UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

02

2. Theory

"...the school shall serve as a laboratory. A place where a child can become an experimentalist," (Palm, 1940: 447).

2.1 Introduction

This chapter includes a review of relevant literature on traditional and non-traditional education methods. By investigating the history of educational theories the designer will be able to better understand how previous theories influenced educational environments and, by understanding current educational theories guidelines for 21st century, appropriate MST educational spaces can be developed. This chapter is concerned with how space can act as an informal teacher and why a school should resemble a real life environment.

"The world is changing at a fast rate with every day and every class period the gap grows wider between what students actually need to learn and what they are being taught." Khan (2012:2)

"In today's world we need a workforce of curious, creative and self-directed lifelong learners. They should be capable of conceiving and implementing innovative ideas." (Khan, 2012:80)

2.2. Educational Theories

2.2.1. The Traditional Model

Both historically and today still, children are still taught in classrooms. These **classrooms have been used as the building blocks of schools (Figure 2.1) .** Traditionally, the teacher belonged in front of the blackboard where he or she passed knowledge onto the students. This traditional hierarchy of the teacher-fronted way of teaching led to the following spatial conditions. The classroom environment had to ensure that children are distracted as little as possible and the teacher should have the best view over the class. The classroom became and stayed the territory of the teacher where children have little to no control over it. **The dominant spatial character of the typical school's physical make-up is a series of autonomous, compartmentalised spaces.** The doors to these spaces are arranged in repetition along long corridors. Windows are usually set high so that seated pupils can not look out, thereby limiting any potential external distraction (Hertzberger, 2008:28).

In this model the teacher is the most important and dominant person in the room, the pupils visit the classroom for a predetermined length of time within a predetermined schedule. In most instances **there is little flexibility for a student to adapt the environment to his own needs.** they are only passing through being instructed by the teacher at the same standardised speed as everyone else.
Salman Khan, founder of the online secondary school, Khan Academy, questions the traditional classroom model where information is transferred from the teacher to pupils in school time and homework done solitarily. He questions whether this model still makes sense in a digital age (2012: 5). **He posits that the needs of education are changing and that the traditional classroom model can no longer satisfy these needs.** The traditional model revolves largely around passive learning. In the traditional model students are grouped in age groups and are pushed through at an one-speed-fits-all pace (Khan, 2012:1).

There is a limited amount of time to grasp a given concept despite a variety in comprehension time amongst pupils (Khan, 2012:39). **Schools have prescribed times and methods in which learning must take place. This pace might not be optimal for each student** (McCombs and Whistler, 1997:42). Once a topic has been covered the class moves on, those that do not comprehend are left behind.

The conventional approach to learning is to take pieces of subjects and separate them. A group will spend an allocated time on a piece of information, get tested and move on (Khan, 2012:48-51). Sometimes the teaching process consists only out of rote memorisation with plug-in formulas. In the current model Physics is taught in a separate class from Algebra and Calculus despite it being a direct application of the latter two. Chemistry is partitioned from Physics even though they study many of the same phenomena. **All of these divisions limit understanding and suggest a false picture of how the universe actually works** (Khan, 2015:49).

In the 1990s, McCombs and Whisler (1997:38) asked students and teachers in America why they feel that school is not working for them. **The pupils stated that it feels like the school curriculum is not relevant to the real world.** They feel detached from teachers and peers, they do not receive the support they need, they feel like they do not belong and they feel misunderstood (1997:38). The educators on the other hand said the model is flawed because of a high dropout rate, low achievement by students, low motivation etc. **The educators' focus lay with behaviour and performance, while the students focussed on feelings and needs** (McCombs and Whisler, 1997: 37-38).

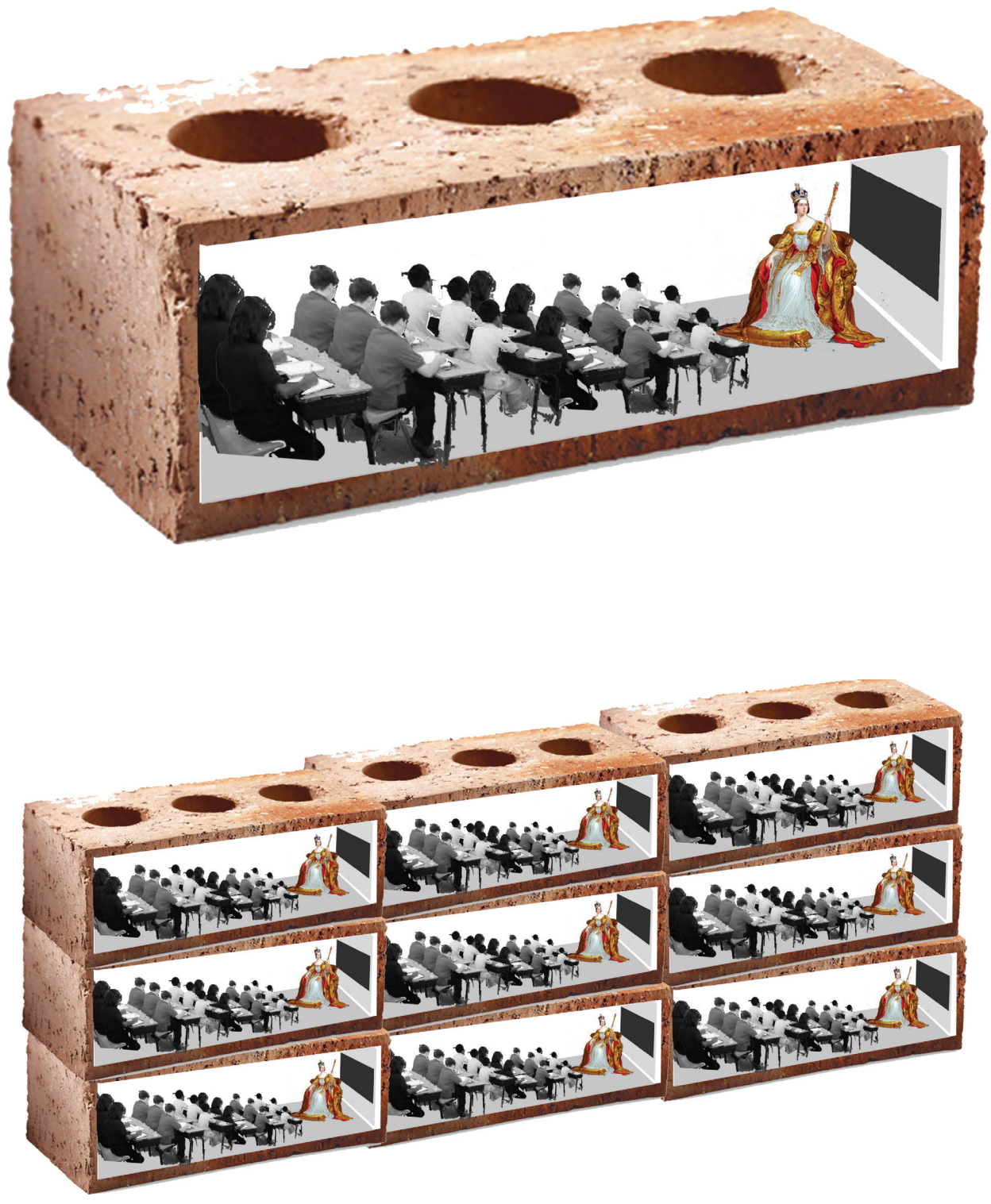


Figure 2.1 Classrooms as building blocks (Author 2016)

2.2.2. The New Education Movement

The new educational movement started about a hundred years ago. Many current alternative education systems are based on these new theories.

