

**An exploration of design thinking and its potential implications
for problem-solving skills for grade 7 senior phase learners.**

by

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I declare that **An exploration of design thinking and its potential implications for problem-solving skills for grade 7 senior phase learners** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references. I also understand what plagiarism entails and am aware of the University's policy in this regard. I did not make use of another student's previous work and submitted it as my own.



Karen Rabie

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Chapter 1: Introduction

1.1 Background and problem statement

The complexity of the world's escalating problems, such as the effects of global warming, increasing globalisation, growing scarcity of food, water and energy resources, fast-changing technological advances and, in South Africa, a flawed education system and high unemployment, means that we need to develop relevant thinking skills that might equip the new generation to develop suitable solutions. It is more and more important for learners to develop skills whereby they can respond flexibly to complex problems. As schools are the only compulsory place for learners to develop creative meta-competencies, it is crucial that they develop the necessary skills while still at school (Sheer, Noweski & Meiner at the Hasso Plattner Institute 2012:8). Essential for innovation are a diversity of perspectives and ideas on complex problems, and the ability to communicate effectively and manage information in teams to produce new knowledge with diverse solutions (Carroll, Goldman, Britos, Koh, Royalty & Hornstein 2010:38).

In South Africa, the implementation of Outcomes-based Education (OBE) in 1997, the changing of this to the Revised National Curriculum Statement three years later, and the introduction of the Curriculum Assessment Policy Statement (CAPS) in 2011 have caused much of the instability and fluidity that now characterise the South African educational landscape (Schäfer & Wilmot 2012:42). Professor Kobus Malan, from the University of Pretoria's Faculty of Education, mentions that the complex and multifaceted educational transformation in South Africa has plunged the science of education into a paradigmatic crisis (Malan 2000:26). Government schools are now relying on standardised teaching, time allocation to subjects, weighting of study areas and standardised assessment, as seen in the CAPS Creative Arts senior phase document for grades 7–9 (South Africa. Department of Basic Education 2011:9-10, 21-22, 63-68). The latest development of the diagnostic systemic evaluation tool of Annual National Assessments (ANA) further complicated the South African schools' task of guiding students to find the correct answers. This tool has unfortunately evolved into a content-based test, with results being used to "label and punish" schools and districts in relation to performance. This labelling has changed the way in which schools and teachers perceive the ANA; in 2014 and 2015 schools started "teaching the ANA tests" to the detriment of the curriculum (Naptosa 2015).

Professors Kobus Lombard and Mary Grossner (2008:25) from North-West University argue that all of these changes restrict creative thinking and critical thinking skills. Manfred Max

Bergman and Zinette Bergman (2011:135) point out that South Africa's primary and secondary schools perform poorly even in comparison with other African countries.¹ For example, Grade 8 learners had the lowest score out of 46 countries in Mathematics and Science in 2004 (Bergman & Bergman 2012:S35). Myburgh and Prince (2014) comment in *Rapport* newspaper on the problem of mathematics and science among the grade 12 learners' pass results. The article states that according to the South African Institute of Racial Relations, the percentage of learners passing with a 70% and above dropped from 8.3% in 2008 to 5.9% in 2013. Furthermore, the fact that more and more learners choose Mathematical Literacy, which does not prepare them for scientific studies, adds to the seriousness of the problem (Myburgh & Prince 2014). Mtshali (2014b:sp) reports that the World Economic Forum rated South Africa's state of mathematics and science education as the worst in the world. The report assessed 148 countries, out of which South Africa was ranked number 148. The Department of Education responded by saying that the report was based on opinions or perceptions of selected executives (Mtshali 2014a:sp).

Lombard and Grossner (2008:561) explain that one of the main goals of the educational system nowadays should be to develop critical thinking skills. Sonn (in Lombard and Grossner 2008:572) states that "much of today's classroom learning is focused on activities by which the learner acquires facts, rules and action sequences, and the majority of lessons require outcomes only at the lower levels of cognition: knowledge, comprehension and application". Results of the research by Lombard and Grossner (2008:572) show deficiencies in critical thinking ability among the research participants, a heterogeneous group of 117 first-year education students enrolled for a B Ed degree. The research indicates that learners need to become much more aware of their own learning, think independently from their teachers, and learn to think critically, to derive their own patterns of thought and meaning from the content presented to them, and to go beyond the content of their textbooks, reflecting and interpreting their knowledge and taking risks in the process of learning. It is such findings that highlight the need for the research that is being undertaken here.

¹ Bergman, Bergman and Gravett (2011) developed a systematic framework for conceptualising, analysing and testing dysfunctions in schools (Bergman & Bergman 2012:S35).

In discussing this very problem, Swee Hong “David” Kwek (2010:1) argues that the “cultivation of a broader set of skills and dispositions beyond core content knowledge is critical, and learners merit the investment of more time in the classroom”. He quotes McWilliam’s view that “the message from the work place is a compelling one: Our learners will not be working on routine information seeking and routine problem solving; they will forge new, dynamic relationships and tackle novel challenges with sophisticated technology” (Kwek 2010:3). It is clear that these new contexts and challenges require new twenty-first century competencies and skills (Owen 2006:25; Kwek 2012:8). Mtshali (2014b:sp) reports that employers worldwide say they cannot find the skills in the workplace.

One way of developing problem-solving skills in various disciplines, especially with regard to those ‘wicked problems’ that fall beyond pre-tested paradigms, is the current use of design thinking as a process. Tim Brown (2008:86), CEO of IDEO, a global design consultancy, argues that the approach of Thomas Edison (1847–1931) was an early example of the use of design thinking, “a methodology that imbues the full spectrum of innovation activities with a human-centred design ethos”. Design thinking has developed and is being applied in all areas of life to generate new products, services, business models, and in education.

Integrative and collaborative work is integral to design thinking (Brown 2008:86; Caroll *et al* 2010:41). The need for integration and collaboration arises from the increasing complexity of people’s lives. Products, services and problems surrounding these issues can be better solved by interdisciplinary work, using the input of many disciplines and collaborative work for the best possible solutions. Design thinking has been used with great success in collaborative projects such as the development of the coasting Shimano bicycles. IDEO was invited to collaborate in the project and the interdisciplinary team launched a human-centred research approach. Brown (2008:90) explains that the application of design thinking at the earliest stages of innovation led to the complete solution; the team dealt with feelings of intimidation by American consumers by designing a simple type of coasting bicycle. These bicycles helped Americans reconnect with their happy childhood memories, and at the same time opened up a huge untapped market.

A deeper understanding of users’ needs and empathy towards them is critical to provide a more effective product outcome, as can be seen by the development of the OXO Good Grips range of products for users with arthritis by Dan Formosa (McDonagh & Thomas 2010:462). Another example that clearly shows the importance of an empathetic approach to solve

complex problems is India's Avarind Eye Care Centre, providing both preventative care and diagnostic screening (Brown 2008).

Continual reflection throughout the problem-solving process, as used by design thinking, is crucial to developing a preferred solution out of many possible solutions, and being able to change and test the design throughout the whole design process. Donald Schön describes the process as reflection *in* action and reflection *on* action, where the designer changes and develops the design with the increase of knowledge and understanding (Schön 1983:280). These concepts are discussed in more detail in Chapter 2.

Against the background of the problems in South African education, and the need for learners to be equipped with problem-solving skills, the research questions for this study focus on the possibilities of design thinking as an approach in a South African classroom, and the potential of design thinking tools and methods a teacher could use at school level.

1.2 Aims and objectives

The aim of this study is to explore the use of design thinking skills and their potential implications for developing problem-solving skills in learners.

The objectives of this study are:

- To determine the characteristics and methodology of design thinking suitable for school learners
- To determine an approach to experimenting with design thinking as a general² skill in a real-life school situation
- To investigate the possibilities of using design thinking in a school situation
- To reflect on, interpret and evaluate the outcomes of the project.

1.3 Research methods

The first and second objectives of this study are theoretical in nature and based on a literature study. The purpose of these objectives is to identify and explore selected concepts in order to determine a working framework for the practical part of the study. Authors such as Buchanan (2001), Lawson (2006), Brown (2008), Owen (2006) and Cross (2011) have been

²General design-thinking skills include all possible areas of design thinking as described by Buchanan (Van Zyl 2008:1): communication (signs and words); construction (things); strategic planning (action); and systemic integration (thought). This then includes all areas in design such as art and design, technology and objects, management, education, and planning of systems, as a general approach to problem solving and innovation, not limited to or exclusive of the solving of design problems.

identified as seminal sources. The researcher explored design thinking and the characteristics and methods thereof, specifically looking at how selected studies apply design thinking methodology to arrive at some unique solutions in various disciplines other than design (such as business and education). The outcome of this part of the study was not to cover the entire scope of literature currently available on design thinking, but through purposive selection to provide a functional platform and approach to the rest of the study.

The third objective was to investigate the possibilities of design thinking in a school situation; therefore a practical approach was selected: to explore a design-thinking process in a real-life classroom situation. Data collection would be done using qualitative, action-research methods with a group of learners. Qualitative research is based on a naturalistic approach that seeks to understand phenomena in context (or real-life settings) (Maree 2007:78). It focuses on describing and understanding phenomena with an emphasis on the quality and depth of information (Maree 2007:51). As the research was to be conducted on a relatively small group of learners in a real-life situation, this method was well suited to this research.

Participatory action research is strongly collaborative and requires the participation of various participants, in this case school learners, as part of the research. Action research often involves continuous reflection, followed by action, in turn leading to reflection. (This is also one of the design thinking skills.) The researcher focuses on a practical problem experienced by participants, for which a practical solution is sought. It requires an understanding of the context and possible solutions to the problem. (The learners in this case became participants in carrying out the research, while the researcher acted as mediator and facilitator to help participants plan and implement the project.) Thereafter evaluation is done based on existing data to determine the effectiveness of the research (Maree 2007:74, 136).

The design-thinking model of Lawson (2006:291) was put into practice by guiding the learners through the process: formulating (identifying the problem and different perspectives, as in brainstorming); representing (using different ways of representing and the 'conversation' between the designer and the representation); moving (changing design because of reflecting); evaluating (knowing when to evaluate or even suspend evaluation); and reflecting (reflection on action and in action) (Lawson 2006:292-301). Lawson's model (2006:291) was expanded with other models such as that of Brown (2008:88-89). The steps of design thinking as used by Brown (2008) include: 1) the collaborative, integrative aspect of design thinking, using brainstorming as part of the starting point of the project; 2) the need to think in a human-centred, environmentally friendly way; 3) applying the use of prototyping

and sketching as one of the important aspects of design thinking; 4) the necessity to reflect while working and consider the possibility that the design can change during the process; 5) the final evaluation of the participants' work. The model of Dr Maureen Carroll and others, on the other hand, starts the design thinking process with 1) a point of view; 2) observing; 3) understanding the problem; 4) ideating, 5) prototyping and 6) testing. Brown and Carroll *et al's* models are discussed in more detail in Chapter 2.

The group chosen for participating in the research project consisted of 25 grade 7 learners from Halfway House Primary School in the Midrand area. The learners at the school come from various cultures and different social and economic backgrounds, and include male and female learners and different academic levels. The group consisted of learners interested in art, who were already involved in the art club, participating in a variety of projects. These learners already involved in the art club knew the researcher, and had also already set aside some time for art club. Selecting the art club learners enabled the research to be conducted outside formal school times and therefore it did not interrupt the normal school programme.

The research methodology is explained in more detail in Chapter 3.

1.4 Rigour and credibility

The criteria for qualitative research are credibility, transferability, dependability and conformability (Koonin 2014:252-253, 258-260). Credibility refers to the accuracy of the process; transferability is the possibility of generalisation, or using a similar approach in other or similar circumstances; dependability refers to the research process and integration of data; and confirmability concerns how the data flows, and whether other researchers, using the same material, would come to the same conclusions. All these factors contribute to the trustworthiness of the study (Koonin 2014:252-253, 258-260). In the final chapter this study will be evaluated against these criteria. The research design was compiled keeping these criteria in mind. Other similar studies were also consulted as examples in the research.

1.5 Research ethics

Participants and their parents were requested to sign a letter of consent, explaining the reason for the research and the procedure to be followed (see Appendix C for example of letter). The participants granted their consent to use their work, and were asked to state whether they could be identified either by name or image, or whether they wanted their identity to remain confidential. The letters of permission to use the photographs of their work and themselves were signed by the learners and their parents. No one requested to remain

confidential. The researcher received approval from the Ethics and Research Committee in the Faculty of Humanities at the University of Pretoria to conduct this research. Permission was requested from the Head of Halfway House Primary for the learners to participate and this was granted (See Appendix C for example of this letter).

Materials regarding the workshops are archived, according to requirements of the Department of Visual Arts, for 15 years.

1.6 Structure of this document

Chapter 1 provides the problem statement of this research in education worldwide. This is then narrowed down to a South African education point of view, posing the question of whether the education system in SA is preparing learners with the necessary problem-solving skills to enter the demands of the workplace and the general demands of the 'wicked problems' experienced in our fast-changing twenty-first century world. The chapter discusses the aims and objectives and the rigour and credibility of this research.

Chapter 2 defines design and introduces the nature of design thinking in general as found in design thinking discourse; design thinking in other disciplines, and the two main perspectives on design thinking: the IDEO and Stanford approaches and the implementation of design thinking in these two mainstreams. This research focuses on the Stanford approach on preparing learners in primary schools to use design thinking to develop more problem-solving skills. The chapter then discusses some design thinking research at schools, and the different intelligences of learners, as researched by Prof. Howard Gardner, as a holistic approach.

