

A conceptual framework to measure creativity at tertiary educational level

by

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ABSTRACT

Creativity only recently became the subject of systematic research, specifically over the past two decades. This is largely due to the fact that creativity is often misunderstood due to inconsistencies concerning the definition of creativity, the methodologies used to explain creativity as a phenomenon and the various measurement instruments to determine creative ability. Even though creativity is misunderstood, it should not be underestimated, because it is the fuel that leads to the development of new knowledge, products, services and other advances to improve human life and is an important knowledge resource in the global knowledge economy.

The knowledge economy of today places great value on education and creativity as critical knowledge resources. Education not only provides knowledge, expertise and research capabilities, but plays a critical role in the development of creative skills and educational institutions should therefore be able to measure creativity and to implement practical ways to develop these skills. The focus of this study was to investigate the measurement of creativity specifically at a general and tertiary educational level. The research indicated that there are various creativity models and measures available, but it is important to find a reliable and valid measure for creativity which can impact positively on testing and tracking of creativity in South African at a general level and at a tertiary educational level. The research also indicated that various challenges exist in developing reliable and valid instruments to measure creativity.

Several research studies were investigated to form part of a new conceptual framework to measure creativity. From an academic viewpoint, the identification and application of all the relevant influences, identified from these studies, were essential in the construction of a framework that can guide the measurement of creativity at a general and tertiary educational level.

The aim of this study was to identify the influences that are most important in measuring creativity in the tertiary educational sector in South Africa. The study led to the invention of two conceptual frameworks using the identified influences and presented the interrelationship between these influences. The primary theoretical background and concepts in creativity and measuring creativity for this study ranged from the history of creativity research, covering a total of twenty-five models between the period 1929 to 2009. The extensive review of literature resulted in the identification of 28 creativity influences that were grouped into 18 cognitive

psychology influences and 10 personality characteristics influences. These influences were then reduced into a manageable set for this thesis involved selecting the most commonly used reliable and valid creativity influences. This led to the identification of 9 influences to measure creativity at a general level and 11 influences to measure creativity at a tertiary educational level.

The empirical study was conducted among a sample of 500 undergraduate students, per questionnaire, from the North-West University in Potchefstroom (NWU). The empirical study based on the selected 9 and 11 influences respectively yielded results that measured the strength of each influence and the interrelationship of influences. The results were analysed by the process of factor analysis, and were presented in the form of two conceptual frameworks to measure creativity (one at a general level and the other at a tertiary educational level).

The results of the study confirmed that different influences have different effects on measuring creativity. The conceptual framework to measure creativity at a general level (CF1) included external factors that influence creative potential, for example, religion, culture and family. The conceptual framework to measure creativity at a tertiary educational level (CF2) included cognitive and thinking processes required at tertiary educational level, for example, synthesis, association and experimentation.

The uniqueness and value of the study lies in the evaluation of various creativity influences that was collectively assembled in two conceptual frameworks that were then compared by using a comparative analysis to determine the most suitable framework for a tertiary educational setting. The most important contribution of the study is therefore the construction of these conceptual frameworks through which creativity could be measured.

Keywords: creativity, creativity models, creativity approaches, creative thinking, creativity measurement instruments, tertiary education

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LIST OF ABBREVIATIONS

CFA	-	Confirmatory Factor Analysis
CF1	-	Conceptual framework to measure creativity at a <i>general</i> level
CF2	-	Conceptual framework to measure creativity at a <i>tertiary educational</i> level
EFA	-	Exploratory Factor Analysis
FE	-	Further education
HE	-	Higher education
KMO	-	Kaiser-Meyer-Olkin measure of sampling adequacy
NWU	-	North-West University of Potchefstroom
ROI	-	Return on investment
SAS	-	Statistics Analytical System
SPSS	-	Statistical Package for the Social Sciences

CHAPTER 1

NATURE AND SCOPE OF THE STUDY

1.1 INTRODUCTION

The post-modern global economy can be described as the knowledge economy which is marked by technological innovations, the globally competitive need for innovation and the development of new products and processes to improve human life and solve problems on the planet (Baron & Shane, 2008:77). The knowledge economy became important in the late 1900s-2000s and is largely focused on technology and human capital. The transition from the post-industrial period required that the rules and practices that determined success in the industrial economy were rewritten to meet the demands of a globalized and interconnected economy. In the current economic landscape, human capital is more likely to be valued for intellect, social skills, and reputation (DeNisi, Hitt & Jackson, 2003:4-6). Knowledge resources such as information, computer networking, education (to gain know-how and expertise) and creativity are as critical as other economic resources and conventional production factors.

It is interesting to note that Drucker (2002:3-5) had already introduced the concept of a “Knowledge economy” in 1966 in his book “The effective executive”, in which he identified a knowledge driven economy as an prerequisite for economic growth and development. Todaro (1999:299-300) supported the knowledge economy theory and pointed out that education and society’s propensity to instil innovative change are key drivers to further develop a modern knowledge driven economy. More recently, the World Bank identified four key criteria that a country should meet before the country is able to participate in the knowledge economy, namely that a country should have (Worldbank, 2011:1):

- a National Innovation System (NIS) that allows for the flow of technology and information among people, enterprises and institutions,
- an educational system,
- a sound institutional and economic regime; and
- a telecommunications infrastructure.

The term *knowledge-based resources* refers to skills, abilities, and learning capacity. People can develop these through experience and formal training (DeNisi, Hitt & Jackson, 2003:6). Creativity and tertiary education play a critical role in the knowledge economy and can be linked together; education, and specifically tertiary education, is critical in this economy because education provides knowledge, know-how, expertise and research communities. Tertiary education can utilize creativity in the development and delivery of tertiary educational programmes, measure students' creativity and develop critical creativity skills in students in various disciplines. Robinson (in Vilalba, 2008:4) stressed that creativity is just as important in education now as literacy and that it should be treated with the same status.

Creativity plays a key role in innovation and impacts greatly on the rise of the creative class (Pink, 2005:1-2). The focus of this economy is on fostering and encouraging right-directed thinking (representing creativity and emotion) over left-directed thinking (representing logical, analytical thought). Creativity can be taught and developed through tertiary education.

Tertiary education and creativity are therefore important resources that have the potential to reshape countries, companies, communities and people. De Bono said that creativity is the most important resource of all, because without creativity, there will be no progress and people will not be able to come up with creative solutions to solve national and international problems (Infinite Innovations Ltd, 2006:1).

The focus of this study is to determine how creativity can be measured at a general level and at tertiary educational level specifically, in an effort to understand creativity as a phenomenon and as resource in the knowledge economy.

1.2 CONCEPTUAL DEFINITIONS

The following definitions are important for this study.

1.2.1 Knowledge and knowledge economy

Knowledge refers to the theoretical or practical understanding of a subject, which can include factual information and descriptions, and/or skills acquired through education or experience.

Knowledge can be implicit (practical skill or expertise) or explicit (theoretical understanding of a subject) (Sun, Mathews & Lane, n.d.:2-3). Knowledge acquisition involves cognitive processes like perception, learning, communication, association and reasoning. Tertiary education plays an important role in acquiring implicit and explicit knowledge.

Knowledge is also viewed as reliable information that can be put to work in the service of people, and which can be communicated in comprehensible ways so that people everywhere can become more self-reliant and self-sufficient. Knowledge is the ultimate economic renewable source as it is not depleted by use and the value of knowledge to an economy comes from sharing with others.

The knowledge economy describes a set of new sources of competitive advantage which can apply to all sectors. These sources are the effective use of knowledge, skills and innovative potential (Brinkley, 2006:1-3).

1.2.2 Creativity

Creativity is a mental and social process involving the discovery or new association of ideas or concepts which is fuelled by the process of either conscious or unconscious insight. Creativity can be seen as an “assumption-breaking process” where creative ideas are generated when one discards preconceived assumptions and attempts a new approach or method that might seem unthinkable to others. Torrance observed that creativity is “a successful step into the unknown, getting away from the main track, breaking out of the mould, being open to experience and permitting one thing to lead to another, recombining ideas or seeing new relationships among ideas” (Afolabi, Dionne & Lewis, 2009:2). The accepted definition of creativity is the production of something original and useful. Creativity is not about inventing something totally new, but rather about making new – synergistic – connections.

Hitti (2008:1) explains, “For creativity to have a chance, the brain needs to get out of its own way and go with the flow.” This means that the brain's dorsolateral prefrontal and lateral orbital regions should be less active and the medial prefrontal cortex should be more active. The ‘quiet’ brain regions are involved in consciously monitoring, evaluating, and correcting behaviours; while the medial prefrontal cortex allows self-expression and the brain's sensory

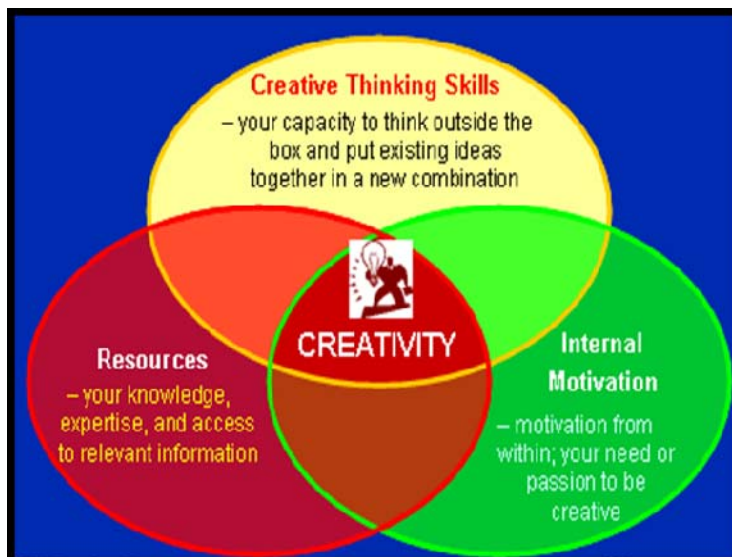
regions need to be more active. According to Braun (in Hitti, 2008:1), it's almost as if the brain ramps up its sensorimotor processing in order to be in a creative state. Braun (in Hitti, 2008:1) states further that there is no single creative area of the brain but “when you move from either of the control tasks to improvisation, you see a strong and consistent pattern of activity throughout the brain that enables creativity.”

Creativity occurs on the right side of the brain when ideas are sparked, but to make creativity useful requires both divergent thinking (generating many unique ideas) and convergent thinking (combining those ideas into the best result), which can be taught, according to Kaufman (Bronson & Merryman, 2010: 21, 23).

Kotelnikov (2010:1) indicates that three elements are vital for an individual to be creative as illustrated in Figure 1.1, namely:

- The individual must have creative thinking skills;
- The individual must have the passion to be creative (internal motivation); and
- The individual must have the necessary resources.

FIGURE 1.1: CREATIVITY IN INDIVIDUALS



Source: Kotelnikov (2010:1)

1.2.3 Tertiary education

Tertiary education, also referred to as further education (FE) or higher education (HE), includes undergraduate and postgraduate education. Colleges and Universities are the main institutions that provide tertiary education and can be public or private institutions. Successful completion of tertiary education generally concludes in the receipt of certificates, diplomas, or academic degrees.

1.2.4 Innovation

Creativity is needed for innovation. Innovation is the process of both generating and applying creative ideas in some specific context. In other words, innovation involves the introduction of something new and valuable – an artefact or a method – into a functioning production, marketing, or management system, according to Cropley (2008:257).

Innovation, according to Kotelnikov (2010:1), occurs at six interwoven areas in the organisation, namely organisational-, strategy-, technology-, process-, product- and marketing innovation. These seven interwoven areas are illustrated in Figure 1.2 below.

FIGURE 1.2: SYSTEMATIC APPROACH TO INNOVATION



Source: Kotelnikov (2010:1)

Afuah (in Cropley, 2008:258) indicates that new technological knowledge and new market knowledge to processes and people lead innovation. Christensen, Anthony and Roth (in

Cropley, 2008:258) indicate that three factors define an organisation's strengths and weaknesses in relation to the innovation process, namely:

- What a firm has (the importance of resources),
- How a firm does its work (the importance of processes), and
- What a firm wants to do (the firm's values).

Innovation is tied to behaviours, actions and personalities of the individuals, or actors. Luecke and Katz (in Cropley, 2008:258) highlight two stages in the process of innovation where these behaviours, actions and personalities play an important role, namely:

- Invention that consists of idea generation, idea evaluation and opportunity recognition (creativity), and
- Exploitation that consists of development and commercialisation (innovation).

Organisations need systems to be in place that provide the proper measurement, motivation, incentives and rewards to foster innovation that is aligned with the innovation strategy. It is necessary to design a system that encourages innovation and a structured process that guides the development of ideas.

Innovation in an organisation is often used to refer to the entire process by which an organisation generates creative new ideas and converts these into useful and viable commercial products, services and business practices and is often referred to as "*thinking outside the box*". Thinking outside the box is a helpful state of mind when trying to come up with a solution to a problem. It is a way of looking at something and turning it on its head in order to come up with a new answer.

1.3 PROBLEM STATEMENT

In some countries, like the United States of America (USA), creativity scores have been declining since the 1990s due to the lack of creativity development in schools and the lack of children's participation in creative activities (Bronson & Merryman, 2010:21). This has a spill-over effect on tertiary education. This trend was determined after 300 000 Torrance scores of children and adults were evaluated. The most concerning trend is that this decline is specifically prominent in pre-school to grade six children.

When this study was undertaken, there was no indication that the South African Government focused on creativity in schools or at tertiary education level. There was no evidence that creativity testing and tracking of children in South Africa were undertaken to determine if a similar trend is occurring in South Africa. Furthermore, innovation is (according to the Department of Science and Technology, (2007:25)) a national priority while, unfortunately, creativity (according to the National Development Plan for 2030 led by Minister Trevor Manuel (Anon., 2011:146-147)) is not viewed as one. However, creativity is needed for innovation (Crompton, 2008:257). This lack of focus on creative development could seriously impact negatively on the competitive advantage of South Africa in a knowledge economy.

In other countries, creativity development is a national priority. These countries realized the important role of creativity. The British secondary-school curricula, for example, were revamped to emphasize idea generation and Torrance's creativity test was implemented to assess the progress of children. The European Union designated 2009 as the *European Year of Creativity and Innovation*. Conferences on the neuroscience of creativity, the implementation of problem-based learning programs and financing teacher training are some of the actions taken in 2009 in Europe. The educational system of China was reformed to adopt a problem-based learning approach (Bronson & Merryman, 2010:21). The focus on creativity in problem-based learning will help Britain, the European Union and China to become more competitive and to develop their economy to create a better life for all its citizens.

It is evident from the discussion thus far that creativity and education are closely related in the knowledge economy. It is important to measure creativity to gain insight in the creative potential of individuals. Results, based on valid and reliable research, can then offer valuable insight into the creativity of individuals and plans can then be put in place to develop this critical skill in individuals at various levels in society. This will be valuable especially at tertiary educational level to ensure that graduates are competent to meet the challenges of a complex, volatile and uncertain globalized knowledge economy.

Due to the inconsistencies concerning the definition of creativity in various disciplines, inconsistencies in the methodologies that are used to measure creativity, issues of subjectivity, issues of honesty in self-assessments and the low correlational ratings of

creativity tests in terms of measures of real-life creativity (Vilalba, 2008:4), it appears that it is difficult to identify one reliable and valid measure that can measure creativity at tertiary educational level, and specifically a measure for a South African tertiary context.

Various creativity models and measures are available, but it is important to find a reliable and valid measure for creativity which can impact positively on testing and tracking of creativity at South African tertiary educational institutions. South African graduates without creativity skills can impact negatively on their firms' ability to be competitive, innovative and its ability to solve complex problems. This can have a negative effect on South Africa's ability to compete in the knowledge economy.

There is therefore a need to study creativity as a phenomenon, and creativity models, tests and tools specifically, to create a valid and reliable conceptual framework that can be utilized in the measurement of creativity in tertiary education institutions in South Africa.

1.4 STATEMENT OF PURPOSE

The purpose of this study is to examine creativity models, tests and tools to identify factors to measure creativity and to create a valid and reliable conceptual framework to measure creativity at tertiary educational level.

1.5 RESEARCH QUESTIONS

Quantitative research was used in this study and the following research questions were posed to narrow the purpose statement:

- How can creativity be defined and explained?
- What are the unresolved issues in creativity research and measurement of creativity?
- Which creativity models, tests and tools exist?
- How effective are these creativity models, tests and tools to explain and measure creativity?
- What are the challenges in measuring creativity?
- Which factors can be used to measure creativity at a general and tertiary educational level?

- Can a conceptual framework be developed to measure creativity at tertiary educational level and what should this conceptual framework look like for the South African tertiary educational context?

1.6 RESEARCH OBJECTIVES

The primary objective of this study was to construct a conceptual framework to measure creativity at tertiary educational level in the Republic of South Africa.

The secondary research objectives were to:

- Clarify the concept of creativity by performing an in-depth theoretical study thereof;
- Theoretically examine creativity research approaches since 1929 in an effort to determine how creativity can be measured;
- Extract and select creativity influences from literature;
- Identify measuring criteria for each creativity influence;
- Construct a measuring instrument from the literature to measure creativity at a tertiary educational level (Questionnaire 1);
- Construct a measuring instrument from the literature to measure creativity at a general level (Questionnaire 2);
- Purify these two measuring instruments and determine the reliability of the data;
- Test both these measuring instruments for structural and content validity;
- Compare the two conceptual frameworks (CF1 and CF2); and to
- Recommend a valid and reliable conceptual framework to measure creativity at tertiary educational level.

1.7 RESEARCH PHILOSOPHY

The researcher used *Positivism* as the main philosophy of the study and also considered the impact of the *Post-Positivism* philosophy.

1.7.1 Positivism

The basic reasoning of positivism assumes that an objective reality exists which is independent of human behaviour (Crossan, 2005:49). Reasoning about an objective reality moves from theoretical ideas to a logical conclusion through deductive thinking. Deductive thinking works from the more general to the more specific, for example, theory moves to hypothesis, which then moves to observation, and then to confirmation. This enables a researcher to test the hypotheses with specific data, which either confirms or does not confirm original theories (Trochim, 2006:1 & Dash, 2005:1).

Positivism supports quantitative research that uses numerical measurements and statistical analysis of measurements, for example, experimental design and surveys. The advantage of this approach is that it places emphasis on objectivity, reliability of findings and encourages replication (Anon., 2004:1).

The major criticism of the positivist approach according to Trochim (2006:1-2) is that it does not provide the means to examine human beings and their behaviours in an in-depth way which might be required in this study.

The researcher decided to use the positivist approach to achieve the objectives of this study. The approach encouraged the use of questionnaire surveys to gather data and then analyse data statistically. The researcher has compiled a questionnaire where respondents were required to choose between options on a 7-point Likert scale. Each rating was linked to a numerical number, which enabled the researcher to quantify responses.

1.7.2 Post-positivism

For the post-positivist researcher reality is not a rigid thing and does not exist in a vacuum. There are various factors that influence reality construction and the most significant factors are culture, gender and beliefs. These factors influence individual behaviour, attitudes, external structures and socio-cultural issues. Post-positivism gathers evidence that is valid and sound proof for the existence of phenomena and do not claim that it provides that absolute truth through the establishment of generalisation and laws like positivism. This philosophy is open to the fact that the potential observation that was previously thought to be true was in fact false.

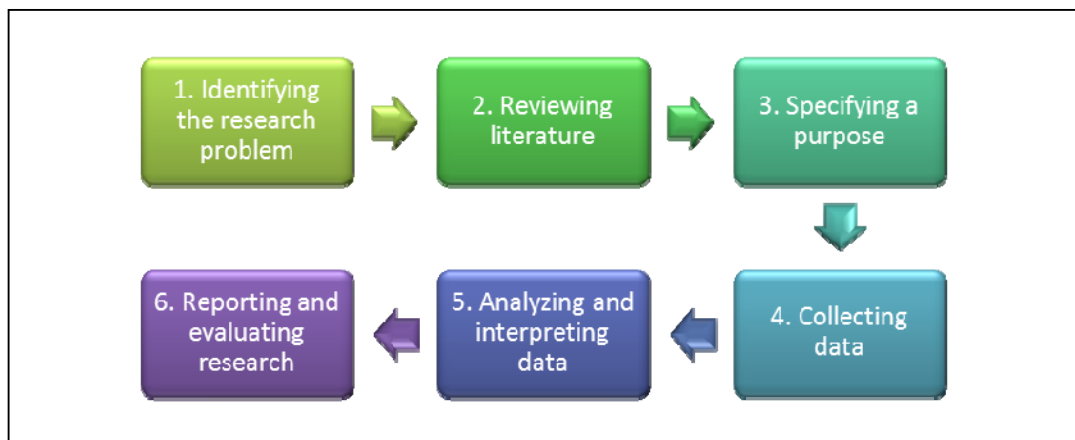
This falsification (disproving of theories and laws) is more useful than verification, as it provides more useful research questions and practices. The researchers using this philosophy should be intentionally critical and test ideas against the evidence from the data gathered (Crossan, 2005:53; Dash, 2005:1).

The researcher will consider the impact of this philosophy because this approach is beneficial to assess the emotional and human experience of the respondents and access underlying issues regarding the measurement of creativity at tertiary educational level. The approach however could be expensive and time-consuming and the researcher feels that posing questions in the form of a questionnaire would ensure that confidentiality would not be compromised and the sample will easily be reached.

1.8 RESEARCH METHODOLOGY

The following research process cycle was used in this study.

FIGURE 1.3: RESEARCH PROCESS CYCLE



Source: Own compilation

Research is a process in which the researcher collects and analyses information to increase understanding of a topic or issue. The researcher starts off by identifying a problem that defines the goal of the research (point 1 in the research process cycle). Literature is then reviewed to gather data about the problem and to help find solutions or to gather information to support predictions (point 2). The purpose of the study is then specified (point 3).

The research design (point 4-6) of the research process cycle will be discussed in more detail below because it forms the foundation of the whole study that will follow in the next chapters.

1.8.1 Research design

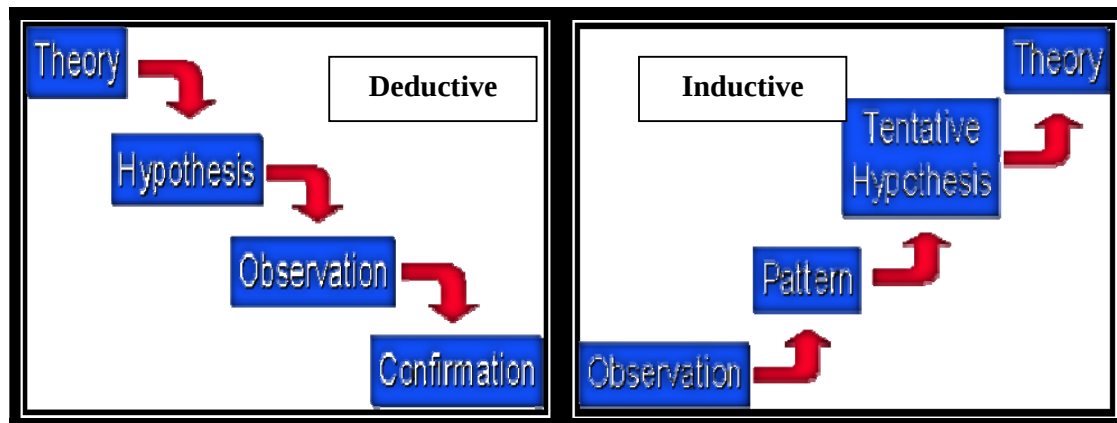
The research design is the plan that the researcher used to collect data and to ensure that the research is not biased and that the results are valid and reliable.

There are two broad types of reasoning (Trochim, 2006:1) that the researcher considered during the research design namely:

- Deductive reasoning that works from the more general to the more specific, and
- Inductive reasoning that moves from specific observations to broader generalizations and theories.

The differences are illustrated in Figure 1.4 below.

FIGURE 1.4: DEDUCTIVE REASONING VERSUS INDUCTIVE REASONING



Source: Trochim (2006:1)

The researcher used deductive reasoning or the top-down approach in this study because it works from the more general to the more specific. The multivariate statistical technique factor analysis was utilized in this study specifically (see 1.8.2.5.2 for detail about factor analysis). The reasoning started with a theory about creativity based on various creativity models, tests

and tools. It was then narrowed down into specific creativity influences that were tested. From there, specific factors were identified to measure creativity and a conceptual framework was developed. This type of research is narrower in nature than inductive reasoning and supports the positivist philosophy.

The researcher realised that at a PhD level of study inductive reasoning or the bottom-up approach could also add value and that most social research involves both inductive and deductive reasoning processes at various stages in the research process (Trochim, 2002:1-2). The researcher therefore evaluated different models and focused on the detection of patterns and regularities in creativity models as well; however, deductive reasoning was mainly used because this study cannot end with general conclusions and theories as the aim was to create a specific framework to measure creativity.

1.8.2 Collecting quantitative data

1.8.2.1 Determining the participants of the study (target population)

The first step in the process of collecting quantitative data is to identify the people to study (Creswell, 2008:141). The researcher asked four questions to determine the unit of analysis, the group that will be studied, the procedure to select participants and the number of people needed for the data analysis.

The first question was, “*Who does the researcher want to generalise to?*” This question refers to the theoretical population and in this study it will be the tertiary educational sector in South Africa. The theoretical population (tertiary educational sector) is too large for the researcher to attempt to survey all of its members.

The second question was, “*What population can the researcher get access to?*” This question refers to the study population and in this study the focus was on undergraduate tertiary students from the North-West University in Potchefstroom (NWU). Ethical clearance was obtained from NWU’s Ethics Committee to conduct the study and to use this study population.

The third question was, “*How can the researcher get access to them?*” This is the sampling frame and the researcher received permission to randomly distribute and collect questionnaires at the NWU Potchefstroom Campus.

The final question was, “*Who is in the study?*” This question refers to the specific sample for the study. As the theoretical population was too large, a smaller sample was used to represent the population and reflected the required characteristics of the population for this study. The study aimed to use at least 500 undergraduate students in the named sector and the aim was to obtain a 60% response rate which will result in 300 usable results.

1.8.2.2 Sampling

The researcher decided to use convenience sampling. This method is used in exploratory research where the researcher is interested in getting an inexpensive approximation of the truth (Castillo, 2009:1). This non-probability method is less complicated than other sampling methods and is often used during preliminary research efforts to get a gross estimate of the results, without incurring the cost or time required to select a random sample. This method is useful in pilot studies and suitable if questionnaires are used as research instruments.

The researcher is aware of various challenges that must be considered when sampling is done. The biggest problem with convenience sampling is that there is no evidence that the sample will be representative of the population the researcher wants to generalise to. This problem was avoided because undergraduate NWU students were identified during lecture periods and were asked to complete the questionnaires. The questionnaires were collected just before lecture periods ended. The population was therefore representative of the target population and no-one could pose as a student due to various access control mechanisms at the University.

Another challenge is that sampling is a difficult multi-step process that makes the introduction of a systematic error or bias possible. The Varimax rotation was used to purify the instrument and to eliminate all non-loading criteria as well as the criteria that dual-load strongly on more than one factor (Field, 2002:449-450)

It might also not have been possible to have access to the full sample identified and therefore the aim was to get a 60% response rate.

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was also used to ensure that sampling was adequate for the study (Field, 2002:445).

1.8.2.3 Research instruments

The researcher decided to use a questionnaire as the research instrument. The reasons for adopting this approach were that:

- Questionnaires enabled the researcher to obtain a large amount of data from a sizeable population;
- The use of questionnaires permitted the researcher to study more variables at one time than is typically possible in laboratory or field experiments. The researcher considered it to be the most economical way of gathering data;
- Questionnaires made it possible to generalise to a larger population; and
- The use of questionnaires enabled the researcher to pose the exact same set of questions to subjects. The aim was to collect descriptive and explanatory data about opinions and behaviours that influence creativity and the measurement of creativity.

Questionnaires, therefore, supported the positivist and deductive approach that the researcher followed.

The researcher, however, acknowledged that using questionnaires has a negative side as well. This negative side includes various issues for example:

- It is very difficult to realise insights relating to the causes of or processes involved in the phenomena measured, especially if closed questions are being used.
- There are also sources of bias such as the self-selecting nature of respondents, the point in time when the survey is conducted and personal bias of the researcher when choosing the research design. Often this is not done on purpose and the researcher tried to eliminate bias as much as possible. The researcher's awareness of possible bias when choosing the research design enabled the researcher to be careful and evaluate various options before deciding on the research design for this study.
- It is time consuming to construct a questionnaire and analyse the data. Getting responses are dependent on the goodwill of the respondents towards the researcher and

the research topic. Respondents will be more willing to respond if they can be convinced of the benefit that it will have for them.

1.8.2.3.1 Questionnaire development

Two questionnaires were developed in an effort to find the best measurement tool for creativity at tertiary educational level. The guidelines of Leung (2002:144) were used to design and structure the questionnaire. The guidelines assisted in the development objectives; determining the sampling group, writing and administering the questionnaire and finally interpreting the results.

To construct the questionnaire, creativity influences were identified, reduced and operationalised. The number of items in the questionnaire per influence were then determined and ranged between two to twelve questions per influence. Table 1.1 outlines the number of items per influence for general creativity and Table 1.2 outlines the number of items per influence for creativity at tertiary educational level below.

TABLE 1.1: NUMBER OF ITEMS PER INFLUENCE (GENERAL CREATIVITY)

NO.	INFLUENCE	NUMBER OF ITEMS
1	Eight dimensional thinking	8
2	Fluency	3
3	Motivation	7
4	Cognition	9
5	Communication	2
6	Originality	3
7	Synthesis	4
8	Culture	3
9	Environment	12
	Total number of items	51

TABLE 1.2: NUMBER OF ITEMS PER INFLUENCE (CREATIVITY AT TERTIARY EDUCATIONAL LEVEL)

NO.	INFLUENCE	NUMBER OF ITEMS
1	Eight dimensional thinking	8
2	Fluency	3
3	Motivation	7
4	Cognition	9
5	Communication	2
6	Originality	3
7	Synthesis	4
8	Sensitivity	3
9	Four dimensional thinking	4
10	Development	5
11	Imagination	7
	Total number of items	55

The origins of questionnaire items were linked to specific sources based on the literature study and two structured questionnaires were created. Attached to the questionnaires was a covering letter that consisted of an introduction message to encourage participation, an explanation of the purpose of the study and clear instructions on how respondents should complete the questionnaires (See Annexure B & C).

The questionnaires consisted of two sections.

- Section A contained the demographical information and included aspects like age group, gender, residence, mother tongue, year of study, mode of study and faculty of study.
- Section B contained the creativity influences and items linked to these influences. The section consisted of closed questions linked to a 7-point Likert scale. A Likert scale was used because it is easy to understand, lead to consistent answers and responses can easily be captured, analysed and evaluated (Syque, 2010:1).

The two structured questionnaires used in this study were distributed directly to the sample and collected after the questionnaires had been completed.

