axis

Exterior overlap with facade panel

Interior overlap with facade panel

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

Louvre panels colour coded according to classroom colour palette, darker colour for semi-flexible features

Air flow and view once louvres are opened. Varying levels of privacy and natural ventilation, controlled by user

Overlapping 'S'-profile for an air-tight connection when closed

Powder-coated Aluminium finish, operated by hand or rotation bar fixed to the side of the louvres
Two types of custom facade sandwich panels are manufactured to accommodate the four interchangeable facades, as well as the doorway 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 assigned 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

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

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

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

- Solid composite wood extrusion

Back ET

- 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

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Figure 132: Roof Structure _ Extruded trusses

**Final Iteration**
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

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.

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 height 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, TPA + 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).

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

STEP 09.
Install the roof sandwich panels. Starting with the panels along the lower extruded boundary trusses with the integrated gutters, 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.
9.2.2 SECTION AND DETAILS
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 at 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 texture 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 texture 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.

Ø 200 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 M5 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 structurally 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 1000lter 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

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

Figure 135: Learner desks - Final Iteration

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.

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

FINAL ITERATION

Various modes of use, and group configurations possible

Figure 136: Learner desks - Iterative Process
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 Ø15mm 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 Porabolic 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 classroom 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
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.

Incorporate side and front handles for ease of operation.

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

Figure 139: ‘Write’-boards _ Initial Iterative Process

ITERATIVE PROCESS
Figure 140: ‘Write’-boards _Iterative Process Finalisation

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.

Blind Mortice & Tennon Sequence
Slot Sequence Interlock with Tennon
Blind Mortice & Tennon Sequence

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.

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 & tenon, as well as slot interlock and tenon 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 trolley frame structure with pop-rivets, functioning 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.

SmartSurface whiteboard coating

SmartSurface chalkboard coating

Storage boxes and a shelf for writing utensils, drawing equipment, books and teaching materials.

**ADDITIONAL FEATURE: TROLLEY**

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

Figure 141: ‘Write’-boards_Final Iteration Composition

Figure 142: Trolley

Figure 143: ‘Write’-board_Final Iteration

**FINAL ITERATION**
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 allows 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 assigning flexibility to the wall-unit with regards to the level of display.
Figure 144: Support Wall __ Iterative Process 01
ITERATIVE PROCESS

Figure 145: Support Wall _ Iterative Process 02
A wall mounted storage unit with a vertical tambour door system, supplied by to control the level of display. Further designed with the acoustic line material finish.

Storage lockers for learners, varying in size.

Exposed shelving for display or storage purposes.

1200mm wide workstation:
- Could be used as a 300mm counter-top for display and storage purposes.
- Could be converted to a 600mm worktop for individual and small group study, computer stations or science experiment bench.

Storage unit with a 5kg CO2 Fire extinguisher, and a fire blanket mounted to the interior door surface.

Storage unit for a 10 litre waste water canister, and a Microlene Under Bench water filtration system, supplied by Davey.

840 x 2100mm x 1000 litre JoJo Slimline Water Storage Tank.

Splash-back, using the Smart Surface Whiteboard coating on the plywood interior panel surface.

230 x 430 x 150mm Franke Kubus under-mount sink with faucet and wrist action lever handle, controlling the supply of potable water.

450mm Tip-out bin unit with a perforated front panel allowing quick access.

Wobble stool.

Light shelf.

1200mm wide workstation.

Figure 146: Support Wall _ Final Iteration
Figure 147: Support Wall _ Section: Utility Segment
Figure 148: Support Wall _ Section: Multi-Functional Segment

- **Section Multi-Functional Segment**

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

- Ø275 x 65mm LED downlight fitted within the lightshelf and connected to the solar panel via a municipal electrical grid.

- 1208 x 2400 x 12mm plywood interior face, screwed through the aluminium anodised sheet fast-over 40mm from the edge with M5 x 20mm flat countersink head screws at 300 c/c spacing.

- 300 x 1200 x 20mm plywood countertop, with 50mm balustrade edge overhang. Hinges are screwed to the countertop within a 50mm recess to be flush with the countertop surface.

- 600 x 900 x 20mm plywood workbench, hinged to the countertop for optional use, with M5 x 80mm flat countersink head screws, using two 10" hinges at 500mm c/c spacing.