Chapter 3 discusses and presents an application of design thinking done at a school with the introduction of the problem statement of environmental art from a conservation point of view to produce works of art by manipulation of the natural landscape to the learners. Sustainable environmental art, which is produced with a consideration of the wider impact of the work and its reception in relationship to its environment, is emphasised. In this project, learners had to plan their own individual design to use as a control project. Thereafter they worked on the problem statement in groups, being introduced to design thinking skills and methodology on their prototype solutions and sketches and ideas, and developed much empathy for people and the environment within this specific problem. The chapter concludes with their final execution of their various groups' designs in a different medium.

Chapter 4 is an analysis and reflection of the researcher in a structured way, as the researcher observed the work of the learners while they worked and interacted with them, as

well as holding some formal focus group discussions with the learners at the end of the workshop.

In Chapter 5 the researcher discusses the outcomes of this research, the contribution to design discourse and research and the implications for design thinking in schools – particularly its potential for schools in South Africa. Finally the chapter discusses the limitations of this research, issues of rigour and the conclusions.

Chapter 2 The nature of Design Thinking

2.1 Introduction

This chapter provides some definitions of design itself, before discussing the nature of design thinking. We then consider the rising interest and use of design thinking in disciplines other than design, and its applicability to many other areas of life. As regards design thinking in education, two prominent perspectives on design thinking, those of Stanford and IDEO, are briefly explored. The chapter discusses some examples of design thinking research at schools using the Stanford approach, which is the method used by the researcher in this study. The chapter concludes with examples of how some researchers have successfully applied design thinking to the challenges in education in order to promote problem-solving skills and creative confidence.

2.2 Defining design

Before we can look at the nature of design thinking, we need to look at what design is. The very word *design* needs some defining, but the concept of design seems to be a remarkably supple one, with different descriptive and formal definitions (Buchanan 1992:18). Buchanan (2001:9) offers the following definition: “Design is the human power of conceiving, planning, and making products that serve human beings in the accomplishment of their individual and collective purposes”.

The origin of the word *design*, according to the Oxford dictionary, can be traced to its use in late Middle English as a verb in the sense 'to designate'. It came to English via Italian from the Latin *designare*, 'to designate', reinforced by the French *désigner*. Lawson (2006:4) points out that design is used as both a noun and a verb, and says that it can refer to either the process or the end product.

ico-D, an international council of design in Montreal, Canada, defined design during its general assembly on 18 October 2013 as follows (ico-D 2013:sp):

Design is a constantly evolving and dynamic discipline. The professionally trained designer applies intent to create the visual, material, spatial and digital environment, cognisant of the experiential, employing interdisciplinary and hybrid approaches to the theory and practice of design. They understand the cultural, ethical, social, economic and ecological impact of their endeavours and their ultimate responsibility towards people and the planet across both commercial and non-commercial spheres. A designer respects the ethics of the design profession.

2.3 The nature of design thinking

Design thinking has gained popularity over the past few years; since the first design thinking research symposium in 1992, multiple models have emerged, based on different approaches and using different theories from design methodology. Kees Dorst, from the University of Technology in Sydney, Australia, discusses the eagerness of other fields to apply design thinking practices to deal with complex and open-ended challenges in a variety of organisational problem-solving and innovation instances (Dorst 2011:521-522).

Tim Brown (2008:87,88) describes design thinking as “an approach that uses the designer’s sensibility and methods for problem solving to meet people’s needs in a technologically feasible and commercially viable way”. In other words, design thinking is “human-centred innovation”. He emphasises the creative, human-centred, holistic approach of design thinking and speaks about empathy towards people and a ‘people first’ approach (Brown 2008:87,88). Richard Buchanan (1992:12), a design researcher and seminal author, developed a design thinking matrix which he describes as the history of design thinking formed through encounters with new problems. He describes design in four broad areas, which he calls ‘orders’ or design thinking spaces. These are: communication (signs and words); construction (things); strategic planning (action); and systemic integration (thought). He then interconnects these with designer abilities, which are inventing, judging, deciding and evaluating. In an ever-changing world, faced with an increasing complexity of life, people need such adaptable problem-solving skills (Buchanan 1992:12).

Charles Owen (2006:17) says that design thinking is a way of thinking that parallels other ways of thinking – like science thinking – but offers a way of approaching issues, problems and opportunities almost uniquely suited to innovation. He explains that “design thinking is in many ways the obverse of scientific thinking”, and it is his view that the two complement each other. According to Owen (2006:1), design thinking is suited to the best interests of humankind and the environment. He says that knowledge is generated and accumulated through action. It becomes a cycle in which knowledge is used to produce works, and in turn these works are evaluated to build knowledge (Owen 2006:20, 26).

Brown (2008:87), like Owen, emphasises the acquiring of knowledge through the ‘action’ side in collaboration with the thinking side of design thinking, becoming able to understand strengths and weaknesses and to choose the best option for the challenge at hand. Closely related to the action part of design thinking is the importance of prototyping or sketching during the process. By making something visual, people learn about the strengths and weaknesses of an idea and are able to identify new directions that need to be taken (Brown

2008:87). Lawson (2006:297) calls this a dialogue between the sketch or prototype (visualisation process) and the designer. Schön (1983:280) discusses the importance of reflection-in-action and the fact that doing and thinking are complementary.

Integrative and collaborative work is integral to design thinking (Brown 2008:86; Caroll *et al* 2010:41). The need for integration and collaboration arises from the increasing complexity of people's lives. Products, services and problems surrounding these issues can be better solved by interdisciplinary work, using the input of many disciplines and collaborative work for the best possible solutions.

Design thinking has been used with great success in collaborative projects such as the development of the coasting Shimano bicycles. IDEO was invited to collaborate in the project and the interdisciplinary team launched a human-centred research approach. Brown (2008:90) explains that the application of design thinking at the earliest stages of innovation led to the complete solution; the team dealt with the fact that adults felt intimidated by riding bicycles, by designing a simple type of coasting bicycle. These bicycles helped Americans reconnect with their happy childhood memories, and at the same time opened up a huge untapped market.

Lucy Kimbell, who teaches design practice to MBA students at the University of Oxford, argues that it is not well understood just what design thinking is supposed to be, and that the critical rethinking of design thinking in design discourse has only just begun (Kimbell 2015:288).

As can be seen in Figure 1 by the example of the design thinking model of Brown, it is not a linear process but remains fluid and loops back to the different phases as the process develops according to the developing needs and growing insight of the design. The fluidity of this process can also be seen in some other models in Chapter 2, as well as in the researcher's own model in the last chapter.

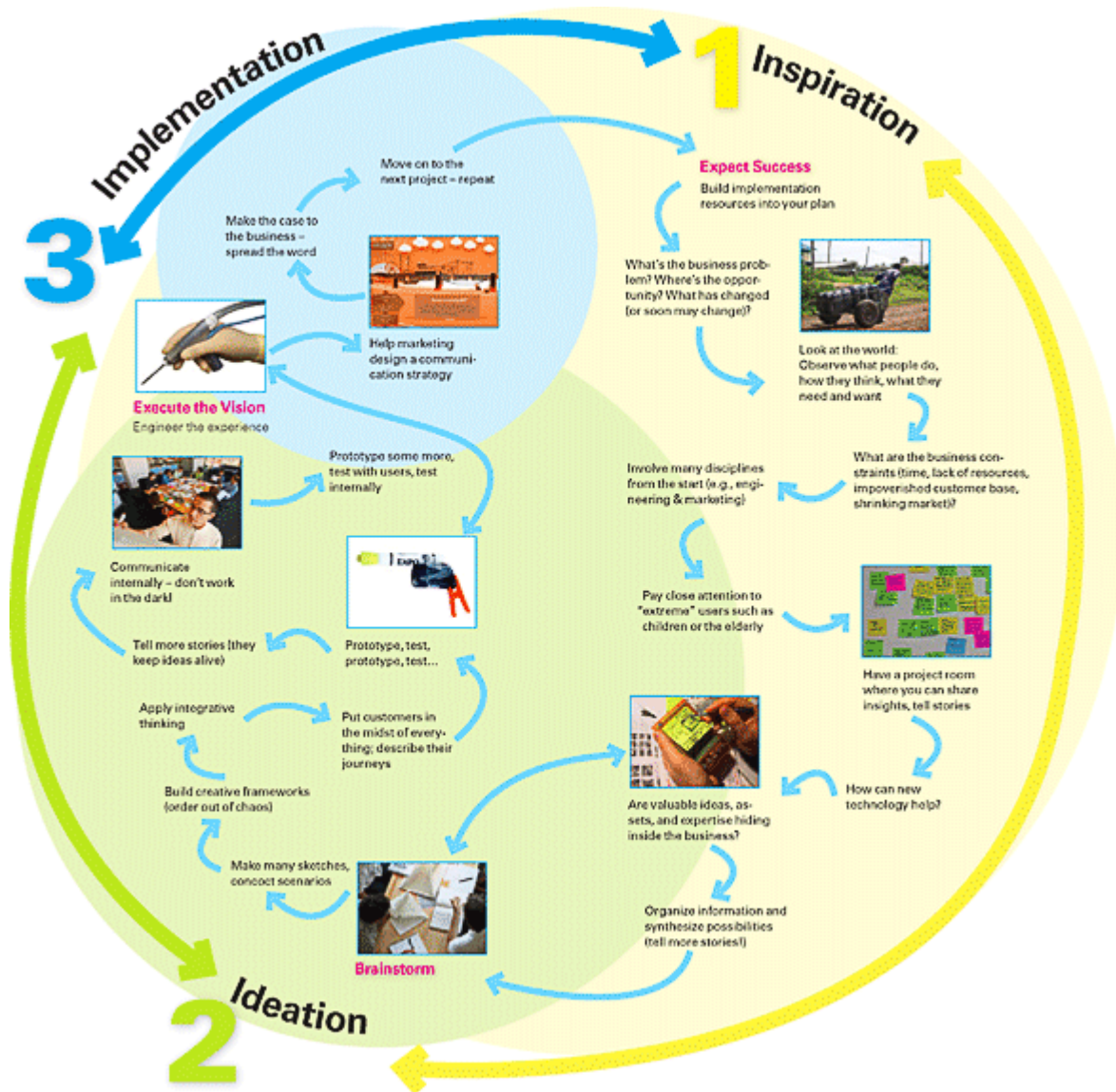


Figure 1 Tim Brown's design thinking process (Brown 2008:88)

According to Brown, design projects must ultimately pass through three spaces (see "Inspiration, Ideation, Implementation"). These are labelled "inspiration," for the circumstances (be they a problem, an opportunity, or both) that motivate the search for solutions; "ideation," for the process of generating, developing, and testing ideas that may lead to solutions; and "implementation," for the charting of a path to market. Projects will loop back through these spaces – particularly the first two – more than once, as ideas are refined and new directions taken.

2.4 Design thinking applied to other disciplines than design

Design thinking has developed and is being applied in many areas of life to generate new products, services and business models. Brown says, “Thinking like a designer can transform the way you develop products, services, processes – and even strategy” (Brown 2008:85).

In recent years there has been an upsurge of interest in design thinking in design discourse. As previously mentioned, Buchanan’s development of a design thinking matrix is a seminal source in which he describes the history of design thinking as it encounters new problems (Buchanan 1999:12). Research done by authors in design discourse, where design thinking is used in the creative industries and many other areas, is also important for this study because design thinking has the potential to enhance many aspects of human life.

Lawson (2006:234) is of the opinion that a certain degree of design thinking is naturally practised by everybody. He says that people are all actually practising design in their daily lives by choosing what to wear (fashion designers), deciding how to decorate their homes (interior decorators), planning their gardens (landscape architects), even planning and organising their time and many other activities (Lawson 2006:234). Brown (2008:87) also believes that many people outside the design profession have a natural aptitude for design thinking, which the right development and experience can unlock. Nigel Cross (1998:25) comments that designing is something that all people do; something that distinguishes humans from animals, and (so far) from machines. The ability to design – as the ability to conceive, plan and realise products that serve the individual and collective purposes of people (Buchanan 2001:9) – is a part of human intelligence. This natural ability to design has a long history, evidenced by artefacts of previous civilisations and traditional craftwork done by children as well as adults. It therefore seems that design thinking can be developed by teaching and learning the process.

Authors such as Brown of IDEO and Tony Golsby-Smith have successfully, and with much confidence, implemented design thinking skills in several situations. Brown (2008) cites India’s Avarind Eye Care Centre, providing both preventative care and diagnostic screening, as one such example. Brown says that breakthroughs of ideas are inspired by a deep understanding of consumers’ lives. He also says that sometimes innovations have to account for vast differences in cultural and socioeconomic conditions (Brown 2008:90-91). This project included the rural poor population and enormous unmet needs. The company discovered that, using relatively inexpensive technology from its own manufacturing plant, it

could produce intraocular lenses (supplied by other suppliers for \$200 a pair) for \$4 a pair. Avarind has consistently exhibited many characteristics of design thinking and built a systemic solution to a complex social and medical problem (Brown 2008:90-91).

A practical application of design thinking was made by Golsby-Smith, when he used the four orders described by Buchanan and applied them in a practical way to Australia's Tax Law Improvement Project. He describes where each of these orders of signs and words (communication), construction (things), strategic planning (action) and systemic integration (thought) fitted into the Tax Law Improvement Project, and how each of these orders influenced this project (Golsby-Smith 1996:5–25).