In the early 1900s, **John Dewey** initiated a modern movement in education. According to Reuben Parker, Dewey's progressive education led to the notion that "the school shall serve as a laboratory. A place where a child can become an experimentalist" (Palm, 1940:447). **Dewey's work influenced educational theories of the twentieth century and is used as guiding principles for experiential learning.** In 1938, he wrote *Experience and Education* in which he tried to clarify the growing conflict between traditional education and his progressive approach (Kolb, 2014)

The term progressive was used by Dewey in his theory where **he stated that education is a constant reconstruction of experiences** [John Dewey (Palm, 1940:449)]. To him school activities should be current and representative of life (Palm, 1940:448). **Schools are places** where pupils receive life apprenticeships and **where meaning, knowledge and skills are embedded in reality.**

Jean Piaget followed in Dewey's footsteps and believed that **pupils naturally build and alter comprehensions through everyday interactions with their surroundings**. To Piaget, the aim of education was to provide a stimulating environment which supports pupils' natural epistemic curiosity (Hannafin and Land, 1997:169).

Piaget believed that the principal goal of education should be to create pupils who are capable of doing new things, pupils who do not simply repeat what other generations have already done. **Pupils should be creative, inventive and discoverers** (O'Donnell et al, 2010).

In 1922 **Carleton W. Washburne,** who at that time was the president of the Progressive Education Association, developed the concept of Mastery Learning. **Mastery learning** was built firstly on the **belief that any student can learn if the conditions provided matched their needs. Secondly, the curriculum was not structured around** predetermined time per concept but rather around achieving **a certain level of comprehension on a concept.** Thus, exercises could be done at a self-determined pace so that all pupils reached the same level of mastery (Khan, 2012:38-39).

In the 1960s the second wave of progressive education came about by Benjamin Bloom and James Block. With refined testing methods and feedback, **teachers were seen as mentors** instead of lecturers. **Peer assistance and mastery learning was encouraged** (Khan,2012:40). **Student centred experiential learning** (EL) can be defined as a form of **learning from life experience;** often contrasting it with classroom and lecture based learning (Kolb, 1014) Kolb quotes Keeton and Tate, defining EL as:

"Learning in which the learner is directly in touch with the realities being studied. It is contrasted with the learner who only reads about, hears about, talks about, or writes about these realities but never comes into contact with them as part of the learning process." (Kolb, 1014)

Learner-centred is an empirically informed philosophical perspective where one focuses on and understands each learner (McCombs and Whistler, 1997:xii). **Schools** are living systems. Firstly, they **serve students to learn** and secondly, other people who support learning (McCombs and Whisler, 1997:1).

Learner-centred educational systems and **classrooms can better meet the needs of more students,** ensure that students stay in school, and that they learn skills to be productive and satisfied citizens. In addition, these systems can create the desire for lifelong learning (McCombs and Whisler, 1997:36).

In The Foundations of Contemporary Approaches to Experiential Learning, Kolb (2014) argues that **the learning process should be rich with human experiences, shared and interpreted through discussions with one another.**
The world is changing fast, we are more globally connected and access to knowledge has seen an exponential growth. These aspects all add to the need to develop people that can adapt to changing needs, and keep their skills up-to-date (Kolb, 2014)

We need a society of life-long learning. Some believe that **we are heading towards an education revolution fuelled by economic, social and technological changes.** Front-loaded educational practices are becoming obsolete (Kolb, 2014)