- Ø20 x 4mm aluminium semi-circle formed grip handle/door pull/powdercoated according to the classroom colour palette.

- 500 x 598 x 1200mm storage unit, made with 16mm plywood panels. Divided into various size pockets for items. Ø20 x 4mm aluminium semi-circle formed grip handle, colour co-ordinated according to the classroom colour palette.

- Ø330 x 500 x 450mm height adjustable wobble stool, upholstered from the 'Hierarchy' supplied by Giorgio Sanc, 48mm brushed stainless steel arm with a carpeted polypropylene base corresponding with the classroom colour palette and a 20mm plywood seat.
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.

1. Support wall always connected to the support corner, where the water tank is situated.

2. Louvre panels: one perpendicular to the support wall, the other in the opposite corner, parallel to the first.

3. Viewing facade: always connected to the entrance corner, so allow for the social zone.

4. Site configuration: None or two flexi-components should be provided. This would prevent ‘lost spaces’ between units, which are a result of narrow throughways, and potentially creates outdoor spaces for both social and learning experiences.

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Figure 149: Unit composition rules to follow

Figure 150: Unit composition legend

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LEGEND:
- SUPPORT WALL
- VIEWING FACADE
- TEACHING WALL
- OPERABLE FACADE
- LOUVRE PANEL
Figure 151: Unit composition scenarios
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 conducive to learning was created.
NATURAL VENTILATION

Operable clerestory windows
Louver panels at the back end wall and opposite corners
Cross ventilation through the louver 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 avoid 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
Ecophon Solo, custom shape, acoustic panels suspended 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 155: Spatial Quality
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.
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.
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 whiteboards 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.
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.
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.
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.
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.

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.
The existing site comprised of several portable classrooms and panellised prefabricated buildings. All the portable classrooms are removed from the site and proposed to be reused elsewhere, or recycled as far as possible. The concrete pathway connecting these portable classrooms are also demolished. Ablution facilities are removed, and the proposed placement for new ablution facilities are provided, even though these facilities are not further investigated within the design proposal.

Panellised prefabricated buildings are mostly retained with minimal changes being made. New deployable learning units are arranged on site and connected by way of the addition platforms and ramps proposed within the design. Multiple configuration of the new units are possible, investigate the most applicable composition on this specific site. All trees present on the existing site are kept in place, except for one tree that will be moved to the centre green space as the placement of a new learning unit conflicts with the current position of the specific tree.

**EXISTING CONDITION**

**REMOVAL OF EXISTING INFRASTRUCTURE**

**ALTERNATIVE SITE SCENARIOS**

Figure 162: Site Transformation  
Figure 163: Alternative Site Scenarios
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.
The existing scenario poses several threats 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.

Figure 165: Existing Scenario 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.

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
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.
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.
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.
CHAPTER 12: STATING REFERENCES

CHAPTER 13: PROVIDING APPENDICES

PART E — ASSIST
REFERENCES


13.1 THE ‘CHECK-UP AUDIT’
Reference framework

**WELL-BUILDING STANDARD**

- International WELL-Building Institute (2014)

**SA NORMS AND STANDARDS**

- South African Department of Basic Education (2013)

**‘WHEEL OF WELLNESS’ THEORY**


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

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

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

<table>
<thead>
<tr>
<th>Programme</th>
<th>GENERAL DESIGN</th>
<th>TECHNIFICATION / SPECIFICATION</th>
<th>POLICY</th>
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<tbody>
<tr>
<td>Relating the programme on site, and the function of the space, therefor informing the specific activities that would / should take place within the space.</td>
<td>Spatial layout and overall design informed by these stipulations, considering spatial quality requirements &amp; other properties that need to be addressed through the design intervention. (eg. services, views, thermal/ acoustic / lighting quality, dimensions etc.)</td>
<td>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.</td>
<td>Not relating to the spatial design or technical specifications, but rather proposing certain changes or implementations to the policies, rules and regulations employed on site.</td>
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### WELL-BEING