Dan Formosa, one of the founders of SMART design in New York, participated in the development of OXO Good Grips range of products for users with arthritis, which were enthusiastically received and used by many other people (McDonagh & Thomas 2010:462). McDonagh and Thomas (2010:458) cited this approach of Formosa in the research they did on empathy in the development of innovation. They discuss some examples of products that provide a positive user experience that can empower people and contribute to a healthful environment, reasoning that a deeper understanding of users' needs and empathy towards them is critical to providing a more effective product outcome. They cite the OXO Good Grips range of products as examples of products conferring positive experiences for the user (McDonagh & Thomas, 2010:458). They reason that well-designed products are intuitive and contribute to a person's quality of life and independence.

Of interest is an article published on 14 November 2015 in the *New York Times* on Phil Gilbert, the General Manager of Design at IBM, who is leading the company in the 'design thinking' way, in that the business first identifies the user's need and then works towards the product (Lohr 2015). IBM's management saw the importance of adapting to changes needed to grow new lines of business that would grow faster than the old ones declined. This is done by researching people's needs, then building prototype products quickly, testing them with users, modifying and refining them. IBM believes in its ability to transform and stay ahead of the relentless advance of digital technology and the changing needs of people by the use of design thinking in the company.

Across corporate America there is rising interest and enthusiasm for design thinking, not only to develop products but also to develop services and plan strategies and company change in general. The September 2015 cover article of the *Harvard Business Review* was on "the evolution of design thinking", discussing why design thinking is important in the

twenty-first century. One of the authors was David Hall, the founder of USBCT, a Taiwan-based company that provides executive coaching, management strategy, start-up mentoring, sales training, marketing training, project management training and business coaching in design thinking. He says: “Design thinking gives us that frame of mind that prepares us for any task, project, management challenge or strategy” (Hall 2015:55).

Ayşe Birsel, who leads the design studio Birsel + Seck with her husband in New York, devised a fun project on how to use design thinking to build the life you always wanted. She says that life is like a design problem, being full of constraints such as time, money, age and circumstances. Thereafter she describes how to think like a designer and the steps to take to change your own life (Birsel [Sa]:sp).

2.5 Design thinking in education

Design thinking has been used with much success in education by schools worldwide to empower students with critical thinking skills and creative confidence, helping them to become involved in their own learning and to develop metacognitive skills to prepare them better for the ever-changing challenges awaiting them in the workplace. Some examples, and their positive results, will be mentioned in this dissertation.

There are two prominent perspectives on design thinking from an educational viewpoint: those of IDEO and Stanford.

2.5.1 The IDEO approach

In the IDEO approach, design thinking is used as a tool for teachers to innovate and make classroom experiences more meaningful. The *Design Thinking for Educators Toolkit 2012* is a useful online resource which also describes several research cases in America where design thinking is being successfully applied. It takes educators through the steps of discovery (understanding the challenge, preparing research and gathering inspiration), interpretation (searching for meaning and framing opportunities), ideation (generating and refining ideas and brainstorming), experimentation (making prototypes and getting feedback) and evolution (tracking learning and moving forward) as seen in Figure 2 (*Design thinking for educators toolkit* 2012:9). An example of a research project that has used the IDEO approach as part of a Master’s degree dissertation is that by Kwek (2011).

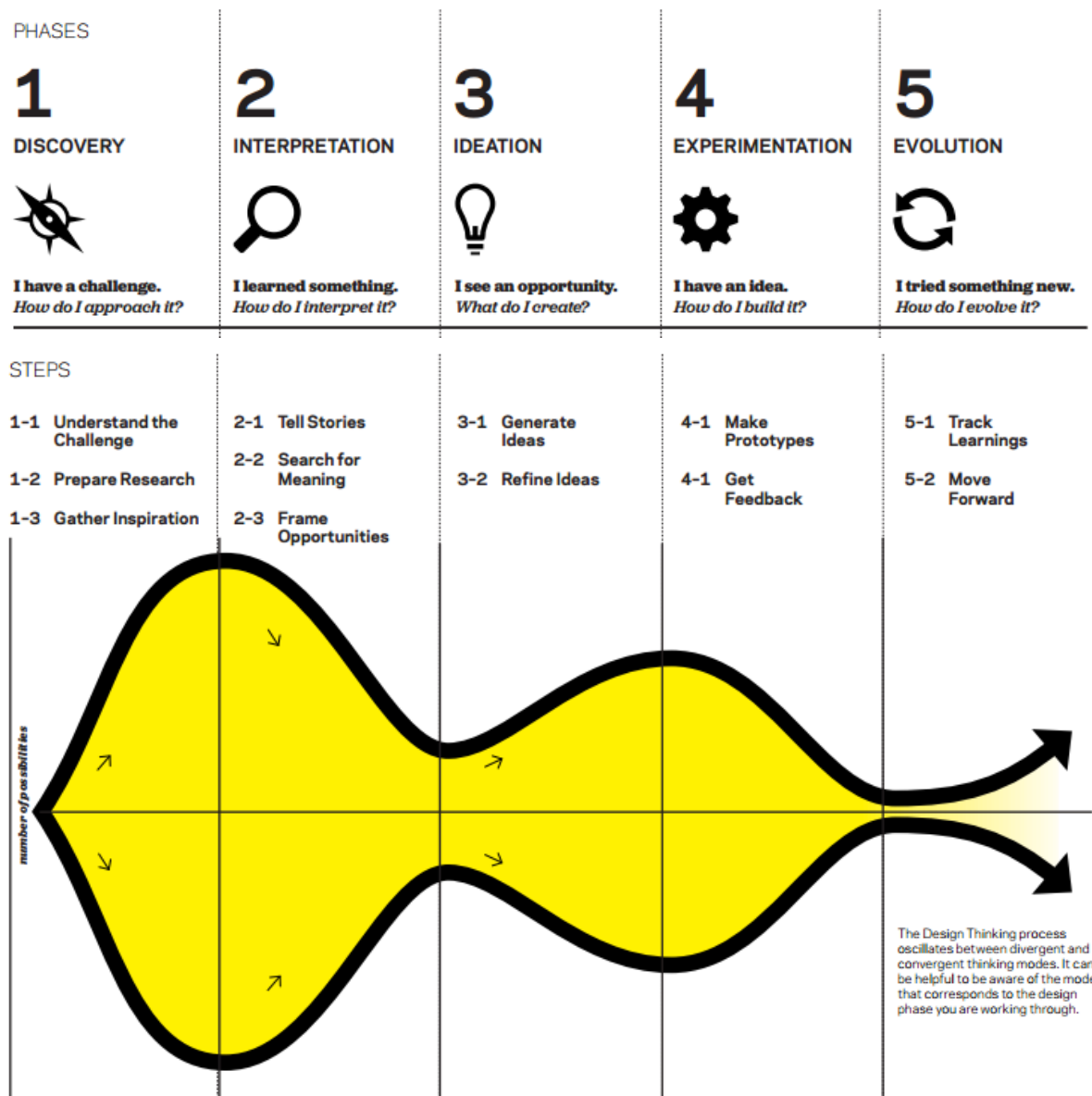


Figure 2 The IDEO Design Thinking Process for Educators Toolkit (*Design Thinking for Educators Toolkit 2012:15*)

2.5.2 The Stanford approach

Stanford's approach to education in schools is to empower learners with design thinking skills to help them to address challenges in more creative and holistic ways. Carroll *et al*, from the Hasso Plattner Institute of Design at Stanford University, did some research, taking a team of university instructors to a public school to study the effects of design thinking and

how it might empower them to solve problems and to develop their creative confidence. Carroll *et al* (2010:39), for instance, state that “design thinking requires that students identify the problem for themselves. Figuring out which questions to ask and what problems are worth solving gives students a different sense of agency”. This requires students “to be strategic and metacognitive about when to apply creative thinking and when to apply analytical thinking. Students must recognize where they are in the process and apply different ways of thinking to produce the best results” (Carroll *et al* 2012:1). Design thinking is an approach to learning that focuses on developing children’s creative confidence (Carroll *et al* 2010:38). This is the approach that the researcher used in this study.

The Stanford use of innovative thinking to empower learners may be well suited to the South African school context, especially with the demands made on learners by the complex multicultural situation and developmental challenges. Little design thinking research has been done in the South African educational context, or for that matter in any of the developing countries. The crucial question is whether design thinking holds any potential as a method to equip learners with creative, innovative, problem-solving skills for their own and the country’s future.

2.6 Design thinking research at schools

As stated in the introduction, this research looks at the implementation of design thinking in the classroom. Authors such as Carroll *et al* (2010), Faust and Howland (2013) and Burmeister (2013) describe such research projects.

One of the educational research projects to which this research refers was recorded by Carroll *et al* (2010), who describe a research project in Blackwell in the United States (US) where design thinking was explored in an educational context. The participants were grade 7 learners who were given a real-life challenge to solve. That study found that design thinking provides a powerful alternative and even enriching opportunity. Integrating design thinking into education challenges learners to find answers to complex and difficult problems that could have multiple viable solutions (Carroll *et al* 2010:36). These authors comment that: “creative confidence is an essential part of learning. Design thinking may help students become empowered agents in their own learning who possess both the tools and confidence to change the world” (Carroll *et al* 2010:52).

Carroll *et al* use the following diagram to describe their design thinking process with the learners (see Figure 3):

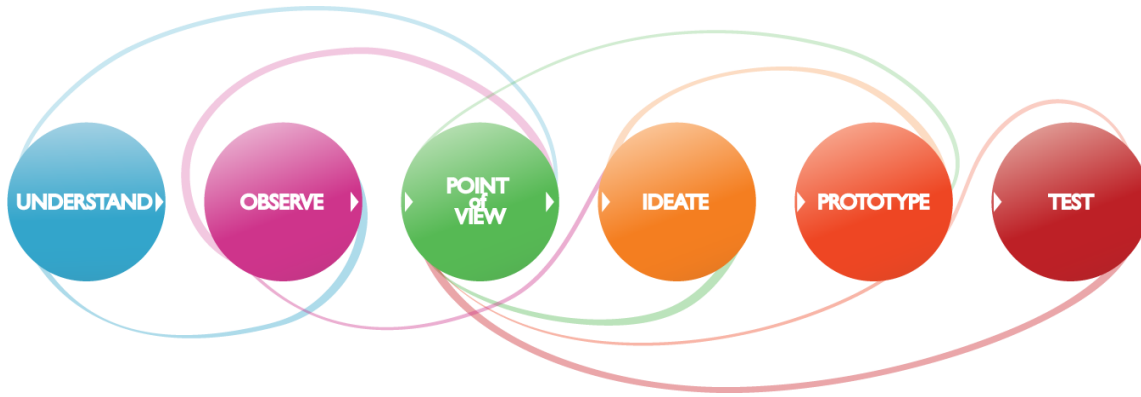


Figure 3 Carroll et al's design thinking process (Carroll et al 2010:40)

Carroll *et al* state that the first phase of the design thinking process is to understand the challenge. This includes research, interviews and multimedia. The learners then learn to observe and they become keen people-watchers, which helps them to develop a sense of empathy. This again helps the learners to develop a point of view as they synthesise all the information they have gathered so far. The foundation of the next ideation phase is brainstorming as many ideas as possible. Prototyping may be two- or three-dimensional visualisation of ideas to convey an idea quickly. Testing ensures that one learns what works and what does not for specific users. These phases do not simply follow a linear process, but can loop back to any other phase as the need arises.

Erik Burmeister (2013:23) writes about taking risks in practice in a public school, focusing on possibilities, not limits. He specifically talks about the human-centred aspect of design thinking, and mentions the revolutionary idea of a school designed around students' articulating what they want and need. Of interest is the article by Susan Faust and Jenny Howland (2013:21-22), who designed a model for their San Francisco school based on Brown's design-thinking methodology of inspiration, ideation and implementation (three overlapping spaces). Their model is called: *How we learn. A model for the twenty-first century* (see Figure 4).

