

Chapter 4: The Design and Development of the Creativity Model

Introduction

In chapter 1, I indicated that UoTs curricular enactment in South Africa since the 1960s has been entrenched in replication of industrial processes and that their curricular mission, post-apartheid, was left untouched. In chapter 3, I focused, among other things, on a study that was conducted by Martinsen (1995) on how guided creative problem-solving can have a positive effect on students' novelty, especially those students who are pedagogically orientated towards replication and mimetic learning. Guided creative problem-solving, in this study, takes place in educational settings that are invitational, thus encouraging students to gain insight and experience on how to flexibly use creativity models to resolve problems that are complex and steeped in 'real-life' situations. In this chapter, I describe the model of creativity that I developed to guide creative problem-solving in the *learnshops*. The creativity model that I developed is underpinned by the TRIZ Method. I provide a brief overview of the historical meaning of TRIZ, the unique features that makes TRIZ stand out among the heuristic problem-solving techniques, and the key principles and essential elements that informed my design of the creativity model. I conclude by presenting my model of creativity and the refinement it underwent during a pilot phase of the study.

Overview of TRIZ

TRIZ is derived from the Russian phrase "*Teoriya Resheniya Izobretatelskikh Zadatch*" which translates into "*The theory of inventive problem-solving*" (Rantanen and Domb 2002: 1). TRIZ is a heuristic problem-solving theory that was developed by the Russian Genrich Saulovich Altshuller in 1946 and by the late fifties it had become a powerful methodology for creative problem-solving in engineering (Savransky 2000).

The uniqueness of TRIZ resides in *“the use of a relatively small number of concepts, heuristics and effective knowledge databases to solve non-routine problems of any of the classes of problems ranging from the improvement of quality or/and quantity to the search for and prevention of shortcomings through creation of fundamentally new techniques to fit new needs”* (Savransky, 2000: ii). TRIZ is also a model-based technology for generating novel ideas and solutions, and thus it becomes compatible with any type of creativity that searches for ideality of existing technologies. TRIZ, unlike other problem-solving techniques such as brainstorming which derives from random ideas generation, aims for systematic and scientific approach to the invention of new systems and the refinement of existing ones (Savransky 2000:4-7). TRIZ has proved to be effective in problem formulation, system analysis, system failure analysis and patterns of system evolution (Polivinkin, 1985; 1991; Altshuller 1984; Sklobosvsky and Sharipov 1995).

According to Rantanen and Domb (2002), TRIZ supports most of the features of good solutions because it ensures that contradictions in the system or technology are resolved through finding relevant information to eliminate these contradictions. TRIZ tends to focus on the use of idle resources thus pitching it closer to the sustainable development discourses with their emphasis on bridling the use of natural resources. TRIZ is also recognized for its reorganization of creative activities. This allows for the transition from the existing ways of conventional problem-solving, where contradictions of the technologies or systems are hidden, thus leading potentially to the use of additional resources, to new ways of systematic and creative problem-solving where contradictions are clarified, idle resources are used and ideal outcomes are illuminated early on to guide the solution space. The features of a good solution that underpin TRIZ are represented schematically in Figure 3.1.:

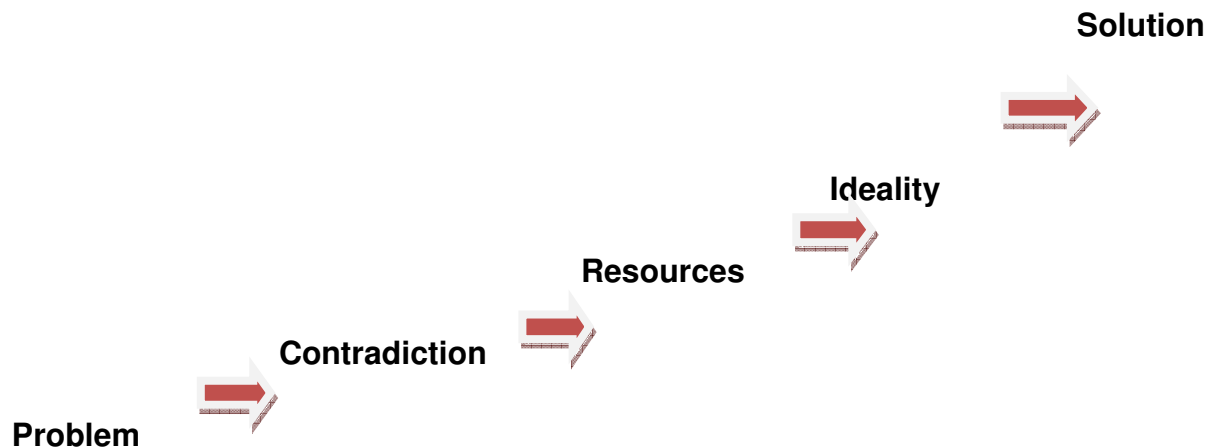


Figure 3.1: Features of good solutions (Rantanen and Domb, 2002: 7)