The researcher acknowledged the existence of demographical variables and aimed to ensure that the questionnaires are culture/ language sensitive to avoid misunderstanding and misinterpretations of the questions asked. This was tested in the pilot study. The demographical information was used to create a profile of the respondents in terms of different age groups and gender groups.

1.8.2.3.2 Pilot study

The pilot study was conducted to identify flaws and misunderstanding of questions, ambiguous instructions and inadequate time limits before sending it out to respondents. This ensured that the questionnaire allowed for demographical variables by being culture/ language sensitive.

The pilot study group consisted of ten undergraduate students. These undergraduate students represented a small sample but provided valuable feedback to ensure that the questionnaires were clearly understood. These undergraduate students did not form part of the main survey.

The feedback was carefully evaluated and the required changes were made in the questionnaires. Changes included small spelling errors that were rectified, changing of questions that had two questions in one and general layout issues, for example lines were added in Section B, Point A: Eight dimensional thinking, to make reading easier.

1.8.2.4 Data collection

The researcher adopted the positivist and deductive approach in the research design. Questionnaires were distributed directly to the respondents in lecture halls, and they completed the questionnaires under supervision of trained research assistants (honours students in research methodology). The completed questionnaires were collected immediately after completion. Two sets of data were collected from the sample. The first questionnaire collected data to measure creativity on a general level (see article 2), while the second questionnaire collected data to measure creativity on a tertiary education level (see article 3). The method of

data collection was regarded as appropriate since it satisfied the demographic profile of the population namely undergraduate students at NWU (Potchefstroom campus).

Volunteering respondents were given twenty minutes to complete each one of the two questionnaires used in the study (forty minutes in total for both questionnaires). It was relative easy to distribute and collect the 1000 questionnaires (500 per questionnaire). The methodology followed led to 644 completed questionnaires that realised a response questionnaire return rate of 64.4%. This meant that a total of 322 (out of 500) questionnaires were completed for creativity at a general level (questionnaire 1) and another 322 questionnaires were completed for creativity at tertiary educational level (questionnaire 2). Comrey and Lee (in Field, 2007:443) classify 300 as a good sample size and indicated that at least 300 responses are needed for factor analysis.

1.8.2.5 Data analysis

The Statistical Package for the Social Sciences Incorporated (SPSS Inc) version 16 of 2008 was used to analyse the data statistically.

The researcher is aware that multiple different statistical procedures (extraction methods) exist by which the number of appropriate number of factors can be identified. By default SPSS does what is called a principal components extraction method. The principal components method was used in this study to analyse the interim correlation coefficient matrix in an effort to explore the inter-relationships between the items. The principal components method basically determined if the items can be grouped together to represent a smaller set of underlying factors.

After conceptual frameworks were developed, one to measure creativity at a general level and one to measure creativity at a tertiary educational level, based on underlying factors, a comparative analysis was employed to compare the two conceptual frameworks (models) and the factors and to identify the most suitable model to measure creativity. Statistical tests were used in the comparative analysis. For example, Pearson correlations were used to determine how similar or different the factors were that were identified in the models. Variance and cumulative variance (Exploratory factor analysis), sample adequacy (KMO), Sphericity

(Bartlett) and reliability (Cronbach Alpha) were also used to compare the two conceptual frameworks.

The specific statistics that were used in this study therefore include the following:

- Descriptive statistics (means and standard deviations) were used to analyse the data.
- Construct validity of the items in the questionnaires was assessed by means of an exploratory factor analysis.
- The reliability of the measuring instruments was assessed by means of Cronbach alpha coefficients (Field, 2007:666).
- The Bartlett test of sphericity was used to examine the appropriateness of factor analysis in this research study and to determine if a variance-covariance matrix was proportional to an identity matrix.
- The Kaiser-Meyer-Olkin (KMO) was used to measure the sampling adequacy.

These statistics are explained in more detail below.

1.8.2.5.1 Descriptive statistics

Descriptive statistics indicate general tendencies in the data (Creswell, 2008:182). Descriptive statistics was used to analyse the demographical data (Section A of the questionnaire) in an effort to determine the spread of scores based on age group, gender, residence, mother tongue, year of study, mode of study and faculty of study. It was also used to purify measuring criteria and to explain the variance in the influences to measure creativity.

Descriptive statistics can be used to determine central tendency (mean, median, mode), variability (variance, standard deviation, range) and relative standing (z-score, percentile ranks) (Swingler, 2011:1).

The mean (M) is used to describe the responses of all participants to items on an instrument. To calculate the mean, all the scores are added and then divided by the number of scores to give an average for all the scores (Creswell, 2008:184 & Swingler, 2011:1). The median divides the scores, rank-ordered from top to bottom, in half. The mode is the score that appears

most frequently in a list of scores and is very useful when a researcher wants to determine the most common score in an array of scores on a variable, according to Creswell (2008:185).

The focus of this study was more on variability (variance, standard deviation and range). Variability indicates the spread of scores in a distribution and enabled the researcher to see how dispersed the responses are to items on the research instrument (Swingler, 2011:1). Variance indicates the dispersion of scores around the mean and is basically the average error between the mean and the observations made. Variance shows how well a model fits the actual data (Field, 2002:6). The problem with variance is that it gives a measure in units squared. Standard deviation assists to overcome this problem and is simply the square root of the variance. Standard deviation measures how well the mean represents the data (Field, 2002:6). Small standard deviations indicate that data points are close to the mean and that the mean is a good fit of the data. A large standard deviation indicates that the mean is not an accurate representation of the data. The range of scores is the difference between the highest and the lowest scores to items on an instrument. Field (2002:7) explained that variance and standard deviation illustrate how the goodness-of-fit of a model can be measured and this makes it important to this study.

1.8.2.5.2 Exploratory factor analysis

Construct validity of the items in the questionnaires was assessed by means of an exploratory factor analysis.

The researcher used factor analysis to identify factors to measure creativity to use in the development of a conceptual framework. Factor analysis is used to determine the number of continuous latent variables (factors) that are needed to explain the correlations among a set of observed variables (factor indicators). Factor analysis is therefore very useful to identify interrelationships among variables to discover if those variables can be grouped into a smaller set of underlying factors (Costello & Osborne, 2005:1).

The purpose of factor analysis is to reduce a large set of data into a smaller subset of uncorrelated factors which enables the researcher to identify specific factors, as well as the factor loadings of variables onto these factors. Factor analysis derives a mathematical model

from which factors are estimated. Factor analysis can only estimate the underlying factors and relies on various assumptions for these estimates to be accurate (Field, 2002:433).

There are seven steps when conducting a factor analysis, according to De Coster (1998:1), which the researcher followed in this study.

- **Step 1: Collect measurements** – The first step, according to Kaplin, Yurt, Guneri and Kurtulus (2010:1301), in completing a factor analysis is to measure the interrelationships among the items. This step leads to the determination of the appropriate number of factors. The variables are then measured on the same (or matched) experimental units.
- **Step 2: Obtain the correlation matrix** – The correlations (or covariances) between each of the variables were obtained.
- **Step 3: Select the number of factors for inclusion** – The researcher used the *Kaiser criterion* to select the number of factors based on the fact that these factors were equal to the number of the eigenvalues of the correlation matrix that were greater than one. The “screen test” was also used to plot the eigenvalues of the correlation matrix in descending order.
- **Step 4: Extract the initial set of factors** – Submission of correlations or covariances need to be made into a computer program to extract the factors as this is too complex to do by hand. There are a number of different extraction methods, including maximum likelihood, principal component, and principal axis extraction. The best method is generally maximum likelihood extraction, unless there is a serious lack of multivariate normality in the measures.
- **Step 5: Rotate the factors to a final solution** – There are many different types of rotation. All these types of rotation attempt to make the factors highly responsive to a small subset of the items. There are two major categories of rotations, *orthogonal rotations*, which produce uncorrelated factors, and *oblique rotations*, which produce correlated factors. The orthogonal rotation, and specifically Varimax, was used in this study because it attempts to maximise the dispersion of factor loadings within factors,

therefore it loads a smaller number of variables on each factor (Field, 2007:746). This simplifies the interpretation of factors.

- **Step 6: Interpret the factor structure** — Rotation produces factor loadings which can be interpreted as a standardised regression coefficient which regresses the factor on the measures. Factors are defined by considering the possible theoretical constructs that could be responsible for the observed pattern of positive and negative loadings. The option also exists of multiplying all of the loadings for a given factor by -1 for ease of interpretation.
- **Step 7: Construct factor scores for further analysis** – The score for a given factor is a linear combination of all of the measures, weighted by the corresponding factor loading. Factor scores of +1 show strongly positive loadings, factors scores of -1 show strongly negative loadings, and factor scores of 0 indicates intermediate loadings. It is important to note that these scores are strongly collinear with the measures used to generate them.

The factor analysis added much value to this study as it identified the criteria pertaining to each factor, and as such, these criteria are statistically proven to measure the specific factors identified to measure creativity. The variance explained by these factors was also calculated, thus showing the relative importance of each of the factors and its respective criteria's importance to the measuring instrument.

Several influences were identified from literature and the researcher had to reduce the data set into a smaller set of uncorrelated factors. This was done in an effort to explain the maximum amount of common variance in a correlation matrix using the smallest number of explanatory concepts (Field, 2002:421). Data reduction helped to identify variables that correlate highly with a group of other variables, but correlate badly with variables outside of that group. The correlations between each pair of variable (influences and items in the questionnaire) were arranged on a correlation matrix (R-matrix) with the focus on common variance. Factors were then identified and compared based on the correlation matrix (R-matrix).

After factors were extracted on SPSS, the researcher had the choice of either selecting factors with Eigenvalues greater than a user-specified value or retaining a fixed number of factors. It is

however better to run a primary analysis with the eigenvalues over 1 option, select a scree plot, and compare the results (Field, 2002:449). If the scree plot and eigenvalues are over 1 the number of factors can be retained, if not, the researcher will examine the communalities and decide which one to follow. The researcher opted to use the Kaiser criterion that suggests that factors with Eigenvalues equal or higher than one should be retained (Hall, n.d.:1). The number of underlying factors was identified for the study only after the eigenvalues were examined.

The research instrument was purified by means of exploratory factor analysis, using a Varimax rotation. Varimax is a good general approach that simplifies the interpretation of factors and when the researcher expects that factors are independent (Field, 2002:449). This rotation was selected because of its ability to maximise variance explained by factors if there is a low correlation coefficient between the factors (Du Plessis, 2010; Field, 2007:749). Factor loadings range from minus one (perfect negative correlation) to plus one (perfect positive correlation). The higher the factor loading (either positive or negative), the more strongly that item is associated with the corresponding factor, and resultantly shows a more relevant definition to the factor's dimensionality (Hall, n.d.:1). A negative loading indicates an inverse impact on the factor, according to Torres-Reyna (n.d.:3). Variables that have large factor loadings on the same axis are assumed to measure different aspects of some common underlying dimension (Field, 2002:425).

Factor loadings of 0.40 were set as the minimum factor loading, while the data was also required to explain a cumulative variance of in excess of 60%. A cumulative variance of in excess of 60% signifies a "good fit" as stated by Field (2007:668). Factor loadings below the required 0.40 were suppressed in this study in order to present the data reader-friendly.

The regression method was used to calculate the factor score coefficients. The factor loadings were adjusted to take account of the initial correlations between variables and differences in units of measurement and the variable variance were stabilized. The downside of the regression method is that the scores can correlate with other factor scores from a different orthogonal factor (Field, 2002: 431).

1.8.2.5.3 Validity

Validity is the development of sound evidence to demonstrate that the intended test interpretation matches the proposed purpose of the test (Moskal & Leydens, 2000:1). Validity, therefore, determines whether the scores from the instrument (not the instrument itself) are valid (Creswell, 2008:162).

Evidence of validity can be based on test content, response processes, internal structure, relationships to other variables and the consequences of testing (Creswell, 2008:162).

Construct validity testing was used in this study because the research questionnaire put forward in this study required a high level of construct validity. Construct validation refers to the operationalisation of a construct in a practical application setting (Iacobucci & Churchill, 2010:256). Theory and data are evaluated when construct validity is used. Construct validity therefore requires a sound theoretical knowledge of the nature of the construct being measured and the way it relates to other constructs. Tull and Hawkins (1993:318) argue that construct validity involves more than just knowing how well a given measure works, as it also indicates why the measure works and this is very important in this study.

Three different types of construct validity can be assessed according to Iacobucci and Churchill (2010:255):

- *convergent validity* which measures correlates positively with other measures;
- *discriminant validity* which does not measure correlates with other constructs from which it is supposed to differ and was therefore used in this study; and
- *nomological validity* which refers to the degree to which the measure correlates in theoretically predicted ways with measures of different but related constructs.

There are three different categories of validity, according to Zikmund (2000:282-4):

- *Content* or *face validity* shows how well the content of a scale represents the measurement task at hand (Malhotra, 2004:269). Content validity therefore considers whether the questionnaire used in the study covers the entire domain of the construct that is being measured (Iacobucci & Churchill, 2010:257). However, content validity is often regarded as a more informal and even a weak assessment of validity.

- *Criterion validity* determines whether the data correlate with other data measuring the same construct (Tull & Hawkins, 1993:318). Construct validity forms part of this category.
- *Predictive validity* is assessed by investigating the possibility that the questionnaire predicts or correlates with a criterion measure which is administered at a later stage (Theron, 2008:186).

1.8.2.5.4 Reliability

The reliability of the data in this study was determined by employing Cronbach's coefficient alpha (α). Cronbach's alpha is a measure of internal consistency and determines how closely related a set of items are as a group (Sprinthall, 2007:314). Technically speaking, Cronbach's alpha is not a statistical test – it is a coefficient of reliability or consistency (Barber, 2007:1).

George and Mallery (2003:231) explained that the Cronbach alpha coefficients are interpreted as follows:

- $\alpha > 0.9$ Excellent
- $0.9 > \alpha > 0.8$ Good
- $0.8 > \alpha > 0.7$ Acceptable
- $0.5 > \alpha > 0.6$ Questionable
- $\alpha < 0.5$ Unacceptable

A "high" value of alpha is often used as evidence that the items measure an underlying (or latent) construct. A high alpha does, however, not imply that the measure is uni-dimensional. Exploratory factor analysis can be used to check dimensionality.

A minimum Cronbach alpha coefficient of 0.70 is normally acceptable and required (Field, 2007:666) and was set as the reliability coefficient for this study. The researcher noted that Schmitt (1996:350) indicated that satisfactory levels of relatively low (e.g. 0.50) levels do not seriously reduce reliability as it depends on the test use and interpretation.

Field (2007:666-669) suggests that in cases of negative reliability coefficients, the data requires some additional analysis before a final verdict on reliability can be rendered. The data in this study was therefore scrutinised, and where needed, inverted to ensure that no

negatively stated questions exist within. The alpha coefficients were then recalculated. No significant improvement in the reliability was achieved. The original coefficients were therefore accepted as the alpha coefficients, and the data pertaining to those factors were regarded to be unreliable.

It is important to note that as reliability declines, the factor is less likely to represent itself in repetitive studies. However, this fact does not make a factor less important (Field, 2007:668-669).

1.8.2.5.5 *Bartlett test of sphericity*

Bartlett's test of sphericity is used to examine whether a variance-covariance matrix is proportional to an identity matrix. Bartlett's test effectively tests whether the diagonal elements of the variance-covariance matrix are equal (group variances are the same), and that the off-diagonal elements are approximately zero (dependent variables are not correlated).

Bartlett's test examines the hypothesis that the variables are uncorrelated in the population. If the population correlation matrix resembles an identity matrix then it means that every variable correlates very badly with all other variables and all the correlation coefficients are close to zero. If the population correlation matrix is an identity matrix then it would mean that all variables are perfectly independent from one another and all these correlation coefficients are zero ($r = 0$) (Field, 2002:446).

The Bartlett method is valuable for this study because it produces scores that are unbiased and that correlate only with their own factor (Field, 2002:431). In essence, the Bartlett's test of sphericity renders a verdict on the suitability of the data to be used in multivariate statistical techniques (such as factor analysis), and favourable values are those that are below the 0.000 level.

1.8.2.5.6 *Kaiser-Meyer-Olkin (KMO)*

The Kaiser-Meyer-Olkin (KMO) measure was used to measure the sampling adequacy and to examine the appropriateness of factor analysis based on the sample characteristics.

KMO can be calculated for individual and multiple variables and represents the ratio of the squared correlation between variables to the squared partial correlation between variables (Field, 2007:735). The KMO measure of sampling adequacy provides an index (between 0 and 1) of the proportion of variance among the variables that might be common variance (Darlington, 2005:58). A value of 0 indicates that the sum of partial correlations (hence, factor analysis is likely to be inappropriate); a value close to 1 indicates that patterns of correlations are relatively compact and so factor analysis should yield distinct and reliable factors (Hutcheson & Sofroniou, 2009:233).

The value for KMO should be greater than 0.5 for the sample to be regarded as adequate for a pair of variables (Field, 2002:445). Values of 0.70 and higher are regarded to be acceptable and this value is set as the minimum required KMO value for this study (Field, 2007:666).

1.8.2.5.6 Pearson's correlation coefficient statistical test

In this study, the strength of the relationship between factors was assessed using the Pearson's correlation coefficient statistical test. The Pearson r can detect differences in two factors' patterns of loadings and differences in the relative magnitudes of those loadings. Field (2007:791) describes Pearson's correlation coefficient as a standardised measure of the strength of relationship between two variables which can take any value from -1 (as one variable changes, the other changes in the opposite direction by the same amount), through 0 (as one variable changes the other doesn't change at all), to +1 (as one variable changes, the other changes in the same direction by the same amount).

The Pearson correlation coefficient was used extensively in the comparative analysis of the two conceptual frameworks that were developed in this study. The aim was to indicate the relationship of the factors as it is regarded to be a simple correlational analysis which shows the various relationships between the different variables by means of a correlation matrix. These correlation coefficients are statistical measures of the covariation, or association between two variables (Xiong et al., 2003:4).

The cut-off correlation for this study was determined to be an absolute Pearson correlation coefficient of 0.30, signifying a medium relationship or correlation between variables (Du Plessis, 2010; Zikmund, 2008:551).

1.9 ETHICAL CONSIDERATIONS

Ethical considerations are a high priority in this study and it was ensured that:

- Literature used for the study was referenced and the sources from which it was obtained clearly indicated.
- The results provided will clearly reveal the actual research results obtained in its entirety.
- Information was not be distorted.
- The identity of respondents to research instruments will remain protected before, during and after the completion of the study.
- Data collected and the results obtained will be held in strict confidence. Propriety data will not be released to competitors.
- There was no intentional or deliberate misrepresentation of research methods or results. An adequate description of methods employed will be made available on request of the supervisor.
- Evidence that fieldwork has been completed according to specifications will, on request, be made available.

In addition, the study has been approved and registered with the Ethics Committee of the North-West University (Potchefstroom Campus).

1.10 LAYOUT OF THE STUDY

The study is presented in six chapters and written in the article format. This means that the study contains four separate but inter-related articles, each with a separate bibliography. The complete bibliography appears at the end of the thesis. The per chapter layout of the study appears below:

Chapter one: Nature and scope of the study

This chapter focuses on the orientation of the study. The background of the study is provided, followed by the problem statement, objectives of the study, research methodology and layout of the study.

Chapter two: Article one: An evaluative approach to creativity

The first article of this study provides the literature and historic-developmental overview of some prominent processes-, systems- and psychology-based approaches between 1929 and 2009. A total of twenty-five models and five research approaches to creativity are highlighted to show how researchers have developed formal methods for understanding and measuring creativity.

Chapter three: Article two: A conceptual framework to measure creativity at a general level (CF1)

The second article explains the approaches to creativity and creativity measurement at a general application setting. The article focuses on research, approaches, common indicators and barriers to creativity measurement and to identify key influences that should form part of a measuring instrument. The primary objective of this article is to create a reliable and valid conceptual framework to measure creativity in a general application setting. The conceptual framework is also empirically validated.

Chapter four: Article three: A conceptual framework to measure creativity at tertiary educational level (CF2)

The third article aims to explain the importance and challenges of creativity at a tertiary educational application setting. The article focuses on research, approaches, common indicators and barriers to creativity measurement at tertiary educational level to identify key influences that should form part of a measuring instrument. The primary objective is to provide a reliable and valid conceptual framework to measure creativity in a tertiary educational setting to support students' creative development. The conceptual framework is also empirically validated.

Chapter five: Article four: A comparative analysis to compare two conceptual frameworks (CF1 and CF2) to measure creativity

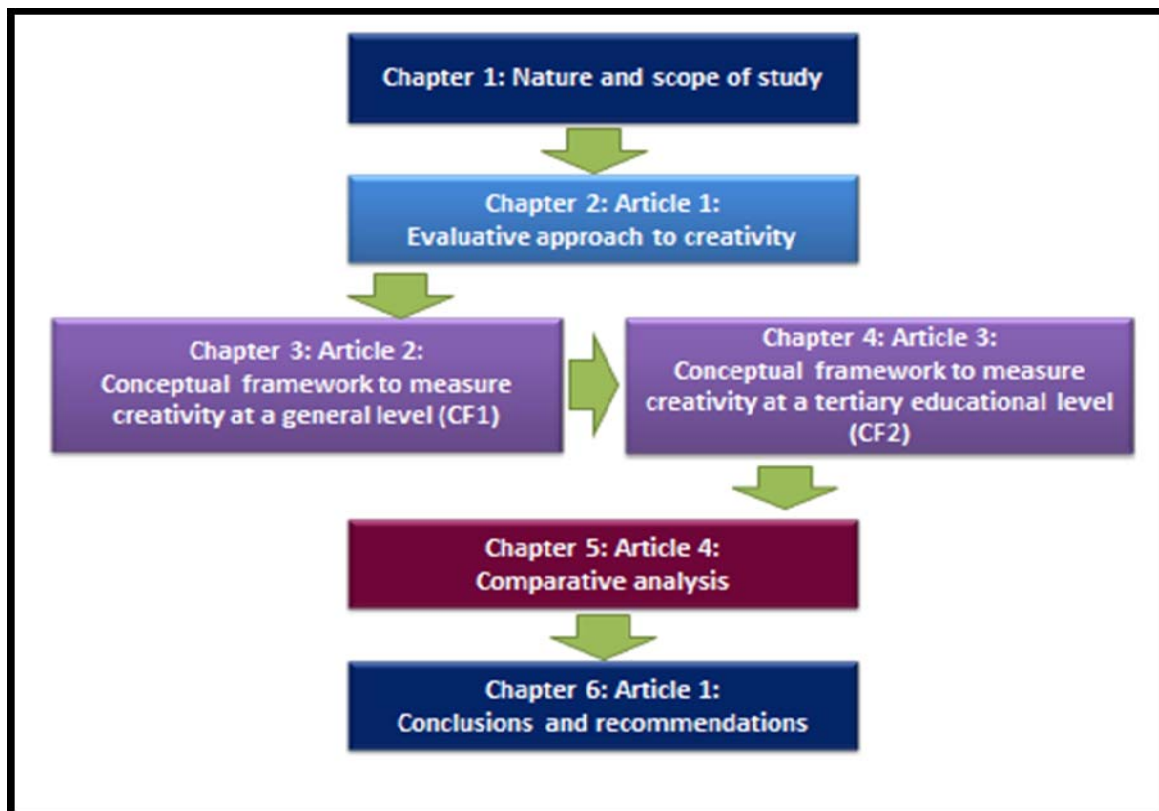
The fourth article is the final article of the study. This article compares and evaluates the two conceptual frameworks (CF1 and CF2) created in chapters three and four. The objective of this article is to empirically determine the best conceptual framework to use to measure creativity at tertiary educational level.

Chapter six: Conclusions and recommendations

This is the final chapter and deals with the overall conclusions and recommendations of the study. This chapter summarises the main findings of the study, draws conclusions and makes recommendations. The chapter provides the main contribution of the study as an integrated whole, namely a conceptual framework to measure creativity at tertiary educational level. The chapter discusses the limitations of the study, after which some directions for further research are provided.

The structure of the study is illustrated in Figure 1.5 below.

FIGURE 1.5: STRUCTURE OF THE STUDY



Source: Own compilation

1.11 SUMMARY

This first chapter sets the background for the study. This chapter explains that the knowledge economy is a globalized and interconnected economy where knowledge resources such as education and creativity are just as important and critical as other economic resources. A link between creativity and tertiary education was also identified. This chapter also explains some important conceptual definitions in this study, explored the problem of South Africa not focusing on creativity tracking and development as it should to enable the country to be competitive in the knowledge economy, formulated the objectives of the study, explained the purpose of the study, and formulated the research questions. The chapter highlights the research methodology used in this study by focusing on the research design, the collection of quantitative data, the analysis of the data and the statistical techniques employed. The chapter finally concludes with the ethical considerations for the study and the structure of the study.

The next chapter presents the first article of the study, namely a literature study of creativity that investigates the development of creativity.

CHAPTER 2

ARTICLE 1:

AN EVALUATIVE APPROACH TO CREATIVITY

Abstract

Creativity is a complex and contentious phenomenon. People make the grave error to give up the thought of being creative because they do not understand the concept of creativity. This article is based on a literature study and provides a theoretical framework to enable the reader to better understand the phenomenon called creativity. The article examines some definitions of creativity and highlights some unresolved issues regarding the definition of creativity.

A historical overview is provided of some prominent process- and systems orientated models. A total of twenty five models since 1929 were studied to show the development of creativity research and creative thinking. Psychology-based approaches, the Hermann Brain Dominance Instrument (HBDI) and the Neethling Brain Instrument (NBI™) are also explained. This is important due to the fact that creativity is mainly based on divergent thinking and personality. The models and psychological approaches show a link between the person, the creative process and the product which is an important starting point for measurement of creativity.

The article further shows that there are four levels of creativity. These levels highlight the complex nature of creativity and consist of the personal (P-creativity) level, the historic/ societal (H-creativity) level, the organisational (O-creativity) level and the animal (A-creativity) level.

The article examines the five research approaches to creativity in more detail because this shows how researchers have developed formal methods for understanding and measuring creativity.

Key words: Creativity, creativity models, creativity approaches, creative thinking, psychological approaches, divergent thinking, personality traits

2.1 INTRODUCTION

In the well-known film by the late director Jamie Uys, *The gods must be crazy*, an empty Coca-Cola bottle fell from the sky and landed in the desert where a few Bushmen lived. For the Bushmen (in the film), this was a very strange gift from the gods and the object mesmerized them. They wondered what the gods had in mind sending them this strange gift and they seriously thought “the gods must be crazy”. The Bushmen, not knowing what the object really was, came up with a variety of novel uses for the empty bottle (thus creativity) which created a lot of humorous moments for the audience who knew that the bottle was thrown from an airplane and is actually used as a Coca-Cola cold drink container. However, the fact that the audience knew the supposedly use for the bottle, signifies a limitation in their creativity as they did not envisage new uses for the bottle. This example stresses the limitation that could be imposed by learning and education on creativity (possibly putting limitations on imagination), while on the other hand, education can also stimulate creative thinking by transferring and adapting concepts and ideas from one scenario to another (making divergent and convergent thinking possible and easier).

From an early age, children experience the magic of stories and learn valuable lessons in a make-believe world created by creative storytellers. Just like the Bushmen, children have no limitations on their imaginations and also have an “uncontaminated mind” (free from imposed and structured thinking and learning). Children are able to create their own magic world while they experiment and learn. They engage in singing songs, playing games and participating in sports. This ability to create, imagine and experiment never stops but often fades as people are exposed to practical and intellectual thinking due to the schooling system and the world of work. Creativity in the adult world has the reputation of being magical and is often associated with the magical Unicorn from fairy-tales (Amabile, 2008:47) and are often misunderstood and not encouraged. The challenge, it seems, is not in the ability to be creative per say, but the attitude, fear and perceptions people have towards creativity due to certain myths. These myths, according to Amabile (2008:47-48) and Khandwalla (2004: 40) are:

- some people are simply born artistic and creative and others are not;
- creativity is associated with a particular personality of a person;

- creativity is often associated with the Einsteins, Picassos, and Shakespeares of the world;
- creative genius is far beyond the average person's grasp;
- creativity is age-afflicted. The perception exists that young people are more creative than older people. This idea is supported by the fact that many middle-aged people feel too set in their ways to change and develop their creative potential;
- creative individuals, especially artists and scientists, are "crazy". Jamison's study of British and Irish poets born between 1705 and 1805 supports this notion. The study revealed that poets were 30 times more likely than the general population to have symptoms of manic-depression, 10 times more likely to commit suicide, and 20 times more likely to have been committed to the asylum; and
- most creative persons are illogical because they think the seemingly unthinkable and do the seemingly undoable.

As a result of all these ill-conceived myths, people are not very keen to experiment with their own creativity.

However, without realizing it, people use their creative ability to understand the world, solve problems and participate in society. Creativity depends to some extent on the intelligence, expertise, talent, and experience of an individual, but also depends on creative thinking as a skill that involves qualities such as the propensity to take risks and to turn a problem on its head to get a new perspective, which can be learned (Amabile, 2008:47).

This article aims to provide a theoretical framework to understand the concept of creativity. The theoretical framework will consist of defining creativity and examining the historical development, levels of creativity and research approaches of creativity. The article will also examine how creativity can be measured, research models to measure creativity and two methods to measure creativity, namely on a general level and on a tertiary educational level.

2.2 PROBLEM STATEMENT

The ability to come up with a variety of novel ideas and to combine convergent and divergent thinking to find solutions to problems are critical to human progress and survival.

Researchers tried to understand how creative thinking proceeds and how creative ideas emerge over time. This led to myths mentioned earlier and some creativity models. After more than 30 years of intensive research on creativity, the field of creativity was declared as a scientific disaster area (Guilford, 1950, in Kaufman, 2003: 235). Some harsh criticism from Gardner (1982) and Weisberg (1986) in Kaufman (2003:235) implied that “no firm knowledge of substantial significance exists in the field of creativity and that the bulk of leading theses have no sound and valid scientific underpinning and amount to little more than misguided myths”. The focus of most of creativity research was on the development of creativity tests rather than the clarification of basic conceptual and theoretical issues. These tests were also not using solid conceptual and theoretical foundation which made the measurement results of creativity questionable. Another challenge is that different researchers took different approaches to understand and explain creativity as a concept, thus creating different definitions and explanations of the concept. For example, explaining creativity from a psychometric approach will differ from a biographical approach and creativity at a personal level will differ from creativity at an organisational level. Furthermore, two types of creativity models were also created, namely process-orientated models where the focus is on the cognitive aspects of creativity and systems-orientated models where the focus is on non-cognitive processes (James, Gerard & Vagt-Traore, 2004:2-3). The variety of definitions about creativity also added to confusion and misunderstanding of the concept. However, it is important to also note that progress has been made in the field on creativity research based on several published reviews, for example Sternberg’s *Handbook of Creativity* (1999), Runco’s *Creativity Research Handbook Volume 1 and 2* (1997; 2002). Valuable insight can be gathered from these researchers and comparisons can be drawn with researchers work in earlier times to evaluate the development in understanding of the concept.