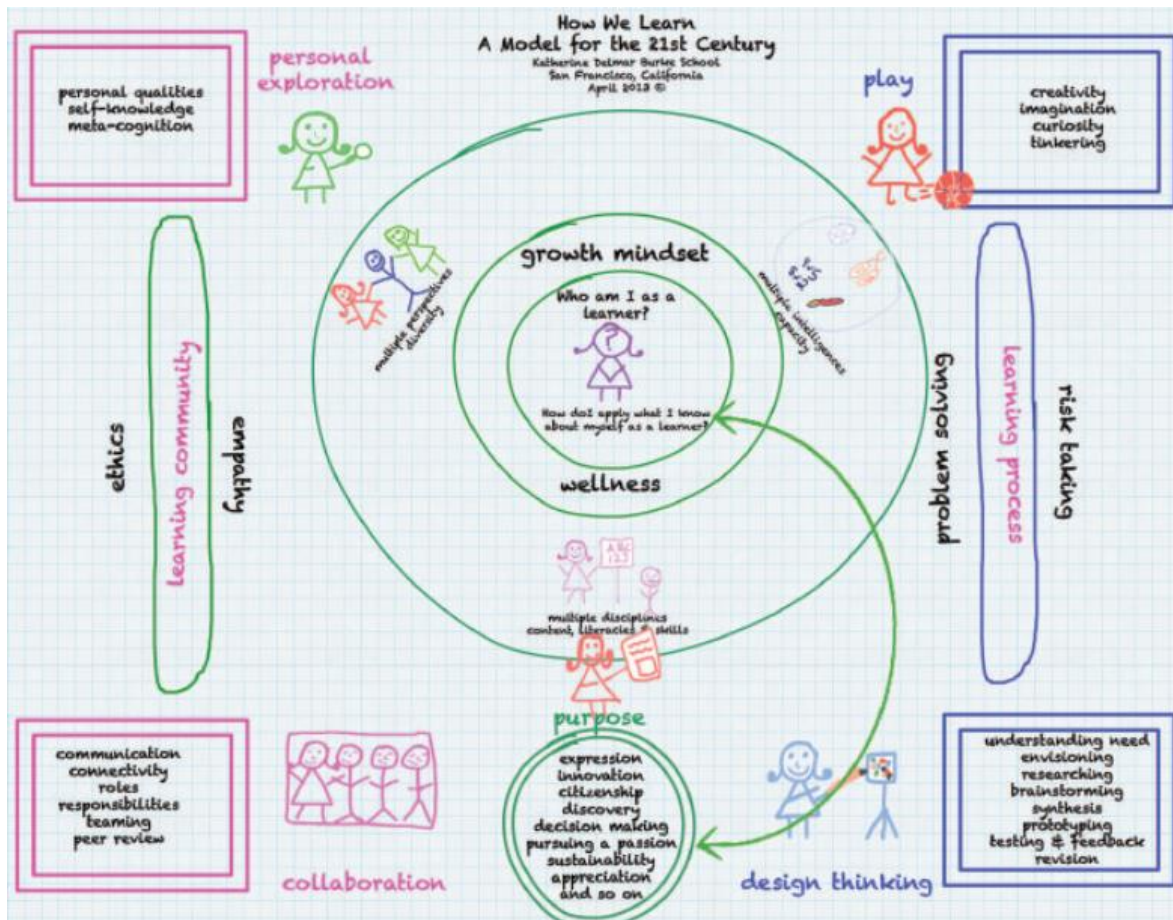


Figure 4 Faust and Howland’s model for schools (Faust & Howland 2013:22)

This model’s perspective moves from the individual learners with their multiple intelligences (verbal-linguistic, mathematical-logical, musical, visual-spatial, bodily-kinaesthetic, interpersonal, intrapersonal, naturalist and existential intelligence), and the multiple perspectives and diversities and disciplines that they are exposed to, to the design-thinking process. During this process, design thinking loops through the different aspects of purpose, the learning community, and personal exploration of the learners, their play and the learning process. This does not follow a linear procedure but loops back continually to the experience of the learner and the information for the specific challenge at hand. This is a holistic approach involving every aspect of the learner’s life.

Their model is also based on the multiple intelligences as researched by Professor Howard Gardner from Harvard University, who published the first seven intelligences in *Frames of mind* in 1983 and added the last two in *Intelligences reframed* in 1999.

The nine intelligences that he believes every individual has are:

1. Verbal-Linguistic Intelligence: well-developed verbal skills and sensitivity to the sounds, meanings and rhythms of words
2. Mathematical-Logical Intelligence: ability to think conceptually and abstractly, and capacity to discern logical or numerical patterns
3. Musical Intelligence: ability to produce and appreciate rhythm, pitch and timbre
4. Visual-Spatial Intelligence: capacity to think in images and pictures, to visualise accurately and abstractly
5. Bodily-Kinaesthetic Intelligence: ability to control one's body movements and to handle objects skilfully
6. Interpersonal Intelligence: capacity to detect and respond appropriately to the moods, motivations and desires of others
7. Intrapersonal Intelligence: capacity to be self-aware and in tune with inner feelings, values, beliefs and thinking processes
8. Naturalist Intelligence: ability to recognise and categorise plants, animals and other objects in nature
9. Existential Intelligence: sensitivity and capacity to tackle deep questions about human existence, such as the meaning of life, why we die, and how we got here

Gardner says: “An intelligence is the ability to solve problems, or to create products that are valued within one or more cultural settings” (Gardner 1999:sp). According to him, every person has all of these intelligences in varying amounts and in different combinations. These intelligences can be developed and strengthened, or ignored and weakened. He believes that we can improve education by addressing the multiple intelligences of our students.

Applying design thinking in schools as part of their education programme has been adopted by many schools worldwide. The IDEO map (Figure 5) includes more than 200 schools around the world that use design thinking as part of their education. The map in Figure 5 shows that unfortunately South African schools have not started implementing design thinking as part of their education programmes.



Figure 5 Map of schools worldwide that are applying design thinking in their education programme. IDEO [sa].

2.7 Conclusion

Having discussed design, the nature of design thinking, design thinking in other disciplines and design thinking in education, this chapter has shown the empowering effect of the design thinking process on problem-solving skills and applying innovation to the challenges mentioned in this chapter. Very little evidence is seen in South African schools of the application of design thinking; nor is there much attempt to accommodate different learning styles in the classroom, since school management focuses on implementing the Department of Education's CAPS curriculum, which emphasises continual standardised assessment.

The next chapter explores the researcher's application of design thinking during a workshop conducted at her school, and the implications thereof.

Chapter 3 Research method and application

3.1 Overview of the research method

Participatory action research is an acceptable method used in design research that also allows for synthesis or creative generative techniques, rather than the more analytic techniques used in other research, because participatory action research is being used in real-life situations solving real problems. Cal Swann (2002:56) mentions that participatory action research has been extensively used in teaching practice. Design thinking and participatory action research both revisit the problem repeatedly, reflection and action repeating themselves as an ongoing cyclical process until the most desired solution has been obtained (De Vos, Strydom, Fouché & Delport 2011:403; Bless, Higson-Smith & Sithole 2013). Collaborative participation, an important aspect of participatory action research, as well as design thinking, draws all participants into the developmental process, empowering all of them as co-learners within the research process. The process becomes visible and both the participants and the researcher benefit (Swann 2002:56; O' Brien 1998:3; Merrifield 1997:4; Maree 2007) (see Figure 6).

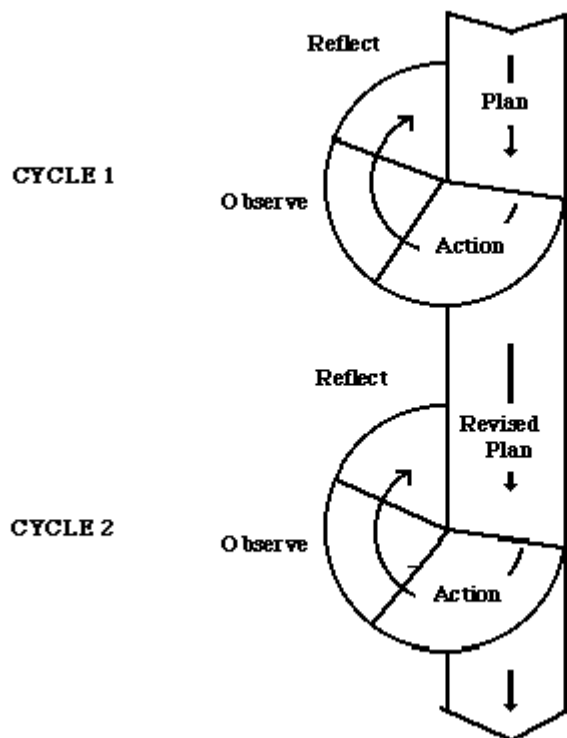


Figure 6 O'Brien's participatory action research diagram showing the ongoing cyclical process (Cherry 1998:4)

Bless *et al* (2013:90) state that participatory action research is distinguished by two characteristics, namely the relationship between the people involved and fact that the outcome of the research brings social change and imparts knowledge to those participating. This coincides with design thinking's human-centred and empathy approach. These authors also mention that participatory action research is of special importance in developing nations, empowering communities with a methodology to solve some practical real-life problems.

3.2 Research approach

The Stanford approach, supported by the theories of Carroll *et al* (2010), Faust and Howland (2013) and Burmeister (2013), as mentioned in Chapter 2, forms the theoretical framework for the rest of this study – where design thinking is practically explored in a real-life school situation. The research approach and method used are those of participatory action research.

As already explained, participatory action research is a qualitative research approach, naturalistic in nature; and seeks to understand phenomena in context (or real-life settings) (Maree 2007:78). Qualitative research approaches focus on describing and understanding phenomena, with emphasis on the quality and depth of information (Maree 2007:51). They require an understanding of the context and possible solutions to the problem.

A benefit, as mentioned by Maree (2007), which this researcher found to be valid, is that action research requires limited and inexpensive resources. It was also found to be cost effective in terms of time, as extensive information could be obtained in the limited time available to the participants and researcher. The interdisciplinary nature of participatory action research, as mentioned by Fouché and Schurink, is another characteristic that is similar to design thinking (De Vos *et al* 2011:310).

The learners in this case become participants in carrying out the research. The researcher acts as mediator and facilitator to help participants plan and implement the project. The design thinking model of Lawson of formulating (identifying the problem and different perspectives, as in brainstorming), representing (different ways of representing and the 'conversation' between the designer and the representation), moving (changing design after reflecting), evaluating (knowing when to evaluate or even suspend evaluation), and reflecting (reflection on action and in action) are put into practice, guiding the learners through the process (Lawson 2006:292-301).

Lawson's model (2006:291) was expanded with other models such as that of Brown (2008:88-89). The steps of design thinking as used by Brown (2008) include: 1) the collaborative, integrative aspect of design thinking, using brainstorming as part of the starting point of the project; 2) the need to think in a human-centred, environmentally friendly way; 3) applying the use of prototyping and sketching as important aspects of design thinking; 4) the necessity to reflect while working and the possibility that the design may change during the process; 5) the participants' final evaluation of their work.

Carroll's model starts the design thinking process with 1) a point of view, 2) observing, 3) understanding the problem, 4) ideating, 5) prototyping and 6) testing. Brown and Carroll's models have been discussed in more detail in Chapter 2.

3.3 Selection of participants

The group chosen for participating in the research project consisted of 25 grade 7 learners from Halfway House Primary School in the Midrand area. The learners at the school come from various cultures, have different social and economic backgrounds, are both male and female and on different academic levels. The group consisted of learners interested in art, who were already involved in the art club, participating in a variety of projects. These learners, being already involved in the art club, knew the researcher, which solved any trust issues, and had also already set aside some time for art club. Selecting the art-club learners enabled the research to be conducted outside formal school times and therefore it did not interrupt the normal school programme.

3.4 Approval by authorities and research ethics

The principal of the school signed a consent letter for the workshop to be conducted on the school grounds during art club, which takes place after school. The participants and their parents each signed a consent form for the learners to participate in the research workshop, allowing their photographs to be published in the dissertation.

3.5 Research design

One of the requirements of research quality is that a systematic process needs to be followed, so that should this process be repeated by other researchers, it would come to similar conclusions. The reliability of this type of research can be compared with similar research conducted in other countries like the US by Carroll *et al*, Burmeister and others, as already referred to in Chapter 2.

The fact that the researcher was involved as both the art club teacher and the grade 7 Art teacher could have contributed to her being biased before the start of the research, but this made trust issues much easier. The learners were immediately willing to be open minded and to share freely. They felt safe in their familiar environment, being with other learners and a teacher that they knew.

3.6 The research design comprised the following steps:

Identification of a real-life problem: A problem that learners were familiar with, yet with a global focus, had to be selected.

Workshop 1: The real life problem. This was the control workshop – introduction of a real life problem; learners did individual work; no design thinking techniques were explained.

Workshop 2: Introduction to design thinking. Learners were exposed to design thinking techniques and approaches (suitable for the age group) – this involved teamwork, exploration, integration of other disciplines, development of solutions, reflection and feedback.

Workshop 3: Generation of solutions. One of the characteristics of design thinking output is that solutions are prototyped and visualised.

Workshop 4: Communicate concepts and reflect. This involved prototyping/visualising solutions and feedback/reflection

3.7 Workshop one: The real-life problem

The first session on 29 October 2014 started with the facilitator giving the learners the research question of environmental art from a conservation point of view; producing works of art by manipulation of the natural landscape. Many of the learners' subjects, such as natural sciences, social sciences and life skills, make them aware of environmental conservation and the problem of global warming, which is in urgent need of consideration. These workshops emphasised sustainable environmental art, which is produced with consideration for the wider impact of the work and its reception in relationship to its environment.

The learners were told which materials they might possibly need (which were only to be natural objects that could be found in the given area or those which the facilitator brought from home). The theme of responsible manipulation of the environment was chosen partly because this question was included in the examination that the Basic Department of Education sent to all the schools in 2011. It included a question and sketch on environmental

art and global warming. Global warming is seen as one of the world’s most urgent current problems. The theme also covered one of the aims of the new National Curriculum Statement for Life Skills: ‘using science and technology effectively and critically showing responsibility towards the environment and health of others’ (South Africa. Department of Basic Education 2011:5).

The researcher introduced the learners to colour slides showing environmentally friendly land art, most created by the Scottish artist Andy Goldsworthy, where the artist had rearranged natural materials found on a site, like branches, leaves, flowers and rocks, while exerting no detrimental effect, with the aim of creating art that helps to improve our relationship with and understanding of the natural world (see Figure 7). Ultimately, the materials used to create the artwork returned to their natural state, leaving no trace of the artwork or interference of humans in the area.