According to Rantanen and Domb (2002), these features of a good solution came into being as a consideration of theories X and Y as they were proposed by McGregor to be diametrically opposed models of problem-solving (McGregor, 2002). The hard model of problem-solving as described in McGregor's Theory X (McGregor, 2002) has largely been discredited because of its emphasis on control. Solutions under the hard model are mediated through budgets and time limits in an atmosphere of some asphyxiating management control. The underlying assumption of such problem-solving conditions is that people need to be controlled and directed tightly so that the end-result of this approach to problem-solving has been minor improvements but has seldom produced great, qualitatively new ideas (Rantanen and Domb, 2002:6). Rantanen and Domb (2002:7) suggest a problem-solving approach that fits McGregor's Theory Y (McGregor, 2002) where people naturally have imagination and creativity in solving problems. This creative problem-solving approach encourages free generation of ideas but lacks the rigour often associated with hard models of problem-solving. TRIZ solves the problems encountered in both these approaches to problem-solving through pursuing the understanding of the problem, modeling the contradictions, checking the patterns of evolution in the problem, removing these contradictions through using idle resources and improving the ideality of the technology or system.

Ideality refers to the pursuit and achievement of a higher design of the technology (Rantanen and Domb, 2002: 7) which means that people that seek the ideality of a technology searches for areas that make the technology not to operate near optimal level and attempt to find ways of resolving those areas of difficulty so that the near optimal status of the technology is achieved.

TRIZ problem-solving relies on the knowledge of the technology or system that needs improvement and the knowledge of the systematic method for improvement as its focus is not on whether people are creative or not but focuses on whether the ideas that are being generated to find a solution are good or bad so that good ones can be elaborated on. TRIZ method insists on knowledge and good information to resolve difficulties in the technology or system and thus thrives on research and management of various pieces of information. Hence, TRIZ calls for people to manage complexity.

The following principles and elements of TRIZ Theory were gleaned to inform the study's creativity model:

-  The use of as few as possible concepts in positing the theory. Creative problem-solving is sufficiently difficult without being obfuscated by a complicated model.
-  Its focus on both technical and non-technical problem-solving. Most of the methods for solving technical problems in engineering are unique to each specialized area of engineering (Savransky, 2000) and are thus very limiting. TRIZ problem-solving heuristics, on the other hand, increases the scope of creative problem-solving as it works well both with engineering and non-technical problems.
-  The use of systematic and scientific approaches to problem-solving. Research-based approaches almost always have a growth focus as users are more likely to generate new insights or information to guide decisions towards solutions.

🌈 Its ideality-driven approach. One of the most important aspects of TRIZ is that it seeks the near optimal operations of existing technologies which is greatly relevant to the study. Ideality search has almost always focused on any of the six classes of inventive problem-solving. These classes of inventive problem-solving are divided in terms of whether they require an entirely new solution or change in the existing techniques. Improvement or perfection in both quality and quantity of product or service class focuses on reducing contradictions in an existing system or technique. The search for and prevention of shortcomings class attempts to diagnose weaknesses, contradictions and flaws in a system or technique before they actually occur and moves towards proactiveness. Cost reduction of existing technique class attempts to trim or significantly reduce existing inputs (capital, human and physical resources) without compromising outputs (products or service). Its primary focus is on productivity of an entity. New use of known processes and systems class is analogous to trying out new ways by sensing limits and creating new insights that transform existing processes and systems into more effective instruments. Generation of new “mixtures” or hybrids of already existing elements class synthesizes these elements in ways that foreground new thinking, new insights and new ways of doing things. I have put these classes of inventive problem-solving at the heart of our creativity model together with the search for ideality of existing technologies.

For the purpose of the study, all technologies that are driven by depleting natural resources are essentially flawed and require improvement. Water, coal-based energy and wood-pulp paper production technologies need urgent attention either by way of significantly reducing unfettered use or turning to alternative resources.