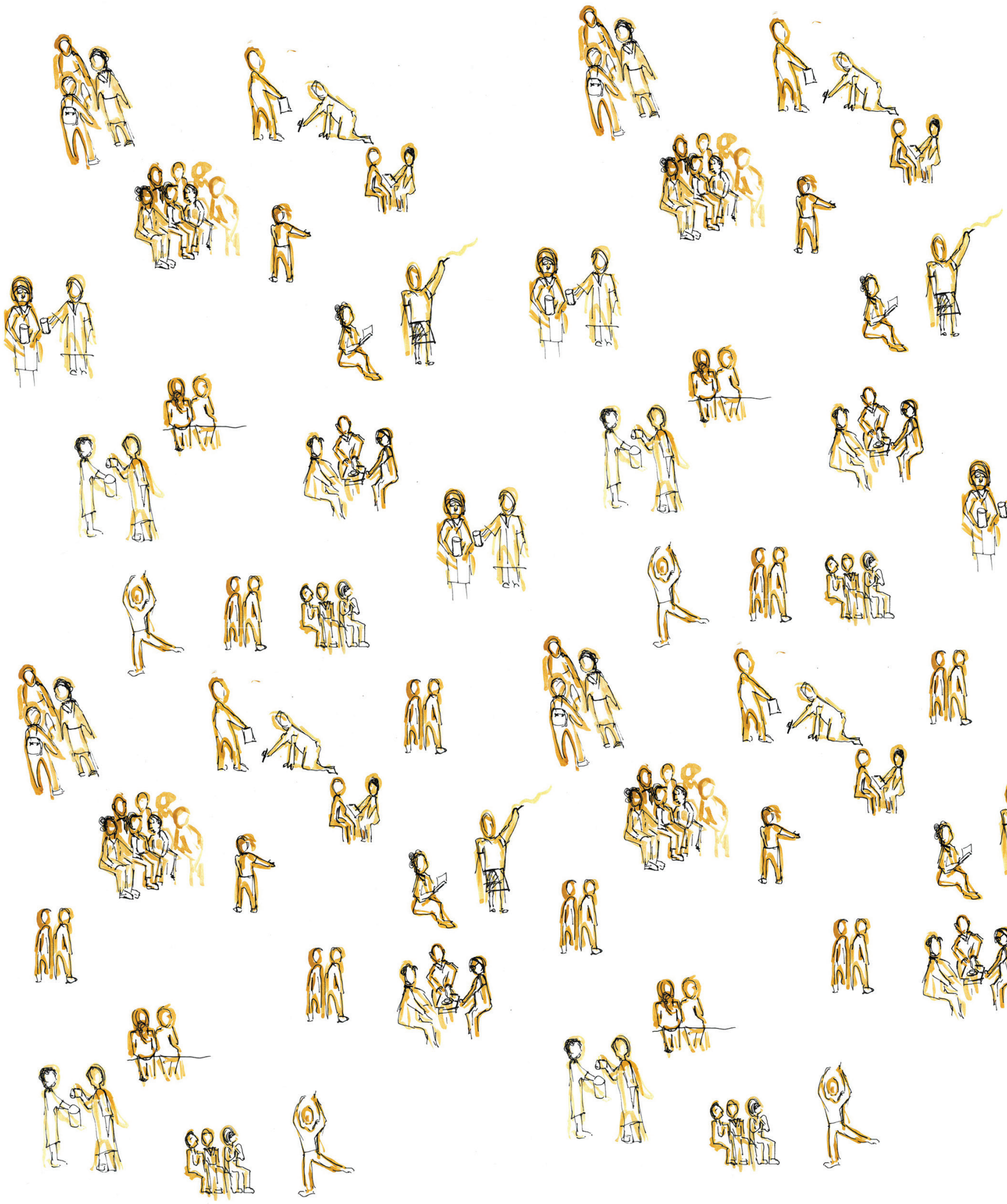


Figure 2.2 Peer assistance and student centered learning (Author 2016)

2.2.3. Informal Education and Museum Education

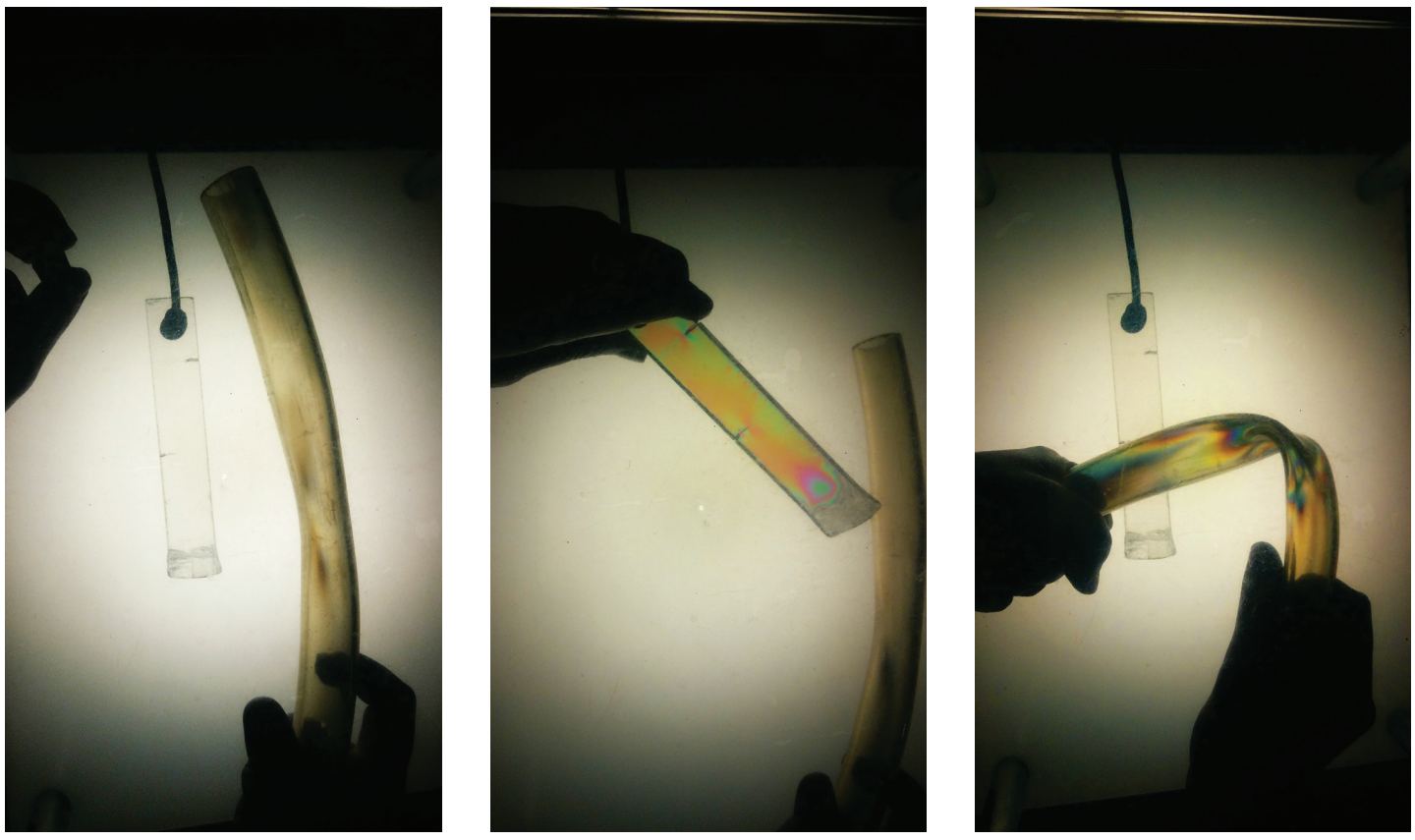


Figure 2.3 Sci-bono Science Centre hands on exhibit (Author 2016).

"The whole point of the Exploratorium is to make it possible for people to believe they can understand the world around them. I think a lot of people have given up trying to comprehend things, and when they give up with the physical world, they give up with the social and the political world as well." – Oppenheimer (Hein, 1990 :xv).

Informal education happens through everyday interactions and through life experiences.
The informal science movement gave people of any age and status access to lifelong learning, debate and entertainment through the exploration of the technological and physical world (Delacôte, 1998:2054). Informal science resources include natural history museums, zoos, science centres and planetariums.
The informal science movement became a success because of its learner-centric approach (Delacôte, 1998:2054).

Museum education and progressive education developed around the same time. Their ideals and practices are similar (Hein, 2006:161). Museum education emphasised the progressive agenda: to learn from an object (Hein, 2006:163). **The keynote of youthfulness** and childhood **is action.** The objectives of a museum should be to understand the interests of the youth. A museum should offer help and opportunities towards learning that schools and homes cannot give (Hein, 2006:167). One such museum was the Exploratorium in San Francisco. **The Exploratorium is a museum of science, art, and perception** (Hein, 1990:vii). A unity of Art and Science is achieved in the museum exhibits. The onlooker is an essential participant in the work (Hein, 1990:viii). This will be discussed in chapter 4.3.3.

In the 1960s, **many museums** and Science centres like the Exploratorium **developed exhibitions modelled on progressive educational theories.** A significant focus shift was for museums to re-establish education as a central idea of museums. There was a universal realisation that **visitors need active engagement in order to ensure understanding** and this led to interactive parts being added into exhibitions (Figure 2.3). This active engagement was evident in Science centres as well as Art and History museums. Thus activity centres, resource rooms and virtual extensions became standard in exhibits (Hein, 2006:171).