Figure 7 Environmental art by Andy Goldsworthy from the video by Adam Ganz

The learners were instructed to do a quick individual planning on cardboard for the environmental art project. They were given paper and pencils to start with to do their planning. At first they were a bit unsure of what to do. Some of the learners started drawing

straight away while others struggled with a blank piece of paper for a while or had to start over again. The researcher at this stage walked among them, encouraging them but offering no extra design thinking skills, and taking photos of the group and of the individual drawings. They had to write down which materials they thought they would use. Design thinking, its characteristics and the practical implementation, was not described at that stage as this exercise was to be used as a control project to compare with the end results after learners had been guided through the use of design thinking during the following workshops. The facilitator informed them that she would introduce them to design thinking in the next workshop and that they would then work in groups (see Figure 8 and 9).

Some of their drawings:

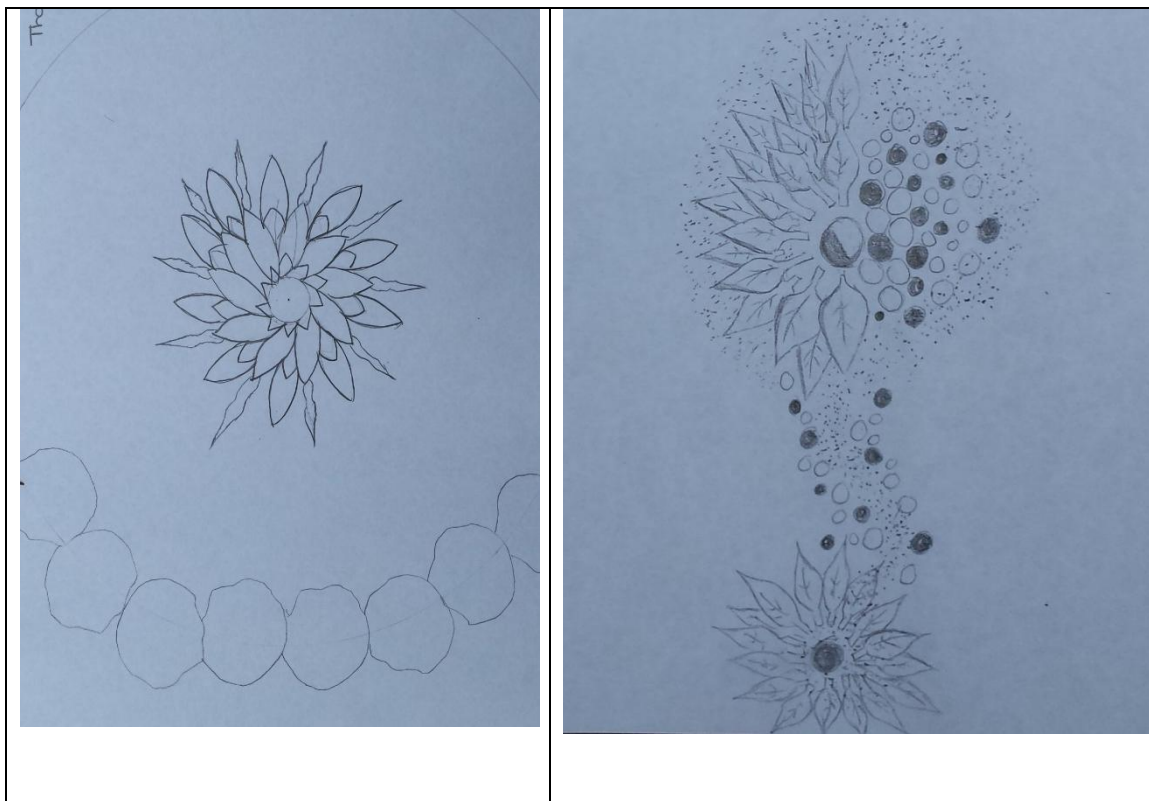


Figure 8 Sketches by individual learners. Photographs by the author

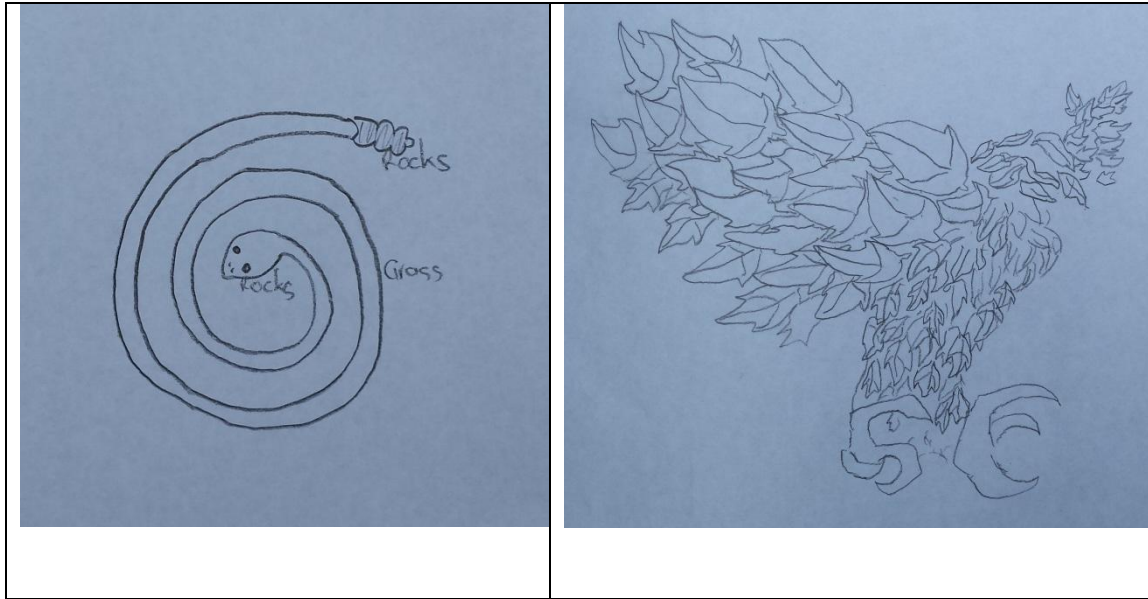


Figure 9 Sketches by individual learners Photograph by the author

The learners were eager to participate, but at this stage still a bit unsure of their information as they discussed possible material to be used. They mentioned the use of sand, rocks, pebbles, sticks, leaves and flowers.

3.8 Workshop two: Introduction to design thinking

The second session started with each one in the group identifying his or her own skills. A friendly and safe environment was provided for this, where there were no wrong or right answers. The researcher asked the learners to sit in groups and gave them each A6 pieces of paper, instructing them to write their talents on the paper. They thoroughly enjoyed this, talked and laughed, asking the facilitator what she thought of certain talents and even coming up with fun-like ideas for talents. The group dynamic seemed to stimulate more creative thinking, daring and having fun with what they did. The researcher said they could write their names at the back of the paper if they preferred to do so or write their talents anonymously. The learners used some Prestik™ to stick their paper on the board. Some of the learners even asked for a second paper to write down more talents (see Figure 10).

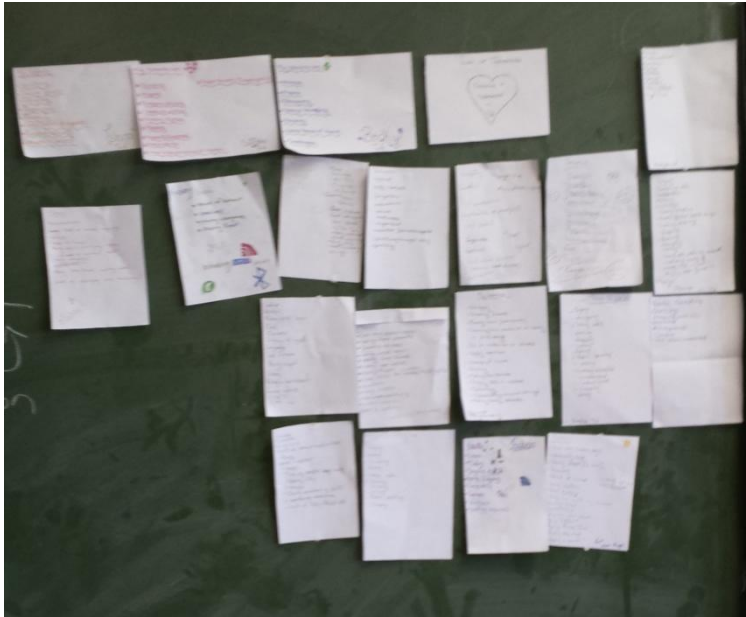
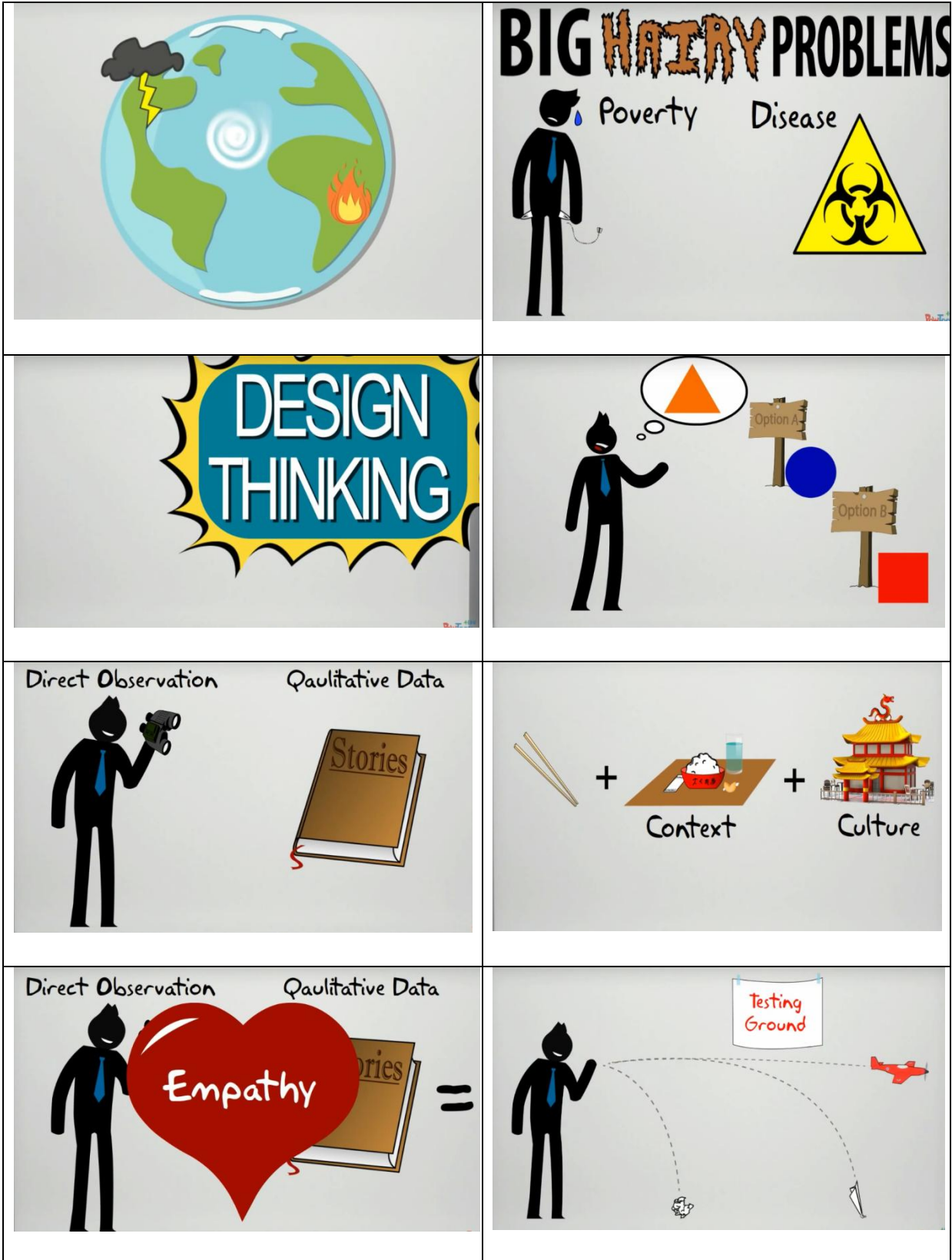


Figure 10 Notes by learners of their talents Photograph by the author

This activity was used to show them why group work is a better option for the project, because of the diversity of input from all of them. This was the starting point of introducing design thinking, collaboration being one of the characteristics. The researcher introduced the learners to design thinking with a video on design thinking by Tim Brown and David Kelly from Stanford on: *What is design thinking?* It started with the world experiencing big, “hairy” problems like poverty and many more, but pointed out that design thinking can help you to tackle your problems. It encourages people to explore alternatives, focusing on the needs of the user, empathy being an important approach. Then ideation and brainstorming were discussed, testing the process with simple prototypes. Design thinking was presented as a process that leads to better creativity and faster, better solutions. After this the facilitator handed out some copies of the key concepts mentioned during the video like empathising, defining, ideating, prototyping and testing.

The following photocopies were handed out to learners after watching the first video on design thinking by Tim Brown and David Kelly (see Figure 11).