Extended opportunities are offered to students in the *learnshops* to pursue the higher designs (ideality) of these technologies. Students' systematic investigation of these resources to seek their ideality brings into sharper focus the value of inventive problem-solving in the context of ideality searching and generation of novel ideas to resolve bottlenecks in the technology (Savransky, 2000). Every effort on ideality status of the existing technologies has, over many years, revealed the consistent emergence of any of the six classes of inventive problem-solving as stated earlier (Savransky, 2000; Rantanen and Domb, 2002). The use of idle resources by TRIZ is in line with general thinking in the 21st Century on environmental sustainability and issues related to recyclability. Given that TRIZ insists on credible knowledge and good information, it resonates strongly with the view that creative problem-solving is essentially research-driven. Hence, the study's educational efforts on creating learning conditions that are conducive to research-driven learning were deemed vital. Our efforts in the *learnshops* were intended to meaningfully contribute to the development of a socially relevant curriculum and set out educational settings that keep students socially engaged and conscious of environmental sustainability for posterity. Based on the key principles of TRIZ, I set out to design a creativity model for use as a guide for students during the *learnshops*. It is illustrated in Figure 3.2, and its six steps are described below.

The Creativity Model

The first critical step in the model relates to the thorough understanding of the technology at hand as a precondition for attempting its ideality. Without such knowledge of the technology any attempt on its ideality may be significantly compromised as suggested by Savransky (2000). The underlying principle in this first step of the model is to demystify the technology and the science behind it. Problem-solvers need to have a thorough knowledge of not only the design and operations of the technology under investigation but also the science and natural resources that were used in developing it.

Without such understanding of the basic issues involved in the technology under investigation, problem-solvers may find it extremely difficult to search for its near optimal status and the trade-offs that may have to be made in order to achieve the near-optimal conditions of the technology. Understanding the technology and the science that informs it is, therefore, a basic requirement in any attempt to search for its near optimal status. It is further expected that problem-solvers would take seriously the global call for reducing GHG concentrations and unfettered use of natural resources and consider the use of eco-friendly resources as part of the search for the near-optimal operations of existing technologies.

The second step will entail determining the current ideality status of the technology, putting questions that focus on whether the technology is operating at near-perfect levels. Given that almost all technologies that were designed during the industrial age were premised on unfettered use of natural resources (Korten, 1995; Castells, 2001), it was taken for granted that most existing technologies would require rethinking and possible redesign to cater for the new dwindling status of natural resources. The focus in step two is on the search for cheaper and more environmentally-friendly resources that are bio-degradable and emit less greenhouse gases (Susuki, 2009). In the *learnshops* I provided some evidence of the environmental challenges of the technologies related to water, coal-based energy and paper production. Students were expected to investigate the issues further.

The third step will relate to the causes or constraints that prevent the technology from operating at near-perfect levels. As I suggested earlier, I also expected students to add to this list of possible causes or constraints as and when their own systematic investigation points to a different set of causation or constraints. It is important to note that this step entails all the six classes of inventive problem-solving as expounded earlier. It was anticipated that students may identify factors that cause the problem within a particular technology and be able to relate them to any of the six classes of inventive problem-solving or even add new factors or causes of the problem.

For example, some technologies may not operate at near-optimal levels because of some contradictions in any of its stages of operation.

Step four will entail decisions on the transition that may be chosen by students in an attempt to resolve identified causes or constraints which would compel them to decide on the pattern of evolution that may be required to achieve the higher design of the chosen technology, even at a level of gaining insight. For example, in order to solve the problem of having to wait for a person to complete talking on a telephone, the engineers who developed mobile phones opted for a pattern of evolution that involves shift from the macro-level (telephone) to the micro-level (mobile phones). The key principle that guided the solution was the principle of segmentation. It is important to note that steps four and five are closely related and operate at the level of the solution space. In step five, the choice will be on the principle that needs to guide the solution and is directly linked to step four.

Step six will involve identifying and estimating the resources that may be required in order to resolve the factors that cause the technology not to perform near-perfect. For instance, in the case of the mobile phones, the problem-solvers had to balance the costs of producing the mobile phones and the need to make them more affordable so that both hardware and software costs had to be taken into account including the size and shape of the mobile phones.