It is important to note that a huge variety of models, approaches, methodologies and tests about creativity exists in literature. The variety of different viewpoints (positive and negative) is adding to the confusion about creativity and makes creativity as a concept challenging to fully comprehend.

This article aims to provide a theoretical framework to help the reader to understand and appreciate the complex nature of creativity based on the various approaches available in literature.

2.3 OBJECTIVES

The primary objective of this article is to provide a sound theoretical basis and understanding of the concept creativity.

To achieve the primary objective, the following secondary objectives are formulated, namely to:

- Clarify the concept of creativity by performing an in-depth theoretical study of creativity models; and to
- Theoretically examine creativity research approaches in an effort to determine how creativity can be measured.

2.4 CREATIVITY

2.4.1 What is creativity?

The Oxford Dictionaries.com (2011:1) defines creativity as *“the use of imagination or original ideas to create something; inventiveness and the use of the imagination or original ideas, especially in the production of an artistic work.”*

Professor Anokhin, a neuroscientist, discovered in his studies that ranged between 1920-1935, that intelligence and creativity are determined by the ability of the brain (the tentacles of the neurons) to make connections and to create new systems and patterns (Whole Brain Thinking Pty Ltd, 2010:2).

Another scientist, Roger Sperry, theorised the ground-breaking “split brain” operation theory which made it possible, for the first time, to study the separate functions of the two hemispheres of the brain. He discovered that each hemisphere had its own functions and that most people prefer the functions and processes of one of the two hemispheres over the other (Whole Brain Thinking Pty Ltd, 2010:2). Sperry received the Nobel Prize in Physiology in 1981 for his discovery concerning the functional specialisation of the cerebral hemispheres. Creative orientated people mostly prefer the functions and processes of the right hemisphere (Bergh & Theron, 2009:114-115).

To understand the workings of the brain alone does not explain creativity. Various scientists, psychologists and academics tried to explain and define creativity (Plsek, 1996:2-6). The common theme in most of the definitions in literature explains creativity as the ability to produce work that is both novel (i.e. original and unexpected) and appropriate (i.e. useful concerning tasks constraints). Plsek (1996:6) also adds that the total creative process is a balance of imagination and analysis and requires a drive to action and the implementation of the ideas.

In the beginning creativity was only associated with divergent thinking but later on it became evident that to be creative requires divergent thinking when many unique ideas are generated and then convergent thinking, when those ideas are combined into the best result (Bronson & Merryman, 2010:21).

The National Advisory Committee on Creative and Cultural Education (NACCCE) in the United Kingdom published a report in 1999 where they provided a definition of creativity (Vilalba, 2008:10). Their definition consists of four characteristics of creativity, namely that creativity:

- Always involves imagination due to the fact that it generates something original.
- Is purposeful as it puts imagination into action to achieve an end.
- Produces something original in a particular field.
- Involves the generation of ideas, the evaluation of these ideas and deciding which idea is the most adequate one.

The NACCCE (1999) opposed the views that creative people are those with “unusual talents”, that are able to make their creative mark without special help and sometimes gain strength from educational failure. This refers to the differentiation maintained in creativity research between eminent-level creativity, which refers to discoveries that are of particular importance to society, and non-eminent-level creativity, which refers to everyday creativity (NACCCE, 1999:28-29). The KEA European Affairs (2006:41) define creativity as “a process of interactions and spill-over effects between different innovative processes”. They define creativity in a cross-sector and multidisciplinary way and differentiate between scientific, technological, economic and cultural creativity.

Florida (2002:30) explains that creativity is multidimensional and experiential, requires “work” to appear and is usually guided by intrinsic rewards. He identified three T’s (Technology, Talent and Tolerance) that constitute the main magnets for creative people (the creative class according to him) which enables them to make a region prosper economically.

Finding the right definition for creativity seems to be a huge challenge due to the fact that there is no consensus as to whether creativity is located in a person, in an end product or in a process. Edwards (1999:6-7) defines creativity as “the ability to find new solutions to a problem or new modes of expression; thus it brings into existence something new to the individual and to the culture”.

From these definitions and views, creativity, for the purpose of this paper, can be defined as the purposeful generation of ideas, the evaluation of these ideas and deciding which ideas are the most adequate that will lead to unexpected and appropriate outcomes. It is important to note that creativity is far more complex than what the definition indicates because creativity manifests itself on different levels and different research approaches are used to explain the phenomenon.

2.4.1.1 Unresolved issues on defining creativity

There is some agreement that creativity has to do with the production of something new, has some sort of value and that everybody can be creative to some extent, according to Vilalba (2008:12). This view is supported by Bergh and Theron (2009:114) and Bronson and Merryman (2011:21-22). However, there are some unresolved issues on defining creativity that play an important role in the definition of creativity.

The first issue is that creativity can refer to personal and social creativity (Mayer, 1999:450). *Personal creativity* refers to creating something new in respect to the person that creates the product. *Social creativity* refers to something new and useful in respect to the social or cultural environment where it is produced. These different views can lead to different definitions. Sailer (2011:7) explains that with social creativity, the majority of discourse on the context of creativity centres on either social and organisational aspects, or geographic spaces.

The second issue is that different approaches have been used to study creativity. Some approaches focused on the need to clarify if creativity is a cognitive ability, a product or a process (Mayer, 1999:450; Walton, 2003:146-148). Other approaches to creativity are related to place, persuasion and potential. *Persuasion* studies how creative people change the way other people think, and *potential* studies emphasize research on those that have potential for creativity but are not realizing it (Runco, 2003:9-12).

The National Advisory Committee on Creative and Cultural Education (NACCCE) (1999:32) maintains that creativity involves originality in three possible ways: *individual*, *relative* or *historic*. *Individual creativity* can be compared with Mayer's personal creativity (creating something new in respect to the person that creates the product). *Relative creativity* refers to originality in relation to a person's peer group. *Historic creativity* refers to original previous output in a particular field (NACCCE, 1999:32).

Creative contributions can be divided into three major categories according to Sternberg (1999) (cited in Vilalba, 2008:12). Contributions can:

- Accept current paradigms;
- Reject current paradigms; and
- Attempt to integrate multiple current paradigms.

All of these issues have to be addressed in a measurement model for creativity and will require a multi-disciplinary approach to creativity.

Since the interest of the thesis is to assess the possibility of measuring creativity and to create a conceptual framework, it is critical to start with a review of creative thinking models.

2.4.2 The development of creativity

2.4.2.1 Creativity models

Creativity models represent theory about creative thinking and how creative ideas emerge over time. Some models make it appear that creativity is a somewhat magical process, while other models lean more toward the theory that novel ideas emerge from the conscious effort to balance analysis and imagination. It is important to understand that while models are

helpful guides they are not to be used too rigidly and that one should not be too dogmatic about when one step of the models starts or ends.

Creativity models can be divided into two types (James, Gerard & Vagt-Traore, 2004:2-3), namely: process-orientated models and systems-orientated models.

Process-orientated models concentrate on cognition aspects of creativity (James et al., 2004:2). Questions that this approach pose are: What and how do creative people think? What are the thought structures during the creative process? Lubart (2000) summarizes the efforts on cognition sub-processes that are crucial to creativity potential (as cited in James et al., 2004:2) as the following:

- Problem finding, formulation and redefinition;
- Divergent thinking;
- Synthesis and combination of information (bisociation, Janusian thinking, homospatial thinking, articulation, analogy and metaphor, remote association, emotional resonance, and feature mapping); and
- Idea combinations through random or chance-based processes.

Various process-orientated models were developed since 1929. Descriptions of these models are provided in Annexure A. It is important to note that other research were done as well and that the researcher highlights the most notable for this study. These models include:

- Wallas' creativity process model (1929);
- Rossman's creativity model (1931);
- Guilford's divergent thinking model (1950);
- Osborn's seven step model (1953);
- Torrance's Tests on creative thinking (1966);
- Kolberg and Bagnall's universal traveler model (1981);
- Bandrowski's model (1985);
- Parnes, Isaksen and Trefflinger's CPS model (1985, 1992);
- Barron's psychic creation model (1988);
- Kirton's model (1989);
- Fritz's model (1991);
- Plsek directed creativity cycle model (1996);

- Luecke and Katz's innovation model (2003);
- Park and Jang's model (2005);
- Byrne's model (2005); and
- Chung, Evenson and Pangaro's model (2009).

System-orientated models take a broader approach to creativity that involves non-cognitive factors as well. Systems-orientated approaches range from social orientated views to individual orientated views (Sternberg & Lubart, 1996; Amabile, 1983) (Cited in James et al., 2004:3). The focus of these models is on the interaction between:

- Domain and individual that transmits information;
- Field and domain that selects novelty; and
- Individual and field that stimulates novelty.

Various systems-orientated models were developed between 1961 and 2005. Descriptions of these models are provided in Annexure A. It is important to note that other research was done as well and that the researcher highlights the most notable for this study. These models include:

- Rhodes's 4P's model (1961);
- Amabile's model (1983);
- Sternberg and Lubart's model (1995-1996);
- Csikszentmihalyi's model (1996, 1999);
- Basadur's model (2000);
- Unsworth's model (2001);
- Florida's creativity index (2002);
- Runco's parsimonious creativity model (2003); and
- Baer and Kaufman's model (2005).

Modern models of the creative process explain creative thinking as complex scripts for higher-order thinking. The complexity is due to the balancing act involved in higher-order thinking at an extended period of time. Even though people process the underlying mental building blocks for creative thinking, using these blocks correctly can be very challenging and requires very difficult work (Plsek, 1996:6).

A number of topics are noted in creativity research and theory (Baer & Kaufman, 2005:1).

These notable topics are:

- Divergent thinking;
- Creativity training;
- Creativity assessment;
- Personality traits of creative people;
- Intrinsic motivation;
- The difference between genius and creativity; and
- Domain generality or specificity of creativity.

2.4.2.2 Psychological approaches

It is important to include psychology-based approaches to creativity because creativity can be seen as a product of the human brain. The main approaches to creativity in these methods focus on attempts to enhance the creative process by facilitating an individual's mental processes. This can be done by:

- Unleashing natural creativity, eliminating mental blocks;
- Stimulation and mobilization of resources helpful for generating ideas by a group or individual; and
- Knowledge-based support, including various analytical steps to organise, restructure and exploit available knowledge and experience and, eventually, utilize specially-developed and structured external knowledge (*innovation knowledge base*).

Psychology-based approaches are also related to studying individual differences and personality attributes. Studies in this line try to find characteristics of creative people and can be divided into psychometric, biographical and historiometric approaches (Plucker & Renzulli, 1999:42; Gruber & Wallace, 1999:111).

Psychometric studies attempt to measure factors of creativity associated with creative people (Plucker & Renzulli, 1999:42). Tools consist of lists of personality traits, self-report adjectives check-list, biographical surveys and interest and attitudes measures.

Biographical approaches involve case studies of well-known creators to provide a holistic picture of the creator and his/her environment. The investigator can attempt to “go into” the creator’s mind and reconstruct the creator’s experience or alternatively appraise the data, explain and interpret it from an “outside” perspective (Gruber & Wallace, 1999:111).

Historiometrics is concerned with the study of famous creators in history and measures creativity based on biographical and historical records. Historiometric approaches transform qualitative facts of history into more precise, clear numerical measurements. Multiple regression, factor analysis and latent-variable models are used to understand the relationship between different aspects of creativity. The subject of study is always a “historical individual”.

Haensly and Torrance (1990) identified over 200 instruments for measuring different aspects of creativity and Houtz and Krug (1995:269-300) classified these tests into various categories:

- Tests of divergent thinking;
- Attitude and interest inventories;
- Personality inventories;
- Biographical measures;
- Ratings by teachers, peers or supervisors;
- Product judgement;
- Self-reports of creative achievements; and
- Eminence or the study of well-known and established creative people.

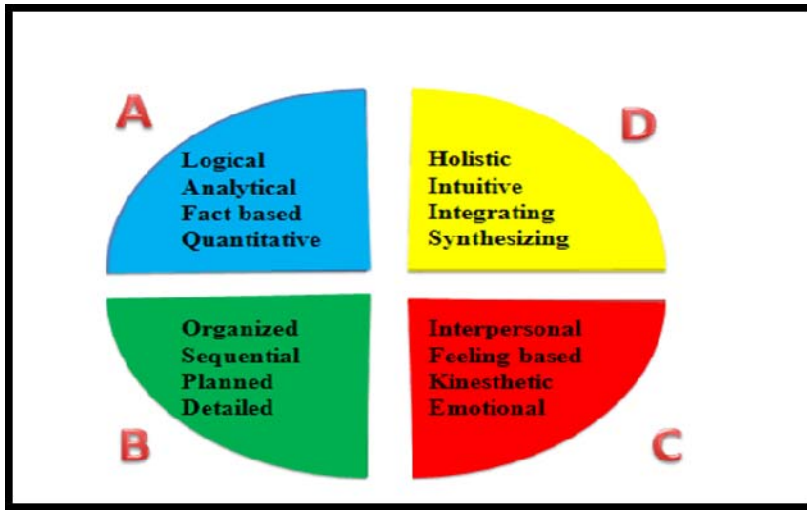
Creativity techniques can be classified into seven categories depending on the methods and means utilized according to Zusman and Zlotin (1998:1). Traditionally, techniques belonging to the first five categories were psychology-based. Today, with the development of knowledge-based approaches (groups 6 & 7); the first five categories may be combined with knowledge as well. A growing number of psychologists are supporting the idea that the seven categories can increase creativity in an individual.

The seven categories are listed below:

- *Conditioning/ motivating/ organising techniques*: These techniques help create an environment that facilitates the removal of various mental blocks and unleashes natural creativity.
- *Randomization*: These techniques force individuals to make more random attempts to solve a difficult problem and to move “outside the box” of their preconceived perceptions and assumptions.
- *Focusing techniques*: These techniques include special focusing techniques to help an individual focus on one issue at a time and avoid frustration.
- *Systems*: A system contains a set of focusing or random steps to be followed in a specific order.
- *Pointed techniques*: These techniques offer single or multi-step recommendations following a pre-determined, promising direction. This direction may be identified as useful based on intuition, experience or documented knowledge.
- *Evolutionary directed techniques*: These techniques offer directions according to fundamental patterns of evolution.
- *Innovation knowledge-base techniques*: These techniques utilize structured knowledge resulting from the past human innovation experience.

The *Herrmann Brain Dominance Instrument (HBDI)* is a system that measures and describes thinking preferences in people. Herrmann identifies four different modes of thinking. According to Herrmann (2010:1) the two hemispheres of the brain can be divided into four quadrants. The left brain hemisphere is divided into A (indicated with blue) and B (indicated with green) and the right brain hemisphere is divided into C (indicated in red) and D (indicated in yellow). The instrument is illustrated in Figure 2.1.

FIGURE 2.1: HERRMANN BRAIN DOMINANCE INSTRUMENT (HBDI)



Source: Herrmann International (2010:1)

The four different modes of thinking are:

A. Analytical thinking

Key words to describe this mode are: logical, factual, critical, technical and quantitative.

Preferred activities in this mode are: collecting data, analysis, understanding how things work, judging ideas based on facts, criteria and logical reasoning.

B. Sequential thinking

Key words to describe this mode are: safekeeping, structured, organised complexity or detailed, planned.

Preferred activities in this mode are: following directions, detail oriented work, step-by-step problem solving, organisation and implementation.

C. Interpersonal thinking

Key words to describe this mode are: kinesthetic, emotional, spiritual, sensory, feeling.

Preferred activities in this mode are: listening to and expressing ideas, looking for personal meaning, sensory input, and group interaction.

D. Imaginative thinking

Key words to describe this mode are: Visual, holistic, intuitive, innovative, and conceptual.

Preferred activities in this mode are: Looking at the big picture, taking initiative, challenging assumptions, visuals, metaphoric thinking, creative problem solving, long-term thinking.

Creativity, Herrmann International (2010) discovered, is a process involving all 4 quadrants and the Whole Brain tools can be used to enhance creativity and innovation by:

- Fostering openness and appreciation for diversity of thought, and
- Sparking creativity and breakthrough ideas.

The Neethling Brain Instrument (NBI™) was developed after extensive international research since 1980 on left/right brain functions. Kobus Neethling, under the research guidance of Professor Paul Torrance at the University of Georgia developed the first NBI™ for adults. Similar methodologies were then applied to develop a number of other whole brain instruments.

Building on the work of Herrmann and Paul Torrance, Neethling determined that both the left and right brain processes (as originally categorised by Sperry) could be divided into two definitive categories, effectively dividing the brain into four quadrants (similar to Hermann).

A Brain Profile report is normally created when this instrument is used. This Brain Profile is a descriptive, non-judgmental analysis, with no profile being better or worse than another. The report aims to give a description of an individual's thought preferences, and makes recommendations based on these thought preferences. A Brain Profile instrument measures thinking preferences, and not skills or ability in executing those preferences. It could therefore happen that an individual has a very strong preference for order, planning and organisation, but has never had the chance to develop the skills to plan and organise. The recommendation would then be that since the desire is there, the skills to support that desire should be developed (Whole Brain Thinking Pty Ltd, 2005:4).

A critical new direction highlighted by Neethling is the view that creative behaviour is linked to four- and eight- dimensional thinking rather than a whole brain approach (Neethling Brain Instruments, 2010:1). Neethling Brain Instruments (NBI) uses more than thirty four- and eight- dimensional assessment tools to identify and develop creative behaviour.

The four-dimensional thinking (or thinking outside the box) theory is the combination of medical science, biological science, psychology, socialization theory, cognitive and control theory and research of linear thinking. Humans live in a three-dimensional world and the calculation of the fourth dimension is instinctive, but some people find it easier to do than others. Four-dimensional thinking has sixteen states, integrating time, especially geologic time, into thinking about consequences of actions. It is not an easy concept as it requires people to think in time instead of only in space. Four-dimensional thinking of consequences for humanity instead of only immediate personal gain helps people to find necessary and contemporary solutions for the improvement of people's circumstances. This is and will prove valuable in mankind's effort to find solutions to improve the world and to ensure that today's solutions will not become tomorrow's problems.

Neethling and his team also developed the NBI™ to much greater levels of refinement and sophistication. The eight-dimension model of thinking preference allows for much greater insight into personal and group development and offers the consultant/facilitator a more impactful diagnostic for a wide range of applications (Whole Brain Thinking Pty Ltd, 2005:6). The eight dimensions, according to Berne and Raviv (2004:237), guide people through the exploration of solutions in eight different thinking directions, one at a time. In each dimension several questions or suggestions are posed to stimulate the thinker's mind in sub-spaces in which solutions may be found. The process serves to generate as many ideas as possible in a short time. It unifies existing problem-solving knowledge, techniques and solutions from different disciplines and technology, inventions, business and marketing, Industry, math and science, art and daily life (Berne & Raviv, 2004:240). Well known methods like Analogy, TRIZ (the Russian acronym for Theory, Solution, Innovation and Problem), SCAMPER (Substitute, Combine, Adapt, Modify, Put to other uses, Eliminate) and Lateral Thinking are part of it.

These eight dimensions are designed to stimulate creative thought and new possibilities. Sometimes, those new possibilities must be rejected due to ethical implications. The methodology focuses only on the process of idea generation of the problem solving process.

It is evident from the NBI™ tools that the definition of creativity has shifted from one-dimensional skills to a four- and eight-dimensional type of creativity that blends logical thinking with creative problem solving. Armano (2008:1) indicates that individuals

possessing this “New Creative Mindset” which he calls Creativity 2.E (C2.E), blend analytical, expressive, curious and sensual qualities into their thinking process. The result is a holistic approach to creativity that is effective across multiple touch points and experiences, and evolves constantly. Creativity 2.E is about being curious, empathetic, analytical, insightful and expressive all at the same time, adopting a variety of new tools, techniques and artefacts and participating in the emerging media.

Researchers agree that most modern models of the process of creative thinking are complex scripts for higher-order thinking. Regardless of a model, creativity calls for an intricate mental dance over an extended period (Plsek, 1996:6). This complexity is what makes creative ideas so rare. Plsek (1996:6) says that, “Even though people possess the underlying mental building blocks for creative thinking, stacking the blocks just right is very difficult work.”

2.4.2.3 Limitations of creativity models

Most models are limited because the models do not:

- Adequately address psychological factors that foster or inhibit the creativity of individuals in the creative process;
- Adequately address social/ environmental factors that impact on the creative process;
- Adequately explain the detailed steps involved in the creative process; and
- Adequately address the manner in which the importance of certain social and psychological factors changes during the creative process.

2.4.3 Creative thinking

The mind of a human works in mysterious ways. The mind shifts between convergent thinking (logical, analytical and rational thinking) and divergent thinking (intuitive, creative and lateral thinking) (Hermann, 1988:57). This can happen within seconds and mostly a human is unconscious of the shifts taking place between the right and left hemispheres of the brain. The right hemisphere provides the ideas and creates new structures, while the left hemisphere analyses and verbalizes that which is created by reason and fact (Kroon,

2000:98). Most people prefer to concentrate on one of the hemispheres as a preferred thinking style.

Creativity is associated with people using divergent thinking (the right hemisphere) more than convergent thinking (the left hemisphere). The reason for this is that creative people display specific cognitive abilities associated with divergent thinking (the right hemisphere), which include the production of a variety of answers, generating many uses for an object in a given time and especially generating unconventional and novel ideas.

Creativity differs from person to person and is due to different factors, which include a person's background, cognitive abilities, intrinsic motivation, personality as well as contextual and social influences (Glover, Ronning & Reynolds, 1989:80-86). Background factors refer to aspects such as parents, school and the environment, which reinforce creative behaviour and provide role models who encourage a person to develop creativity and problem-solving skills. A person's personality highlights the fact that some elements of creativity are inborn and others are developed. The following personality characteristics are associated with creative people according to Kroon (2000:99-100) and Starko (1994:78-86):

- Self-discipline and independence;
- Perseverance, drive and commitment;
- Tolerance of uncertainty;
- Nonconformity to the stereotypes of society;
- Deferred gratification;
- Self-motivation;
- Willingness to take risk;
- Broad interest;
- Curiosity and openness to experience; and
- The value of originality.

The following cognitive abilities are associated with creative people, according to Amabile (1989:49), Kroon (2000:100-101) and Starko (1994:69-75):

- The ability to break out of old habits and ways of thinking;
- Keeping options open as long as possible;
- Deferred evaluation;

- The ability to think broadly;
- Accurate observation of the environment;
- Metaphoric thinking – finding parallels between improbable ideas;
- Flexibility and skill in decision-making;
- Independent judgement;
- Visualising;
- Acceptance that there is not only one right answer; and
- Self-belief.

The abovementioned factors provide a framework that can be used to explain the differences in creative behaviour. Table 2.1 below indicates the link between the person, the creative process and the product.

TABLE 2.1: THE PERSON, THE CREATIVE PROCESS AND THE PRODUCT

Environment				
Person		Process		Product
Background factors		Become aware of a problem or challenge		Innovative products
Cognitive abilities		Gather information		New organisational structure
Personality		Formulate the problem		Solution to a problem
Creative characteristics		Search for ideas		A business plan
		Obtain acceptance and plan action		
Contextual and social influences				

Source: Glover et al. (1989:80-86)

The discussion thus far supports the view that creativity is a complex phenomenon and one can almost understand why some people view creativity as “something mystical”, which is only given to a selected few. These views resulted in people avoiding and denying the value of creativity for a long time and this caused a neglect of creativity research.

In 1950, J.P. Guilford was the first to point out that only 0.2 percent of entries in Psychological Abstracts (during the period 1920-1950) dealt with creativity and he made an earnest appeal

for more focus on creativity as a research area. The neglect of creativity in the research was due to various important reasons (Petrowski, 2000:305):

- Creativity was seen as a mystical phenomenon where the Muse imparts divine inspiration to the artist and this spiritual process does not lend itself to academic examination and analysis.
- Creativity was not acknowledged as important and was totally ignored in early twentieth-century schools of psychology (specifically structuralism, functionalism and behaviourism). People therefore did not research the concept.
- “Pragmatists” who supported creative thinking and research did not validate their ideas and findings with scientific evidence. This made their research efforts not scientific or valuable.

The challenge, then and today, remains people’s attitude, fear and perceptions towards creativity. So, defining and understanding creativity can be problematic. Furthermore, the idea that creativity is a predetermined personality trait appeals to most people at a psychological level because it gives people an excuse for not being creative. This seems to make creativity a rare commodity.

2.4.4 Levels of creativity and research approaches

Creativity seems to be a complex phenomenon as it manifests itself on many levels (Petrowski, 2000:305). These levels are adding to the unresolved issues regarding the definition of creativity (Mayer, 1999:450). These levels include:

- The personal (P-Creativity) level;
- The historic/ societal (H-Creativity) level;
- The organisational (O-Creativity) level; and
- The animal (A-Creativity) level.

Five major research approaches are used to define and explain creativity. These approaches offer unique insights, understanding and application of creativity on a personal-, organisational- and educational level (Petrowski, 2000:305). The five approaches are:

- The psychometric approach;
- The contextual approach;

- The experimental approach;
- The biographical approach; and
- The biological approach.

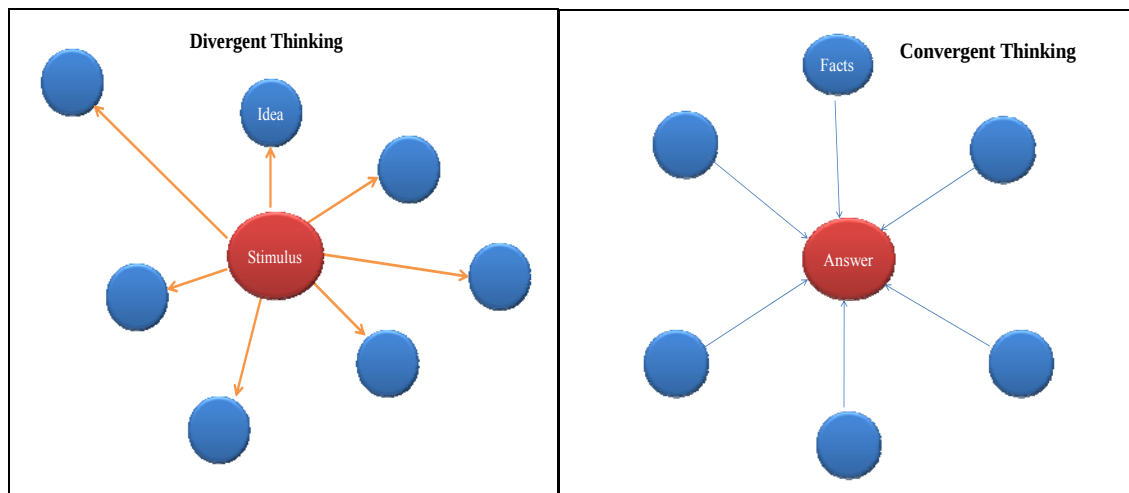
These approaches to creativity are discussed below.

2.4.4.1 The psychometric approach

Psychometricians assume that creativity is a measurable mental trait and focus on developing tests which measure divergent thinking (Plucker & Renzulli, 1999 in Petrowski, 2000:305).

Divergent thinking is the creative elaboration of ideas prompted by a stimulus. Convergent thinking takes place when a person brings material from a variety of sources in an effort to find the “correct” answer to a problem (Atherton, 2011:1). Figure 2.2 demonstrates the difference between divergent and convergent thinking.

FIGURE 2.2: DIVERGENT THINKING VERSUS CONVERGENT THINKING



Source: Atherton (2011:1)

Divergent thinking instruments measure aspects like:

- **Ideational fluency** by asking a question like “List all the things that are white and edible”;

- **Divergent production** by asking a question like “*What are the consequences of people having six fingers instead of five?*”;
- **Expressional fluency** by asking a question like “*Write as many sentences as you can using the words desert, food and army*”; and
- **Word association**, for example “*rat-blue-cottage*”.

Petrowski (2000:305) highlights that scores are based on:

- **Originality** (statistical rarity of given responses);
- **Fluency** (total number of relevant responses);
- **Flexibility** (total number of different categories represented by relevant responses); and
- **Elaboration** (amount of detail in responses).

Psychometricians have proposed many interesting models to explain the relationship between creativity and intelligence. The most important finding is that creativity is not positively correlated with intelligence above an IQ of 120. This verifies that creativity is not unusual or rare (Sternberg & O’Hara, 1999:266).

Psychometricians also studied personality traits of creative individuals and found patterns (Feist, 1999 in Petrowski, 2000:305). Positive traits include:

- Curiosity;
- High levels of personal energy;
- Being attracted to complexity;
- Open-mindedness, and
- Persistence in the face of adversity.

Tests that measure divergent thinking shows that people who scored highly on a divergent thinking attitude instrument display their creative thinking as innovators (who prefer discovering problems) or adapters (who are more concerned with resolving problems than finding them) in organisations (Basadur & Hausdorf, 1996 in Petrowski, 2000:307). Both types are necessary within a creative organisational culture, but they must first understand their stylistic differences and value one another’s contribution in order to work effectively together.

Best-known names in the field of psychometrics, and specifically in terms of creativity tests, are J.P. Guilford (1950) *Structure of the Intellect (SOI) battery* and E.P. Torrance's (1966) *Torrance Tests on Creative Thinking (TTCT)* and *Minnesota Tests of Creative Thinking (MTCT)*.

2.4.4.2 The Contextual approach

Creativity is studied from a systems perspective in this approach. Creativity is explained as a systematic process involving individuals, gatekeepers (representing the field or society), and the culture (or domain) rather than an individual trait. The whole systemic process of individual, gatekeepers and culture is needed to create and validate new ideas (Csikszentmihalyi, 1999 in Petrowski, 2000:307).

The contextual approach considers motivation as an important aspect of the process. Creative people are described as intrinsically motivated and if people are not intrinsically motivated to be creative in a specific domain, they will not be (Petrowski, 2000:308).