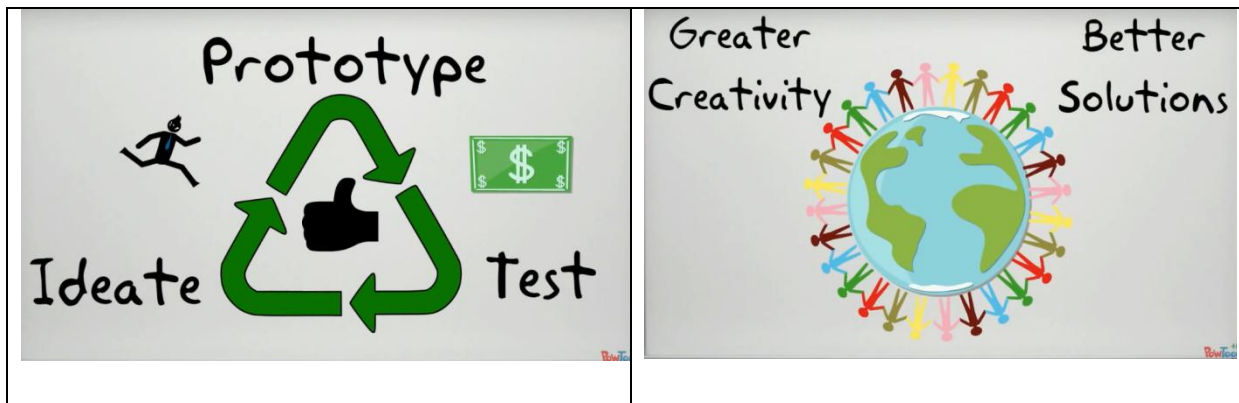


Figure 11 Photocopies handed out to learners (Made from IDEO Video)

This exercise was a starting point for introducing collaboration as one of the methods during the design thinking process, because of the diversity of their talents which would enrich their collective input during the process.

The facilitator informed them that they would discuss and define the problem of world global warming: what caused this, what contributed to this and whether they thought their understanding of global warming and input of environmentally friendly land art could make a difference.

The learners sat in their groups with an A3 paper, pencils and other available materials. The facilitator encouraged them to value one another's opinion as they started randomly adding their ideas on what caused global warming. This process encouraged the learners to brainstorm and come from an empathetic viewpoint towards earth and its people. Some learners found it difficult to write and draw ideas all over the paper and wanted to do neat, organised work. They would be encouraged to take risks and be creative and not worry about any 'mistakes' they made, because they could change and improve their ideas as each one came with new input and ideas. The atmosphere in the class was friendly, excited and cooperative, and the learners were very eager to learn new things. The facilitator encouraged them to add as many ideas as possible and use their imagination.

Some of the brainstorming ideas on the problems of our planet (see Figure 12):



Figure 12 Learners during Workshop Two. Photographs by author

3.9 Workshop three: Generation of solutions.

The third workshop could take place only after the school exams on 26 November 2014. The learners were reminded of this and asked to make the necessary transport arrangements. They were told that the workshop would be on prototyping, with the group going on to the next step of drawing and redrawing and reflecting on the impact of their land art on the environment.

The facilitator realised that it had been quite a while since the learners had last heard about a new concept like design thinking; she needed to refresh their thoughts and showed the learners another short design-thinking video on: “All about learning. Design thinking” by Ana de Armas y Villada, describing design thinking as a cyclical process that allows one to solve complex problems in a creative way (see Figure 13).

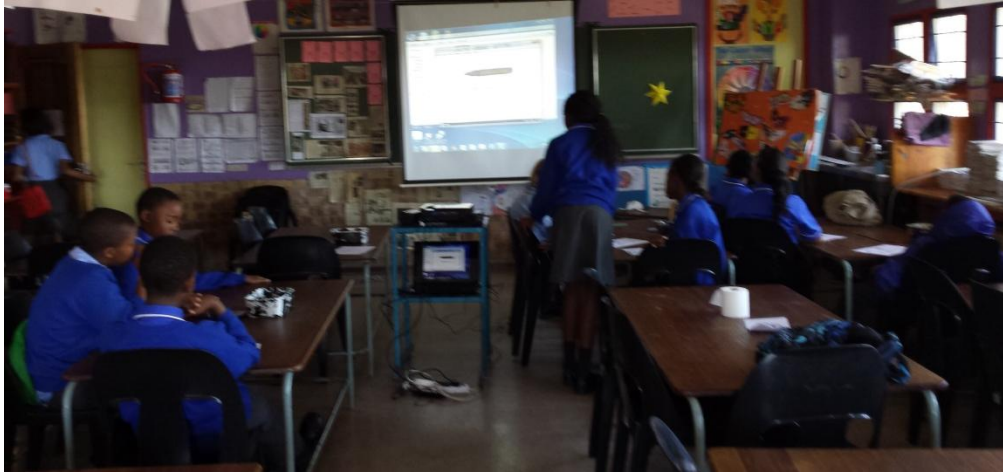


Figure 13 Learners watching a video on design thinking
Photograph by the author

Photocopies copied by the author from the video by Ana de Armas y Villada were handed out to the learners after watching the second video (Figures 14 and 15).

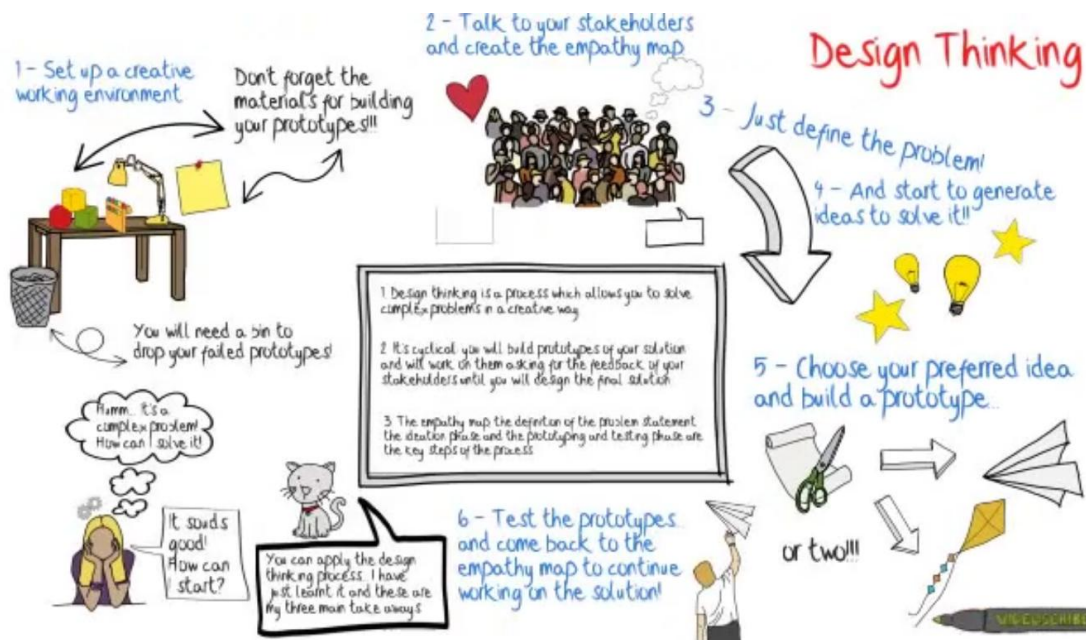


Figure 14 Photocopy handed out learners from the video by Ana de Armas y Villada

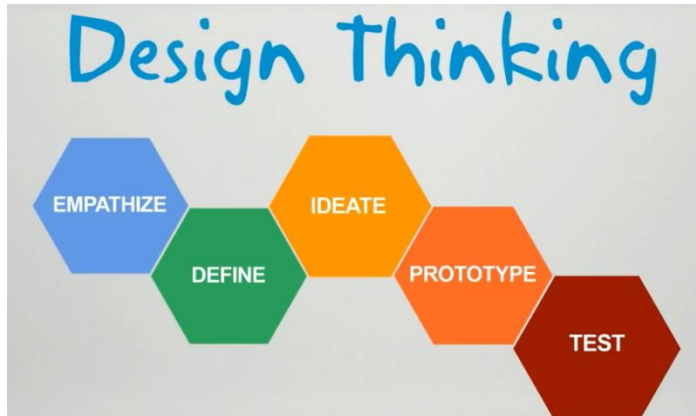


Figure 15 Photocopy handed out learners from the video by Ana de Armas y Villada

The learners started their drawing for their land art project. During this time they could share ideas and reflect and were encouraged to rethink and change their drawing at any time.

They were encouraged to value one another's opinion and take into account the impact of their work on the environment. This was to teach them to empathise with one another and other people, having to take into account the wider impact of their work on the environment and then again the impact of the environment on people and all life on the planet. The one group talked about how families reach out to help Mother Nature's heart. The learners also had to consider the possible materials they could use.

Some learners worked for a while and asked for more paper and restarted. Various materials were made available to the learners, like coloured paper, paint, coloured pencil and crayons (see Figure 16 and 17).

Some of the groups working:



Figure 16 Learners during Workshop Three. Photograph taken by the author
 Some of the planning:

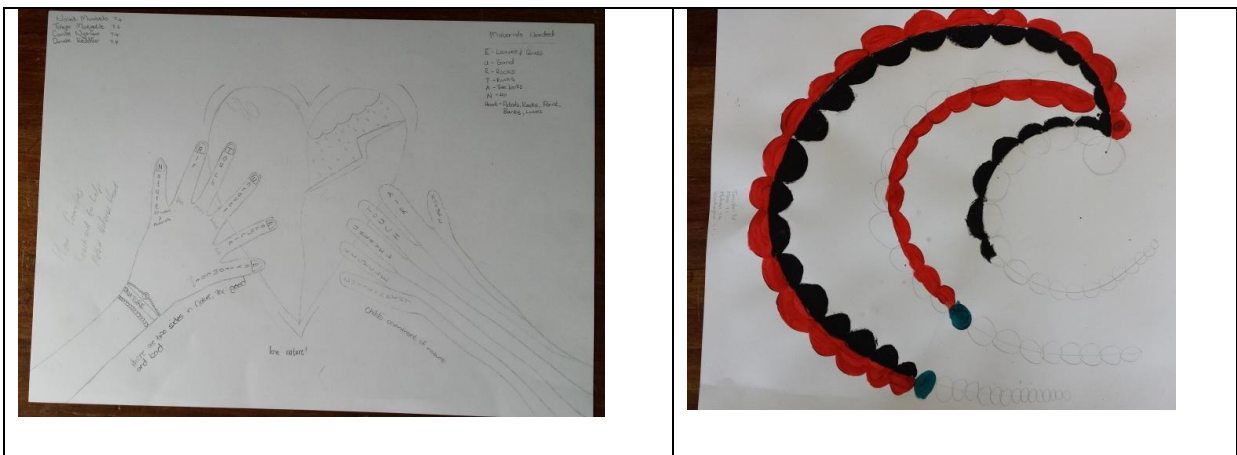


Figure 17 Some of the group work planning. Photograph taken by the author

The next day the facilitator asked the register teachers to send the learners to her classroom. As it was after the exams and the classes were quite empty, she asked the learners to come and sit in her class during school time and do their group work. This way most of the group work got done.

The group work at this stage was still just sketches and rough planning, as can be seen in the photographs of their work.

3.10 Session four – communicate concepts and reflect

By this time the learners were very excited and eager to start, and they all helped to cart the materials in a wheelbarrow from the boot of the car to the area at the school behind the tennis courts which was out of bounds for the other learners because of the remoteness of the area. This gave the learners some uninterrupted time to continue working.

Getting there, the learners worked in the group they had already decided upon during the second workshop. Every group made little heaps of the four different-colour pebbles supplied by the researcher, bark, leaves, seeds and flowers. They even made use of the purple flowers in the field area and seeds from the thorn tree under which most of them decided to work. There was a satisfying mood of cooperation (see Figure 18).

Learners busy with their final environmental artwork:





Figure 18 Groups executing their environmental art.

Photograph by the author

3.11 Concluding remarks

This chapter described the unfolding of the research process and workshop. Chapter 4 will describe the discussions, the informal and formal feedback from the learners and how the research relates back to the research of the selected seminal authors.

Chapter 4 Feedback

4.1 Introduction

This chapter analyses and discusses the feedback provided by the learners, as well as the observations by the researcher. Learners had three opportunities to provide feedback: informally during class and the workshop and formally after the project.

4.2 Informal feedback

The workshop challenged learners to use first paper and after that found objects from nature. This resulted in a shift from 2D to 3D. The researcher's observation was that most of the learners found the change of medium challenging, from working on paper with their drawings and painting tools to using three-dimensional materials that were not as pliable as the other media. They took their sketches along to the working area and managed to come up with some very creative and innovative ideas for adapting their idea to the different media they were working with. During this process the researcher noticed a lot of reflective thinking, discussions within the teams, and the innovative and collaborative process the learners followed during the process. Short cell phone video clips were taken by the researcher during the session, as well as hand-written field notes to assist with the data collection and analysis. A more formal video was taken during the formal feedback and discussion.

The researcher named the five groups:

1. Pebble Heart
2. Mother Nature
3. Bird's Nest
4. Art in Nature
5. Flower

The informal feedback from the different groups was as follows:

4.2.1 *Pebble Heart*

The **Pebble Heart** group had an interesting and more complicated plan than the other groups. Eventually, having to deal with the new medium, they left out the hands on both sides of the heart and added two smaller hearts containing nature (See Figure 19). This was a very lively and happy group consisting of girls from different cultural and socio-economic backgrounds.

They commented on the use of organic objects and the idea of nature bringing everybody together. Some said that working on their own during the planning was boring. They jokingly said that the thing they liked least about the area they were working on was the sun. (This even though they had the freedom to choose the area that they thought was best suited for their idea.) They liked the whole workshop and exploring their talents. Most of them said that the meaningful part was the talking and sharing of ideas. Some commented that group work improved the end result.