- **Social**
- **Psychological**
- **Physical**

Contribution of well-being: Social, Psychological, Physical.
<table>
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<tr>
<th>Aspect</th>
<th>Description</th>
<th>Implication</th>
<th>Source</th>
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<tbody>
<tr>
<td><strong>Fitness / Exercise</strong></td>
<td><strong>PART 1: FITNESS PROGRAMS</strong>&lt;br&gt;Onsite fitness or training programs offered from a qualified professional at least once a month</td>
<td>• exterior education space / sport and recreation facilities</td>
<td>WELL-Building Standard : Fitness_66 (Precondition)</td>
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<td><strong>PART 2: FITNESS EDUCATION</strong>&lt;br&gt;Classes from qualified professional offered at least once every 3 months to cover the following:&lt;br&gt;a. Different modes of exercise&lt;br&gt;b. Safe fitness techniques&lt;br&gt;c. Comprehensive exercise regimens.</td>
<td>• exterior education space / sport and recreation facilities&lt;br&gt;• lecture hall / multifunctional class</td>
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<td></td>
<td><strong>PART 3: PHYSICAL ACTIVITY BREAKS</strong>&lt;br&gt;Early education and primary schools:&lt;br&gt;a. Minimum of 30 minutes daily of moderate to vigorous exercise.&lt;br&gt;b. Removal / reduction in physical activity breaks may not be used as a form of punishment.&lt;br&gt;c. Physical activity breaks are taken before lunch.</td>
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<td><strong>Stress &amp; Addiction Treatment</strong></td>
<td><strong>PART 2: STRESS MANAGEMENT</strong>&lt;br&gt;Qualified counselor offering group / private workshops and referrals, made available</td>
<td>• private &amp; multi-functional spaces for counseling</td>
<td>WELL-Building Standard : Mind_95 (Precondition)</td>
</tr>
<tr>
<td></td>
<td><strong>PART 3: MIND &amp; BEHAVIOR SUPPORT FOR STUDENTS</strong>&lt;br&gt;Program that addresses psychological &amp; behavioral distress available to students:&lt;br&gt;a. Access to short term treatment &amp; referrals to qualified professionals for depression, anxiety, substance use, smoking cessation, addiction and co-occurring mental health issues.&lt;br&gt;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.</td>
<td>• private &amp; multi-functional spaces for counseling&lt;br&gt;• personal / private areas to deal with anxiety and to relax</td>
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<td>Aspect</td>
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| 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.  
| 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 m² 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 & specification | WELL-Building Standard : Light_53 (Precondition) |
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<td>Right to light</td>
<td><strong>PART 1: LEASE DEPTH</strong>&lt;br&gt;75% of the area of all regularly occupied spaces is within 7.5 m of view windows.</td>
<td>• room dimensions&lt;br&gt;• window placement &amp; views</td>
<td>WELL-Building Standard : Light_61 (Optimisation)</td>
</tr>
<tr>
<td></td>
<td><strong>PART 2: WINDOW ACCESS</strong>&lt;br&gt;a. 75% of all workstations are within 7.5 m of atrium / window with views to exterior.&lt;br&gt;b. 95% of all workstations are within 12.5 m of atrium / window with views to the exterior.</td>
<td>• room dimensions&lt;br&gt;• spatial layout of furniture&lt;br&gt;• window placement &amp; views</td>
<td>Dept of Basic Education : SA Norms &amp; Standards for schools</td>
</tr>
<tr>
<td>Windows</td>
<td>Easy operation while considering safety measures &amp; natural ventilation</td>
<td>• window placement &amp; specification</td>
<td>Dept of Basic Education : SA Norms &amp; Standards for schools</td>
</tr>
<tr>
<td></td>
<td>Every regularly occupied space has operable windows that provide access to outdoor air and daylight.</td>
<td>• specification of openable windows&lt;br&gt;• placement for daylight &amp; ventilation</td>
<td>WELL-Building Standard : Air_19 (Optimisation)</td>
</tr>
<tr>
<td>Ventilation</td>
<td>Incorporate natural ventilation through openable windows and permanent wall vents in compliance with the relevant laws &amp; regulations.</td>
<td>• windows placement &amp; specification&lt;br&gt;• wall vents</td>
<td>Dept of Basic Education : SA Norms &amp; Standards for schools</td>
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<td>Aspect</td>
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<tr>
<td>Interior Circulation</td>
<td><strong>PART 1: STAIR ACCESSIBILITY AND PROMOTION</strong>&lt;br&gt;In projects of 2-4 floors, at least one common staircase meets the following requirements:&lt;br&gt;a. Accessible to regular building occupants during all regular business hours.&lt;br&gt;b. Throughout the space, wayfinding signage and point-of-decision prompts are present to encourage stair use (at least one sign per elevator bank).</td>
<td>• stairs : placement &amp; access&lt;br&gt;• signage</td>