Creativity is also linked to expertise in a domain/ field and will be expressed according to a person's type of intelligence (Gardner, 1993 in Petrowski, 2000:308). According to the Multiple Intelligences Theory, there are nine types of Intelligence (Gardner, no date:1) namely:

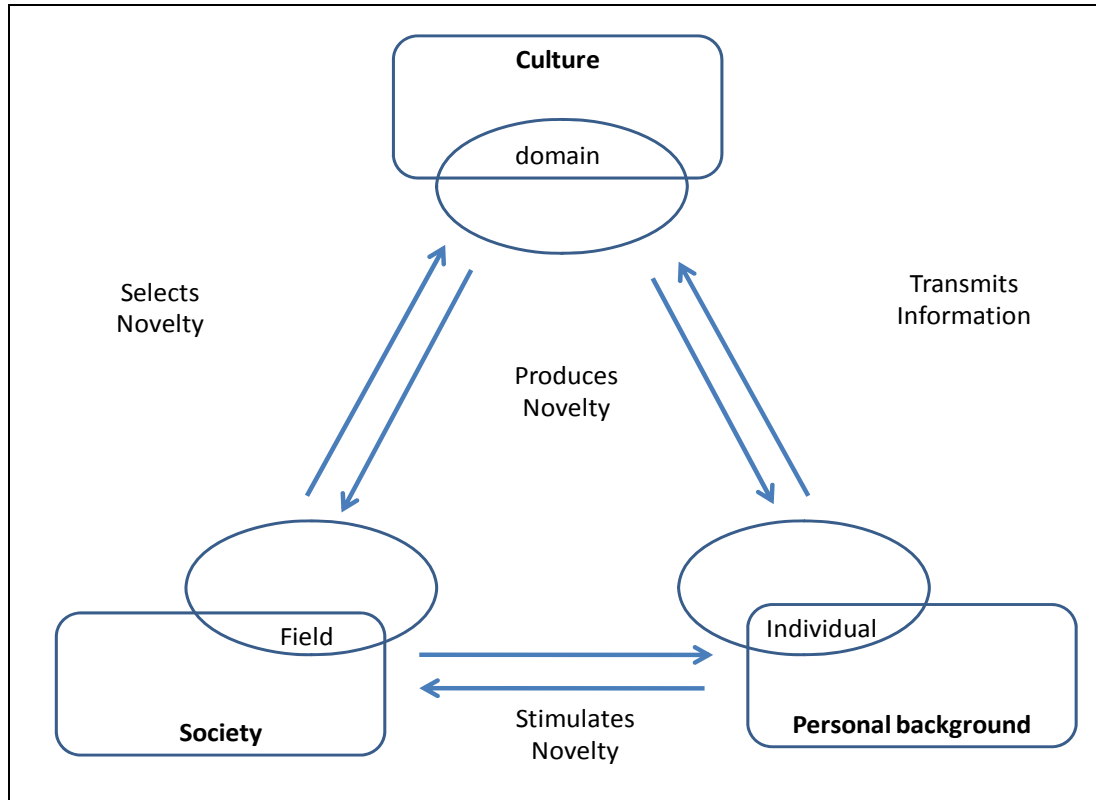
- *Naturalist Intelligence ("Nature Smart")* which can be described as the human ability to discriminate among living things (plants, animals) as well as sensitivity to other features of the natural world (clouds, rock configurations).
- *Musical Intelligence ("Musical Smart")* is the capacity to discern pitch, rhythm, timbre, and tone. This intelligence enables a person to recognize, create, reproduce, and reflect on music.
- *Logical-Mathematical Intelligence (Number/Reasoning Smart)* is the ability to calculate, quantify, consider propositions and hypotheses, and carry out complete mathematical operations. This intelligence enables a person to perceive relationships and connections and to use abstract, symbolic thought; sequential reasoning skills; and inductive and deductive thinking patterns.

- *Existential Intelligence* is the sensitivity and capacity to tackle deep questions about human existence, such as the meaning of life and why do people die.
- *Interpersonal Intelligence* (People Smart”) is the ability to understand and interact effectively with others. This intelligence involves effective verbal and nonverbal communication, the ability to note distinctions among others, sensitivity to the moods and temperaments of others, and the ability to entertain multiple perspectives.
- *Bodily-Kinesthetic Intelligence* (“Body Smart”) is the capacity to manipulate objects and use a variety of physical skills. This intelligence involves a sense of timing and the perfection of skills through mind–body union.
- *Linguistic Intelligence* (Word Smart) is the ability to think in words and to use language to express and appreciate complex meanings. This intelligence allows people to understand the order and meaning of words and to apply meta-linguistic skills to reflect on the use of language.
- *Intra-personal Intelligence* (Self Smart”) is the capacity to understand oneself and one’s thoughts and feelings, and to use such knowledge in planning and directing one’s life. This intelligence allows for the appreciation of the self and the human condition.
- *Spatial Intelligence* (“Picture Smart”) is the ability to think in three dimensions and include mental imagery, spatial reasoning, image manipulation, graphic and artistic skills, and an active imagination.

A well-known researcher that uses the contextual approach to creativity is Csikszentmihalyi (1999) and his model of creativity is illustrated in Figure 2.3 below.

FIGURE 2.3:

CSIKSZENTMIHALYI'S MODEL OF CREATIVITY



Source: Csikszentmihalyi (1999) as cited in Sharma (2004:336)

The model explains that the interaction between domain and individual transmits information, the interaction between field and domain selects novelty, and the interaction between the individual and the field stimulates novelty. This shows that creativity is not the product of single agents but rather social systems making judgements about the agent's offering.

2.4.4.3 The Experimental approach

Cognitive psychologists use the experimental approach to show how creative thinking is dependent on generative processes (memory retrieval, association, mental synthesis) and exploratory processes (attribute finding, hypothesis testing, searching for limitations) which operate within given constraints (Petrowski, 2000:308).

Generative processes consist of retrieval, association, synthesis, transformation, analogical transfer and categorical reduction. These processes result in mental representations called “preinventive” structures of a potential final product (James et al., 2004:3).

In the *explorative phase*, these initial representations are interpreted through attribute finding, conceptual interpretation, functional inference, contextual shifting, hypothesis testing, and searching for limitations. The likelihood however of a creative product is interdependent to the extent to which these processes and structures occur. The difference between creative cognition and problem-solving is thus gradual (James et al., 2004:3).

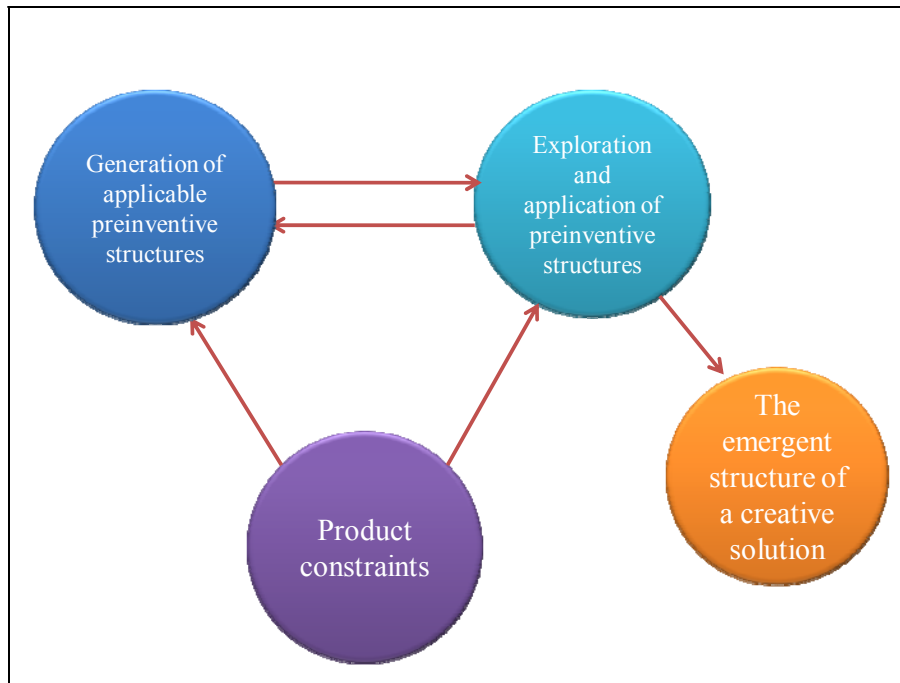
Cognitive psychologists identified the “conceptual expansion” (also called “the mental path of least resistance”) concept in the experimental approach. “Conceptual expansion” refers to the idea that at least eighty percent of the information that the brain uses to be creative is already present during the generative and exploratory processes (Ward, 1995 in Petrowski, 2000:308).

Cognitive psychologists identified four conceptual categories to support their views that true creative thinking is connected to existing structures or needs in meaningful ways (Petrowski, 2000:309). The four conceptual categories are:

- *Creative idealism* refers to ideas that are meaningful and inspirational without being too fantastic or detached;
- *Conservative idealism* describes ideas that are simple extensions of common ideas that were unrealistic to begin with;
- *Realistic realism* refers to ideas that focus on realistic issues and problems; and
- *Fantastic realism* refers to original ideas that no one has yet come up with.

A well-known model using the experimental approach is the Geneplore model of creative cognition (as illustrated in Figure 2.4 below) and was created by Ward, Smith and Finke (1992) (Petrowski, 2000:308; Korba, 1993:6)

FIGURE2.4: THE GENEPORE MODEL



Source: Korba (1993:7)

The GenePlore model of creative cognition is a heuristic model of creative functioning and based upon the principles of cognitive science (Korba, 1993:6). The model consists of two stages:

- *Idea generation* supported by generative processes; and
- *Idea exploration* supported by exploratory processes.

The cognitive processes require both inductive and deductive strategies to discern the preinventive or emergent structures that form creativity. The GenePlore model therefore reflects the hierarchical and lateral interconnection of various cortical functions like mental synthesis, transformation, reduction, interpretation and inference to generate and explore novel ideas or problem stimulus (Korba, 1993:14).

2.4.4.4 The Biographical approach

This approach involves close examination of the life histories of H-creative (historic/ societal creative) individuals. The aim of this approach is to identify developmental experiences and environmental factors that contribute to extraordinary creative achievement (Petrowski, 2000:309). The value of examining biographical information and identifying personality characteristics within the same field and across discipline is that it can predict future creative behaviour (Fillis, 2006:199)

Significant factors used in the biographical approach, according to Simonton (1999) (in Petrowski, 2000:309), include:

- Birth order;
- Childhood trauma;
- Family background;
- Education, and
- Mentors.

Biographical research provides the opportunity to contextualize crucial incidents based on the factors above, from the point of view of the individual's world (Fillis, 2006:200).

What is interesting about this approach is that Biographers proposed a developmental model of creativity that explains that no person is creative all the time. Even the so-called hyper-creative individual spends about ten years mastering a domain and creative breakthroughs only occur after prolonged preparation, normally at ten year intervals. Biographers also explain that there is a deep connection or fit between a highly creative individual and a domain, as well as the sense that something is not quite right in a domain. Creative people are therefore drawn to work on problems (Petrowski, 2000:309-310).

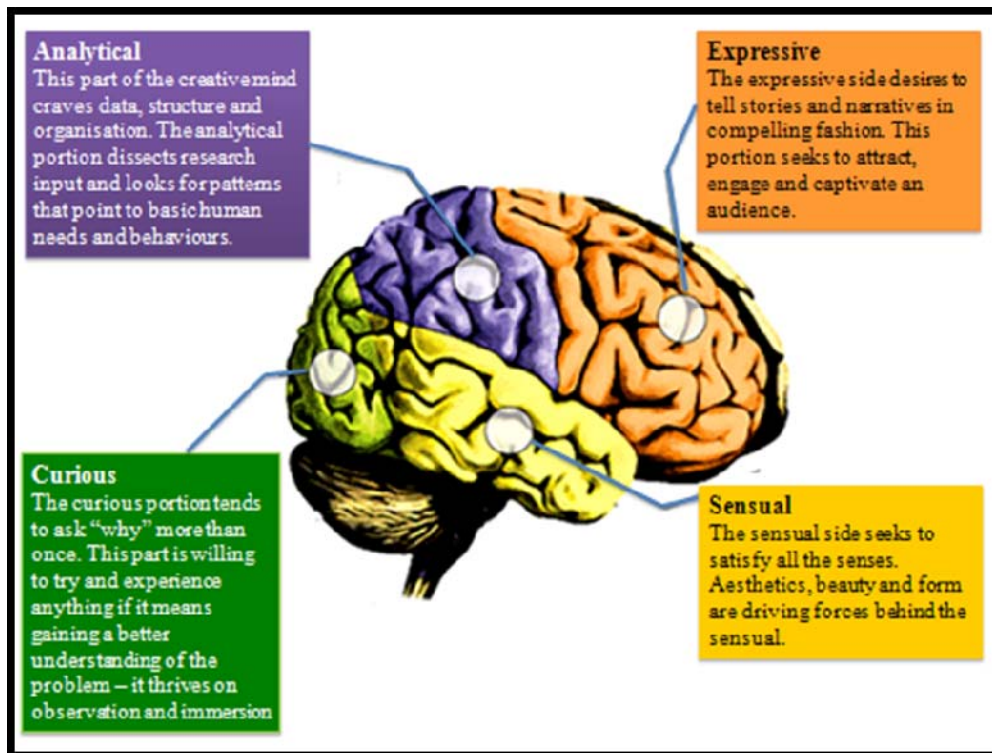
2.4.4.5 The Biological approach

The biological approach is based on the view that psychological traits have a biological basis. The biological approach believes that most behaviour is inherited and has an adaptive (or evolutionary) function. Biological psychologists explain behaviours in terms of the

physiology and structure of the brain (cortical brain activity) and how this influences behaviour. Many biological psychologists have concentrated on abnormal behaviour and have tried to explain it. This is also the case with creativity as most of the research focus on the psychological differences between creative and less creative people (Petrowski, 2000:310).

Armano (2006:1) explains that the creative mind is evolving due to a fast moving world and he calls it the “New Creative Mindset” which is a biological approach. He explains that individuals possessing this “New Creative Mindset” blend Analytical, Expressive, Curious and Sensual qualities into their thinking process. The result is a holistic approach to creativity that is effective across multiple touch points and experiences and is illustrated in Figure 2.5 below.

FIGURE 2.5: ANATOMY OF THE NEW CREATIVE BRAIN



Source: Armano (2006:1)

The most important finding in the biological approach was the relationship that exists between creativity and arousal. Creativity is associated with a state of low arousal. This

means that stress, distractions and constant demands are not conducive to creative thinking. It was evident that creative people need privacy and isolation to create novel ideas and requires stimulation and new experiences (Blyler, 2000 in Petrowski, 2000:310).

The literature study provided the theoretical description of the context of creativity to enhance the understanding of the levels of creativity and the various research approaches used to explain the context of creativity.

2.5 SUMMARY

The article showed that creativity is a complex and contentious phenomenon. It became evident that the well-being and growth of nations, organisations, and even individuals increasingly depend upon creative ability and creative genius, but that people, in general, do not really understand what creativity is. The challenge, then and today, remains people's attitudes, fears and perceptions towards creativity.

The article indicates that it is a grave error when people give up the thought of being creative; that the basic processes of the creative genius are accessible to every person and not only a charmed few; and that creativity can be understood if actions are taken to do so. A theoretical framework was provided to enable the reader to understand the concept of creativity and its measurement, as well as the challenges thereof.

Creativity, in its most simplest form, can be defined as the purposeful generation of ideas, the evaluation of these ideas and deciding which ideas are the most adequate that will lead to unexpected and appropriate outcomes.

The historical development of creativity was discussed. Twenty five models (process- and systems orientated models) were briefly discussed. The article also examined psychology-based approaches, the Hermann Brain Dominance Instrument (HBDI) and the Neethling Brain Instrument (NBI™) as models to explain creativity. General limitations of creativity models were highlighted.

Creative thinking was further explored to explain personality characteristics and cognitive abilities associated with creative people. A link was established between the person, the creative process and the product (Glover et al., 1989:80-86).

Four levels of creativity were identified, namely:

- The personal (P-Creativity) level;
- The historic/ societal (H-Creativity) level;
- The organisational (O-Creativity) level; and
- The animal (A-Creativity) level.

The five approaches to creativity were discussed, namely:

- The psychometric approach;
- The contextual approach
- The experimental approach
- The biographical approach
- The biological approach

Since 1950 researchers have developed formal methods for measuring creativity based on various perspectives and approaches. Measuring creativity was discussed and it showed that a huge variety of creativity measurements exist which test various aspects of creativity. The challenges in measuring creativity were also shown.

Three dimensions of creativity were discussed by using a number of creativity tests used in each dimension. A summary of these tests defined elements of creativity followed as well as a table showing the psychometric properties of creativity tests in terms of reliability and validity.

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CHAPTER 3

ARTICLE 2:

A CONCEPTUAL FRAMEWORK TO MEASURE CREATIVITY

Abstract

Measuring creativity has been problematic and the challenges in operationalising and assessing creativity are still being confronted today. Furthermore, the creation of hundreds of creativity tests intensified the criterion problem for creativity research. There is a need for exploring new creativity measurements to reduce the issues of subjectivity, bias and reliability when measuring creativity.

This study aimed to explain the approaches to creativity and creativity measurement, to review models in literature to find the key influences that should form part of a measuring instrument and to create a conceptual framework to measure creativity.

The primary objective was to provide a reliable and valid conceptual framework to measure creativity in a general application setting. The objective of this study was achieved through undertaking a literature study of creativity research, approaches to measure creativity and the various dimensions of creativity in creativity tests. This was followed by the empirical research. A survey-based research design was adopted using a closed questionnaire to determine the creativity influences to include in a conceptual framework to measure creativity. The sample consisted of 500 students from the North-West University in Potchefstroom.

The results of this study purified the measuring instrument and determined the reliability and validity of the measurement instrument.

Keywords: creativity, creativity models, conceptual framework, creativity measurement instruments, factor analysis, reliability, validity.

3.1 INTRODUCTION

Creativity is litigious and evokes strong emotions in people. Some people might think that creativity is a special ability for a selected few in society and others think that creativity is a skill that can be developed by any individual who wants to be creative. One of the main reasons for these conflicting ideas is people's inability to really understand the creativity phenomenon. More than 400 definitions of creativity have been developed over the last century, according to Nieman and Bennett (2002:400), which add to the confusion and lack of understanding.

The basis of the word creativity lies in the Latin root "*creare*" which means to produce something new (Nieman & Bennett, 2002:400). Creativity is therefore the catalyst in all new creations according to its Latin root.

Oxford Dictionary.com (2011:1) defines creativity as "the ability to transcend traditional ideas, rules, patterns, relationships, or the like, and to create meaningful new ideas, forms, methods, interpretations, etc.; originality, progressiveness, or imagination".

Sternberg (in Kaufman & Sternberg, 2006:1-10) defines creativity as "thinking that is aimed at producing ideas or products that are relatively novel and compelling".

Rhodes (1961:309) organised approximately 50 definitions into four stands:

- Person;
- Process;
- Press (interactions between human beings and their environment); and
- Products as the embodiment of ideas.

Nieman and Bennett (2002:400) identify the following terms as central to the notion of creativity:

- Unusual, uncommon, unique, something with surprise value;
- Practical, functional, feasible; and
- Understandable, able to be used by others.

So what is creativity? Creativity can be explained in the following metaphoric way. *Creativity is like a cat chasing its tail.* In an effort to solve problems people tend to go round and round in circles wanting to find solutions. Sometimes the solution is right before their eyes but they cannot see it. The solution only becomes visible if people look at something familiar in a new and different way. So creativity is basically, *looking at familiar things in a new and different way* (Wilson, 1997:1). The challenge however is the ability to “look in a new and different way” at familiar things.

Researchers and psychologists have tried to determine and measure this creative ability. A variety of measurement instruments were developed in an effort to try to determine if an individual is creative or not, and to find the so-called creativity quotient (CQ). These measurement instruments include the psychometric study of creativity, the social-personality approach, approaching creativity as an exact science like TRIZ, and approaching creativity as a case study, for example. The problem is that most measures of creativity are dependent on the personal judgement of the tester and there seems to be no instrument that can test the creativity quotient (CQ) in the same effective manner as the intelligence quotient (IQ). There is, however, standardised creativity tests, for example, Torrance Tests of Creative Thinking (TTCT) and Guilford’s Battery, which are valid and reliable to some degree, but caution should be taken when inferring estimates of future creative production (Runco, 1999:577).

Another challenge is that some of the instruments and tests that were developed used weak predictive validity coefficients or only focused on one aspect of creativity rather than looking at creativity holistically (Treffinger, Renzulli & Feldhusen, 1971:107; Plucker & Runco, 1998:36). Therefore, a standardized measure, like the intelligence quotient (IQ), seems to be challenging to develop.

This article aims to explain the approaches to creativity and creativity measurement, review models in literature to find the key influences that should form part of a measuring instrument and to create a conceptual framework to measure creativity.

3.2 ORIENTATION TO THE PROBLEM

Measuring creativity has been problematic and the challenges in operationalising and assessing creativity are still being confronted today. Furthermore, the creation of hundreds of creativity tests intensified the criterion problem for creativity research. Some researchers like Sternberg (2001:360-362) and Houtz and Krug (1995:273), see the range of measures as indicative of a variable, dynamic, creative field, which permit flexibility and adaptability to new problems and solutions, maximum theory development, and application to real-world problems.

Others see the measuring of creativity from other psychological and contextual variables as problematic. For example, the research done by Csikszentmihalyi in 1996 clearly indicates that without mastery of a domain, diverse thinking or ideational fluency are not likely to lead to creative products (Gagliardi-Blea & Zimmerman, 2009:160).

There also appears to be certain challenges with measuring creativity in general. These challenges include:

- Inconsistencies concerning the definition of creativity;
- Inconsistencies and limitations of existing creativity measurement methodologies, which include:
 - The reliability of these measurements is inadequate;
 - The validity and predictive validity are questionable;
 - An authentic, unbiased assessment is questionable;
 - The self-assessment aspect might not be 100% honest.
- The problem of what are being measured due to the fact that the basic facets of creativity can be grouped into four qualities: person – characteristics of creative people, process – preferences associated with aspects of the creative process, products – qualities of creative products, and the environment or press – factors in the environment which facilitate creative performance;
- Issues of subjectivity;
- Low correlational ratings of creativity tests in terms of measures of real-life creativity and the role of motivation;

- Creativity labels (e.g. creative, non-creative or something in between) can be problematic, leading some people to believe that they are naturally creative and others to believe they have little or no creative potential (Epstein, Schmidt & Warfel, 2008:8). This enhances the myth that creativity is not for everyone, only a selected few.
- A creativity measurement is a snapshot of a person's current ability, with the possibility that training and education can improve creative abilities. The problem arises when these measurements are not used as a developmental tool.

Thus, in finality, it is evident that there is a need for exploring new creativity measurements to reduce the issues of subjectivity, bias and reliability when measuring creativity.

3.3 RESEARCH OBJECTIVES

The primary objective of this article is to provide a reliable and valid conceptual framework to measure creativity in a general application setting.

To achieve the primary objective, the following secondary objectives are formulated, namely to:

- Extract and select creativity influences from literature;
- Identify measuring criteria for each creativity influence;
- Construct a measuring instrument from the literature to test creativity;
- Purify the measuring instrument and determine the reliability of the data; and to
- Test the measuring instrument for validity.

3.4 LITERATURE STUDY

The history of human thinking can be linked to four approaches to creativity which have led to various creativity models, theories and approaches. According to Sharma (2004:1), the **first** and oldest approach is *the creative leap* which is the belief that creativity comes from God and that people are empty vessels waiting for the Muse to pour the creative suggestion into them. The **second** approach focuses on *natural abilities and personality traits* which encourage people to behave in certain pre-conceived ways. The **third** is the *socio-dynamic*

approach, which emphasizes the importance of the social and environmental factors around the individual that encourage the individual to behave in certain ways to encourage his/ her own creativity. The **fourth** approach is the *pragmatic generative* approach, which encourages the use of new techniques.

There is, however, the need to create an additional approach due to ongoing research that emphasized that 98% of children between 0-3 years demonstrate creativity at a superior level. This is due to the fact that at birth, the brain is without developed preferences, and is therefore, essentially whole as per Ned Herrmann who developed the Herrmann Brain Dominance Instrument (HBDI) (Actionideas, 2010:1).

The history of human thinking is also linked to four clearly defined dimensions according to the Challenge House International Learning Centre (CHI) (no date:1). The **first** dimension thinking (1D) is dominated by survival, basic needs and wants. The **second** dimension thinking (2D) was a great leap forward for mankind and is dominated by vertical or logical thinking which enabled the development of mankind. The **third** dimension thinking (3D) encourages lateral thinking, 'thinking outside the box' and idea generation often based on 'brainstorming' guidelines to solve problems. The **fourth** dimension thinking (4D) is used in the evolution of idea generation and goes one step beyond the generation of ideas and problem solutions by making it ecological and beneficial to the user, in business or personal life.

The phenomenon of creativity appears to be extremely complex and is elusive and the study of creativity has different perspectives and approaches (Kerr & Gagliardi, 2003:3 & Vilalba, 2008:7). Sternberg and Lubart (cited in Vilalba, 2008:8) indicate that creativity research has been marginalized due to the lack of multi-disciplinary approaches and because of the fact that creativity is not clearly defined. There appears to be five commonalities in creativity research, however, namely:

- Creativity involves thinking that aims to produce novel ideas and products;
- Creativity has some domain-specific and some domain-general elements;
- Creativity is measurable to some extent (the focus of this study);
- Creativity can be developed and promoted; and
- Creativity is not highly rewarded in practice.

At first, creativity research was seen as a spiritual process and made use of psychodynamic studies where inner forces (conscious and unconscious emotional and motivational forces) affecting behaviour and mental states were studied (Sternberg & Lubart, 1999:5). Later, creativity research concentrated on pragmatic approaches which focused on the development of techniques to promote creative thinking in organisations. Both approaches lacked theory of creativity as it did not provide a clear idea of what the characteristics of creativity are and they were mainly practical approaches to enhance creativity.

Cognitive psychology studies were used to understand the process of creative thinking which led to most of the model development on creativity. Researchers, however, had different views of creativity. Some assumed that creativity is just extraordinary results of ordinary processes. Others believed that creativity is not different from intelligence (Vilalba, 2008:9). The threshold theory, for example, assumes that there is a “minimum level of intelligence (the lower threshold) below which the person cannot be creative” (Runco, 2007:7). This theory shows that creativity and intelligence are related but only at a certain level of ability.

Other cognitive psychology studies examined the process of creative thinking and the arguments of these studies were based on the possibility if creative thinking can be defined or not. Prominent models of creativity were developed which will be discussed in this chapter.

Psychometric approaches to creativity were also developed and the main focus was to develop tests to measure creativity. Four areas can be differentiated where psychometric methods have been applied in creativity research (Vilalba, 2008:10; Kerr & Gagliardi, 2003: 20-21 and 27-31), namely:

- Creative process;
- Personality and behavioural correlates;
- Characteristics of creative products; and
- Attributes of creative fostering environments.

In the review of the historic development of creativity it became evident that a large number of models exist to explain the process of creative thinking and that certain themes can be identified from these models. These themes can be summarized (Plsek, 1996:6) as:

- The total creative process requires the balance between purposeful analysis, imagination and critical evaluation.
- Older models imply that creative ideas are outside the control of the thinker and result from subconscious processes. Modern models on the other hand, indicate that creative ideas are under the direct control of the thinker and involve the purposeful generation of new ideas.
- Creativity involves action and implementation of ideas to be of real value.

Modern theory of creativity indicates that strong skills in practical, scientific, concrete, and analytical thinking should be supplemented with new thinking to support the generation of novel insights and ideas. People should also acquire the mental scripts to balance and direct traditional and new thinking skills to meet the challenges of the future and to become innovative.

It is evident from the discussion thus far that the phenomenon of creativity is extremely complex and that the study of creativity has different perspectives and approaches. Since 1950 researchers have developed formal methods for measuring creativity based on various perspectives and approaches. These approaches were discussed in 2.4.2.1. It is important to note that these approaches can however be grouped into two different forms of measuring creativity.

3.4.1 Approaches to measure creativity

The first approach relates to the psychological study of creativity. The approach consists of developing tests to measure creativity (Vilalba, 2008:15).

Torrance and Goff (1989)(cited in Cropley, 2008:1) identified no fewer than 255 creativity tests. These tests, to name a few, include personality tests that contain various sorts of creativeness scales, tests that measure the different styles with which people express creativity, tests that measure divergent thinking, tests that measure how suitable various environments are for creative expression and tests that measure creative achievement (Epstein et al., 2008:8).

Hocevar (1981) (cited in Vilalba, 2008:15) classified these tests into the following classifications:

- Tests of divergent thinking;
- Attitude and interest inventories;
- Personality inventories;
- Biographical measures;
- Ratings by teachers, peers or supervisors
- Product judgements; self-reports of creative achievements; and
- Eminence or the study of well-know and established creative people.

The second approach is referred to as a “sector approach”, which looks into specific aspects of a society in relation to creativity (Florida, 2010:1-2). Florida’s “creative class” approach is a good example of this approach.

All these tests have merit; however, many reviewers have questioned its usefulness, usually on the grounds of technical shortcomings (Cropley, 2008:1). It is important to examine why creativity measurements are questioned before discussing some of the creativity measurements currently being used.

3.4.2 Dimensions of creativity in creativity tests

Most of the creativity research, as discussed in 2.4.2, is based on the nature of creative thinking, the distinctive characteristics of the creative person, the development of creativity across the individual life span, and the social environments most strongly associated with creative activity. This research is important as it enabled various psychologists to assess creative thinking and to identify creative traits in people.

Many creativity-related measurements in the form of tests have also been developed based on creativity research approaches. These creativity tests are multifaceted and focus on products, processes and personal factors. Creativity models and research approaches (discussed in 2.4.2) were instrumental in obtaining research to create creativity tests.

Each creativity dimension, which can be linked to some extent to Rhodes' 4Ps, will be briefly discussed to identify the key determinants these tests focus on. It is important to note that there are more creativity tests and only a few are highlighted below.

3.4.2.1 Creative products

Creative products are physical manifestations (i.e. art work, novels, products, furniture) of creative thought and valued for its usefulness, unusualness, novelty, synthesis and relevancy, for example. This is often seen as the innovation aspect of creativity where creative thought is applied to create an artefact or method that often leads to commercialisation.

Two tests are briefly described below.

- **Taylor's Creative Product Inventory (1975)**

The Creative Product Inventory measures generation, reformulation, originality, relevancy, Hedonics, complexity, and condensation were one of the early models to measure the creativity of products (Cropley, 2008:3).

- **Creative Product Semantic Scale (CPSS) (1987)**

Besemer and O'Quin developed the Creative Product Semantic Scale (1987), which is based on three dimensions: novelty (the product is original, surprising and germinal), resolution (the product is valuable, logical, useful, and understandable) and elaboration and synthesis (the product is organic, elegant, complex and well-crafted) (Cropley, 2008:3).

3.4.2.2 Creative process

Graham Wallas is seen as the pioneer in creativity research and was the first to be recognised for a model to explain the process of creative thinking (Plsek, 1996:2). Wallas believed that creative thinking takes place in four stages. This process is important to ensure that novel ideas can appear and can be verified. If the incubation stage (stage two) is skipped, for example, new ideas cannot emerge. Many models followed in an effort to explain the creative process and to develop tests to explain creativity.

Four tests are briefly discussed below.

- **The Torrance Tests of Creative Thinking (TTCT)**

This test was developed in 1966, and it has been re-normed in 1974, 1984, 1990 and 1998. The TTCT is the most commonly used test and is based on divergent thinking (Cropley, 2008:4; Bronson & Merryman, 2011:21). The test materials include a verbal section consisting of six verbal activities (asking, guessing causes, guessing consequences, product improvement, unusual uses, unusual questions and just suppose) and a nonverbal or figural section consisting of three figural activities (picture construction, picture completion and lines or circles). The verbal activities score on fluency, flexibility and originality. The non-verbal activities score on fluency, originality, elaboration, abstractness of titles, and resistance to premature closure. The figural tests score on aspects like storytelling articulateness, synthesis of incomplete figures and fantasy.