The Oppenheimer brothers presented San Francisco's community with a proposal for a museum where people could directly experience and manipulate things, instead of just being told about them. **They wanted to create a place where the public could interact with objects in the way that experimental scientists would do both in the natural world as well as in a laboratory.**

"The museum's mission was to teach that the subject matter of Science is all around us, comprehensible and accessible to all." (Hein, 1990: xv). The aim was to convince people that practising Science can be interesting and fun (Hein, 1990:xv).

2.2.4. Technology and Education

Figure 2.4 How Khan Academy is changing the rules of education (Pugliese, 2011)

Figure 2.5 Pupils from Phomolong Secondary School in Tembisa using tablets in the classroom (Mkhize, 2015).

"Don't limit a child to your own learning, for he was born in another time." - Rabindranath Tagore (Khan, 2012: vii).

With the birth of the Information Revolution, the pace of change has become swift thus creativity and analytical thinking are no longer optional, they are survival skills (Khan, 2012: 7).

The Khan Academy was started by Salman Khan who began by tutoring his cousin Mathematics via the telephone and internet. Today the Khan Academy has grown to become one of the most used online resources to learn Mathematics and Science.

The aim of the Khan Academy was to teach students not only the logic but the beauty of Mathematics and Science. The videos had to be helpful to pupils studying a subject for the first time, for adults who want to refresh their knowledge and for students needing extra help with homework (Khan, 2015:7).

Distributing knowledge through computer-based instruction:
The Khan Academy believes that through lessons and exercises that have been pre-recorded and can be accessed on a computer, valuable class time can be freed up. Traditionally these lessons were and still are used to "broadcast" knowledge to students. Pupils listen passively and there is not an effective way that the teacher can know who comprehends and who does not. Khan argues that if the students have done the lessons beforehand they can discuss it in class with greater opportunity for exchange. A teacher's role is also changing from rote lecturing to inspiring, mentoring and providing perspective. **Computer-based lessons can help teachers to do more teaching by freeing up time for the classroom to become a workshop (Figure 2.4) with interaction and mutual learning instead of the traditional passive sitting** (Khan, 2012:35-36).

The South African Department of Education is moving towards paperless schools by supplying goverment schools with tablets starting in grade 8 and 9 as the first phase. The department have developed a digital learning system (Matshediso, 2014).

Tablets are interactive, light weight devices. They enable students to carry all their learning materials at once. Learners have access to all the apps, e-books and software they need (Pilane, 2015).

By providing students with tablets and giving them access to digital learning students are enabled to take learning into their own hands and to research topics that interest them (Figure 2.5).

2.2.5. Timeline of Educational Theories

Figure 2.7 Before Dewey (Unknown)
This photo is estimated to have been taken between 1900 and 1910 in an American School

Figure 2.9 John Dewey's progressive/experiential classroom

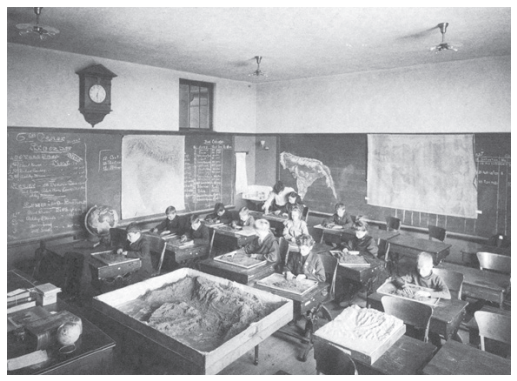


Figure 2.10 John Dewey's progressive/experiential classroom

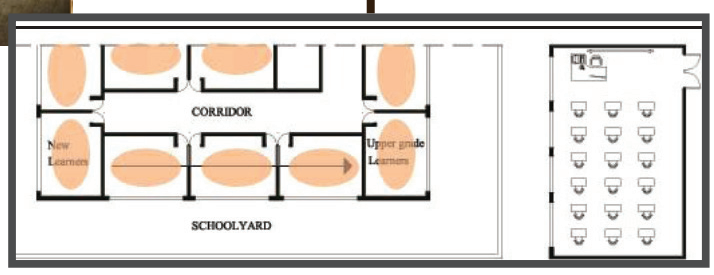


Figure 2.6 Diagram of behaviourism classroom (Guneya & Selda Al, 2012)

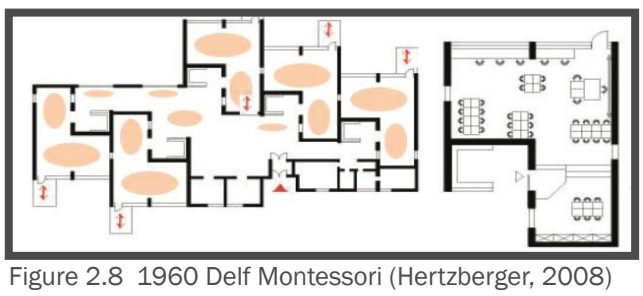


Figure 2.8 1960 Delf Montessori (Hertzberger, 2008)

1840
Horace Mann

1906
Maria Montessori
Casa dei Bambini

1922
John Dewey
Progressive Education

1919
Rudolf Waldorf

1952
Jean Piaget

1790-1810	1870	1913	1950	1960

Prussian model

Free compulsory education

The birth of a public education systems

An industrial-age factory model of education. Around the world public education systems started with the purpose to meet the needs of Industrialism. Subjects were placed in a hierarchy of the most useful subjects firstly for work and secondly for academic ability. The whole education system around the world is a protracted process of university entrance. Universities designed the system in their image (TED Talk, 2013).

Behaviorism
(Edward Thorndike & John Broadus Watson)

In the behaviourism movemnet learning was based on stimulus-response-reinforcement associations, Students learned trough drill and practice (Hannafin and Land, 1997: 172).

Cognitivism
(Ulric Dick Neisser)

Cognitivism was concerned with the processes of learning. Students learned by arranging a slection of stimuli into meaningful units. They were thought to retrieve and use skills and knowledge, connecting new with existing knowledge. (Hooper & Hannafin, 1991).
This information-processing theory led to a shift from the external, behavioural conditions of learning to a system that became more aware of the underlying processes involved in selecting, encoding, and retrieving (Hannafin and Land, 1997: 172-3).