<td>WELL-Building Standard : Fitness_64 (Precondition)</td>
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<td><strong>PART 2: STAIRCASE DESIGN</strong>&lt;br&gt;In projects of 2-4 floors, at least one common staircase meets following requirements:&lt;br&gt;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.&lt;br&gt;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.&lt;br&gt;c. Stair width set at minimum of 1.4 m between handrails, or width allowable by local code.</td>
<td>• stairs : placement &amp; access&lt;br&gt;• elevator placement&lt;br&gt;• SANS 10400 Part M &amp; Part S</td>
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<td><strong>PART 3: FACILITATIVE AESTHETICS</strong>&lt;br&gt;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:&lt;br&gt;• Artwork&lt;br&gt;• Music&lt;br&gt;• Biophilic elements&lt;br&gt;• Daylighting using windows or skylights of at least 1 m² in size&lt;br&gt;• View windows to outdoors / building interior&lt;br&gt;• Light levels of at least 215 lux [20 fc] when in use.</td>
<td>• sightlines &amp; views&lt;br&gt;• decoration / aesthetic detailing&lt;br&gt;• window placement &amp; sizes for appropriate views / daylighting&lt;br&gt;• user experience</td>
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<tr>
<td>Signage</td>
<td>A name board indicating school details 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</td>
<td>• signage • public views of school</td>
<td>Dept of Basic Education : SA Norms &amp; Standards for schools</td>
</tr>
<tr>
<td>Innovative Design</td>
<td>Promote efficient &amp; cost effective design to create enabling and inclusive teaching &amp; learning environments</td>
<td>• overall design &amp; detailing</td>
<td>Dept of Basic Education : SA Norms &amp; Standards for schools</td>
</tr>
<tr>
<td>Administration areas*</td>
<td>Areas used by staff and management for the purposes of day to day running of the school. Include the following :</td>
<td>• required facilities / admin areas with minimum sizes • spatial layout &amp; building / room dimensions</td>
<td>Dept of Basic Education : SA Norms &amp; Standards for schools</td>
</tr>
<tr>
<td>Principal’s office</td>
<td></td>
<td>• 20m²</td>
<td></td>
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<tr>
<td>Deputy Principals office</td>
<td></td>
<td>• 15m²</td>
<td></td>
</tr>
<tr>
<td>Head of Department (HOD) office</td>
<td></td>
<td>• 15m²</td>
<td></td>
</tr>
<tr>
<td>Administration</td>
<td></td>
<td>• 20m²</td>
<td></td>
</tr>
<tr>
<td>Reception Area</td>
<td></td>
<td>• 15m²</td>
<td></td>
</tr>
<tr>
<td>Printing Room</td>
<td></td>
<td>• 15m²</td>
<td></td>
</tr>
<tr>
<td>Staff Kitchenette</td>
<td></td>
<td>• 12m²</td>
<td></td>
</tr>
<tr>
<td>Staff Room</td>
<td></td>
<td>• 60m²</td>
<td></td>
</tr>
<tr>
<td>Storage Area (for admin purposes)</td>
<td></td>
<td>• 15m²</td>
<td></td>
</tr>
<tr>
<td>Sick Room</td>
<td></td>
<td>• 15m²</td>
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*Refer to original document (Annex E) for Administration area requirements per school type
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</table>
| 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             | 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
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<tbody>
<tr>
<td>Physical Activity Areas</td>
<td>One of the following requirements are met:</td>
<td>• sport &amp; recreational facilities&lt;br&gt;• access and pedestrian movement to facilities</td>
<td>WELL-Building Standard : Fitness_68&lt;br&gt;(Optimisation)</td>
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<tr>
<td></td>
<td>a. Physical activity facilities in form of gymnasium / playing field must be provided on-site.&lt;br&gt;b. Free, direct pedestrian access to gymnasiums, playing fields or swimming pools through a shared facilities agreement / similar arrangement.</td>
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<tr>
<td>Active transportation support</td>
<td>PART 2: POST COMMUTE &amp; WORKOUT FACILITIES _ Provided on site or within 200m of building's main entrance: &lt;br&gt; a. One shower with changing facility for the first 100 regular building occupants &amp; one additional shower for every 150 regular building occupants thereafter.&lt;br&gt;b. One locker for every 5 regular building occupants, or evidence that the lockers provided exceed demand by at least 20%.</td>
<td>• ablution facilities : to include showers and lockers&lt;br&gt;• water and sanitation layout</td>
<td>WELL-Building Standard : Fitness_69&lt;br&gt;(Optimisation)</td>
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<td>PART 3: BICYCLE STORAGE FACILITIES Provided within 30m of building main entrance: &lt;br&gt; a. Basic bicycle maintenance tools, including tire pumps, patch kits and hex keys available for use.&lt;br&gt;b. Separate &amp; secure storage for bicycles, sized at 5% or more of all building staff &amp; students above grade level 3, calculated at peak occupancy.</td>
<td>• facilities provided for bicycles</td>
<td></td>