- **Wallach and Kogan (1965) creativity test**

This test contains three verbal subtests (instances, alternative uses and similarities) and two figural stimuli subtests (pattern meaning and line meanings). Today, some users also score the test for flexibility, originality (statistical uncommonness) and usefulness (practicality and relevance to reality) (Cropley, 2008: 4-5).

- **Sternberg's Triarchic Abilities Test (1997)**

An important development in creativity testing originates from increasing recognition of the fact that actual creative production does not depend on divergent thinking alone, but also requires convergent thinking. Rickards (1994) (cited in Cropley, 2008:5) claims that the process of creativity needs both kinds of thinking to be effective. Sternberg's Triarchic Abilities Test (1997) highlights that intellectual ability can be better understood in terms of analytical-, practical- and synthetic ability (Koke & Vernon, 2003:1803-1807).

- **The Creative Reasoning Test (CRT)**

Developed by Doolittle in 1990, this test proves to be a problem-solving test that adopts a novel approach (Cropley, 2008:6). The novel aspect of this test is that the

problems to solve are presented in the form of riddles. The test requires associative, inductive and divergent thinking (Cropley, 2011:3).

3.4.2.3 Creative person

3.4.2.3.1 *Biographical inventories*

Biographical inventories are standardized questionnaires used for collecting biographical data (i.e. demographical information, family background, educational history, employment history, as well as items involving opinions, values, beliefs and attitudes).

Three biographical inventories are indicated below.

- **Schaefer and Anastasi's biographical inventory and Taylor's Alpha Biographical Inventory (ABI)**

These tests were created in 1968. The Schaefer and Anastasi's biographical inventory consists of 165 items, and Taylor's Alpha Biographical Inventory (ABI), consists of 300 items. These tests do not focus exclusively on creativity but is important to note in terms of characteristics of creative people. The areas it focus on includes family background (e.g. educational level of parents, degree of public recognition of parents or siblings), intellectual and cultural orientation (e.g. interests and hobbies, level of availability of demanding literature, frequency of visits to museums or art galleries), motivation (e.g. possession and use of special equipment such as a microscope, taking summer jobs in a field of interest) and drive towards novelty and diversity (e.g. level of interest in unusual art forms, extent of unconventional collections) (Cropley, 2011:4).

- **The Life Experience Inventory (LEI)**

This test was developed by Michael and Colson in 1979, is a 100 item inventory that concentrates on factual information (e.g. number of changes of address in childhood, composition of family, education, hobbies and recreation) (Cropley, 2011:4).

- **Creative Activities Checklist**

Runco developed this Checklist in 1987. The test simply asks respondents to indicate the frequency of their participation in literature, music, drama, arts, crafts and science (Cropley, 2008:7-8). Runco maintains that creative personality encompasses: Autonomy, flexibility, preference for complexity, openness to experience, sensitivity, playfulness, tolerance of ambiguity, risk taking or risk tolerance, intrinsic motivation, psychological androgyny, self-efficacy and wide interest and curiosity. He further notes that creative personality varies from domain to domain (Runco, 2007:315).

3.4.2.3.2 *Special personal properties*

Special personal properties refer to personal traits or personal unique characteristics that make individuals unique and can be useful as an indication of personality types and creative personality.

Three tests are discussed briefly below.

- **Creativity Checklist (CCL)**

This test can be used for people at all ages and was created by Johnson in 1979. Observers rate the behaviour of people on eight dimensions: fluency, flexibility, constructional skills, ingenuity, resourcefulness, independence, positive self-referencing and preference for complexity (Cropley, 2008:8).

- **The Creative Styles Questionnaire (CSQ)**

This test, created by Kumar, Kemmler and Holman in 1997, measures seven dimensions: belief in unconscious processes, use of techniques, use of other people, final product orientation, environmental control, superstition and use of senses (Cropley, 2008:9).

- **The Abedi-Schumacher Creativity Test**

This test was created in 1994 by O'Neil, Abedi and Spielberger. Here, indicators of creativity are flexibility, fluency, originality and elaboration (which can be linked to some process orientated models discussed in 2.4) (Cropley, 2008:9).

3.4.2.3.3 *Motivation and attitudes*

Creativity is influenced by motivation and attitude. Research has shown that intrinsic motivation is the principle of creativity (Hennessey & Amabile, 1987:6) and that creative attitude can be taught (Davis & Rimm, 1985:231).

Three tests are discussed briefly to indicate the determinants used in these tests.

- **Williams’s “How do you really feel about yourself?” test**

This test, created in 1972, measures curiosity, imagination, risk-taking and preference for complexity. Divergent feelings and aspects like fluency, flexibility, originality and elaboration are tested (Cropley, 2008:9).

- **The Creatrix Inventory (C & RT)**

This test was created by Byrd in 1986 and integrates both cognitive (thinking) and non-cognitive (motivation) dimensions of creativity. The inventory looks at eight styles, namely: reproducer (low on creative thinking and risk taking), modifier, challenger (high on risk taking and low on creativity), practicalizer, innovator (high on creative thinking and risk taking), synthesizer, dreamer (high on creativity and low on risk taking), and planner (Cropley, 2008:10).

- **Kirton’s Adaptation-Innovation Inventory (KAI)**

This test, created in 1989, distinguish between people who seek to solve problems by making use of what they already know and can do (adaptors), and people who try to reorganise and restructure the problem (innovators). Both styles are involved in creative problem solving. The innovative style leads to higher productivity and involves greater motivation to be creative, higher levels of risk-taking, and greater self-confidence (Cropley, 2011:6).

3.4.2.3.4 Summary of creativity tests

The dimensions of creativity that emerge from the tests (test defined elements and psychometric properties of creativity tests in terms of reliability and validity) are presented in the tables below.

TABLE 3.1: TEST DEFINED ELEMENTS OF CREATIVITY

Test defined elements (Product & Process)	
PRODUCT • Originality • Relevance • Usefulness • Complexity • Understandability • Pleasingness • Elegance/ Well-crafted • Germinality	PROCESS • “Uncensored” perception and encoding of information • Fluency of ideas (large number of ideas) • Problem recognition and construction • Unusual combinations of ideas (remote associations, category combination, boundary combination, boundary breaking) • Construction of broad categories (accommodating) • Recognizing solutions (category selection) • Transformation and restructuring of ideas • Seeing implications • Elaborating and expanding ideas • Self-directed evaluation of ideas
Test defined elements (Personality/abilities & Motivation)	
PERSONALITY/ ABILITIES • Active imagination • Flexibility • Curiosity • Independence	MOTIVATION • Goal-directedness • Fascination for a task or area • Resistance to premature closure • Risk-taking

• Acceptance of own differentness • Tolerance for ambiguity • Trust in own senses • Openness to sub-conscious material • Ability to work on several ideas simultaneously • Ability to restructure problems • Ability to abstract from the concrete	• Preference for asymmetry • Preference for complexity • Willingness to ask many (unusual) questions • Willingness to display results • Willingness to consult other people (but not simply to carry out orders) • Desire to go beyond the conventional
--	--

Source: Cropley (2008:1-2)

TABLE 3.2: PSYCHOMETRIC PROPERTIES OF CREATIVITY TESTS IN TERMS OF RELIABILITY AND VALIDITY

	Reliability		
Aspect of Creativity	Internal	Test-Retest	Inter-rater
Creative Products	.70-.90+	--	.70-.90+
Creative Thinking	.70-.90+	.60-.75	.65-.90+
The Creative Person			
• Biographical inventories	.50-.90	--	.90
• Special personal properties	.45-.90+	.55-.80+	.70-.90
• Motivation and attitudes	.60-.80+	.60-.80	.75+
	Validity		
Aspect of Creativity	Ratings	Other Tests	Real Life
Creative Products	--	--	--
Creative Thinking	.25-.70	Up to .70	.30-.70
The Creative Person			
• Biographical inventories	--	--	.60
• Special personal properties	.20-.70	.20-.60	.30-.40
• Motivation and attitudes	.60-.70	.20-.55	.25-.50

Source: Cropley (2008:1-2)

3.4.3 Limitations of creative models and approaches

Most models have limitations due to the fact that the models do not adequately address:

- Psychological factors that foster or inhibit creativity;
- Social/ environmental factors that impact on the creative process; and
- The manner in which the importance of certain social and psychological factors changes during the creative process.

Most models do not identify specific components that can be used to extract factors to examine the creative process. Models will need to be viewed in combination to find suitable factors pertaining to thinking styles, attitudes, behaviour, skills, characteristics and personality components.

It is evident from the historical overview of creativity research that the understanding of creativity differs due to the approach chosen to study it. Tests of creativity at individual level require either some type of divergent or some personality traits associated with creative behaviour. Test conditions could also affect the results. The differentiation between creative thinking and knowledge proficiency is also problematic. It is also evident that tests on creativity are significantly different than tests on intelligence.

The most plausible approach to creativity is a multidisciplinary approach, in which creative behaviour and thinking emerged from the combination of the right variety of elements in a very sophisticated interrelationship (Vilalba, 2008:28).

The following aspects will need to be considered in measuring creativity, namely:

- Indicators of creative performance need to be identified;
- Processes which are vital to creative efforts that will offer explanations for creative behaviour and which focus on causal factors which are universal and involved in all creativity will need to be identified; and
- Creativity should be defined in such a way that it can be measurable and different from aspects like “discovery, innovation, originality and imagination”.

Many creative-thinking methods and techniques can be found in literature. The British company Mycoted, which is an educational body that promotes creativity and innovation in

students, for example, listed one-hundred-and-eighty-three creative-thinking methods in alphabetical order (Lau, Ng & Lee, 2009:72). The challenge is to find the most suitable technique and to use a technique that has been tested to ensure success.

Lau et al. (2009:72) highlight that one of the most significant studies on classifying these creativity techniques was conducted by Butler and Kline in the 1990s. This classification was merely done for convenience in terms of their research and not to measure or facilitate creativity at tertiary educational level, for example. Butler and Kline indicated that there is no one best method of creating solutions to ill-defined problems. They categorized all creativity methods into three groups, namely:

- Brainstorming skill;
- The Hierarchical Technique; and
- The Skill for changing perspectives.

3.5 RESEARCH METHODOLOGY

The study consisted of quantitative research. Quantitative research was done by analysing literature studies and identifying specific creativity influences. Based on this research, a questionnaire was constructed with the aim to identify factors and to create a conceptual framework to measure creativity. The questionnaire consisted of a 7-point Likert scale to capture the views of respondents. This part of the research study was performed in April 2010 to November 2010.

Data was collected, analysed, purified and tested in February 2011 to April 2011. The reliability measure, Cronbach Alpha, was used to test the reliability and internal stability of the questionnaire. The data was subjected to a principal factor analysis using a Varimax, normalized rotation. The Kaiser, Meyer and Olkin (KMO) analysis was used to determine if the sample employed was suitable for analysis. The Bartlett test of sphericity was employed to test the data's suitability for factor analysis. A total of 500 questionnaires were distributed of which 322 were completed, signifying a response rate of 64.4%. The data was captured by the Statistical Consultation Services of the North-West University and analysed with the Social Package for Social Sciences Version 18 (SPSS, 2009).

In order to achieve the primary objective, the following five steps were followed:

- Step 1:** Extracted and selected creativity influences from literature.
- Step 2:** Identified measuring criteria for each creativity influence.
- Step 3:** Construct a measuring instrument from the literature to test creativity.
- Step 4:** Purify the measuring instrument and determine the reliability of the data.
- Step 5:** Test the measurement instrument for validity.

These steps and the results are discussed below.

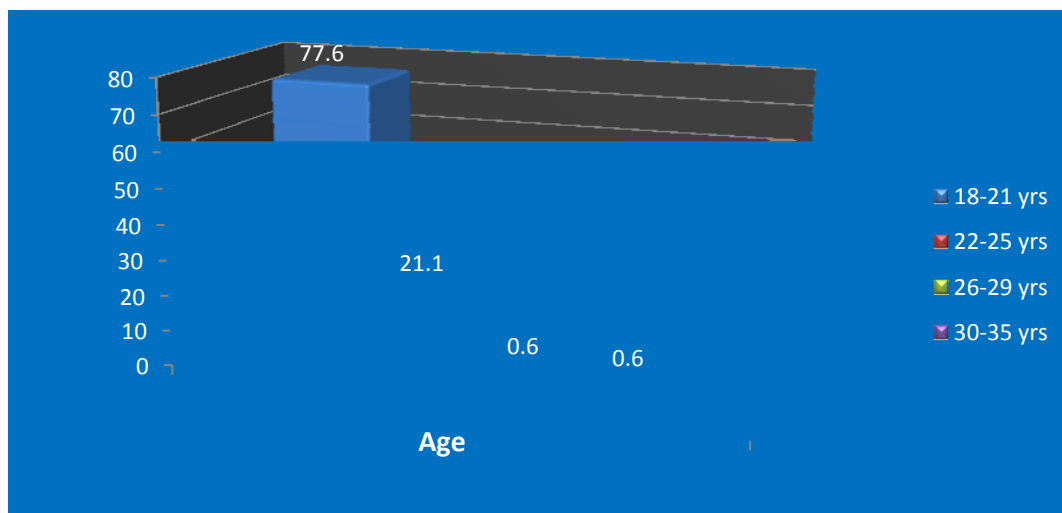
3.6 RESULTS

3.6.1 Demographic profile of the respondents

The profile of the respondents includes age, gender, mother tongue, region of residence, year of study and faculty of study.

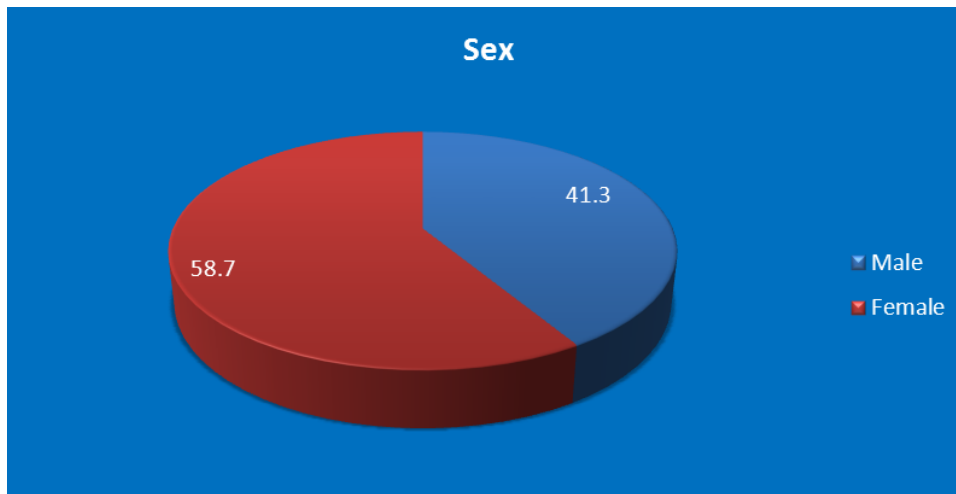
In terms of the age demographic, most of the respondents fell within the age group of 18-21 years (77.6%). This is a typical phenomenon for undergraduate students. No respondent was older than 35 years. The overall results appear in Figure 3.1 below.

FIGURE 3.1: AGE GROUP OF RESPONDENTS



In terms of gender, most of the respondents were female (58.7%). The overall result is shown in Figure 3.2 below.

FIGURE 3.2: GENDER OF RESPONDENTS

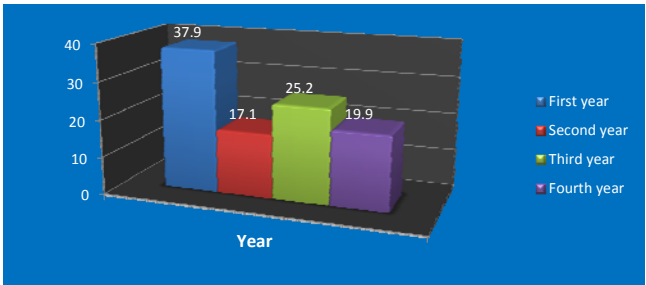


Most of the students' mother tongue are Afrikaans (89.8%). The result is not a surprise as North-West University students of the Potchefstroom campus are predominantly Afrikaans-speaking. English was 5% and Tswana 2.2%. The rest was divided between Xhosa, Northern Sotho, Swazi and other.

In terms of province of residence, most of the students resided permanently in North West (33.4%) and Gauteng (30.9%). The other provinces had a permanent residence of less than 7% and in total, all the other regions, accounted for 35.7%.

Most of the students in the sample were first-year students (37.9%) followed by 25.2% of the respondents who were third-year students. The remainder of the respondents were equally distributed between second-year and fourth-year students. The overall result is shown in Figure 3.3 below.

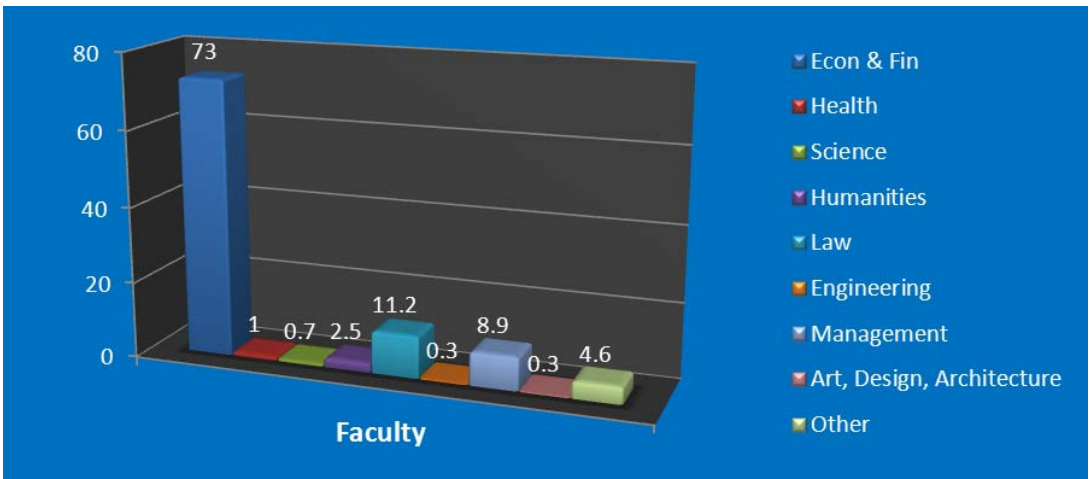
FIGURE 3.3: YEAR OF STUDY



Most of the students were full-time students (98.4%). This is also normal for a residential university like North-West University.

The majority of students who participated in the study were studying at the Faculty of Economic and Financial Sciences (68.9%). The overall result of the faculty of study of the participants is shown in Figure 3.4 below.

FIGURE 3.4: FACULTY OF STUDY



3.6.2 Research steps to achieve objectives of the study

3.6.2.1 Step 1: Extracted and selected creativity constructs from literature.

Twenty-eight creativity influences were identified from literature and grouped into two groups, namely cognitive psychology and personality characteristics. Eighteen influences were identified in the cognitive psychology group and ten in the personality characteristics group. See influences in Figure 3.5 below.

FIGURE 3.5: CREATIVITY CONSTRUCTS FROM LITERATURE



Source: Own compilation

3.6.2.2 Step 2: Identified measuring criteria for each creativity construct.

The influences were rated based on research support. Nine influences were identified based on support by five or more researchers. The influences appear in Table 3.3.

TABLE 3.3: DESCRIPTION AND SOURCES OF INFLUENCES

	INFLUENCE	DESCRIPTION	RESEARCHERS
1	Eight dimensional thinking	The ability to consider the dimensionality (i.e. space, time, cost, colour) of an issue to create ideas and combine objects, concepts and processes to find creative solutions	Berne & Raviv (2004:237-238), Bergh & Theron (2009:124, 414-415), Forex (2010:1), Creative Creativity (2007:1), Plsek (1996:3-4), Runco (2007:395)
2	Fluency	The ability to produce a great number of ideas or problem solutions in a short period of time	Pérez Alonso-Geta (2009: 311), Forex (2010:1), Creative Creativity (2007:1), Plsek (1996:3-4), Bergh & Theron (2009:124), Runco (2007:95)
3	Motivation	The drive to solve problems internally and externally.	Pérez Alonso-Geta (2009: 311), Unsworth (2001: 289-297), Bergh & Theron (2009:415), Runco (2007:403), Zusman and Zlotin (1998:1)
4	Cognition	The ability to understand a variety of information easily, to discover different links (obvious and not so obvious) and to identify contradictions in accepted knowledge	Baer & Kaufman (2005:4-6), Bergh & Theron (2009:414), Runco (2007:403), Pérez Alonso-Geta (2009: 308), Cropley (2008:262)
5	Communication	The ability to persuade others that creative ideas are valuable and reveal creative ideas to knowledgeable others	Jackson & Shaw (2005) in Kleiman (2008:210), Pérez Alonso-Geta (2009: 311), Cropley (2008:258), Forex (2010:1), Bergh & Theron

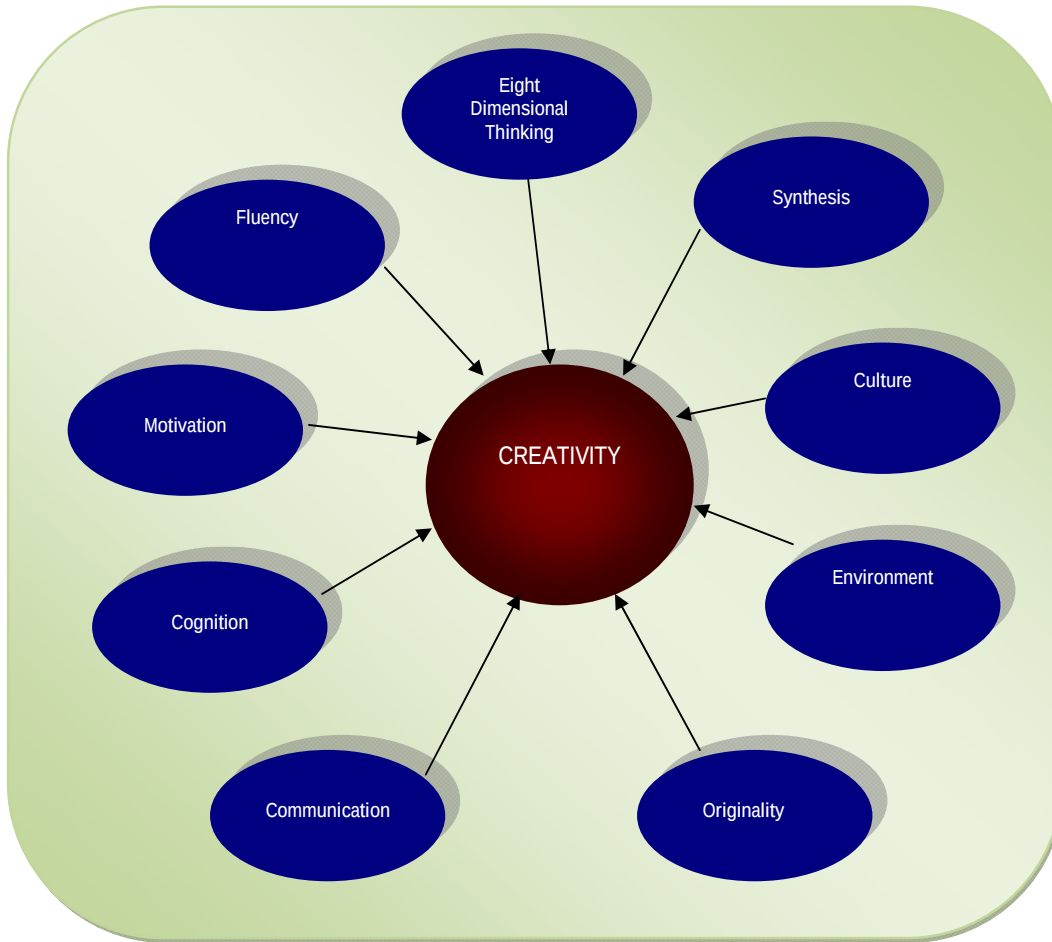
			(2009:115, 124), Runco (2007:396)
6	Originality	The ability to produce new and original ideas on a regular basis	Jackson & Shaw (2005) in Kleiman (2008:210), Pérez Alonso-Geta (2009: 308), James, Gerard & Vagt-Traore, 2004:3), Forex (2010:1), Creative Creativity (2007:1), Bergh & Theron (2009:124, 414), Runco (2007:95)
7	Synthesis	The ability to find the connection between items or variables by using associations, sequences or analogies between items or variables.	Pérez Alonso-Geta (2009: 311), Vilalba (2008:13), Forex (2010:1), Runco (2007:402), Bergh & Theron (2009:414), Plsek (1996:3-4), James, Gerard & Vagt-Traore (2004:3)
8	Culture	The influence of culture in providing the defined symbol system which enables a person to be creative	Csikszentmihalyi (1999:314), Bergh & Theron (2009:114), Runco (2007:396), Baer & Kaufman (2005:4-6), Florida (2010:1)
9	Environment	The influence of family, community, religion, society and country on a person's creative ability	Brunn (2009:2), Bergh & Theron (2009:415), Runco (2007:403), Csikszentmihalyi (1999:314), Brunn (2009:2), Vilalba (2008:20-21)

The nine influences identified in Table 3.3 were then used as measuring criteria for the research instrument.

3.6.2.3 Step 3: Operationalisation of influences.

The nine influences were operationalised to reflect the understanding of the concepts in the context of the present study. The complete set of operationalisations appears in Table 3.4. The conceptual framework for creativity is shown in Figure 3.6.

FIGURE 3.6: CREATIVITY – CONCEPTUAL FRAMEWORK



The operationalisation in Table 3.4 was based on the relevant definitions in the literature sources indicated. In some cases, operationalisation was slightly adapted to reflect the objectives of the present study. Upon finalization of the nine influences, items to measure the influences were also identified. These questions, its literary origin and the relevant constructs appear in Table 3.4.

TABLE 3.4: OPERATIONALISATION OF QUESTIONNAIRE ITEMS

DIMENSION	CODE	ITEM	SOURCE
Eight dimensional thinking		To help me find solutions or generate ideas I look for the uniqueness in:	Berne & Raviv (2004:237-238), Bergh & Theron (2009:124, 414-415), Forex (2010:1), Creative Creativity (2007:1), Plsek (1996:3-4), Runco (2007:395)
	A1N1	processes	
	A1N2	1.1 objects	
	A1N3	1.2 features	
	A1N4	1.3 situations	
		I consider the dimensionality of an issue to create ideas in terms of:	
	A2N1	2.1 space	
	A2N2	2.2 time	
	A2N3	2.3 cost	
	A2N4	2.4 colour	
	AQ3	I determine if things can be done from different points of view	
	A4N1	To find creative solutions, I combine:	
	A4N2	4.1 objects	
	A4N3	4.2 concepts	
	A4N3	4.3 processes	
	A5N1	To find creative solutions, I separate:	
	A5N2	5.1 concepts	
	A5N2	5.2 processes	
	A5N3	5.3 resources	
	A5N4	5.4 objects	
	A5N5	5.5 dimensions	
	AQ6	I like to modify my creative solutions	
	A7N1	I look for similarity in:	
	A7N2	7.1 concepts	
	A7N2	7.2 problems	
	A7N3	7.3 solutions	
	A7N4	7.4 patterns	

	A7N5	7.5 processes	
	A8N1	To find the best creative solution, I:	
	A8M2	8.1 estimate	
	A8N3	8.2 simulate	
Fluency	B1	8.3 experiment	Pérez Alonso-Geta (2009: 311), Forex (2010:1), Creative Creativity (2007:1), Plsek (1996:3-4), Bergh & Theron (2009:124), Runco (2007:95)
	B2	I have the ability to produce a great number of ideas	
	B3	I have the ability to produce solutions to problems in a short period of time	
Motivation	CN1	I can simultaneously propose a variety of solutions to a specific problem	Pérez Alonso-Geta (2009: 311), Unsworth (2001: 289-297), Bergh & Theron (2009:415), Runco (2007:403), Zusman and Zlotin (1998:1)
	CN2	I am driven by external pressures (including other people) to solve problems	
	CN3	I am driven by external pressures (including other people) to solve self-discovered problems	
	CN4	I am self-motivated to resolve externally defined problems	
	CN5	I am self-motivated to solve self-defined problems	
	CN6	I am always motivated to be creative in my own interest areas	
	CN7	I am motivated to be creative in an environment that tears down my barriers to creative thinking.	
Cognition	DN1	I am always motivated by other people to use my creative skills	Baer & Kaufman
	DN2	I attain understanding from a variety of information sources without difficulty	
		I can discover different links and relationships (obvious and not so obvious) when I look at	

		different information sources	(2005:4-6), Bergh & Theron (2009:414), Runco (2007:403), Pérez Alonso-Geta (2009:308), Cropley (2008:262)
	DN3	I can cope with complexities when I need to resolve a problem	
	DN4	I do not get stuck on a set of rules to solve a problem	
	DN5	I can easily see different aspects of a problem	
	DN6	I can recognise gaps in my existing knowledge	
	DN7	I can identify contradictions in accepted knowledge	
	DN8	I can predict appropriate creative solutions to a problem after analysing the contradictions in a problem	
	DN9	I agree that the use of scientific approaches outside a specific field of study can be helpful to develop creative solutions	
Communication	EN1	I am able to persuade others that my ideas are valuable	Jackson & Shaw (2005) in Kleiman (2008:210), Pérez Alonso-Geta (2009:311), Cropley (2008:258), Forex (2010:1), Bergh & Theron (2009:115, 124), Runco (2007:396)
	EN2	I use communication as a tool to reveal my creative ideas to knowledgeable others	
Originality	FN1	I propose new ideas on a regular basis	Jackson & Shaw (2005) in Kleiman (2008:210), Pérez Alonso-Geta (2009:308), James, Gerard & Vagt-Traore, (2004:3), Forex (2010:1), Creative
	FN2	I intentionally engage in unpopular ideas	
	FN3	I am able to redefine a known problem from a completely different perspective	

			Creativity (2007:1), Bergh & Theron (2009:124, 414), Runco (2007:95)
Synthesis	GN1	I can find the connection between items	Pérez Alonso-Geta (2009: 311), Vilalba (2008:13), Forex (2010:1), Runco (2007:402), Bergh & Theron (2009:414), Plsek (1996:3-4), James, Gerard & Vagt- Traore (2004:3)
	GN2	I find new solutions by using associations between items	
	GN3	I like to combine various concepts to find solutions to problems	
	GN4	I am able to see problems in a novel way	
Culture	HN1	My culture provides the defined symbol system which enables me to be creative	Csikszentmihalyi (1999:314), Bergh & Theron (2009:114), Runco (2007:396), Baer & Kaufman (2005:4- 6), Florida (2010:1)
	HN2	My culture is open-minded to novel ideas	
	HN3	My culture supports my creative thoughts	
Environment	IN1	My family influenced the way I think about my own creative ability	Brunn (2009:2), Bergh & Theron (2009:415), Runco (2007:403), Csikszentmihalyi (1999:314), Brunn (2009:2), Vilalba (2008:20-21)
	IN2	My family encouraged me to be creative when I was growing up.	
	IN3	My family did not value my creative output when I was growing up.	
	IN4	My community encourages creativity in people	
	IN5	Society stimulates novelty in me	
	IN6	Society selects what novelty is	
	IN7	My religion encourages my creative thinking	
	IN8	My religion encourages my creative output	
	IN9	My country recognizes self expression values	

	IN10	My university/ institution provides a climate that stimulates creativity in me	
	IN11	My country is based on <u>beliefs</u> that are passed down from generation to generation	
	IN12	My country is based on values that are necessary to the functions and fulfilment of intellect and will.	