Figure 2.12 Vittra School, Södermalm (Wendt, 2012)

Figure 2.13 Vittra School, Södermalm (Wendt, 2012)

Figure 2.14 Vittra School, Södermalm (Wendt, 2012)

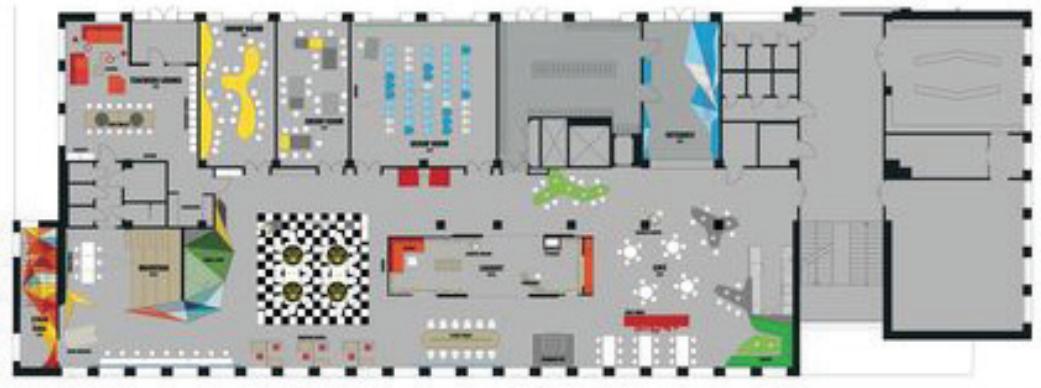
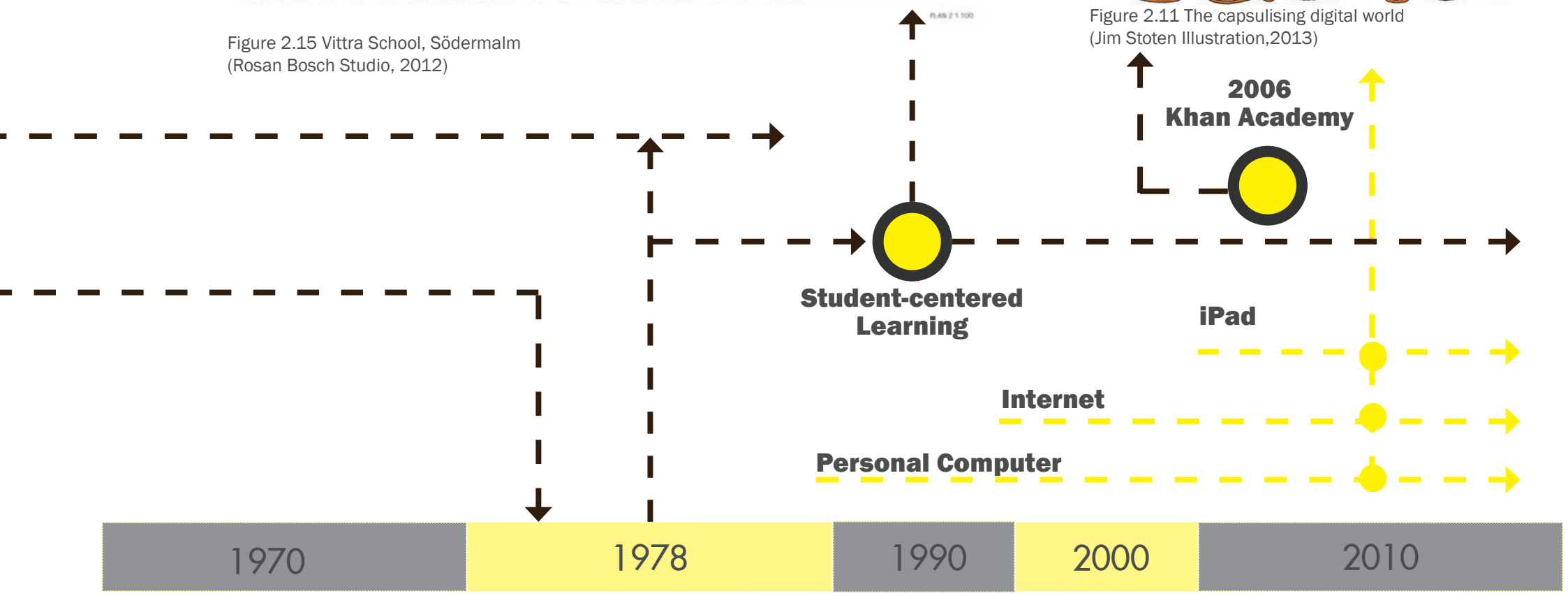


Figure 2.15 Vittra School, Södermalm (Rosan Bosch Studio, 2012)

Figure 2.11 The capsulising digital world (Jim Stoten Illustration,2013)



Social cognitivism theories focused on the relationship between context and knowledge. The socially-mediated dimension of learning and how social context influenced understanding became the focus (Young & McNeese in Hannafin and Land, 1997: 172-3). It was belived that the context in which a student formed meaning of knowledge played an integral part in the understanding. Thus knowledge isolated from contexts has little productive value. It became important for learning to happen in a contextually-rich enviroment with authentic experiences (Hannafin and Land, 1997: 172-3).

Contemporary constructivism evolved from the theories of Piaget (1952) and Vygotsky (1978). Constructivists believed that knowledge is not fixed or external. They say that it is individually constructed.

Students form an understanding through experiences. Student-centered learning environments emphasise real experiences that enable students to construct individual meaning. Today many contemporary learning systems are based on constuctivism (Hannafin and Land, 1997: 172-3).

.

2.3. Spatial Theories

2.3.1. The School as a Micro-City

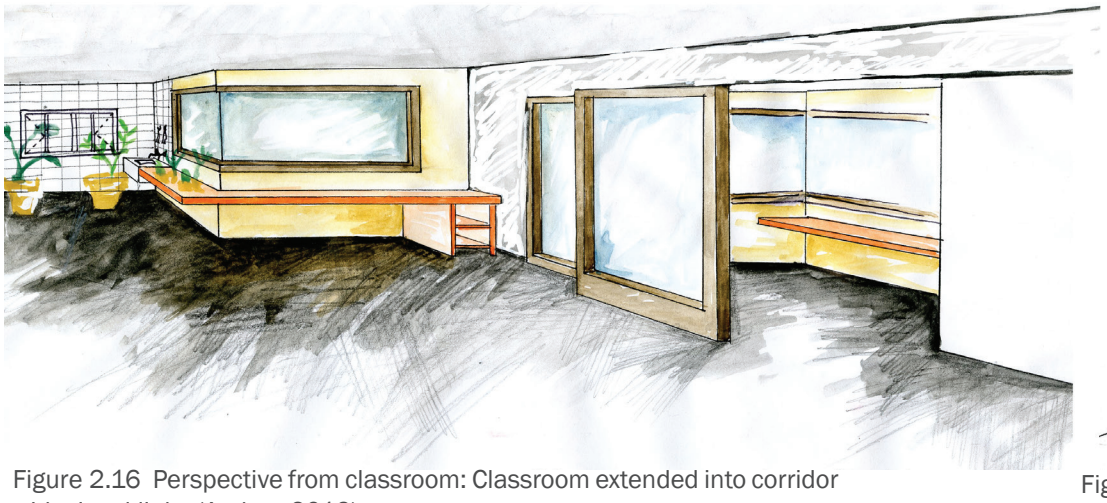


Figure 2.16 Perspective from classroom: Classroom extended into corridor with visual links (Author, 2016).