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<td></td>
<td>Natural surveillance incorporated in open areas &amp; relationships between buildings as far as possible.</td>
<td>• building layout&lt;br&gt;• sightlines / views</td>
<td>Dept of Basic Education : SA Norms &amp; Standards for schools</td>
</tr>
<tr>
<td>Injury prevention</td>
<td>PART 1: SUFFICIENT LIGHTING Outdoor lighting meets the following requirements: &lt;br&gt; a. Emit no light above the horizontal plane.&lt;br&gt;b. Use shielding: viewing angle = not less than 80°.&lt;br&gt;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.</td>
<td>• lighting layout &amp; specification</td>
<td>WELL-Building Standard : Fitness_P8&lt;br&gt;(Precondition)</td>
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| 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 |  |
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</table>
| 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 1,900m²: average sound pressure level from outside noise intrusion is less than or equal to 35 dBA.
  b. Spaces greater than 1,900 m²: 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) |
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| Acoustics       | **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) |
| Pedestrian activity | **PART 6: NOISE CRITERIA IN SCHOOLS**  
While unoccupied & measured in geometric center of the room: Classrooms: less than 35.  
**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  
• placement / relation to noise sources  
• 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  
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 & furniture  
• pedestrian walkway  
• public space & communal area  
• aesthetic design | WELL-Building Standard : Fitness_67 (Optimisation) |
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<tr>
<td>Security &amp; Safety</td>
<td>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</td>
<td>• boundary wall / fence &lt;br&gt; • arrangement / policy for security or response company &lt;br&gt; • Fire regulations: SANS 10400 Part T</td>
<td>Dept of Basic Education : SA Norms &amp; Standards for schools</td>
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<tr>
<td>Water</td>
<td>Available at all times for drinking, personal hygiene &amp; food preparation (where appropriate). Sufficient water-collection points &amp; water use facilities available to allow convenient access. Choice of appropriate water technology is based on assessment &amp; should be maintained in good working order.</td>
<td>• water supply points &lt;br&gt; Options: municipal reticulation network, rain water harvesting &amp; tanker supply from municipalities when required, mobile tankers, boreholes / local reservoir &amp; dam &lt;br&gt; • water &amp; sanitation supply layout &lt;br&gt; • drainage</td>
<td>Dept of Basic Education : SA Norms &amp; Standards for schools</td>
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<tr>
<td>Sanitation</td>
<td>Sufficient number of sanitation facilities - easily accessible, provide privacy &amp; security, promote health &amp; hygiene standards, comply with all relevant laws &amp; 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 toilets - no plain pit / bucket latrines allowed</td>
<td>• obscure glazing must be used in both male and female toilet windows &lt;br&gt; • boys and girls toilets must as far as possible be separate &lt;br&gt; • *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 &amp; basins. 2x Female staff toilet and 1x basin. 1x Male staff toilet with 1x urinal and 1x basin. 1x Unisex disabled toilet &amp; basin. *Refer to original document (Annex G) for different school types</td>
<td>Dept of Basic Education : SA Norms &amp; Standards for schools</td>
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| 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.  
**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  
• eating space (size and furnishing)  
• spatial layout & amenities  
• detailed design of programme & furnishing / furniture with provision for appliances | WELL-Building Standard: Nourishment_52 (Optimisation) |
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| 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 | |
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| Biophilia (i)               | **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. |
|                             | **PART 2: PATTERN INCORPORATION**  
Biophilia plan with description of how project incorporates nature's patterns throughout design. |
|                             | **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. |
| Biophilia (ii)              | **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%). |
|                             | **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 |
|                             | **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. |                                                                                                 | WELL-Building Standard : Mind_88 (Precondition)       |