The measuring instrument, as shown in the Table 3.4 above, requires empirical testing. This was done by collecting primary data by having the respondents in the sample complete the structured questionnaire (as described in Chapter 1).

3.6.2.4 Step 4: Purify the measuring instrument and determine the reliability of the data

3.6.2.4.1 *Reduction of the measuring criteria*

The instrument was purified by means of exploratory factor analysis, using a Varimax rotation. This rotation was selected because of its ability to maximise variance explained (Field, 2007:636). Factor loadings of 0.40 were set as the minimum factor loading, while the data is also required to explain a cumulative variance of in excess of 60% (Field, 2007:668). In addition to ensure that the data is suitable for further analysis, the data is subjected to the Kaiser, Meyer and Olkin (KMO) measure of sampling adequacy that determines if the sample employed is suitable for analysis. Values of 0.70 and higher are regarded to be acceptable and set as the minimum value for this study (Field, 2007:666). Further, Bartlett's test of sphericity is also used as it is a measure that renders a verdict if data is suitable for multivariate statistical analysis, such as factor analysis. The required values of Bartlett need to be lower than 0.005 to proceed with factor analysis (Field, 2007:640, 642 & 648). (Refer to Chapter 1 for more detail on the statistical techniques used in this study.)

The data required three rounds of purification to eliminate all non-loading criteria as well as the criteria that dual-load strongly on more than one factor. The results of the purification over the three rounds of exploratory factor analyses appear in Table 3.5 below.

TABLE 3.5: PURIFICATION OF THE MEASURING CRITERIA

ROUND	VARIANCE EXPLAINED	KMO	BARTLETT	CRITERIA ELIMINATED
1	0.652	77.57%	0.000	CN5, AQ3, GN1, B1, A7N3, A2N4, CN1, GN3, CN3, A4N1, A4N3
2	0.674	76.40%	0.000	A4N2, FN1, DN1, DN8, HN1, A5N1, A5N2, A2N2, DN4, CN4
3	0.702	75.52%	0.000	DN6, A7N2, IN10, A5N5

From the table above it is clear that the variance explained improved as the 25 criteria which had either low factor loadings or strong dual-loadings on more than one factor, were omitted from the measuring instrument. Both the KMO and Bartlett tests showed favourable values with KMO in excess of 0.75 in all three cases and with the Bartlett test also remaining below the 0.000 level. The results from the purification process show that the elimination of the non-loading items improved the variance explained while no deterioration of the sample adequacy and factor extraction resulted.

3.6.2.4.2 *Factor analysis*

The purified data set were subjected to the exploratory factor analysis to determine the factors and their respective measuring criteria pertaining to creativity. The KMO and Bartlett's tests appear in the Table 3.6 below.

TABLE 3.6: KMO AND BARTLETT TESTS

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	.751
Bartlett's Test Approx. Chi-Square of Sphericity	3203.071
df	465
Sig.	.000

A total of nine components were extracted from the data. These components explain a cumulative variance of 73.57% (See Table 3.7 below).

TABLE 3.7: VARIANCE EXPLAINED

Component	Initial Eigenvalues			Extraction Sums of Squared			Rotation Sums of Squared		
	Loadings			Loadings			Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.613	27.784	27.784	8.613	27.784	27.784	4.791	15.456	15.456
2	2.984	9.626	37.410	2.984	9.626	37.410	3.345	10.790	26.246
3	2.505	8.081	45.490	2.505	8.081	45.490	3.117	10.055	36.300
4	2.226	7.181	52.671	2.226	7.181	52.671	2.341	7.551	43.852
5	1.719	5.544	58.215	1.719	5.544	58.215	2.272	7.330	51.181
6	1.444	4.659	62.874	1.444	4.659	62.874	2.051	6.616	57.797
7	1.186	3.826	66.701	1.186	3.826	66.701	1.785	5.757	63.553
8	1.121	3.615	70.316	1.121	3.615	70.316	1.763	5.688	69.241
9	1.009	3.254	73.570	1.009	3.254	73.570	1.342	4.328	73.570

The variance explained is also favourable and exceeds the required 60% which signifies a “good fit” as stated by Field (2007:668). The Kaiser criterion suggests to retain those factors with eigenvalues equal or higher than one (Hall, n.d.:1).

After the eigenvalues were examined, the number of underlying factors was identified. A common criterion to use is a number of factors equal to the number of Eigenvalues that are greater than one (Hall, n.d.:1). Table 3.7 shows nine eigenvalues greater than one, and therefore, nine factors are extracted to measure creativity.

The Varimax rotational method was used as it maximises the variance explained by factors if there is a low correlation coefficient between the factors (Du Plessis, 2010; Field, 2007:749). The rotated factor matrix displays the factor loadings (correlation scores) between each survey item and underlying factor (Hall, n.d.:1). The Varimax rotated factor table appears in Table 3.8. Factor loadings below the required 0.40 are suppressed in the table in order to present the data in a reader-friendly manner.

TABLE 3.8: ROTATED FACTOR MATRIX

	Component								
	1	2	3	4	5	6	7	8	9
dn2	.820								
dn3	.814								
dn1	.760								
cn6	.697								
cn7	.680								
en2	.678								
aq6	.611								
en1	.577								
b3		.785							
gn4		.778							
b2		.768							
a8n3		.560							
in6		.491							
a7n1			.834						
a7n5			.834						
a7n4			.755						
a2n1			.628						
in8				.908					
in7				.864					
in11					.873				
in12					.827				
in9					.655				
in4						.823			
in5						.808			
a1n3							.723		
a1n1							.625		
a5n4							.425		
in3								-.795	
in2								.767	
fn2									.701
a2n3									-.572

Table 3.8 shows the factors and the items that loaded onto the nine factors. Factor loadings range from minus one (perfect negative correlation) to plus one (perfect positive correlation). The higher the factor loading (either positive or negative), the more strongly that item is

associated with the corresponding factor (Hall, n.d.:1). A negative loading indicates an inverse impact on the factor according to Torres-Reyna (n.d.:3).

Nine factors were identified by the analysis above to include in a conceptual framework to measure creativity. Based on the content of the correlated items, a name or label was developed for each underlying factor. The factor then became part of the conceptual framework for explaining creativity. The nine factors identified were:

- **FACTOR 1: COGNITION AND COMMUNICATION**

Factor 1 is the most important factor and has been identified as *Cognition and Communication*. The eight items loading onto Factor 1 point to finding different links and relationships when looking at a variety of information sources, as well as the ability to cope with complexities, the motivation to tear down barriers to creative thinking and the ability to use communication effectively to reveal creative ideas to others and to persuade others that these ideas are valuable. The factor explains a favourable variance of 15.46%.

- **FACTOR 2: PROBLEM-SOLVING**

Factor 2 has been identified as *Problem-solving*. The five items loading onto Factor 2 all point to the ability to produce solutions to problems by looking at a variety of solutions in a novel way, solving problems in a short period of time and using experimentation to find the best creative solution. The factor explains a favourable variance of 10.79%.

- **FACTOR 3: DIMENSIONAL THINKING**

Factor 3 has been identified as *Dimensional Thinking*. The four items loading onto Factor 3 all point to the ability to look for similarity in concepts, processes and patterns to find creative ideas, and the ability to consider the dimensionality of an issue in terms of space. The factor explains a favourable variance of 10.06%.

- **FACTOR 4: RELIGION**

Factor 4 has been identified as *Religion*. The two items loading onto Factor 4 points specifically to the impact religion has on an individual's creative output and creative thinking. Both these two items show high factor loadings (0.90 & 0.86) showing strong correlations to the factor. The factor explains a favourable variance of 7.55%.

- **FACTOR 5: COUNTRY OF ORIGIN**

Factor 5 is another important factor and has been identified as *Country of origin*. The three items loading onto Factor 5 all point to the impact the country of origin has on beliefs, values and self-expression and its impact on the creative thinking of people living in a certain country. This factor can be directly tied to *Florida's Creativity Index* where creativity is viewed as the “ultimate economic resource”, because creative people are attracted to places that are characterised by a “culture that’s open-minded and diverse” which ultimately turns into economic value (Florida, 2010:1). The factor explains a favourable variance of 7.33%.

- **FACTOR 6: CULTURE**

Factor 6 has been identified as *Culture*. The two items loading onto Factor 6 both have high factor loadings in excess of 0.80 which show high correlations to the factor. Both these items point to the impact of society and community on people’s creativity. The factor explains a variance of 6.62%.

- **FACTOR 7: UNIQUENESS**

Factor 7 has been identified as *Uniqueness*. Three items loaded onto Factor 7. All three these items point to the ability to find solutions or generate ideas by looking at the uniqueness in features and processes and to separate objects to find creative solutions. The factor explains a variance of 5.76%.

- **FACTOR 8: FAMILY**

Factor 8 has been identified as *Family*. There are two items loading onto Factor 8. These items point to the impact of family (-0.79) and the role of family members to encourage and value creativity while growing up (0.77). However, the negative factor loading shows that the item “*My family did not value my creative output when I was growing up*” was not a negative family influence on creativity because the negative loading inverts the negatively formulated item to be positive. The factor explains a favourable variance of 5.69%.

- **FACTOR 9: CHALLENGING THE STATUS QUO**

Factor 9 is labelled *Challenging the status quo*. There are two items loading onto Factor 9. One of the items loading heavily (0.70) on Factor 9 points to the *need to intentionally engage in unpopular ideas*. The other item correlates negatively on the factor, rendering the view that

cost (-0.57) is **not** (hence the negative loading) perceived to be a limiting factor in creativity. This factor explains a variance of 4.33%.

3.6.2.4.3 *Reliability*

The reliability of the data was determined by employing Cronbach's coefficient alpha (α). The Cronbach alpha coefficients are interpreted as follows (George & Mallery, 2003:231):

- $\alpha > 0.9$ Excellent
- $0.9 > \alpha > 0.8$; Good
- $0.8 > \alpha > 0.7$; Acceptable
- $0.5 > \alpha > 0.6$ Questionable
- $\alpha < 0.5$ Unacceptable

A minimum coefficient of 0.70 is normally required (Field, 2007:666), although Schmitt (1996:350) indicates that satisfactory levels of relatively low (e.g. 0.50) levels do not seriously reduce reliability as it depends on the test use and interpretation. This view is supported by Cortina (in Field, 2007:666) who states that alpha coefficients are acceptable at the 0.58 level when ratio-scales are used (such as the case with this study). For this study, a reliability coefficient of 0.70 is set to conform with the general norm. However, the lower limit by Cortina of above 0.58 is also set as a secondary acceptable reliability coefficient. The reliability of the nine factors is shown in Table 3.9.

TABLE 3.9: RELIABILITY OF THE FACTORS

FACTOR	CRONBACH ALPHA
1	0.858
2	<i>0.635</i>
3	0.828
4	0.853
5	0.740
6	0.788
7	<i>0.572</i>
8	-1.071
9	-0.313

Factors 1, 3, 4, 5 and 6 all have very satisfactory reliability coefficients well in excess of the required 0.70. Factor 2 is marginally below the upper limit of 0.70, but well above the lower reliability limit of 0.58, with a reliability coefficient of 0.64. Factor 7 is marginally above the lower limit set by Cortina with a reliability coefficient of 0.57 (0.572), and therefore, accepted as a reliable factor.

Factor 8 and 9 shows a negative reliability coefficient. In this regard, Field (2007:666-669) suggests that in cases of negative reliability coefficients, the data requires some additional analysis before a final verdict on reliability can be rendered. The data is scrutinised, and the where needed, inverted to ensure that no negatively stated questions exist within. Then the alpha coefficients are recalculated. If no significant improvement in the reliability is achieved, the original coefficients are accepted as the alpha coefficients, and the data pertaining to that factor is thus regarded to be unreliable. These prescriptions were followed, but to no avail. The two factors remained unreliable; hence their original alpha coefficients are shown in the table above as negative values (Factor 8 and Factor 9). In this regard, it is important to note that as reliability declines, the factor is less likely to represent itself in repetitive studies. However, this fact does not make a factor less important to the current study, and as such these two factors should be interpreted with this constraint in mind (Field, 2007:668-669).

3.6.2.5 *Step 5: Test the measurement instrument for validity*

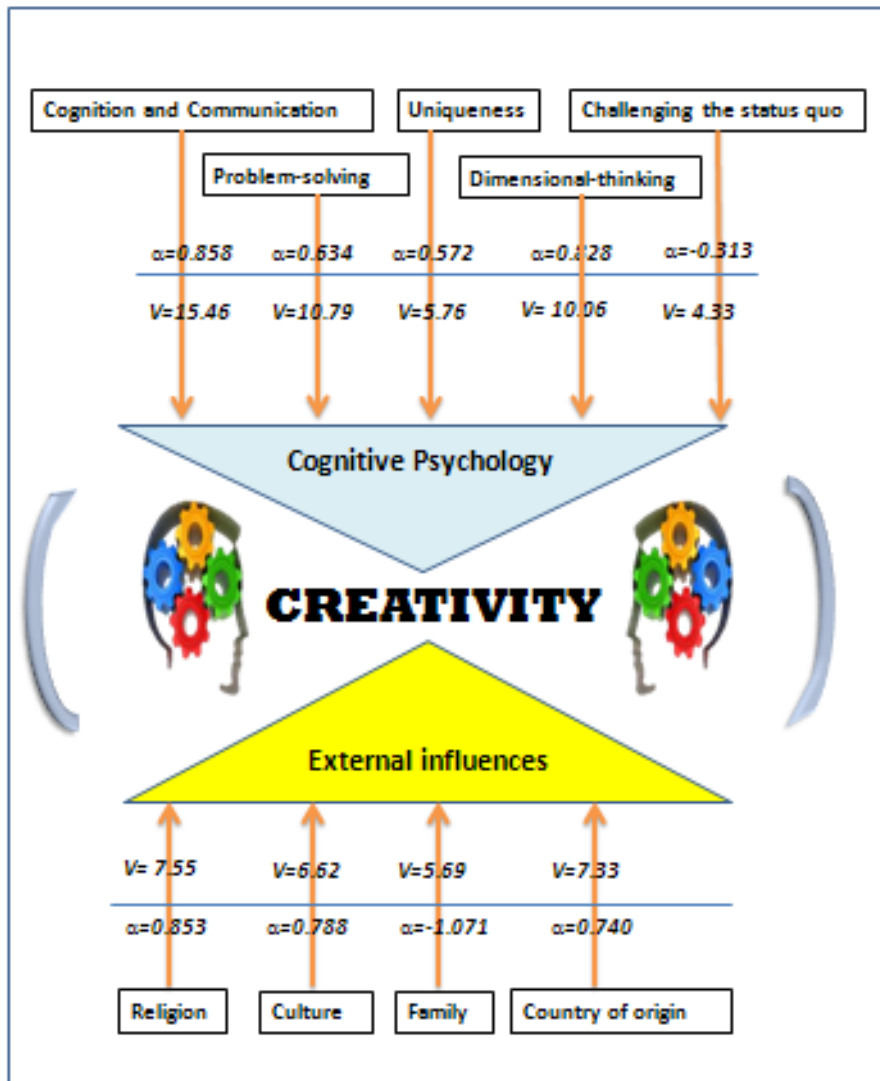
The validity of the factors has been given in Table 3.9 (Factor table). The factor analysis identified the criteria pertaining to each factor, and as such, these criteria are statistically proven to measure the specific factor. The variance explained by these factors are also calculated, thus showing the relative importance of each of the factors and its respective criteria's importance (see the factor loadings of each criterion) to the measuring instrument. The purified measuring instrument, as shown in Table 3.5, is thus proven to be a valid measuring tool to measure creativity.

3.7 AMENDED CONCEPTUAL FRAMEWORK TO MEASURE CREATIVITY (CF1)

From the analysis above, and the elimination of less important criteria, a new framework to measure creativity is constructed. The amended conceptual framework appears in Figure 3.7 and the amended questionnaire to measure creativity appears in Table 3.10.

Figure 3.7 follows on next page

FIGURE 3.7: CREATIVITY – AMENDED CONCEPTUAL FRAMEWORK (CF1)



Source: Own compilation

The detailed amendment appears in the table below where the measuring criteria are shown as well.

TABLE 3.10: AMENDED QUESTIONNAIRE (CONCEPTUAL FRAMEWORK – CF1)

FACTORS	NO	ITEM
Cognition and communication	1	I can discover different links and relationships (obvious and not so obvious) when I look at different information sources
	2	I can cope with complexities when I need to resolve a problem
	3	I attain understanding from a variety of information sources without difficulty
	4	I am motivated to be creative in an environment that tears down my barriers to creative thinking
	5	I am always motivated by other people to use my creative skills
	6	I use communication as a tool to reveal my creative ideas to knowledgeable others
	7	I like to modify my creative solutions
	8	I am able to persuade others that my ideas are valuable
Problem solving	9	I can simultaneously propose a variety of solutions to a specific problem
	10	I am able to see problems in a novel way
	11	I have the ability to produce solutions to problems in a short period of time
	12	To find the best creative solution, I experiment
	13	Society selects what novelty is
Dimensional thinking	14	I look for similarity in concepts
	15	I look for similarity in processes
	16	I look for similarity in patterns
	17	I consider the dimensionality of an issue to create ideas in terms of space
Religion	18	My religion encourages my creative output
	19	My religion encourages my creative thinking
Country of origin	20	My country is based on <u>beliefs</u> that are passed down from generation to generation
	21	My country is based on values that are necessary to the functions

		and fulfilment of intellect and will
	22	My country recognizes self-expression values
Culture	23	My community encourages creativity in people
	24	Society stimulates novelty in me
Uniqueness	25	To help me find solutions or generate ideas I look for the uniqueness in features
	26	To help me find solutions or generate ideas I look for the uniqueness in processes
	27	To find creative solutions, I separate objects
	28	My family encouraged me to be creative when I was growing up
Family	29	My family did not value my creative output when I was growing up
	30	My family encouraged me to be creative when I was growing up.
Challenging the status quo	31	I intentionally engage in unpopular ideas

3.8 CONCLUSIONS

From this study the following conclusions can be drawn:

1. This article focused on creativity research (models and approaches) to extract creativity influences to be used as measuring criteria for creativity. Based on the literature study, twenty-eight creativity influences were initially identified and grouped into two groups, namely cognitive psychology and personality characteristics. Eighteen influences were identified in the cognitive psychology group and ten in the personality characteristics group. Based on research support, only 9 influences consisting of 51 items relating to these influences were identified to be used in the measuring instrument after the operationalisation process.
2. The measuring instrument was then purified by employing various statistical tests. Exploratory factor analysis using Varimax rotation was used due to its ability to maximize variance explained. The rotated factor analysis explained a variance in excess of 0.70%. The variance explained indicated that the measuring tool to measure creativity was able to explain more than 70% of the items that measure creativity, and

as such the retained items could be regarded to be valid in measuring what they are intended to measure (A variance of 60% explained is regarded to a “good fit to the data”).

3. The Kaiser, Meyer and Olkin (KMO) measure of sampling adequacy indicated that the sample was adequate. Values of 0.70 and higher are regarded as acceptable. This study had a value of 0.751.
4. The Bartlett’s Test of sphericity measures if data is suitable for multivariate statistical analysis, such as factor analysis. The approximate Chi-Square for this study was 3202.071, the Degrees of Freedom (df) was 465 and the Significance (Sig.) was 000. This indicated that the data was suitable for use in multivariate statistical analysis such as a factor analysis.
5. The measuring criteria required three rounds of purification to eliminate non-loading criteria as well as criteria that load strongly on more than one factor. In total, 25 criteria were eliminated from the measuring instrument.
6. The initial data set, consisting of 9 influences and 51 items, were decreased to achieve a validated measuring instrument. As a result, the original 9 influences and 51 items are discarded and the new validated questionnaire is employed to measure creativity.
7. The factor analysis identified nine factors and retained 29 items of the original items. These factors are Cognition and communication, Problem-solving, Dimensional thinking, Religion, Country of origin, Culture, Uniqueness, Family and Challenging the status quo. These factors were used to create an amended conceptual framework and questionnaire items. These 9 factors explained a cumulative variance of 73% which exceeds the required 60% to represent a good fit to the data.
8. The Cronbach coefficient alpha was used to test the reliability of the factors and the reliability of the seven more important factors were good, while the last two factors cannot be regarded as reliable. This was shown in Table 3.9.

3.9 SUMMARY

This article identified a reliable and valid conceptual framework to measure creativity in a general application setting.

This conceptual framework incorporated various approaches, models and creativity tests based on an extensive literature study, thus making it plausible to use to measure creativity. The

conceptual framework combined creative behaviour and thinking and linked it in a sophisticated interrelationship, which is evident from the factors identified to measure creativity and the statistical tests used. These factors are: cognition and communication, problem-solving, dimensional thinking, religion, country of origin, culture, uniqueness, family and challenging the status quo.

This conceptual framework can play an important role in measuring creativity in the future and has the potential to be applied and tested in various settings. The conceptual framework also offers the possibility to be used in future creativity research and to be developed further to play an important role in the development of individuals' creative abilities.

The researcher acknowledges, however, that measuring creativity remains challenging and that psychological factors still play a role in fostering or inhibiting creativity, that social factors impact on the creative process and that these factors can change during the creative process.

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CHAPTER 4

ARTICLE 3:

A CONCEPTUAL FRAMEWORK TO MEASURE CREATIVITY AT TERTIARY EDUCATIONAL LEVEL

Abstract

The role of tertiary education is becoming more important than before in equipping graduates with creative skills and competencies to apply in the global and competitive business and social environments. It is therefore important that tertiary education institutions measure the creativity of students to actively support students' creative development. Measuring creativity at this level, however, has been problematic due to the diverse teaching and learning processes and programmes available at tertiary educational institutions and the challenges in operationalising and assessing creativity at tertiary educational level. Even with these challenges, there is a need to start focusing on creativity measurements at tertiary educational level to ensure that graduates can face the challenges of the future.

This article aimed to explain the importance and challenges of creativity at tertiary educational level. The literature study focused on research, approaches, common indicators and barriers to creativity measurement at tertiary educational level to identify key influences that should form part of a measuring instrument. Finally, based on literature and empirical research, the primary objective of the study was to provide a reliable and valid conceptual framework to measure creativity in a tertiary educational setting to support students' creative development.

To achieve the primary objective, the literature study was followed by empirical research. A survey-based research design was adopted using a closed questionnaire to determine the creativity influences to include in a conceptual framework to measure creativity. The sample consisted of 500 students from the North-West University in Potchefstroom.

The results of this study purified the measuring instrument and determined the reliability and validity of the measurement instrument.

Keywords: tertiary education, creativity, creativity models, creativity measurement instruments, factor analysis, reliability, validity.

4.1 INTRODUCTION

Universities, one of the main tertiary education institutions, are among the oldest institutions and for many centuries universities contributed to educating students and enriching nations. Universities have proven to have the ability to reinvent themselves in the face of large cultural challenges to ensure it remains a critical component of human development (Livingston, 2010:61).

Universities today are once again facing great challenges and need to consider various options to ensure it remains an important key in the empowerment of people. Livingston (2010:61) identified rising costs, increasing competition due to easily accessible alternative forms of learning due to the Internet, and the growing importance of creativity to enable students to meet future challenges in the global and competitive business and social environments as key challenges facing universities today.

Creativity specifically has become a critical consideration, because “creativity becomes a force of great value when it is applied to causes that benefit humankind and the world at large” (Livingston, 2010:61). The question however is not how to teach creativity, but rather how to understand, harvest and build up the creativity that every student already possesses. The starting point will be to assess current creativity levels of students using a creativity measurement tool and to utilise the information obtained to develop students’ creative thinking skills.

The purpose of universities and other tertiary educational institutions therefore lies beyond career preparation only. These institutions should ensure that students can meet the challenges of the future and contribute original thought to challenges in the workplace and society as a whole. It is therefore necessary to support students to apply creative thinking skills and to develop creativity at various levels.

This article aims to explain the importance and challenges of creativity and creativity measurement at tertiary educational level. The literature study focuses on creativity research and approaches, as well as common indicators and barriers to creativity measurement at tertiary educational level in an effort to identify key influences that should form part of a

measuring instrument. Finally, based on literature and empirical research, a reliable and valid conceptual framework to measure creativity in a tertiary educational setting will be identified.

4.2 ORIENTATION TO THE PROBLEM

Creativity is often associated with the Einsteins, Picassos, and Shakespeares of the world. People tend to think that creative genius is far beyond their grasp and tend to give up all thought of being creative. This is often the result of the creativity myths, like “people are born creative”, the belief that young people are more creative or that creativity is associated with a particular personality or genius. In reality, all human beings are inherently creative (to a greater or lesser extent) and education can be used to stimulate and develop creativity in human beings.

Education and creativity are therefore indicators of integral human development, according to Pérez Alonso-Geta (2009:306). Education can be described as the “process that aims to go beyond socialisation and to make the educated person an unique individual”. Education, therefore, has the potential to promote and develop creativity in humans.

The problem with tertiary education, specifically in South Africa, is that it normally pays little attention to students’ creative development because the focus is more on theoretical knowledge and intellectual development. Creativity is seldom an outcome of tertiary education and creativity is often inhibited by predictive outcome based course designs (Jackson, 2006:2 & 4). Creativity therefore is rarely an explicit objective of the learning and assessment process (except for certain disciplines in the performing and graphic arts).

Measuring creativity at tertiary educational level is also a challenge. Creativity is not being measured at South African tertiary education institutions due to the lack of research and the challenge of finding a valid and reliable measuring instrument. Pérez Alonso-Geta (2009: 310-311) explains that the creation of measuring instruments to identify the creative abilities of students are problematic. Numerous tests have been produced based on different definitions of creativity. These tests can be divided into five groups namely:

- Aptitude tests, for example, Torrance’s tests of creativity, Guilford’s tests of creative production and association tests;

- Creative personality tests;
- Inventory tests which compare the evolutionary development patterns and biographical behaviour of individuals;
- Project tests, for example, the Rorschach test that determines if the answer is original or not statistical; and
- Performance tests which test artistic abilities and psychometric tests.

Based on these tests, two main tendencies in measuring creativity can be identified (Pérez Alonso-Geta, 2009:311), namely:

- Tests that measure creativity through the ability to produce creative “answers” when confronted with a specific stimulus, and
- Tests which measure characteristics that form the basis of the creative personality.

The problem therefore is which of these measurement instruments are valid and reliable to use in tertiary educational settings to measure students’ creative potential.

4.3 PROBLEM STATEMENT

Tertiary education plays an important role in developing the potential of students. However, according to Jackson (2006:1), enabling students to be creative should be an explicit part of the tertiary education experience and tertiary education should help students to develop their understandings and awareness of their own creativity as they develop their self-identity.

Tertiary educational institutions need to see creativity for the important role it plays in preparing people for an uncertain and complex world that requires creative and analytical capabilities (Jackson, 2006:2). It is therefore important to be able to measure creativity at tertiary educational level and to determine if progress was made during the course of study. Currently, a variety of different creativity measurements exists. The problem at South African tertiary educational institutions appear to be that different disciplinary interpretations of creativity exist, which makes the identification and measurement of creativity difficult. Focus on creativity is also placed more on subjects like Arts than Sciences and to agree to measure creativity of all students and then to find a valid and reliable tool to use nationally is a challenge. It is, however, critical to focus on creativity at this level of education as it has an

impact on how South African graduates are able to apply their education to resolve challenges creatively now and in the future.

4.4 RESEARCH OBJECTIVES

The primary objective of this article is to provide a conceptual framework to measure creativity at tertiary educational level in South Africa.

To achieve the primary objective, the following secondary objectives are formulated, namely to:

- Clarify the concept, indicators and barriers of creativity at tertiary educational level by performing a theoretical study thereof;
- Theoretically examine creativity measurements and approaches in tertiary education; and to
- Create a conceptual framework to measure creativity at tertiary educational level (CF2).

4.5 LITERATURE STUDY

4.5.1 Creativity and tertiary education

Contemporary society is characterised by complex and rapid transformation processes in all spheres of life. Creativity has been identified as the major driving force in the development of a knowledge society and as the critical skill needed to adequately address complexities and challenges at all spheres of life (European University Association, 2007:6).

Tertiary educational institutions are facing a huge challenge as it needs to play an active role in the development of a knowledge society. Garcia-Cepero (2008:295) explains that tertiary educational institutions should produce graduates that are able to manipulate, transform and create new knowledge and not only be well-educated.

To meet this huge challenge, tertiary educational institutions should provide educational opportunities that will allow students to develop their creative potential to enable them to

respond to the challenges and needs of society. Tertiary educational institutions should educate students to think critically, analyse problems of society and to look for solutions to the problems of society. Curricula should include approaches that facilitate the acquisition of skills, competences and abilities for communication, creative and critical analysis; independent thinking and team work in multicultural contexts, where creativity also involves combining traditional or local knowledge and know-how with advanced science and technology. New methods of education imply new types of teaching-learning materials coupled with new methods of testing that will promote memory, comprehension, skills for practical work and creativity (UNESCO, 1998:8-9).

Another challenge is that disciplinary interpretations of creativity at a tertiary educational level exists (Griffith Institute for Higher Education, 2004:3-5). This can make the identification and measurement of creativity difficult.

In *business*, creativity is associated with “entrepreneurship” which requires certain skills like observation of the market, insight into customer needs, invention, innovation, a willingness to take risks, securing outside investment, delivering the product or service, financing, marketing and management.

In *marketing (part of business studies)*, creativity is closely linked with the personal process of coming up with new inventions, processes and ideas. Creativity is seen as the source of ideas that can hopefully be turned into profitable and useful innovations that meet consumer needs.

In *criminology*, creativity is seen as the means of addressing issues and problems in the criminal justice system. The starting point is to understand the criminal justice systems and to know whether the issue is systematic, resource-based, historical or cultural. Each innovation requires evaluation and ongoing research. Creativity and innovation are directly connected to applied knowledge in this discipline.

In *design*, there are four major aspects of creativity, namely:

- An inquisitive mind;
- A keen eye on the world around;

- Knowledge of the elements and principles of design; and
- A passion to experiment, which is the cornerstone of creativity.

In *engineering*, creativity is seen as requiring knowledge of technology and an understanding of the human condition, both locally and around the world. Creativity is used to help solve existing problems (market pull) and to create new futures (technology push). Creativity is needed to think “outside the square” to solve complex issues and to ensure that solutions are meeting technical, economic, social and environmental requirements.