They had the idea of love for nature and people caring for nature, and nature then in turn caring for people. Their image showed the good side of nature on the left-hand side, with clouds, water, plants and flowers. The right hand side represented the bad side of nature with storm clouds, tornadoes, thorns, earthquakes with a crack in the soil and volcanoes.



Figure 19 Pebble Heart group work. Photograph taken by the author

4.2.2 Mother Nature

The **Mother Nature** group consisted of two boys and three girls. They agreed on the one boy's design during group work, but during execution thereof they were the group with the most disagreements. After the researcher showed them how to work out the proportions of the features in the face by looking at one another's faces, they worked together. They commented on the challenge of group work and the change of medium but their solution was very creative and they came up with a successful end result (see Figure 20).



Figure 20 Mother Nature group work

Photograph taken by the author

4.2.3 *Bird's Nest*

The **Bird's Nest** group worked together quietly. This was a group of three girls from different cultural backgrounds. Their comment was that one gave an idea and then someone else gave another idea and then stuff changed slightly. The one girl said that the part she liked least was the session before this one, when she was out of energy (that was just after they had completed their exam writing session the day before). This group session with a totally different medium from any they had ever used at school was, according to them, the best. Another girl said that she thought this type of working would help her in high school. She liked doing the finished product, though according to her the change of medium was her biggest obstacle, as this did not always do as she wanted and they had to improvise (see Figure 21).



Figure 21 Bird's nest group work. Photograph taken by the author

4.2.4 Art in Nature

The **Art in Nature** group was the first group to explore the area for more material. They walked all over the place. They were also three girls from different cultural backgrounds and commented that the fact that they could combine their ideas was good. They worked in a quiet and relaxed way and covered quite a big area. Their work blended into the area and did not stand out as clearly as some of the other groups, but they felt free enough to work this way (see Figure 22).



Figure 22 Art in Nature group work. Photograph taken by the author

4.2.5 Flower group

The **Flower group** agreed that the change of medium and the practical planning were challenging and that they had to adapt and make other plans, but that the group work was fun. This group consisted of three girls and one boy. They seemed to enjoy this and looked happy, making many jokes (see Figure 23).



Figure 23 Flower group work. Photograph taken by the author

4.3 Formal feedback

The formal focus-group discussion took place after break, giving another hour to wrap up everything. A video recording was done here to assist with the data collection. The video was taken by the school's Head of Department: Life Skills and Creative Arts, Mr Theron.

The researcher chose to direct the following questions to the group:

“Which part did you like most?”

The learners tried their best to behave in an orderly way and started off pacing themselves that way and answering, but they were so happy and excited towards the end that they started talking at the same time; however, the facilitator was able to decipher this. Since the learners were relaxed and happy they expressed themselves freely. This can be seen during the attached video.

They liked working in groups and sharing their ideas. The one girl said she liked the bonding in their group and to learn how different people worked to create their masterpiece. Another girl commented that being able to talk and share freely during school time without getting a demerit was really nice. This caused a lot of happy laughter. A boy said he liked actually creating the idea they had in class. Some even commented that taking all the materials to the area was fun. Most of them liked creating the finished product where there was no right or wrong, everyone's idea counted and they could be as creative and as innovative as they would like to be. This is also seen by other researchers as an important aspect of design thinking (Chapter 2).

“Which part did you like the least?”

A few of them immediately responded that it was the sun. (One group wanted to execute their idea on some sand which was in the sun.) One girl joined in the spirit of the moment, responding that it was the shade. Some of them found the carting of the heavy materials to the area in a wheelbarrow hard work.

“How did you experience the group work?”

Everybody was so excited that they talked at the same time. The head leader girl said that it was like Hartebees. (That was the venue where they went for the Leaders' Camp and they loved that experience and talked about it throughout the year.) The informal feedback also confirmed that they especially liked the group work, being able to share and discuss their different ideas, which helped them to develop a better end product.

“What about obstacles and how did you overcome them?”

One of the small girls said that bringing the materials was heavy and that will-power helped her to overcome. They laughed and the researcher joined in and said jokingly that she got the others to do the job for her. They all laughed again. The group that had worked in the open area with sand said that they had had to pull up some of the grass and weeds that were in the way of the design. Many agreed that it was a challenge trying to create the idea they had had in class in a different medium. They said that they had to make another plan and prioritise. The one group found it challenging to agree about the execution of the face. The researcher asked them about this and they said they were arguing about sorting out the face. (This group realised that there was more than one solution; the researcher, as mediator, helped them to look at the real-life object (features) as reference material for the

placing of facial features, which helped them to continue with their work). They did not explain this during this video as there were too many others talking.

4.4 How does this compare with design thinking theory?

The learners started working on the project using an interdisciplinary, collaborative approach to a real-life environmental problem, as stated by Brown (2008:86) and Carroll *et al* (2010:41). Their perspective changed as they shared their ideas and their view of what they wanted to do changed and developed. The learners talked a lot about sharing and how this helped to improve the end result. Their individual skills and knowledge based on other subjects added to the innovative process that took place in their understanding of the problem. This led to their formulating the problem, as mentioned by Lawson (2010:292), because in this stage they were able to identify the problem, and their different viewpoints also helped them to frame it better (Lawson 2010:292-293).

As their understanding of the problem deepened, they developed more empathy towards humans and the environment. The Pebble Heart group commented that as they developed a better understanding, they realised that people caring for nature had the consequence of nature caring better for people. Brown (2008:86) repeatedly emphasises the importance of a human-centred design approach. He emphasises the creative, human-centred, holistic approach of design thinking and speaks about empathy towards people and a 'people first' approach (Brown 2008:87, 88). He described examples in which empathy contributed towards the design solution, for instance the Shimano bicycle project (Brown 2008:90). McDonagh and Thomas (2010:458) support this approach, mentioning the OXO Good Grips range of products for arthritis patients in the research they did on empathy supporting innovation. They reason that products designed in a human-centred way are critical to providing a more effective product outcome.

The learners' representation of the developing solution involved many two-dimensional drawings as well as the final three-dimensional art work. Lawson (2010), Brown (2008) and Carroll *et al.* (2006), as well as some others referred to during this research, emphasise the importance of prototyping and sketching as one of the aspects of design thinking. During this prototyping process of the workshop in this study, reflection in action and on action took place repeatedly. Lawson (2010:293) calls this the conversation that the artist has with the design, and he and Schön (1983:280) refer to the reflective process as necessary to develop a desirable end result. Owen (2006:20, 26) points out that in the cyclical process, knowledge is used to produce works, and in turn these works are evaluated to build knowledge. Making something visual helps people to learn about the strengths and weaknesses of an idea and

identify new directions that need to be taken (Brown 2008:87). The learners all spoke about having to adapt and improvise as they started to execute their idea in a different medium. Even though they saw this as a challenge, they enjoyed the process and took risks because there was no right or wrong choice. and this improved their creative confidence.

As the learners adapted to the medium, the design-thinking step of moving took place, as the learners repeatedly reflected on their work and the process, while some changes took place and the final design took shape. Lawson (2010:295) calls this development or transformation moving.

The skill of evaluation that Lawson (2010:299) mentions was evident during the process when the learners had to decide when to change the design and when to leave it as it was.

Their testing took place by their noting that they had succeeded in fulfilling the criteria of using environmentally friendly materials that would not harm the environment or people, and that this type of art would just be reabsorbed by nature with time.



Figure 24 The group and the researcher at the end of the workshop.

Photograph taken by Mr. P Theron

Another teacher reported that the learners entered her class in very high spirits, looking very happy.

Chapter 5 Discussion and conclusion

5.1 Introduction

This chapter continues the discussion and interpretation of findings from chapters 1 to 4. As an educator and qualified designer, the researcher based her research on the problem statement in Chapter 1. This clearly indicated the complexities that learners worldwide, and in this research specifically South African learners, have to deal with, as well as the fact that education in South Africa needs to better equip and prepare learners for their future role as problem solvers in the workplace and their lives in general.

The aim of this study was to explore the use of design thinking skills and their potential for developing problem-solving skills in learners.

The objectives of this study were:

- To determine the characteristics and methodology of design thinking suitable for school learners
- To determine an approach to experimenting with design thinking as a general skill in a real-life school situation
- To investigate the possibilities of design thinking in a school situation
- To reflect on, interpret and evaluate the outcomes of the project

The methodology followed during this research started with a literature study to identify and explore selected concepts in some similar studies carried out by other researchers in order to determine a working framework for the practical part of the study. The researcher explored design thinking and its characteristics and methods, specifically looking at how selected studies had applied design thinking methodology to come to some unique solutions in various disciplines other than design.

Thereafter, the researcher selected a practical approach to applying a design thinking process in a real-life classroom situation. Data collection was done using qualitative, action research methods with a group of learners. Participatory action research is strongly collaborative and requires the cooperation of various participants. In this case the school learners, being part of the research, were well suited to this specific research project. The researcher relied on selected design thinking models of Lawson (2006), Brown (2008) and Carroll *et al* (2010). These were selected out of the extensive literature on design thinking

that was also consulted for this study. These core models and other sources were used to inform the research methodology chosen.

In Chapter 2 the researcher presented definitions by some seminal authors of design and design thinking, and described their models of the design thinking process. The successful application of design thinking in other disciplines like business, products, services and systems was also discussed. The chapter also highlighted the rising interest and enthusiasm for design thinking, not only to develop products but also to develop services, training and coaching of staff and to plan strategies and change in general for US companies. The chapter also included a map of schools worldwide that are applying design thinking in their education program.

The two different approaches to design thinking in education, with their accompanying models of IDEO (Brown 2008) and Stanford (Carroll *et al* 2010), were also outlined and discussed. This study looked at some research done on applying design thinking in schools as part of their education program. The multiple intelligences, as presented by Gardner (1999), were also introduced here to indicate the diversity of learning styles that learners display.

Chapter 3 presented an overview of the method of participatory action research. The approach and some characteristics of participatory action research were discussed in the context of the design thinking models of Lawson (2006), Brown (2008) and Carroll *et al* (2010). The chapter mentioned the selection of participants and letters of consent to all the relevant parties necessary for the approval of authorities, and research ethics.

The research design was described, starting with Workshop 1 as the control workshop, without any design thinking principles being applied. Workshop 2 followed, with exposure to design thinking and the application of the characteristics of collaboration, integration, brainstorming, reflecting, changing and the development of the initial design. In Workshop 3, the learners executed their prototypes to enable them to visualise their designs, a step which is one of the characteristics of design thinking. Workshop 4 involved the final prototyping of the designs, crucially moving from one medium to another. This involved much collaborative work, visualising, reflecting, adapting, evaluation and more changes and development of their product.

Chapter 4 included informal and formal feedback, as the researcher took field notes and photographs during her observations of the last workshop, as well as a video of the final group discussion. There were five groups that executed their work in the open on the school grounds, and the researcher moved from one group to another, talking to the learners, informally taking special note of the way the design thinking process unfolded during the interaction of the learners. In the formal feedback the researcher asked the group a few questions to which they responded. This, and the informal observations and field notes, helped the researcher to evaluate and reflect on this research and compare this with the theory of the literature study.

5.2 Outcomes and reflection

5.2.1 Personal reflection on research approach and knowledge gained

The researcher found that the process and methods suited the nature of the research problem. The selected models described in chapters 2 and 3 provided conceptual frameworks and informed the research process. The qualitative research approach and participatory action research method allowed the researcher to be part of the process as an active participant. This allowed the researcher to build on her knowledge about the learners (participants) and their capabilities and limitations. Setting the research in a familiar environment could build on the trusting relationship between teacher/researcher and learners, while the theoretical models could be adjusted and simplified to suit the age group and their capabilities.

The researcher also had to continuously reflect while facilitating the research and project – providing a continual process of gaining understanding and knowledge. To a teacher and designer this happens subconsciously on a daily basis and contributes to tacit knowledge, but the systematic research process, theoretical understanding and documentation allowed the researcher to be specifically more conscious of the knowledge gained during the research process. The action research process also allowed a rich experience and learning curve that would not have been possible to achieve using any other research method. From the feedback from learners, it appeared that the benefit was mutual in terms of experience.

A challenge was to balance the role of active participant and research observer. This was achieved by offering guidance about the process but not intervening in the actual execution of learners' artworks. As an art teacher, the researcher was already especially sensitive to

the need, in any teaching situation, to provide only information and some direction, as every learner has his or her own skills, talents, perceptions and interpretations, and needs to develop his or her own end product without the teacher's interfering with the creative process. This is a valuable lesson for any teacher – to allow learners the opportunity to think for themselves and sort problems out independently.