|                             |                                                                                                                                          |                                                                                                 | WELL-Building Standard : Mind_100 (Optimisation)       |
|                             |                                                                                                                                          | • green infrastructure on site  
• natural daylighting  
• space layout - views and sightlines                                                                 |                                                                                                     |
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<tbody>
<tr>
<td>Flexibility of space</td>
<td>Creating a multi-functional space to allow for multiple education &amp; support functions</td>
<td>• flexibility / adaptability / multi-functional space / multi-functional furniture / furnishing</td>
<td>Dept of Basic Education: SA Norms &amp; Standards for schools</td>
</tr>
<tr>
<td>Adaptable Spaces</td>
<td>PART 1: STIMULI MANAGEMENT Seating &amp; spatial layouts: organized into separate workplace zones &amp; provide differing degrees of sensory engagement. Regularly occupied spaces of 186m² / larger establish appropriate zones based on the below guidelines: a. Programming plan, using data from interviews, surveys, focus groups &amp; 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 &amp; at least one visual vertical surface area for communicating ideas or work.</td>
<td>• spatial layout &amp; amenities (informed by contextual analysis &amp; research) / quiet zones / collaboration spaces with furnishing / design elements for display / expression &amp; collaborative work</td>
<td>WELL-Building Standard: Mind_89 (Optimisation)</td>
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<td>Aspect</td>
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<td>Adaptable Spaces (continued)</td>
<td>PART 2: PRIVACY Projects with gross floor area greater than 1,860m² provide designated quiet space for focus, contemplation &amp; 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.</td>
<td>• spatial layout  • views &amp; sightlines / spatial hierarchy for various levels of privacy  • acoustic materials &amp; control  • furniture &amp; furnishing  • lighting design &amp; specification</td>
<td>WELL-Building Standard: Mind_89 (Optimisation)</td>
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| 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 susceptibility                                                                 | • specification of materials & finishes  
• construction / fixing methods                                                                            | WELL-Building Standard : Air_04 (Precondition)                                                          |
| Electronic connectivity     | Wired / wireless connectivity for purposes of communication. (Includes : Telephone, fax, internet & intercom / public address system.) Must be maintained in good working order. | • maintenance  
• connectivity and appropriate 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.  
PART 2: SHOWER MOISTURE BARRIER  
If present, an airlock or ventilation barrier is required between showers and changing rooms | • regulating humidity  
• ventilation                                                                                               | WELL-Building Standard : Air_16 (Optimisation)                                                          |
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| 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.  

**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). | - spatial layout of rooms  
- technification / specifying doors etc  
- equipment specification to be low-emission (printers & copiers)  
- ventilations systems | WELL-Building Standard: Air_17 (Optimisation) |
| 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 |                                                                                          |
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<td>Smoking ban</td>
<td><strong>PART 1: INDOOR SMOKING BAN</strong>: Building policy or local code reflects that smoking and the use of e-cigarettes is prohibited inside the project.</td>
<td>• school rules / policy</td>
<td>WELL-Building Standard : Air_02 (Precondition)</td>
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<td>Mold &amp; Microbe</td>
<td><strong>PART 2: MOLD INSPECTIONS</strong> _ 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.</td>
<td>• inspections : Mold &amp; microbe, water damage</td>
<td>WELL-Building Standard : Air_06 (Precondition)</td>
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| 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 170: Presentation layout 02
Figure 173: Presentation layout 05
Figure 174: Presentation layout 06
the end...