In *humanities*, creativity is intrinsic to the discipline itself and a crucial component to the academic study of art, literature, history, language, philosophy, social life and popular culture. Creativity is seen as the ability to discover and articulate new meanings, devise new arguments or syntheses, and find new ways of extending, modifying or contesting existing arguments or syntheses, within a given field of social and cultural phenomena. The creative dynamic involves two phases:

- The *process of immersion* which is the prerequisite to a new argument or syntheses derived from personal experience or a literary work, an historical period, a particular community or subculture, or a philosophical system.
- The *process of articulation* to transmit new insights to others, but also in order to bring the idea, argument and syntheses itself to completion.

According to research by Baer and Kaufman (2005:7), three creativity factors of nine academic areas were identified by means of factor analysis. These factors are:

- Creativity in the areas of interpersonal relationships, communication, solving personal problems and writing.
- Creativity in the areas of arts, crafts and bodily/ physical creativity (seen as ‘hands-on-creativity’).
- Creativity in Mathematics and Science.

Creativity should be used as the instrument by which students become able responders and agents for change. Education, however, is a double-edged sword that can be used to either cultivate or stifle creativity. The lecturer is the fundamental reference point in the tertiary institution and his/her role is of prime importance in promoting creativity in the students.

Lecturers should help students to take advantage of their instinctual imaginings and encourage creativity and new thinking all the time. Graduates should be creative, innovative and able to adapt to new situations when they enter the working world.

It is evident that creativity is an important attribute of a successful graduate of tertiary education, recognised by universities and employers alike. Many universities make explicit mention of the importance of creativity as a graduate attribute. To name a few examples, the University of Sydney states that its graduates should be “creative and imaginative thinkers”, the University of Melbourne states that graduates will become “critical and creative thinkers”, London Metropolitan University indicates that graduates will have the ability of “working through problems and making creative and purposeful change and adaptations” and the Griffith University, Queensland, indicates that graduates will have the skills to “be creative and innovative” (Petocz, Reid & Taylor, 2009:409).

4.5.1.1 Creative studies at tertiary educational level

The Buffalo University of New York realized that creativity is a critical life skill and created an International Centre of studies in Creativity in 1967. The Centre offers undergraduate and postgraduate programmes aimed to help students to master creativity, to enable them to operate as a creative problem-solver and to lead change.

The undergraduate programme requires 18 credit hours and basically focuses on the following topics (International Centre of studies in Creativity, n.d.:1):

- CRS 205: Introduction to Creative Studies;
- CRS 302: Creative Approaches to Problem Solving;
- CRS 303: Creative Leadership Through Effective Facilitation;
- CRS 304: Developing Creative Problem Solving Facilitation;
- CRS 320: Applications of Creativity and Innovation; and
- Plus 3 credit hour approved elective.

There are two postgraduate programmes. The graduate certificate in creativity requires 15 credit hours and includes the following (International Centre of studies in Creativity, n.d.:1):

- CRS 559 Principles in Creative Problem Solving;

- CRS 560 Foundations of Creative Learning;
- CRS 580 Creativity Assessment: Methods and Resources;
- CRS 610 Facilitation of Group Problem Solving;
- CRS 635 Creativity and Change Leadership;
- CRS 625 Current Issues in Creative Studies; and
- CRS 670 Foundations in Teaching and Training Creativity.

The Centre also offers a master's degree program that consists of three major strands (International Centre of studies in Creativity, n.d.:1):

- The Foundations of Creativity strand examines approaches to assess and define creativity and models and theories to understand creative behaviour;
- The Creative problem-solving and facilitation strand focuses on ways to foster creative potential by helping students to learn, apply and teach specific creative problem-solving tools; and
- The Research, Development and Dissemination strand focuses on research to enable students to make a contribution to the emerging discipline of creativity studies.

The Buffalo University of New York can be described as the front runner and is adding great value in creativity awareness and research in the discipline. The University views creativity as a system, which includes people, product, process, environment, and leadership (International Centre of studies in Creativity, n.d.:1). Unfortunately, the importance of creativity studies are not realized at all tertiary educations in all the countries to date.

4.5.2 Tertiary education creativity research

There are a relatively small number of research studies that have focused on academics' perception of creativity (Kleiman, 2008:210) and the measurement of creativity in tertiary education. Most of the research is mainly based on creative teaching and learning techniques.

Lau, Ng and Lee (2009:73) categorised creativity techniques in five categories specifically for the use in design students. Their method focused on heuristic tools to generate creative solutions to ill-defined problems. The categories are:

- *Identifying and mapping attributes* which work as a cognitive organisational tool for defining the nature of the problem by using critical analysis.
- *Making possibilities* to help generate new alternatives for further consideration.
- *Changing and shifting perspectives* which use tools mainly to provide divergent views for students in generating ideas and solutions.
- *Making associations and analogical thinking* which help students to generate ideas from cultural and current issues and so facilitate students' associations and imagination.
- *Probing emotion and the subconscious* are used to create possible ideas as well as making creative decisions.

This categorisation can possibly be used in other disciplines at tertiary educational level, but need to be researched as no indication could be found in literature that this was done as yet.

Investigating and measuring creativity is an important strategy to ensure that students are equipped for the future because evaluation, which forms part of the educational programs of creative development, introduces analysis and provides information for educational improvement (Pérez Alonso-Geta, 2009:306-307).

It is important to look at the research done in education in terms of creativity.

4.5.2.1 The Enrichment Triad Model (ETM) (1970)

The *Enrichment Triad Model (ETM)* was developed by Renzulli in the 1970s. It is a programme for infusing high-end learning strategies into existing educational programmes to promote excellence, enhance self-confidence, and nurture creativity in students (Garcia-Cepero, 2008:295). The programme was developed as an alternative to the available models for gifted education and has been transferred to the regular classroom as a model to develop students' creative productivity.

ETM in tertiary educational settings can contribute to the development of creative productivity, high-end learning and skill, high self-regulating skills and high levels of motivation among students (Garcia-Cepero, 2008:300).

This programme is still unexplored and unknown in tertiary education faculties but has the potential to infuse enriched experiences into higher education (Garcia-Cepero, 2008:295). The model however does not offer insight into measuring creativity at tertiary educational level.

4.5.2.2 A conceptual map of creativity in teaching and learning (2004)

A conceptual map of creativity in teaching and learning was created from Phenomenography in 2004 (Tan & Prosser, 2004:269). Phenomenography focuses on the limited but qualitatively different number of ways in which individuals experience, perceive, apprehend, understand and conceptualise various phenomena. The central part of the research consisted of in-depth, semi-structured and face-to-face interviews. The research is, however, still emergent and requires further analysis, but it offers helpful clues regarding creativity in the context of learning and teaching.

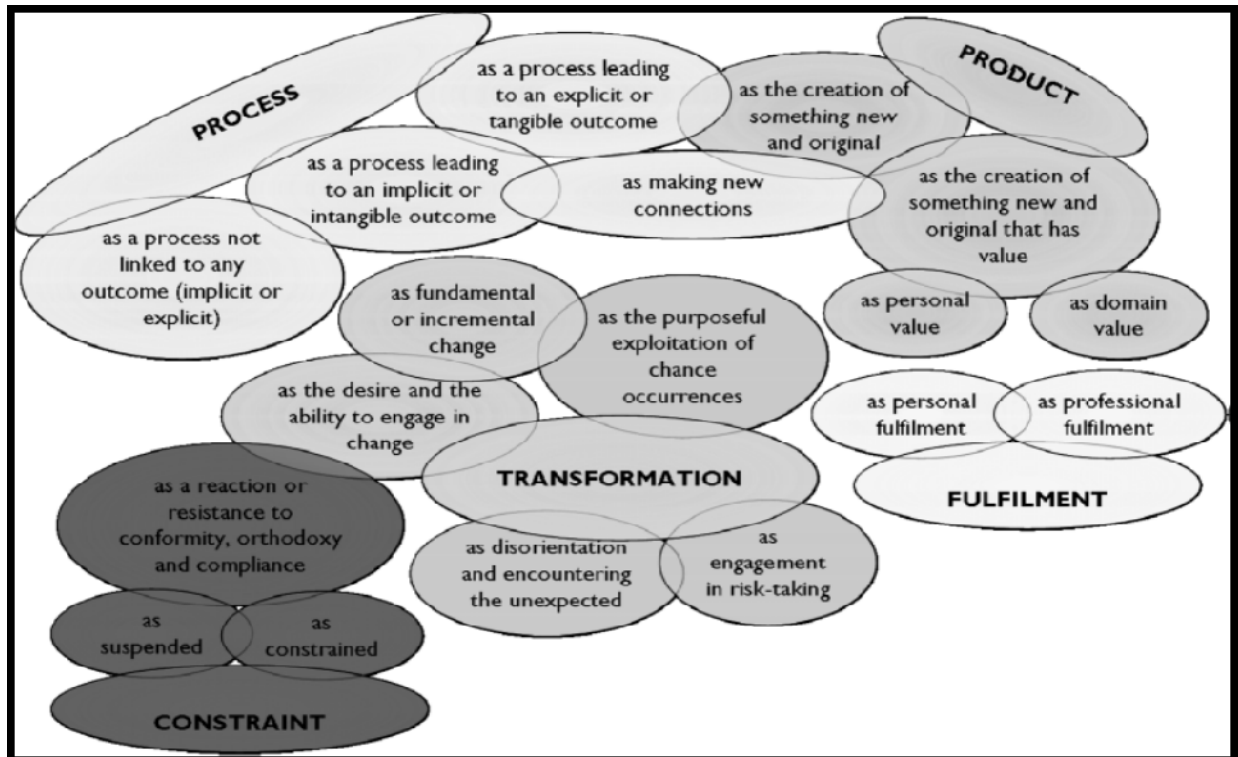
What initially emerged from the study was a list of thirty possible different variations in conception of the experience of creativity in learning and teaching. A process then followed in which the variations were categorized, distilled and reduced under five main categories which focused varyingly on the experience of creativity as:

- *A constraint-focused experience* which appears in several forms, e.g. constrained in order to enable student creativity, constrained by the institutional environment, and constrained in order to meet the expectations of the students.
- *A process-focused experience* which include those processes that lead to explicit outcomes or products, those that lead to implicit outcomes, and those that are not necessarily linked to any outcome.
- *A product-focused experience* focuses on the production of either something that is simply new and original, or the production of something in which notions of novelty and originality combine with notions of utility and value.
- *A transformation-focused experience* is the engagement in a process that is transformative either in itself, or is undertaken with the intention (implicit or explicit) of being transformative. Encountering and exploiting chance and risk-taking appear as important factors in this category.

- A *fulfilment-focused experience* is strongly linked to notions of personal and professional fulfilment and freedom in the way academics conceptualise creativity.

The categories and variations are depicted in the conceptual map below.

FIGURE 4.1: CONCEPTUAL MAP OF CREATIVITY IN LEARNING AND TEACHING



Source: Kleiman (2008:211)

If the five key aspects of variation are placed on a continuum of inclusivity, it would position creativity as a *constraint-focused experience* at the “lower” end and a *fulfilment-focused experience* at the “higher” end. It also appears logical that creativity as a *process-focused experience* should precede creativity as a *product-focused experience*. However, this seems problematic as it seems that there is a conception of creativity-as-process that is not linked to product (Kleiman, 2008:211-212).

The conceptual map offers valuable variations that can be considered in the conceptual framework to measure creativity at tertiary educational level.

4.5.2.3 Jackson and Shaw's creativity studies (2005)

Under the sponsorship of the Imaginative Curriculum Network, Jackson and Shaw (2005, as cited in Kleiman, 2008:210) compiled the results of “many workshops, interviews and email surveys” in a list of the most common ideas academics associate with creativity. The list includes:

- originality;
- being imaginative;
- exploring for the purpose of discovery;
- doing/ producing new things (invention);
- doing/ producing things no-one has ever done before (innovation);
- doing/ producing things that have been done before but differently (adaptation, transference); and
- communication.

The value of this list of influences is that it can be incorporated in the questionnaire items and then used to identify specific factors to include in a conceptual framework to measure creativity at tertiary educational level.

4.5.2.4 A phenomenographic analysis by Petocz, Reid & Taylor (2009)

A phenomenographic analysis was done on business students by Petocz, Reid & Taylor (2009:409-415). This study identified that although the notion of creativity makes an appearance in the lists of graduate attributes from many universities, it seems that it is rarely discussed as a concept with students, and rarely appears as part of the formal material of a course of tertiary study, at least in business. Rather, it is held up as a characteristic to aim for, and students are told that the highest marks will be reserved for work that displays creativity. The study highlights the importance for students to be aware of the contextual aspects of creativity and the different ways in which creativity is recognised in the particular domain in which they are working (Petocz, Reid & Taylor, 2009:414-415).

4.5.2.5 Educational Model for Creative development (PECEI)

The model was developed by the Institute of Creativity and Educational Innovations (INCEI). The model is based on the indicators that have traditionally been considered as those that define creativity and innovation (Pèrez Alonso-Geta, 2009:305). The model adopts the approach that creativity is an acquired skill, although some individuals possess this quality naturally, which enable students to find new solutions to different problems posed.

The model is a strategic model that relates to the individual (development of creative and entrepreneurship spirit), to the process (of innovation), to the product, and to the context. In order to evaluate creativity, mental and behavioural aspects are measured and basic indicators are used that can be categorised in terms of the subject, the process and the context (Pèrez Alonso-Geta, 2009:311). Behavioural and biographical inventories are then used on those identified as creative through a questionnaire.

Indicators of creativity, according to this model are:

- Sensitivity in general and when faced with a problem;
- Knowing how to discover what is beyond the established information or insufficiently explained;
- Ability to detect problems and anticipate consequences;
- Fluency;
- Productivity in the sense of not being content with the first results and continuing seeking alternatives;
- Ability to formulate new hypotheses and new approaches;
- Mental flexibility;
- Capacity to change perspectives;
- Unique character;
- Self-confidence;
- Capacity for syntheses;
- Association;
- Analysis;
- The ability to refine resources;
- Imagination;

- Desire for achievement;
- Organisation;
- Communication; and
- Searching for experiences.

In relation to the individual, the model defines creativity by:

- Divergent thinking;
- Originality;
- Flexibility;
- Independence;
- The motivation to succeed;
- Sensitivity;
- The capacity for inventiveness; and
- Imagination.

The model indicates that students should be freed from the limitations and obstacles which impede creative behaviour, namely:

- Fear of making mistakes;
- Fear of failure;
- Lack of motivation;
- Laziness;
- Negativity;
- Dependence on the group; and
- Insecurity.

The model also highlights the other potentialities that should be developed such as:

- Self-reference;
- Self-confidence;
- Proactiveness;
- Knowing how to delay gratification;
- Imagination;
- Curiosity;

- Interest;
- A critical sense;
- The ability to assume collective thought;
- Overcome frustration; and
- Persevere towards achievement.

The first step is to promote (at a cognitive level) the development of new beliefs and opinions. To do this, new patterns of perception need to be developed to allow a person to free himself or herself from prejudices and to develop new beliefs and attitudes. An individual's expectations influence the change and development of new beliefs and attitudes.

The model also implies that the teaching practice will always be “probabilistic” in the sense that certain teaching practices might not produce certain outcomes. The “resistance” of students should always be taken into account. The educator cannot abandon or cling to authority as this would favour convergent thinking, submission and impede the development of creative ability. The educational environment should be conducive and permits original contributions and divergent thinking (Pérez Alonso-Geta, 2009:311).

The process in the PECEI model should be understood as a tool of thought. The process requires:

- Inventiveness by having an idea, a hypothesis, a project and being able to develop it.
- The ability to use ideas outside of the judgement system.
- Ideas have to manifest, be developed, tested, evaluated and modified and the ability to escape the typical dominant idea should be enhanced.
- Stimulation, intuition, direction and perseverance are required to overcome the environment and its resistance and to give incentive to the effort of achieving.
- Divergent and critical thinking are essential because it defines the direction when confronted with multiple options.
- Various strategies can be used to improve the creative process.

This model is important to consider in the creation of a conceptual framework to measure creativity at tertiary educational level because it identifies indicators of creativity and offers insight into the measurement of creativity.

Additional to the indicators of creative performance in this model, there are other common indicators that can also be used as well that are important in developing a conceptual framework to measure creativity in tertiary education.

4.5.3 Common indicators of creative performance

Baer and Kaufman (2005:4-6) highlighted the initial requirements for creativity in their Amusement Park Theoretical (APT) Model as:

- *Intelligence* – some basic level of cognitive ability is needed to be creative. Once a person's IQ reaches approximately 120, the chances are small that any further advances in IQ will increase creativity. In extreme cases, Simonton (1994 as cited in Baer & Kaufman, 2005:5) suggests that a very high-IQ individual may not be able to communicate ideas in an effective manner to other people. This lack of communication may result in brilliant ideas never being implemented. However, there is a positive correlation between IQ scores and creative performance in virtually all domains.
- *Motivation* – This refers to the simple necessity of being highly motivated one way or another. If a person is not motivated to do something, then that person will not create anything in the first place. Motivation is a different construct from intelligence because it changes from moment to moment and from task to task. Motivation results from both positive and negative experiences that interact within the individual to produce very unique interests and drives in individuals. Motivation that increases productivity is likely to also lead to higher levels of creativity success.
- *Suitable environments* – refers to past and present environments and environmental influences. Individuals will be creative if creative thoughts are supported by their culture or family. If it is not supported, the individual will find it difficult to be creative. Environments can either contain the tools and material necessary to support creativity or be not supportive at all.

In 2005, Scientific American listed the following indicators of creativity (Creative Creativity, 2007:1):

- *Ideational fluency* - The number of ideas, sentences and associations a person can think of when presented with a word.

- *Variety and flexibility* - The diversity of different solutions a person can find when asked to explore the possible uses of an item/s.
- *Originality* -The ability to develop potential solutions other people cannot think of.
- *Elaboration* -The skill to formulate an idea expands on it, and then works it to form a concrete solution.
- *Problem sensitivity* - The ability to recognize the central challenge within a task, as well as the difficulties associated with it.
- *Redefinition* - The capacity to view a known problem in a completely different light.

The above indicator corresponds to Guilford's Divergent Thinking Model and the Torrance Test of creative thinking.

Marin and de la Torre (1991) (in Forex, 2010:1) identified core indicators needed by an individual in the creative process and some general indicators correspond to indicators identified by other researchers. These indicators are:

- *Originality* which refers to new, unique and authentic products.
- *Flexibility* to generate new responses to new situations and change.
- *Productivity or fluency* that refers to the number of answers and solutions provided in a situation.
- *Preparation* in organising information.
- *Analysis* to distinguish and differentiate one concept from others.
- *Synthesis* refers to the ability to produce diagrams, organise information and extract the most valuable features.
- *Opening mental* refers to a person seeking the greatest possible number of alternatives.
- *Communication* to share messages, products and discoveries with others.
- *Sensitivity* to the problems.
- *Empathy* to perceive and explore difficult and problematic situations.
- *Redefining* is the ability to find uses, functions, applications and different from the usual definitions.
- *Level* is the inventive ability to perceive reality and transform it partially or fully.
- *Expression* is the ability to free a person from bondage and break stereotypes.
- *Sense of humour* is key to activate and maintain creativity.

- The *element of surprise*.

Highly creative individuals are described by various sources as:

- Altruistic (unselfish) rather than courteous;
- Curious rather than self-confident;
- Self-starting rather than obedient.

4.5.4 Common barriers to creative performance

In literature a lot of barriers can be identified as well as ways to overcome these barriers. It is important, however, to mention some of the most pertinent barriers before a conceptual framework to measure creativity in tertiary education can be created.

Adair (2010:1) highlights six barriers to creative thinking, namely:

1. The tendency to focus on the negative aspects of problems and expend energy on worry.
2. Fear of failure.
3. Not having time to think creatively when overstressed.
4. The tendency to conform to accepted patterns of belief or thoughts (following the status quo).
5. Conscious or unconscious assumptions.
6. Over-reliance on logic

In addition to Adair, the Creativity Web (1999:1) identified the following obstacles to creativity, namely:

- Being too busy and getting too involved with a problem.
- Having conflicting goals and objectives.
- Not allowing enough time to relax.
- Competition in the present environment can hamper motives for creative output.
- Fear of criticism.
- Lack of confidence.
- State of mind/body (for example, experiencing negative stress).
- Dehumanizing mass media can contribute to limitations on creativity.

- Creativity is hampered by a too-hectic environment that does not provide quiet time for reflection and introspection. It is also hampered by:
 - o a sterile environment that does not feed the senses;
 - o demands for quick production of results;
 - o harsh words (from others or self);
 - o rigid rules and barriers that prevent the gathering of information and/or from connecting with others.

Other factors that limit creative behaviour (Creativity Web, 1999:1) include:

- *Stress* which drains energy that could otherwise be used creatively.
- *Routines* or set ways of performing tasks that become too entrenched causes one to limit the range of responses available and can lead to the development of the "bureaucratic mind".
- *Beliefs* limit response options and cause people to "filter out" information which contradicts their belief, and cause a "reality tunnel".
- *Ego* can lead to people aggressively defending it, to the detriment of themselves, their creativity, and society.
- *Fear* of self-expression and of the judgement of others can severely limit one's creativity.
- *Self-criticism* is a limiting factor of an individual's creativity.

It is important to note these barriers as it could play a role in measuring creativity.

4.6 RESEARCH METHODOLOGY

The study consisted of quantitative research. Quantitative research was done by analysing literature studies and identifying specific creativity influences. Based on this research, a questionnaire was constructed with the aim to identify factors and to create a conceptual framework to measure creativity in tertiary education. The questionnaire consisted of a 7-point Likert scale to capture the views of respondents. This part of the research study was performed in April 2010 to November 2010.

Data was collected, analysed, purified and tested in February 2011 to April 2011. The reliability measure, Cronbach alpha, was used to test the reliability and internal stability of

the questionnaire. The data was subjected to a principal factor analysis using a Varimax, normalized rotation. A Kaiser, Meyer and Olkin (KMO) analysis was used to determine if the sample employed is suitable for analysis. The Bartlett test of sphericity was employed to test the data's suitability for factor analysis. A total of 500 questionnaires were distributed of which 322 were completed, signifying a response rate of 64.4%. The data was captured by the Statistical consultation services of the North-West University and analysed with the Social Package for Social Sciences Version 18 (SPSS, 2009). (Please refer to Chapter 1 for the detailed discussion of the research methodology).

In order to achieve the primary objective, the following five steps were followed:

- Step 1:** Extracted and selected creativity influences from literature.
- Step 2:** Identified measuring criteria for each creativity influence.
- Step 3:** Construct a measuring instrument from the literature to test creativity.
- Step 4:** Purify the measuring instrument and determine the reliability of the data.
- Step 5:** Test the measurement instrument for validity.

These steps and the results are discussed below.

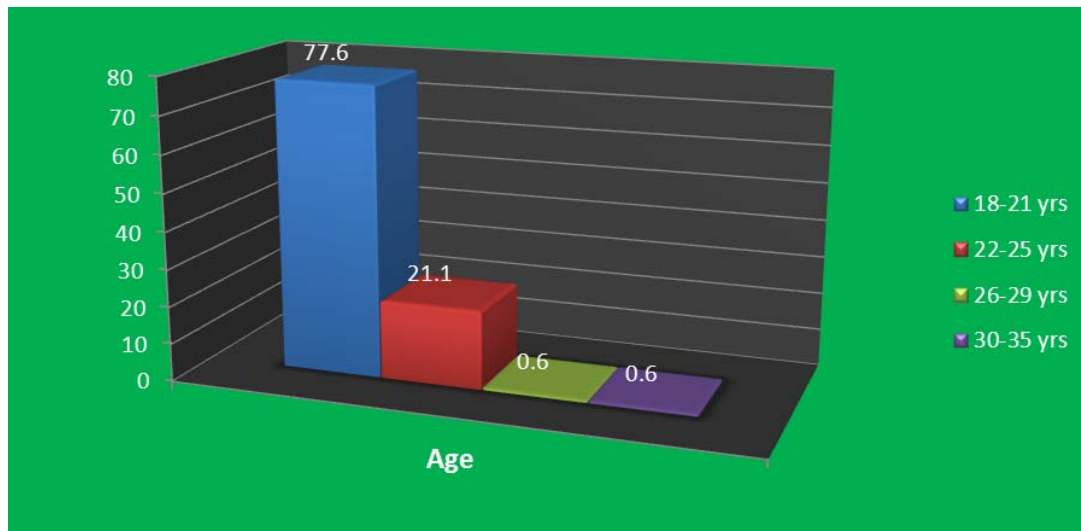
4.7 RESULTS

4.7.1 Demographic profile of the respondents

The profile of the respondents includes age, gender, mother tongue, region of residence, year of study and faculty of study.

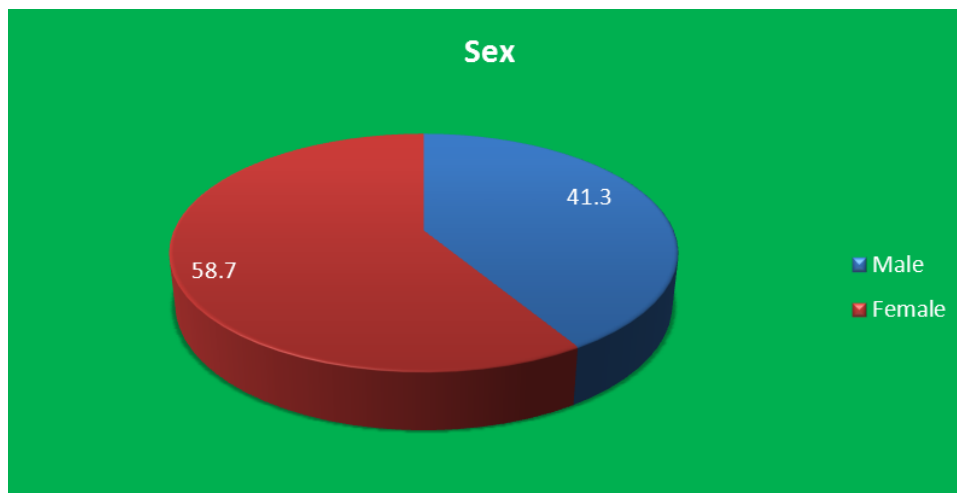
In terms of the age demographic, most of the respondents fell within the age group of 18-21 years (77.6%). This is a typical phenomenon for undergraduate students. No respondent was older than 35 years. The overall results appear in Figure 4.2 below.

FIGURE 4.2: AGE GROUP OF RESPONDENTS



In terms of gender, most of the respondents were female (58.7%). The overall result is shown in Figure 4.3 below.

FIGURE 4.3: GENDER OF RESPONDENTS

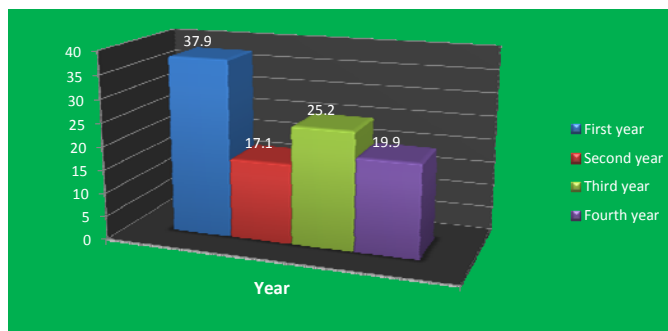


Most of the students' mother tongue are Afrikaans (89.8%). The result is not a surprise as North-West University students of the Potchefstroom campus are predominantly Afrikaans-speaking. English was 5% and Tswana 2.2%. The rest was divided between Xhosa, Northern Sotho, Swazi and other.

In terms of province of residence, most of the students resided permanently in North West (33.4%) and Gauteng (30.9%). The other provinces had a permanent residence of less than 7% and in total, all the other regions, accounted for 35.7%.

Most of the students in the sample were first-year students (37.9%) followed by 25.2% of the respondents who were third-year students. The remainder of the respondents were equally distributed between second-year and fourth-year students. The overall result is shown in Figure 4.4 below.

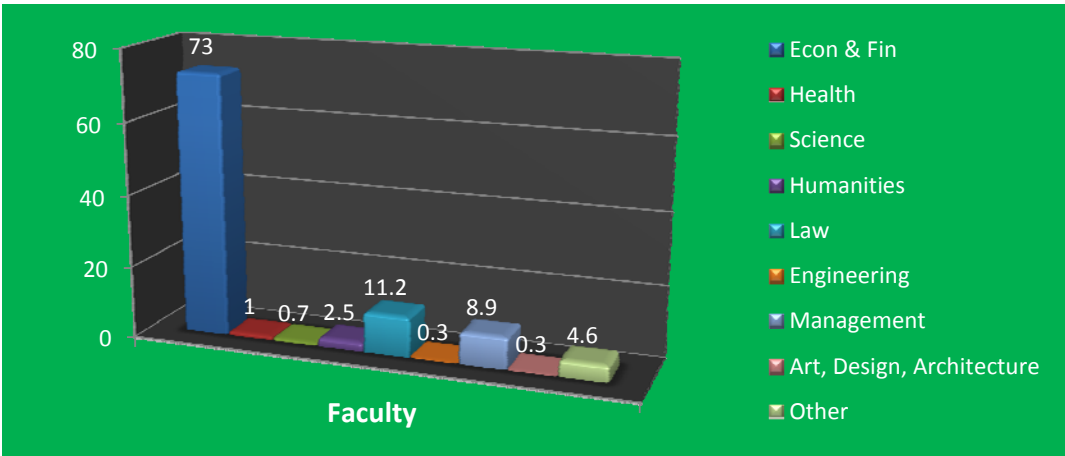
FIGURE 4.4: YEAR OF STUDY



Most of the students were full time students (98.4%). This is also normal for a residential university like North-West University.

The majority of students who participated in the study were studying at the Faculty of Economic and Financial Sciences (68.9%). The overall result of the faculty of study of the participants is shown in Figure 4.5 below.

FIGURE 4.5: FACULTY OF STUDY



4.7.2 Research steps to achieve objectives of the study

4.7.2.1 Step 1: Extracted and selected creativity constructs from literature

Twenty-eight creativity influences were identified from literature and grouped in two groups, namely cognitive psychology and personality characteristics. Eighteen influences were identified in the cognitive psychology group and ten in the personality characteristics group. See influences in Figure 4.6 below.

FIGURE 4.6: TERTIARY EDUCATION CREATIVITY CONSTRUCTS FROM LITERATURE



Source: Own compilation

4.7.2.2 Step 2: Identified measuring criteria for each creativity construct

The influences were rated based on the number of research support, e.g. five or more literature sources was required to include influences in the questionnaire. Eleven influences were identified based on support by five or more researchers. The influences appear in Table 4.1.