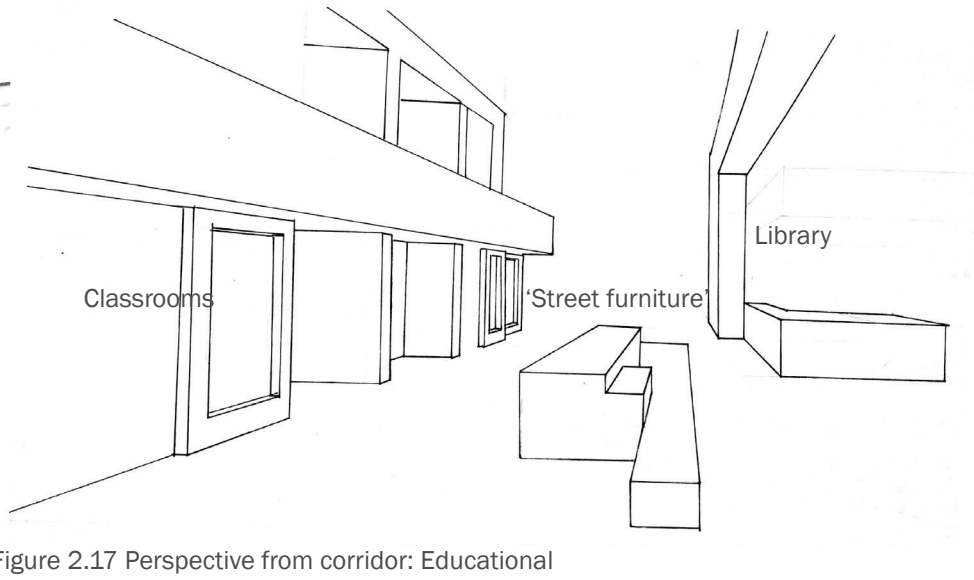


Figure 2.17 Perspective from corridor: Educational shopping street (Author, 2016)

"We must make buildings in such a way that they are an incentive for people to undertake activities." Herman Hertzberger (2008)

For many pupils, school is their second home and for some even their first (Hertzberger, 2008:69). **The progressive educationalist believed that it is the school's job to achieve learning in its widest sense.** Unfortunately schools with their minimal spatial programs are not designed to achieve the progressive ideals. Ambitious pedagogic ideals are often not realised due to the penny-pinching reality. Tight budgets result in schools that consist of **classrooms of minimal size with no flexibility** to practice something outside of the traditional study program. Hertzberger (2008: 68) argues that it is these spatial limitations that **prevent a broader learning program.**

Times are changing and so is the spatial requirements of schools. **Computers are changing education and the spaces in which education happens.** The amount of stimuli in the modern world causes distraction, loss of concentration and motivation. **Schools are now competing against the internet and television.**

Complicated situations at home are changing the needs of pupils at school. School, to some, has become their safe space. These elements call for new spatial conditions (Hertzberger, 2008: 69).

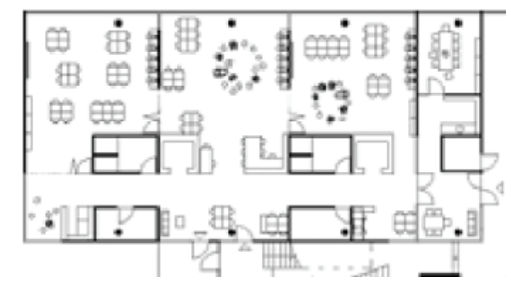
The educational facilities of the middle ages were collections of teachers and students that were attracted to these facilities because of what they had to offer. **Universities were market places of ideas, people shopped around town for ideas and learning that was applicable to them** (Alexander et Al, 1977:232).

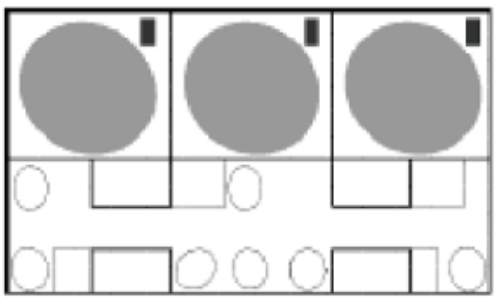
Schools should be more adaptable and have more open forms. Architects should search for a new form of learning space that **enables a wider range of experiences like that found in a city and on the internet** (Hertzberger, 2008:69).

To achieve an **educational shopping experience** (Figure 2.17) the physical and social environment of a school should encourage freedom of thought and individuality. The school environment should allow the student to find out for himself or herself what ideas make sense to them. The school setting should expose the student to a variety of ideas enabling the opportunity for the student to make up his or her own mind (Alexander et al, 1977:232).

There is a shift to a more personal initiative in learning, thus there is a need for an environment that is more house-like, closer and less detached. **Pupils personalise schools with an array of drawings and models.** Thus a school's aesthetic is seldom what the architect had envisioned. Architects should design schools that allow for deviation, change and the unexpected, in order for a school to become like a city (Hertzberger, 2008:72). Alexander et al (1977:232) recall the image of a traditional market place where the stall owners have developed a speciality and students were attracted to them because of their genuine quality.

The site for this design investigation, Shift College, is an inner city school, the pupils either live in the city or commute from nearby townships. It is argued that by designing a school that resembles their everyday surroundings of a city or a





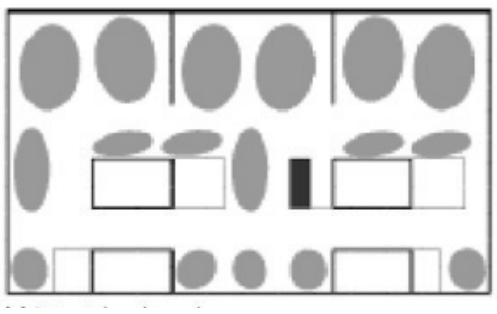


Figure 2.19 From adult-fronted to social learning (Hertzberger, 2008)

Figure 2.18 Experiential learning in a school (Hertzberger, 2008)

marketplace, the students should be able to relate better to their school environment.

The presence of others are what gives school spaces the most meaning (Hertzberger, 2008:69).

In South Africa people have diverse backgrounds and cultures, schools should have spaces where these pupils can interact with other students. Thus preparing them to interact with people from all walks of life when they leave school.