5.2.2 Visualising the process

As part of reflection, the researcher designed Figure 25 to simplify and visualise the design thinking process she used with the learners at her school. This is not a linear process and the learners would cycle back to any of the former steps as necessary. This is therefore a cyclic process, not following a specific order:

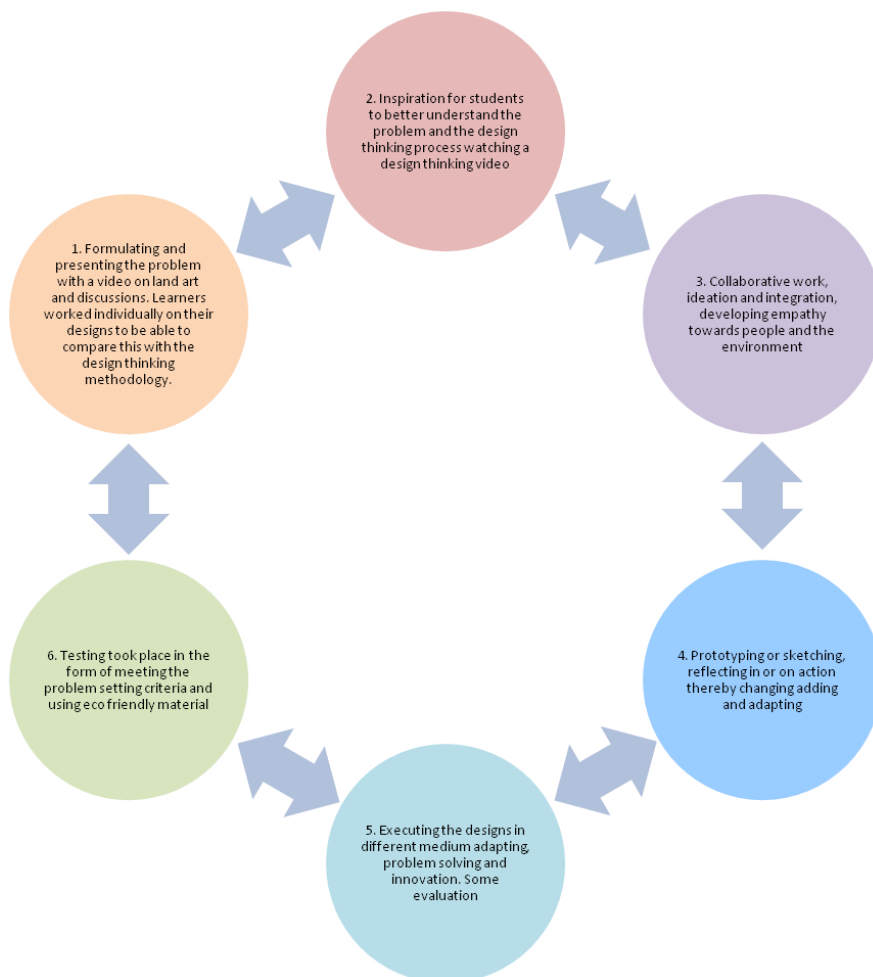


Figure 25 The design thinking process used with the learners in this research.

Created by the author

1. In formulating and presenting the problem, the learners watched a video on environmentally friendly land art. During this stage the learners started developing an understanding of the problem that kept on developing throughout the whole process. They started their drawings on an individual basis, enabling the researcher to use this as a control project when measured against each learner's application of the design thinking methodology. This was also to help them to understand the influence of design thinking skills as against their individual skills.
2. Inspiration to better understand the problem included the two design thinking videos on design thinking skills. The skills were reinforced by handing out photocopies (copied from the videos) of the different steps in the videos.
3. During collaborative work and ideation among the learners, the learners brought their different skills together, which acted as an innovative process. As they first of all concentrated on the problem with which they were faced, the learners clearly developed a more human-centred approach, with empathy towards people and the environment and the effect of the one on the other. This process also linked to their existing knowledge learned during other subjects and their general knowledge of the environment.
4. In the prototyping, planning and drawing of their designs, they discussed their ideas and the facilitator saw how they reflected on their ideas and added and changed some of their drawings; she saw some development of problem-solving skills during this process. The process of reflecting in action and on action showed itself at this stage as well. The learners were not afraid to take risks and the researcher noted their creative confidence growing. They were often aware of this change as the innovative process intuitively took place.
5. During the executing of the design in their different groups, with a different medium from that used in the planning they had done in class, the researcher saw much adapting and changing of some parts of their designs. They actually showed much confidence in trying to overcome the difficulty of how a different medium responded during the execution, and seemed to enjoy the whole process. The researcher noted their skills of evaluating their own work and deciding when to adapt the design and when to leave it as it was at that stage.
6. The only form of testing was to take note that they had succeeded in fulfilling the criteria of using environmentally friendly materials that would not harm the

environment or people, and that this type of art would just be reabsorbed by nature with time.

This whole process moved through the different stages more than once, as a repeating cyclical process.

5.3 Outcome: potential of design thinking methods at school level

During the research the objective of determining the characteristics and methodology of design thinking suitable for learners of this age was determined as set out in the diagram and discussion. The learners adapted quite easily to the design thinking process they were taken through, especially as their creative confidence grew.

The real-life situation which was presented to the learners was an environmental problem which also relied on their former knowledge as learned through many of their other subjects and some exposure during their lives through TV, observation, reading and discussions with their parents and other people. They could therefore rely on an interdisciplinary approach which was already in place, despite the limited time available for the workshop itself. The project itself was environmental art, which exposed them to executing their ideas in a different medium, which added another challenge and opportunity to develop their problem-solving skills.

This investigation of the possibilities of design thinking in a school situation proved to be successful. It shows much potential for implementing this in other subjects at school and many other real-life situations.

In reflecting on, interpreting and evaluating the outcomes of the project, the researcher became more and more aware of the positive benefits of developing learners' problem-solving skills and creative confidence, as well as developing their skills and talents in a more balanced and holistic way. The design thinking methodology influenced their thinking skills, providing them with so much more than an individual approach to any problem. They realised that they could take risks and fail, try again, reflecting while working, until they came to a solution which worked better than the initial one. They also saw that there can be more than one solution and not only one right answer, as so often is the case at school with their other subjects. Their empathy towards the specific topic clearly developed as they gained more understanding. Their enthusiasm and enjoyment of the project also increased as they became active participants in working with the learning material at hand. They became fully involved, therefore, not just passively receiving learning material or even remaining disengaged, but cooperating and learning much more than in many other situations.

5.4 Issues of credibility and research quality

The overarching question to ask when conducting qualitative research is whether the research is trustworthy. Trustworthiness can be achieved through credibility, transferability, dependability and confirmability of the research (Koonin 2014: 258-259). The credibility of this research was attained by the accuracy and believability with which the researcher interpreted the results. This was increased by triangulation (using more than one method of data collection, such as field notes, photographs, videos and focus groups). Credibility increases when findings are believable to the participants. This was found to be so during the focus group discussions.

Transferability in this case mean that the process can be used in different situations and contexts. This study was partially based on the research done by authors such as Carroll *et al* (2010), Faust and Howland (2013) and Burmeister (2013), as well as design thinking approaches conducted in other situations such as used by IDEO. This study is therefore part of the current research done on design thinking. Moreover, the design thinking approach was adjusted to specifically suit schoolchildren in grade 7. By following this research approach, similar studies could be conducted at various school levels and other real-life contexts. The researcher therefore has come to the conclusion that this research is transferable to similar situations by other researchers.

Dependability, quality of the process of integration and confirmability refer to the data collection method, data analysis and theory generated (Koonin 2014:259). The systematic gathering of research data, analysis and generation of a model contribute to the dependability of this research. One of the characteristics of confirmability is that if the research data was studied by other researchers, they would come to a similar conclusion. The researcher believes that this study adheres to this requirements. Although the researcher was an active participant, the process of not actively giving advice during execution helped in maintaining a balance and avoiding bias.

The research process thus helped to achieve the aim and objectives of this study.

5.5 Limitations

The study was representative of a small group of learners from one school although they did represent the South African diverse culture and came from different socio-economic backgrounds. A selection of design thinking methods was applied, and not the full range of characteristics of design thinking. Limited time after school hours within a rigid school system limited the length of time spent per workshop session, as did other academic

demands the learners had to fulfil. Other practical issues included limited time and budget. However, this type of research, one of the first of this nature conducted in South Africa, should provide a platform for future research.

One of the limitations was the short notice that the researcher received giving her the go-ahead for the workshops, only two weeks before the learners' final exam. The execution of the third and fourth workshops became extremely difficult after the exam, as many learners do not come to school at all after the exams. This problem was escalated by various factors: transport problems; parents who had already made other plans to go on holiday; some of the learners having to take care of younger brothers and sisters; a family bereavement or medical appointments. This was discussed with the other grade 7 educators, and then with the principal, Mr Pillay, who graciously allowed the researcher to hold the last and fourth workshop on Friday 28 Nov 2014 between first- and second-break during school time, which gave them about two hours' time to work.

5.6 Conclusion and potential for future research

Learners in primary school are still at a receptive age, eager to accept and learn new innovative ideas and to develop their creative confidence. The researcher sees this as an important age at which to be exposed to design thinking skills and to develop problem-solving skills. This could actually be implemented at an even younger age, to better prepare learners to participate and be aware of their own learning process, instead of passively relying on the teacher and their textbooks.

This research proved to be successful, as the learners progressively showed design thinking skills. They might not have been aware of their development as the researcher saw it, but the objective was to test the development of their problem-solving skills as they were exposed to design thinking skills. These skills have much potential to help prepare young learners to solve complex problems as presented in the twenty-first century, especially in a multi-cultural, socially complex country like South Africa. Design and science thinking as complementary thought processes can contribute to advisory tasks of dealing with 'wicked' problems and coming up with desirable solutions. As Albert Einstein states: "a problem cannot be solved at the same level it was created" (Lipton & Bhaerman 2010: xix).

As the researcher sees it, there is unfortunately not much scope for design thinking in the rigid way the public education curriculum is practised at the moment. The approach would probably be better accepted by South Africa's private schools. It is a paradox that knowledge about the way people learn is increasing, yet our education system seems to apply very little

of this with its standardised method of teaching and continual testing, concentrating mainly on the languages and mathematical subjects. This is not a balanced and holistic approach to accommodate all the learners with other talents, and does not develop learners' general abilities to the full.

However, the researcher finds it encouraging to see how much intuitive design thinking is present when teaching and in the response of some learners, and believes that this can be encouraged and developed during teaching and learning of any area, even in informal situations.

The implications for design thinking in schools are myriad, in view of the impact it has on the ways in which learners engage in the learning process and how it challenges them to think in new ways and take risks. It has much potential as a tool for students to become aware of where they find themselves in the learning process, enabling them to think for themselves, to develop their creative confidence and to become fully and actively engaged in their learning process.

There is much more research that can be done to teach design thinking skills to both learners and educators, as is done with great success in some US schools. The potential for future research in South Africa is enormous, as this has been very little explored; the impact of this kind of teaching and learning process and dealing with future real-life challenges has much potential and much to contribute, not only towards education but also further on in the lives of these students in the workplace and their lives in general.

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Appendices

Examples of the consent letters signed by all participants, together with the letters of approval to commence with this study are available at the Department of Visual Arts.

Consent letter for the school

Consent letter for the parents/guardians

Learner consent from



Consent letter for the school:

Dear Mr. Pillay,


This letter is to formally request to use your school as a research site. The research will take the form of a design thinking workshop, where learners would learn to apply design thinking methods during a research project on responsible manipulation of the environment.

As part of my final study for a Master’s degree in Information Design I would like to conduct a workshop at your school as an extra mural activity for about 10-15 learners. This research will explore design thinking and its potential implications for problem solving skills for grade 7 senior phase learners.

The consent of parents will be sought separately. Those learners who themselves or whose parents would prefer them not to participate or be photographed need not be involved in the workshop. A learner may also withdraw, at any time, should they no longer wish to participate.

Please indicate below:

I hereby give Mrs. Karen Rabie permission to use the Halfway House Primary School as a research site and conduct a design thinking workshop at the school:

Mr. Pillay.......... [MR SILAS PILLAY]

Date.....2014-03-17.....Signature..........



Consent letter for parents:

Dear Halfway House Primary School Parents/Guardians,

Mrs. Karen Rabie, a Masters degree student in Information Design from the Department of Visual Arts at the University of Pretoria will be holding a design thinking workshop for a selected group of students during the first term of 2014.

The learners will do an environmental art project, teaching them to use design thinking methodology. This research will explore design thinking and its potential implications for problem solving skills for grade 7 senior phase learners.

Material will be provided at school and will take place during the art club time on Wednesday afternoons in the art class and on the school grounds. There will be five sessions of approximately an hour and a half.

The form below is to request your child to take part in the workshop. It is not compulsory and at any time during the workshop during the workshop your child no longer wishes to participate they may withdraw.

Parental consent form, please complete.

Yes I'd love

No thanks, rather exclude

Also: Some fotos and videos will be taken during the workshops for accuracy purposes for the research document. This will be safely stored at the Department of Visual Arts. If you would prefer you child to stay anonymous, please indicate so.

I dont mind my child's name may be mentioned.

I would prefer my child to stay anonymous.

Parent/Guardian name.....

Date..... Signature.....



Learner consent form

Dear Halfway House Primary School Learner,

Mrs. Karen Rabie, a Masters degree student in Information Design from the Department of Visual Arts at the University of Pretoria will be holding a design thinking workshop for a selected group of students during the first term of 2014.

The learners will do an environmental art project, teaching them to use design thinking methodology. This research will explore design thinking and its potential implications for problem solving skills for grade 7 senior phase learners.

Material will be provided at school and will take place during the art club time on Wednesday afternoons in the art class and on the school grounds. There will be five sessions of approximately an hour and a half.

The form below is to request you to take part in the workshop. It is not compulsory and at any time during the workshop during the workshop you no longer wish to participate you may withdraw.

Learner consent form.

I agree to participate in this workshop.

No thanks, rather exclude me

Also: Some fotos and videos will be taken during the workshops for accuracy purposes for the research document. This will be safely stored at the Department of Visual Arts. If you would prefer to stay anonymous, please indicate so.

I dont mind my name may be mentioned.

I would prefer to stay anonymous.

Learner name.....

Date..... Signature.....