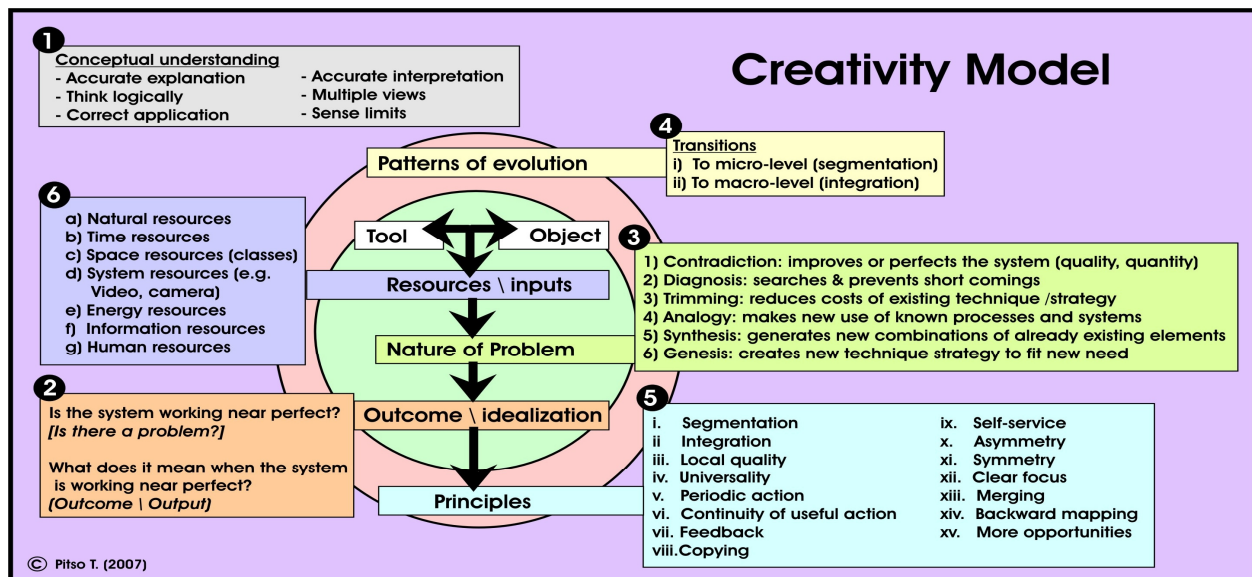


Figure 3.2: The Creativity Model developed, showing its six steps

The conceptual framework of this model was given credence by its presentation at conferences and in peer-reviewed journals. It was first presented at the International Conference on Learning held in Johannesburg, South Africa in 2007 (Pitso, 2007) and accepted for publication in the a peer-reviewed International Journal of Learning, Volume 14, Number 8 (Pitso, 2007).

In 2009, the model was presented at another peer-reviewed conference entitled 'International Multi-Conference on Engineering and Technological Innovation' held in Orlando, Florida (Pitso, 2009) and the overall rating of the paper was 9/10 as judged by three blind reviewers (Appendix 1). Prior to using the model in the *learnshops*, the model was piloted on 53 Power Engineering undergraduates and was rated, during two focus group interviews, as user-friendly by the participants. I understand that to be sufficiently skilful in TRIZ and models underpinned by TRIZ considerable time is needed and our current educational settings struggle to provide time in the existing curricular conditions that continue to be mediated mainly through industrial images of strict timelines as indicated earlier. According to Savransky (2000: ii):

“Becoming proficient in TRIZ concepts, heuristics and instruments requires time, but it results in much more effective problem-solving. As you gain extensive practice applying TRIZ, you will become so skilled in it that the problem-solving process will be less conscious and more automatic. You will also experience the joy of creativity and be able to solve problems in other fields”.

When I invited the lecturer in the planning of the *learnshops*' educational settings, I was driven by the need to provide students with ample opportunities to practise problem-solving using the creativity model I developed to guide their creative problem-solving and also expose the lecturer on how learning environments can be reorganized to serve different educational demands.

The study was organized in such a way as to still work within the framework of the semesterized curriculum of the institution and the practicalities of competing interests among students who showed increased interest in the *learnshops* but had to deal with their prescribed work as final year students.

Summary

This chapter set out to demonstrate how the creativity model that formed part of guided, systematic creative problem-solving in the *learnshops* was designed and the its theoretical underpinning that was set to be TRIZ. The brief overview of TRIZ was undertaken and the key principles that informed our model were delineated as gleaned from the TRIZ overview. We also presented our TRIZ-based Creativity Model.