Architects need to counterbalance the individual attention of the computer and cell phone screen. Circulation spaces can be used to reconnect the student submerged in the virtual world. These spaces should become more relevant as social space in order to create the reality of community (Hertzberger, 2008:69).
The school environment should provoke exchange and confrontation, intellectually, culturally and politically, in order to give a more expansive view of the world. **Learning should not be restricted to the classroom walls but should claim the whole building** (Figure 2.20). Space can be used to show pupils and teachers possibilities, to inspire them and open them up for change. A school building should be able to change its contents, thus enabling it to function in changing situations (Hertzberger, 2008:69-70).

Schools should provide spaces that act as 'nests', **places that resemble shelters, the right size for individuals, as well as groups,** to imbed themselves in work. Students can still access the virtual world in books and on the internet but from the safety of these "nest" spaces. The space surrounding the 'nest' should arouse students' curiosity and encourage confrontation (Hertzberger, 2008:35).

Outside the classroom pupils come into contact with others busy with school activities which they are perhaps not ready for. These activities can have a magical galvanising effect on pupils (Hertzberger, 2008:46). **Access to ideas are facilitated by allowing the student to view into the window when he or she cannot access the door** (Alexander et al, 1977:101) (Figure 1.17). The students acquire insight into what there is on offer. This way pupils get a taste of what they are going to be confronted with later in their school careers (Hertzberger, 2008:46).

Hertzberger (2008:123) warns against a network of excessively long dark corridors where pupils walk past each other with no architectural language that encourages contact. Such spaces only manage to encourage pupils to become anonymous to each other. Nair and Gehling, in Harrison and Hutton (2014:85) insist that **long corridors do not function as good public space in schools**.

To Hertzberger (2008:123) architects designing schools should firstly strengthen spatial unity, and ensure clarity of organisation after which the smaller units that a school is made out of should be tied together as a coherent whole. These units can be compared to urban quarters and neighbourhoods which are tied together by their main roads and smaller network of streets, thus becoming an entity that is accessible to all (Hertzberger, 2008:123). **Successful public spaces have three important characteristics: the marketplace, thoroughfares and meeting places** (Gehl in Harrison and Hutton 2014:90). The marketplace in the school is where ideas can be exchanged. Thoroughfares encourage people to move, thus needing a destination on each end as well en route. Meeting places allow people to pause and chat (Harrison and Hutton, 2014:90).

Educational buildings that are structured as streets and squares in order to form a small city ensures that there is a great deal of social contact, confrontations, adventures, meetings and discoveries. **Pupils come into contact with a wider world, not just with those their own age** (Hertzberger, 2008: 123).

Interactive and collaborative leaning can happen in circulation spaces. Niches in corridors create cave-like spaces that aid in individual study and reflection (Harrison and Hutton, 2014: 85)

In order to encourage interaction in school buildings, storeys should be tied up through visual links (Figure 2.16), to prevent floors from becoming detached, isolated departments. A split-level can connect floors and voids. This makes a building legible and suggests continuity of space and thought. By increasing the height of ceilings over **circulation spaces,** their importance is emphasised and **when filled with natural light they resemble outside streetscapes.** By projecting vertically through the building, the building organisation becomes clear and the circulation becomes the main artery of the building. The internal traffic becomes visible to all (Hertzberger, 2008:124).

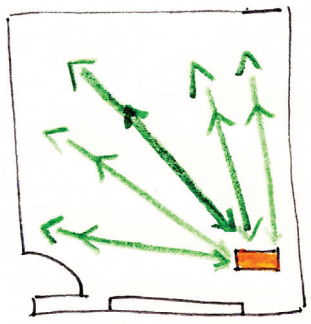


Figure 2.23 Traditional classroom

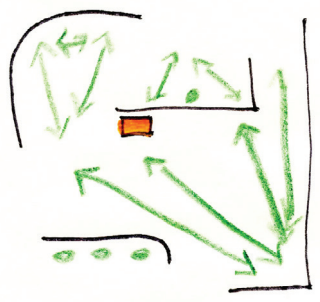


Figure 2.24 Articulated classroom

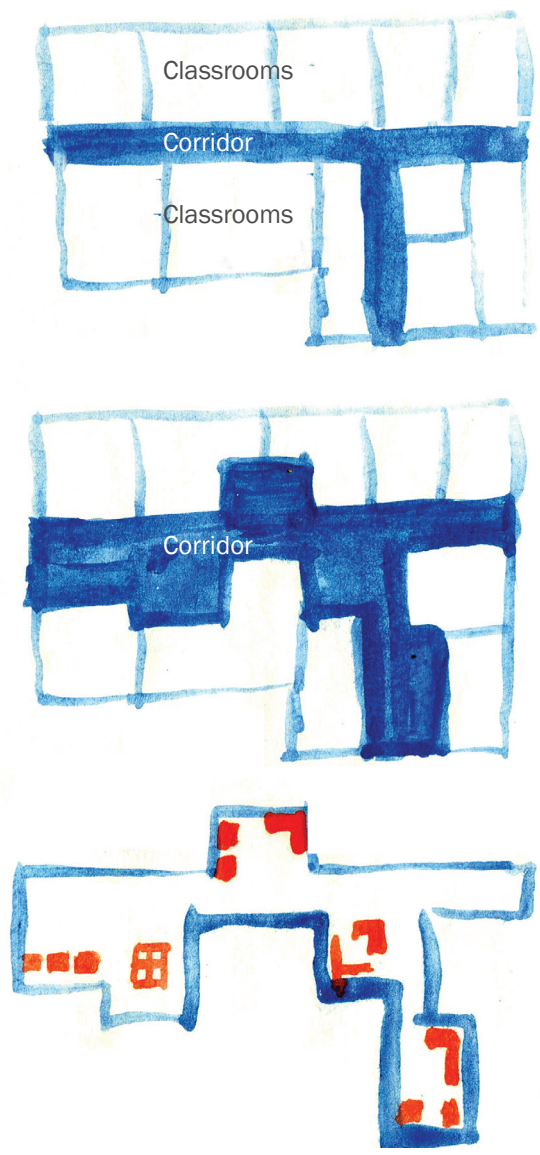


Figure 2.20 Plan diagram of transformation of long corridor into educational and social learning street

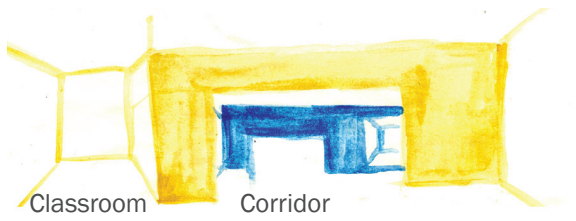


Figure 2.21 Perspective of classrooms claiming space from corridor

Figure 2.22 Sectional diagram of corridor spaces connection vertically

2.3.2. The Environment as Third Teacher

"There are three teachers of children: adults, other children, and their physical environment."- Loris Malaguzzi (in O'Donnell Cannon Design, Wicklund Pigozzi, Peterson, Architects Inc, VS Furniture., & Bruce Mau Design, 2010).

O'Donnell et al (2010) view space as the third teacher and compiled 79 design principles to guide the design of interior space so as to enhance learning. In the following section, selected principles are investigated and aligned with the educational theories previously discussed.

- **The environment can enhance learning by providing the necessary basic spatial requirements needed for different ways of learning to take place.**

Spaces should be designed for speech and hearing. Classrooms must have acoustic qualities that enhance the audibility of words, achieved by a quiet background and by controlling reverberation. Young pupils have smaller vocabularies compared to adults. This makes it difficult for them to fill in words and syllables that are not heard clearly (O'Donnell et al, 2010: no. 8). Increased daylight in interior spaces helps to cut down on absenteeism and to improve test scores (O'Donnell et al, 2010: no. 9).

- **Locations of learning activities can change**

This enables students to explore concepts in different environments (O'Donnell et al, 2010: no. 10). These environments can be formal learning spaces, or an open auditorium-type space, or even a cul-de-sac could be utilised for this. Open auditorium-type spaces become demonstration spaces visible from the main circulation route encouraging passersby to stop and engage (Figure 2.27). Cul-de-sac spaces are also visible from circulation routes taking up the space of a classroom, they serve as hubs for informal learning activities (Figure 2.30). These spaces contain flexible furnishings and collaborative technology. They catch and accommodate the spillover pre-class and post-class as well as class activities (Harrison and Hutton, 2014: 143). Teachers should be freed from the desk at the front of the classroom and new settings for teaching and learning should be encouraged (O'Donnell et al, 2010: no. 12).

- **Pupils in the act of learning should be displayed**

This enables them to track progress (O'Donnell et al, 2010:15). Open auditorium-type spaces can be used to display student data and presentations (Harrison and Hutton, 2014: 143). By displaying student work, pupils from lower grades know what is to come and what is expected from them in the future. Displays encourage peer review and assistance.

- **Schools should emulate museums**

When an environment, classroom or museum, is rich in evocative objects it stimulates active learning by allowing pupils to pick what they want to engage with (O'Donnell et al, 2010: no16). Students can design in-school museums, this enhances their creativity and broadens their own as well as their peers' knowledge. Pupils can learn through project-base learning by designing exhibitions for a wide range of topics. Exhibition-based projects can work in any school, scholars can share important topics to their peers and community. School museums combine creative and academic learning and they connect students with their community (D'Acquisto, 2013). **By creating schools that emulate museums and Science centres, the planes and elements that the space is made out of can have an informal learning quality as well as a space defining function.**

- **Informal learning achieved through revealing how stuff works.**

A school's infrastructure can become exposed, to display all the usually hidden flows of water and waste and so pupils are taught the workings of the real world (O'Donnell et al, 2010: no42).

- **Cross-pollination of Art and Science**

The 79 design principles of Cannon Design, VS Furniture and Bruce Mau Design (2010) reiterate the theories of Frank Oppenheimer (Hein,1990): **Art and Science need each other. Thus it is essential that students have a place for cross-disciplinary work** for their minds to flourish (O'Donnell et al, 2010: no18). Connections should be drawn between traditionally separated subjects to honestly represent them as they exist in the real world.

- **The outside should be brought inside**

The community, the landscape, and faraway places should be represented in the classroom through visuals and objects that call them to mind (O'Donnell et al, 2010: no19). By curating, displaying and demonstrating on everyday objects concepts can be related back to the outside world.

- **Studios, workshops and laboratories**

Students of all ages need a place where they can be hands-on. These spaces enable them to learn through touch, manipulating and making things with their hands (O'Donnell et al, 2010: no54). Cognitive development can be enhanced by providing places where pupils can test new skills (O'Donnell et al, 2010: no13) (Figure 2.25). By allowing students time and space where they can choose what they want to learn can illuminate their individual intelligences (O'Donnell et al, 2010: no14)(Figure 2.26). **Studios, workshops, and laboratories should be provided where pupils can translate theory and test them on practical applications** (O'Donnell et al, 2010: no72). Maker-spaces can help to achieve this. **A makerspace is a Science lab, Computer Study lab, Woodwork room and an Art room all at once.** It should accommodate a wide range of activities, tools and materials enabling cross-pollination of activities that are necessary for the design, making and exploration process (Cooper, 2013).

- **Furniture can enhance learning**

Furniture and classrooms should absorb growing bodies, and allow for fidgeting, twisting and movement (O'Donnell et al, 2010: nos. 20 ,21 ,22). **Classrooms should be agile and able to be reconfigured easily for different kinds of learning** (O'Donnell et al, 2010: no. 23).

- **Technology enhances the learning capabilities in a space and can enhance how space can act as a teacher.**

Expand learning beyond the classroom's four walls. Classrooms should have the capacity to link into virtual learning opportunities. Install technology that simulates the real world. The environment should allow teachers to adapt their methods as technology changes. **Students should have laptops and places where they can be unplugged and still connected** (O'Donnell et al, 2010: no73-75 & 77).


Figure 2.25 Science lab, International School of India by Cannon Design


Figure 2.26 Scocial Learning Spaces, International School of India by Cannon Design


Figure 2.30 Group work spaces, International School of India by Cannon Design


Figure 2.27 Open Theatre, North Shore Country Day School by Cannon Design


Figure 2.28 Social Learning Space, North Shore Country Day School by Cannon Design


Figure 2.29 Learning Landscape, Hamilton South Eastern School District Senior Academies by Cannon Design

2.4 Conclusion

The time has come to transform educational buildings, the form of which was derived to facilitate traditional teaching. The physical environment can enhance learning by encouraging different ways of learning. Space can act as a teacher through informal learning.

Classrooms should be designed to encourage adaptation for different tasks. Students do not have uniform needs and do not flourish in the same type of spaces. This can be overcome by designing spaces that cater to both individual needs as well as that of the group's needs. The physical environment should encourage active learning. Interior spaces should have a student-centred approach. Users should be able to manipulate space for their needs.

By arranging classrooms and facilities in such a way that they better relate to and connect with each other students can be stimulated to draw connections between subjects. To form a more holistic view of the physical world, the compartmentalised perspective of subjects and themes can be broken down through spaces that blur the boundaries.

Schools should provide the basic facilities needed to enable learning but they should also be able to adapt to changing needs. Schools therefore need a new set of facilities, add-ons, where students can take their traditionally taught material and explore, interact and adapt these into innovative ideas and understanding. Thus grounding concepts in self-experienced, real life situations that clarify the relevance of what they have learned.

Students are training to become citizens in towns and cities. By designing schools to resemble a city students become more prepared for the situations that they will encounter after schooling.