TABLE 4.1: DESCRIPTION AND SOURCES OF INFLUENCES IN TERTIARY EDUCATION

	INFLUENCE	DESCRIPTION	RESEARCHERS
1	Eight dimensional thinking	The ability to consider the dimensionality (i.e. space, time, cost, colour) of an issue to create ideas and combine objects, concepts and processes to find creative solutions	Berne & Raviv (2004:237-238), Bergh & Theron (2009:124, 414-415), Forex (2010:1), Creative Creativity (2007:1), Plsek (1996:3-4), Runco (2007:395)
2	Fluency	The ability to produce a great number of idea or problem solutions in a short period of time	Pérez Alonso-Geta (2009: 311), Forex (2010:1), Creative Creativity (2007:1), Plsek (1996:3-4), Bergh & Theron (2009:124), Runco (2007:95)
3	Motivation	The drive to solve problems internally and externally	Pérez Alonso-Geta (2009: 311), Unsworth (2001: 289-297), Bergh & Theron (2009:415), Runco (2007:403), Zusman and Zlotin (1998:1)
4	Cognition	The ability to understand a variety of information easily, to discover different links (obvious and not so obvious) and to identify contradictions in accepted knowledge	Baer & Kaufman (2005:4-6), Bergh & Theron (2009:414), Runco (2007:403), Pérez Alonso-Geta (2009: 308, Cropley (2008:262)
5	Communication	The ability to persuade others that creative ideas are valuable and reveal creative ideas to knowledgeable others	Jackson & Shaw (2005) in Kleiman (2008:210), Pérez Alonso-Geta (2009: 311), Cropley (2008:258), Forex (2010:1), Bergh & Theron (2009:115, 124), Runco (2007:396)
6	Originality	The ability to produce new and original ideas on a regular basis	Jackson & Shaw (2005) in Kleiman (2008:210), Pérez Alonso-Geta (2009: 308), James, Gerard & Vagt-Traore, 2004:3), Forex (2010:1), Creative Creativity (2007:1), Bergh & Theron (2009:124, 414), Runco (2007:95)
7	Synthesis	The ability to find the connection between items or variables by using associations, sequences or analogies between items or variables.	Pérez Alonso-Geta (2009: 311), Vilalba (2008:13), Forex (2010:1), Runco (2007:402), Bergh & Theron (2009:414), Plsek (1996:3-4), James, Gerard & Vagt-Traore (2004:3)

8	Sensitivity	The ability to display keen perception, being observant in recognising difficulties within a task and having insight into various aspects of a problem	Pérez Alonso-Geta (2009: 311), Runco (2007:315), Creative Creativity (2007:1), Forex (2010:1), Basadur (2007:8)
9	Four-dimensional thinking	The ability to consider consequences of one's actions holistically, in terms of space and time	Whole Brain Thinking Pty Ltd (2005:6), Whitney (2008:1), Neethling (2010:15), Pérez Alonso-Geta (2009: 311)
10	Development	The ability to gradually elaborate and explore ideas to find the best solution	Plsek (1996:6), Bergh & Theron (2009:124), Pérez Alonso-Geta (2009: 311), Zusman & Zlotin (1998:1)
11	Imagination	The ability to make associations and form a mental image of something not present to the senses or never before wholly perceived in reality	Plsek (1996:6), Bergh & Theron (2009:115, 414), Runco (2007:95), Jackson & Shaw (2005) in Kleiman (2008:210), Hermann International 2010:1)

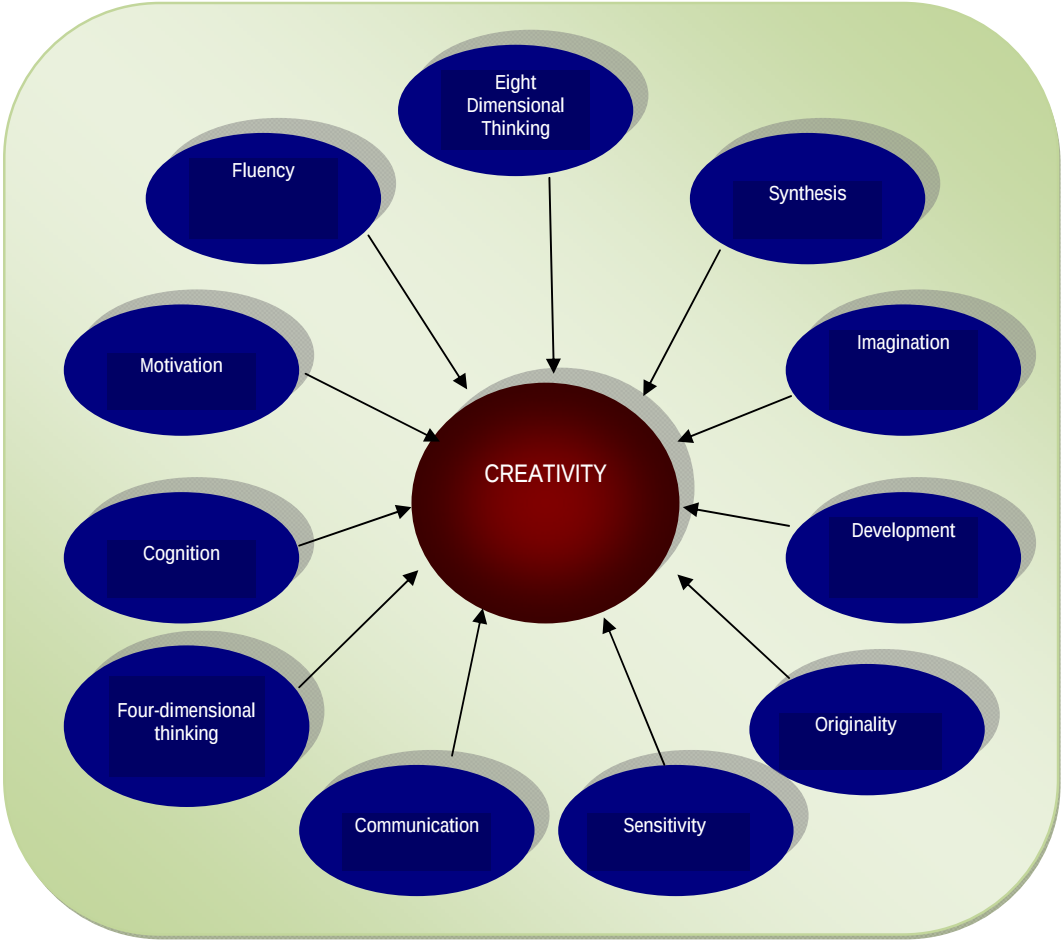
The eleven influences identified in Table 4.1 were then used as measuring criteria for the research instrument.

4.7.2.3 Step 3: Operationalisation of influences

The eleven influences were operationalised to reflect the understanding of the concepts in the context of the present study. The complete set of operationalisations appears in Table 4.2.

The conceptual framework for creativity is shown in Figure 4.7.

FIGURE 4.7: TERTIARY EDUCATION CREATIVITY – CONCEPTUAL FRAMEWORK



The operationalisation in Table 4.2 was based on the relevant definitions in the literature sources indicated. In some cases, operationalisation was slightly adapted to reflect the objectives of the present study. Upon finalisation of the eleven influences, items to measure the influences were also identified. These questions, its literary origin and the relevant constructs appear in Table 4.2.

**TABLE 4.2: OPERATIONALISATION OF TERTIARY EDUCATION
QUESTIONNAIRE ITEMS**

DIMENSION	CODE	ITEM	SOURCE
Eight dimensional thinking	A1N1	To help me find solutions or generate ideas I look for the uniqueness in processes	Berne & Raviv (2004:237-238), Bergh & Theron (2009:124, 414-415), Forex (2010:1), Creative Creativity (2007:1), Plsek (1996:3-4), Runco (2007:395)
	A1N2	To help me find solutions or generate ideas I look for the uniqueness in processes objects	
	A1N3	To help me find solutions or generate ideas I look for the uniqueness in processes features	
	A1N4	To help me find solutions or generate ideas I look for the uniqueness in processes situations	
		I consider the dimensionality of an issue to create ideas in terms of space	
	A2N1		
	A2N2	I consider the dimensionality of an issue to create ideas in terms of time	
	A2N3	I consider the dimensionality of an issue to create ideas in terms of cost	
	A2N4	I consider the dimensionality of an issue to create ideas in terms of colour	
	AQ3	I determine if things can be done from different points of view	
	A4N1	To find creative solutions, I combine objects	
	A4N2	To find creative solutions, I combine concepts	
	A4N3	To find creative solutions, I combine processes	
	A5N1	To find creative solutions, I separate concepts	
	A5N2	To find creative solutions, I separate processes	
	A5N3	To find creative solutions, I separate resources	
	A5N4	To find creative solutions, I separate objects	
	A5N5	To find creative solutions, I separate dimensions	
	AQ6	I like to modify my creative solutions	
	A7N1	I look for similarity in concepts	
	A7N2	I look for similarity in problems	
	A7N3	I look for similarity in solutions	
	A7N4	I look for similarity in patterns	
	A7N5	I look for similarity in processes	
	A8N1	To find the best creative solution, estimate	
	A8M2	To find the best creative solution, simulate	
	A8N3	To find the best creative solution, experiment	

Fluency	B1	I have the ability to produce a great number of ideas	Pérez Alonso-Geta (2009: 311), Forex (2010:1), Creative Creativity (2007:1), Plsek (1996:3-4), Bergh & Theron (2009:124), Runco (2007:95)
	B2	I have the ability to produce solutions to problems in a short period of time	
	B3	I can simultaneously propose a variety of solutions to a specific problem	
Motivation	CN1	I am driven by external pressures (including other people) to solve problems	Pérez Alonso-Geta (2009: 311), Unsworth (2001: 289-297), Bergh & Theron (2009:415), Runco (2007:403), Zusman and Zlotin (1998:1)
	CN2	I am driven by external pressures (including other people) to solve self-discovered problems	
	CN3	I am self-motivated to resolve externally defined problems	
	CN4	I am self-motivated to solve self-defined problems	
	CN5	I am always motivated to be creative in my own interest areas	
	CN6	I am motivated to be creative in an environment that tears down my barriers to creative thinking	
	CN7	I am always motivated by other people to use my creative skills	
Cognition	DN1	I attain understanding from a variety of information sources without difficulty	Baer & Kaufman (2005:4-6), Bergh & Theron (2009:414), Runco (2007:403), Pérez Alonso-Geta (2009: 308), Cropley (2008:262)
	DN2	I can discover different links and relationships (obvious and not so obvious) when I look at different information sources	
	DN3	I can cope with complexities when I need to resolve a problem	
	DN4	I do not get stuck on a set of rules to solve a problem	
	DN5	I can easily see different aspects of a problem	
	DN6	I can recognise gaps in my existing knowledge	
	DN7	I can identify contradictions in accepted knowledge	
	DN8	I can predict appropriate creative solutions to a problem after analysing the contradictions in a problem	
	DN9	I agree that the use of scientific approaches outside a specific field of study can be helpful to develop creative solutions	

Communication	EN1	I am able to persuade others that my ideas are valuable	Jackson & Shaw (2005) in Kleiman (2008:210), Pérez Alonso-Geta (2009: 311), Cropley (2008:258), Forex (2010:1), Bergh & Theron (2009:115, 124), Runco (2007:396)
	EN2	I use communication as a tool to reveal my creative ideas to knowledgeable others	
Originality	FN1	I propose new ideas on a regular basis	Jackson & Shaw (2005) in Kleiman (2008:210), Pérez Alonso-Geta (2009: 308), James, Gerard & Vagt-Traore, (2004:3), Forex (2010:1), Creative Creativity (2007:1), Bergh & Theron (2009:124, 414), Runco (2007:95)
	FN2	I intentionally engage in unpopular ideas	
	FN3	I am able to redefine a known problem from a completely different perspective	
Synthesis	GN1	I can find the connection between items	Pérez Alonso-Geta (2009: 311), Vilalba (2008:13), Forex (2010:1), Runco (2007:402), Bergh & Theron (2009:414), Plsek (1996:3-4), James, Gerard & Vagt-Traore (2004:3)
	GN2	I find new solutions by using associations between items	
	GN3	I like to combining various concepts to find solutions to problems	
	GN4	I am able to see problems in a novel way	
Sensitivity	HN1	I am a sensitive person	Pérez Alonso-Geta (2009: 311), Runco (2007:315), Creative Creativity (2007:1), Forex (2010:1), Basadur (2007:8)
	HN2	I can recognise difficulties within a task easily	
	HN3	I am sensitive to the various aspects of a problem	
Four-dimensional thinking	IN1	I consider the consequences for humanity when I look for solutions to a problem	Whole Brain Thinking Pty Ltd (2005:6), Whitney (2008:1), Neethling (2010:15), Pérez Alonso-Geta (2009: 311)
	IN2	I consider immediate personal gains when I look for solutions to a problem	
	IN3	I think about the consequences of my ideas	
	IN4	I can anticipate consequences	

Development	JN1	I do not prematurely judge ideas	Plsek (1996:6), Bergh & Theron (2009:124), Pérez Alonso-Geta (2009:311), Zusman & Zlotin (1998:1)
	JN2	I think ideas through carefully and developing on it	
	JN3	I develop ideas to find the best solutions for a given situation	
	JN4	I make random attempts to solve a difficult problem	
	JN5	I prefer to break away from preconceived perceptions to find solutions to problems	
Imagination	KN1	I generate new ideas by actively searching for associations among concepts	Plsek (1996:6), Bergh & Theron (2009:115, 414), Runco (2007:95), Jackson & Shaw (2005) in Kleiman (2008:210), Hermann International (2010:1)
	KN2	I use brainstorming to make associations regarding a given concept	
	KN3	I make the effort to actively search for associations	
	KN4	I generate ideas by finding as much alternatives as possible	
	KN5	I always look at the big picture	
	KN6	I like to take initiative and challenge assumptions	
	KN7	I like to challenge assumptions	

The measuring instrument, as shown in the Table 4.2 above, requires empirical testing. This was done by collecting primary data by having the respondents in the sample complete the structured questionnaire (as described in Chapter 1).

4.7.2.4 Step 4: Purify the measuring instrument and determine the reliability of the data

4.7.2.4.1 *Reduction of the tertiary education measuring criteria*

The instrument was purified by means of exploratory factor analysis, using a Varimax rotation. This rotation was selected because of its ability to maximise variance explained (Field, 2007:636). Factor loadings of 0.40 were set as the minimum factor loading, while the data is also required to explain a cumulative variance of in excess of 60% (Field, 2007:668). In addition to ensure that the data was suitable for further analysis, the data was subjected to the Kaiser, Meyer and Olkin (KMO) measure of sampling adequacy that determines if the sample employed is suitable for analysis. Values of 0.70 and higher is regarded to be acceptable and set as the minimum value for this study (Field, 2007:666). Further, Bartlett's test of sphericity was also used as it is a measure that renders a verdict if data is suitable for

multivariate statistical analysis, such as factor analysis. The required values of Bartlett need to be lower than 0.005 to proceed with factor analysis (Field, 2007:640, 642 & 648). (Refer to Chapter 1 for more detail on the statistical techniques used in this study.)

The data required three rounds of purification to eliminate all non-loading criteria as well as the criteria that dual-load strongly on more than one factor. The results of the purification over the three rounds of exploratory factor analysis appear in Table 4.3 below.

TABLE 4.3: PURIFICATION OF THE TERTIARY EDUCATION MEASURING CRITERIA

ROUND	VARIANCE EXPLAINED	KMO	BARTLETT	CRITERIA ELIMINATED
1	63.88	0.823	0.000	A1N2, A1N4, A2N4, B1, B3, CN2, EN2, GN1, GN2, GN3, GN4, IN1, IN4, JN1, JN2, JN3, JN5, KN4
2	65.82	0.834	0.000	FN3, DN8, DN9, IN2, HN2, A2N1, A1N3, B2, CN4
3	66.17	0.825	0.000	A8N1, A8N2, IN3, A5N1, CN7

From the table above it is clear that the variance explained improved as the 32 criteria that had either low factor loadings or strongly dual-loaded on more than one factor, were omitted from the measuring instrument. Both the KMO and Bartlett tests showed very favourable values with KMO in excess of 0.80 in all three cases while improving the variance explained from 0.63 to 0.66 when the low- and dual loading criteria were deleted. The Bartlett test of sphericity also remained below the required 0.000 level.

4.7.2.4.2 *Factor analysis*

The purified data set were subjected to the exploratory factor analysis to determine the factors and the respective measuring criteria pertaining to creativity at tertiary educational level. The KMO and Bartlett's tests appear in the Table 4.4 below.

TABLE 4.4: KMO AND BARTLETT TESTS

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	.820
Bartlett's Test of Approx. Chi-Square Sphericity	3859.429
df	741
Sig.	.000

A total of twelve components were extracted from the data. These components explain a cumulative variance of 66.17% (See Table 4.5 below).

TABLE 4.5: VARIANCE EXPLAINED

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.527	21.863	21.863	8.527	21.863	21.863	3.012	7.722	7.722
2	3.217	8.248	30.111	3.217	8.248	30.111	2.605	6.680	14.402
3	2.111	5.412	35.524	2.111	5.412	35.524	2.520	6.461	20.863
4	1.853	4.752	40.275	1.853	4.752	40.275	2.436	6.245	27.108
5	1.620	4.155	44.430	1.620	4.155	44.430	2.428	6.225	33.334
6	1.584	4.063	48.493	1.584	4.063	48.493	2.428	6.225	39.559
7	1.289	3.306	51.799	1.289	3.306	51.799	2.281	5.848	45.407
8	1.202	3.082	54.881	1.202	3.082	54.881	1.955	5.012	50.418
9	1.195	3.064	57.944	1.195	3.064	57.944	1.857	4.762	55.181
10	1.132	2.902	60.846	1.132	2.902	60.846	1.576	4.041	59.222
11	1.055	2.705	63.552	1.055	2.705	63.552	1.565	4.014	63.236
12	1.019	2.614	66.166	1.019	2.614	66.166	1.143	2.930	66.166

The variance explained is also favourable and exceeds the required 60% which signifies a “good fit” as stated by Field (2007:668). The Kaiser criterion suggests retaining those factors with eigenvalues equal or higher than one (Hall, n.d.:1).

After the eigenvalues were examined, the number of underlying factors was identified. A common criterion to use is a number of factors equal to the number of eigenvalues that are greater than one (Hall, n.d.:1). Table 4.12 shows twelve eigenvalues greater than one and therefore there are twelve factors to measure creativity.

The Varimax rotational method was used as it maximises the variance explained by factors if there is a low coefficient between the factors (Du Plessis, 2010; Field, 2007:749). The rotated factor matrix displays the factor loadings (correlation scores) between each survey item and underlying factor (Hall, n.d.:1). The Varimax rotated factor table appears in Table 4.6. Factor loadings below the required 0.40 are suppressed in the table in order to present the data in a reader-friendly manner.

Table 4.6 follows on next page

TABLE 4.6: FACTOR ANALYSIS

	Component											
	1	2	3	4	5	6	7	8	9	10	11	12
kn7	.729											
kn6	.729											
cn5	.674											
kn5	.546											
cn6	.528											
a5n2		.765										
a5n3		.742										
a5n4		.654										
a5n5		.632										
a4n3			.754									
a1n1			.674									
a4n2			.626									
a7n5			.578									
dn2				.769								
dn1				.728								
dn3				.715								
kn1					.724							
kn2					.636							
fn1					.622							
kn3					.526							
en1					.460							
dn6						.696						
dn4						.667						
dn5						.621						
dn7						.570						
a7n2							.748					
a7n3							.712					
a7n4							.616					
a7n1							.557					
cn2								.760				
cn1								.708				
fn2								.595				
hn1									.858			
hn3									.832			
a8n3										.769		
a4n1										.720		
a2n3											.749	
a2n2											.662	
jn4												.882

Table 4.6 shows the factors and items that loaded onto the twelve factors. Factor loadings range from minus one (perfect negative correlation) to plus one (perfect positive correlation). The higher the factor loading (either positive or negative), the more strongly that item is associated with the corresponding factor, and resultantly shows more relevant in definition to the factor's dimensionality (Hall, no date:1).

Twelve factors were identified based on the purification of the measuring instrument and the reliability of the data to include in a conceptual framework to measure creativity. Originally only eleven influences were identified.

Based on the content of the correlated items, a name or label was developed for each underlying factor. The factor then became the theoretical framework for explaining creativity at tertiary educational level. The twelve factors were:

- **FACTOR 1: CHALLENGING THE STATUS QUO**

Factor 1 is the most important factor and has been identified as *Challenging the status quo*. The five items loading onto Factor 1 point to an individual's willingness and motivation to challenge assumptions, to take initiative, to look at the big picture, being creative in an environment that tears down personal barriers to creative thinking and being motivated to be creative in his/ her own interest areas. The factor explains a favourable variance of 7.72%.

- **FACTOR 2: DETACHMENT**

Factor 2 has been identified as *Detachment*. The four items loading onto Factor 2 all point to the ability to separate processes, resources, objects and dimensions in an effort to be creative. The factor explains a variance of 6.68%.

- **FACTOR 3: SYNTHESIS**

Factor 3 has been identified as *Synthesis*. The four items loading onto Factor 3 all point to the ability to combine processes and to look for uniqueness and similarity in processes to help find solutions or generate ideas. The factor also points to the ability to combine concepts to find creative solutions. The factor explains 6.46% of the variance.

- **FACTOR 4: COGNITION**

Factor 4 has been identified as *Cognition*. The three items loading onto Factor 4 all points to the ability to discover links and relationships by looking at different and a variety of information sources, as well as the ability to cope with complexities when a problem needs to be solved. This factor explains a favourable variance of 6.25%.

- **FACTOR 5: ASSOCIATE AND COMMUNICATE**

Factor 5 has been identified as *Associate and Communicate*. The five items loading onto Factor 5 point to the ability to generate new ideas by looking actively for associations among concepts, the use of brainstorming to make associations, to propose new ideas regularly and the ability to persuade others that creative ideas generated are valuable. This factor explains a favourable variance of 6.23%.

- **FACTOR 6: AWARENESS**

Factor 6 has been identified as *Awareness*. The four items loading onto Factor 6 point to the ability to recognise gaps and contradictions in existing knowledge, to see different aspects of a problem and the ability to not get stuck on a set of rules to solve a problem. This factor explains a variance of 6.23%, the same as Factor 5.

- **FACTOR 7: SIMILARITY**

Factor 7 has been identified as *Similarity*. The four items loading onto Factor 7 all point to the ability to look for similarities in problems, solutions, patterns and concepts. This factor explains a variance of 5.85%.

- **FACTOR 8: EXTERNAL MOTIVATION**

Factor 8 has been identified as *External motivation*. The three items loading onto Factor 8 all point to the impact of external pressures and people to solve problems and to intentionally engage in unpopular ideas. This factor explains a variance of 5.01%.

- **FACTOR 9: SENSITIVITY**

Factor 9 has been identified as *Sensitivity*. The two items loading onto Factor 9 all point to the sensitivity of a person to various aspects of a problem. The actual loadings of the two items are very close and differ with 0.03. This factor explains a variance of 4.76%.

- **FACTOR 10: EXPERIMENT AND COMBINE**

Factor 10 has been identified as *Experiment and Combine*. The two items loading onto Factor 10 point to the ability to find the best creative solution by experimenting and combining objects. The actual loadings of the two items are very close and differ with 0.05. This factor explains a variance of 4.04%.

- **FACTOR 11: DIMENSIONAL THINKING**

Factor 11 has been identified as *Dimensional Thinking*. The two items loading onto Factor 11 point to the ability to consider the dimensionality of an issue to create ideas in terms of cost and time. The lowest loading refers to the consideration of the dimensionality of an issue to create ideas in terms of time and the highest to the consideration of the dimensionality of an issue to create ideas in terms cost. The actual loadings of the two items differ with 0.9. The factor explains a variance of 4.01%.

- **FACTOR 12: PROBLEM-SOLVING**

Factor 12 has been identified as *Problem-solving*, since the item loading on Factor 12 point to random attempts to solve a difficult problem. Only one item loads onto Factor 12, albeit with a high loading of 0.88. This factor explains a variance of 2.93%.

4.7.2.4.3 Reliability

The reliability of the data was determined by employing Cronbach's Coefficient Alpha. For this study a reliability coefficient of 0.70 was set to conform with the general norm as explained by Schmitt (1996:350). It is important to note that the lower limit by Cortina of above 0.57 was also set as a secondary acceptable reliability coefficient. The reliability of the twelve factors is shown in Table 4.7.

TABLE 4.7: RELIABILITY OF THE FACTORS

FACTOR	CRONBACH ALPHA
1	0.753
2	0.741
3	0.737
4	0.768
5	0.755
6	0.735
7	0.737
8	0.625
9	0.751
10	0.559
11	0.597
12	***

Factors 1-7 and 9 all have satisfactory reliability coefficients in excess of the required 0.70. Factors 8 and 11 are below the higher reliability coefficient of 0.70, but above the lower limit of 0.57 set by Cortina, and is thus accepted to be reliable factors. Factor 10 is marginally lower than the lower limit of 0.58 set by Cortina with a secondary acceptable reliability coefficient of 0.56, and therefore, this factor might not present itself in repeated research. However, this fact does not make a factor less important to the current study, and as such this factor should be interpreted with this possible constraint in mind (Field, 2007:668-669).

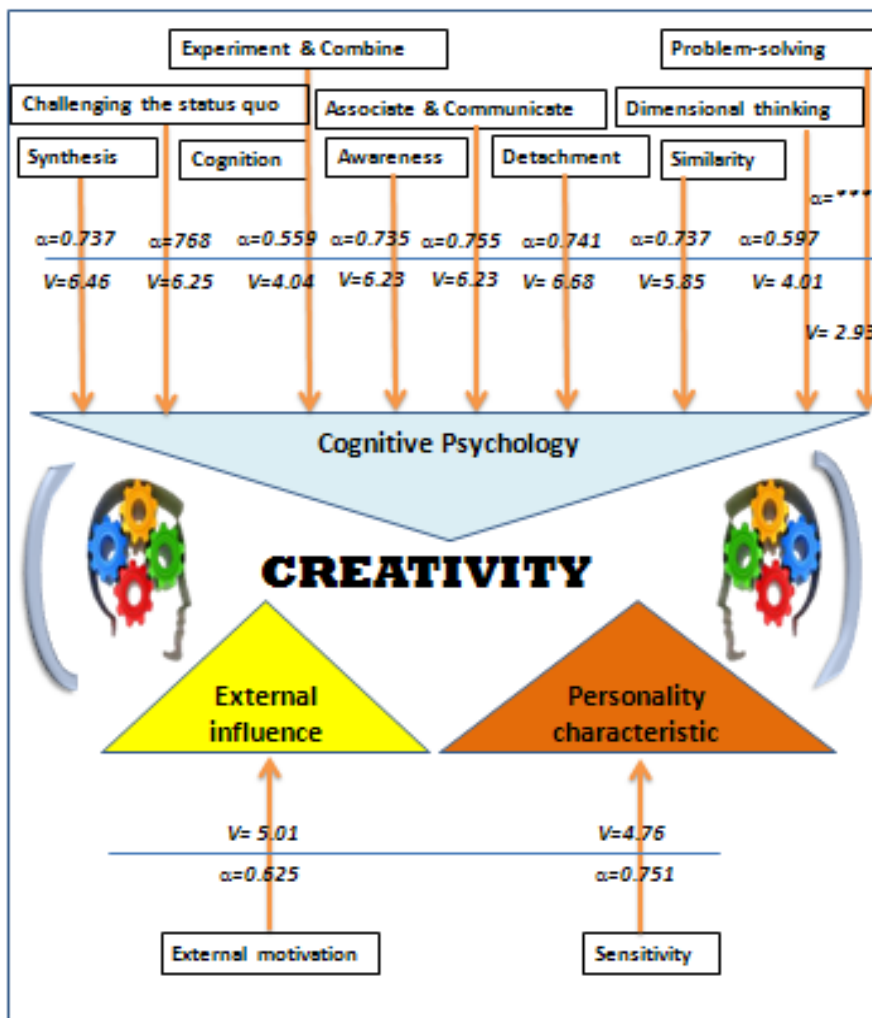
4.7.2.5 *Step 5: Test the measurement instrument for validity*

The validity of the factors has been proven in Table 4.13 (Factor table). The factor analysis identified the criteria pertaining to each factor, and as such, these criteria are statistically proven to measure the specific factor. The variance explained by these factors are also calculated, thus showing the relative importance of each of the factors and its respective criteria's importance (see the factor loadings of each criterion) to the measuring instrument. The purified measuring instrument, as shown in Table 4.10, is thus proven to be a valid measuring tool to measure creativity.

4.8 AMENDED CONCEPTUAL FRAMEWORK TO MEASURE CREATIVITY (CF2)

From the analysis above, and the elimination of less important criteria, a new framework to measure creativity in tertiary educational was constructed. The amended conceptual framework appears in Figure 4.8 and the amended questionnaire to measure creativity at tertiary educational level appears in Table 4.8.

FIGURE 4.8: TERTIARY EDUCATION CREATIVITY – AMENDED CONCEPTUAL FRAMEWORK (CF2)



Source: Own compilation

TABLE 4.8: AMENDED QUESTIONNAIRE (CONCEPTUAL FRAMEWORK - CF2)

FACTORS	CODE	ITEM
Challenging the status quo	1	I like to challenge assumptions
	2	I like to take initiative and challenge assumptions
	3	I am always motivated to be creative in my own interest areas
	4	I always look at the big picture
	5	I am motivated to be creative in an environment that tears down my barriers to creative thinking
Separate	6	To find creative solutions, I separate processes
	7	To find creative solutions, I separate resources
	8	To find creative solutions, I separate objects
	9	To find creative solutions, I separate dimensions
Synthesis	10	To find creative solutions, I combine processes
	11	To help me find solutions or generate ideas I look for the uniqueness in processes
	12	To find creative solutions, I combine concepts
	13	I look for similarity in processes
Cognition	14	I can discover different links and relationships (obvious and not so obvious) when I look at different information sources
	15	I attain understanding from a variety of information sources without difficulty
	16	I can cope with complexities when I need to resolve a problem
Associate and communicate	17	I generate new ideas by actively searching for associations among concepts
	18	I use brainstorming to make associations regarding a given concept
	19	I propose new ideas on a regular basis
	20	I make the effort to actively search for associations
	21	I am able to persuade others that my ideas are valuable
Awareness	22	I can recognise gaps in my existing knowledge
	23	I do not get stuck on a set of rules to solve a problem
	24	I can easily see different aspects of a problem
	25	I can identify contradictions in accepted knowledge
Similarity	26	I look for similarity in problems
	27	I look for similarity in solutions
	28	I look for similarity in patterns
	29	I look for similarity in concepts
External motivation	30	I am driven by external pressures (including other people) to solve self-discovered problems
	31	I am driven by external pressures (including other people) to solve problems
	32	I intentionally engage in unpopular ideas
Sensitivity	33	I am a sensitive person

	34	I am sensitive to the various aspects of a problem
Experiment and combine	35	To find the best creative solution, I experiment
	36	To find creative solutions, I combine objects
Dimensional thinking	37	I consider the dimensionality of an issue to create ideas in terms of cost
	38	I consider the dimensionality of an issue to create ideas in terms of time
Problem-solving	39	I make random attempts to solve a difficult problem

4.9 CONCLUSIONS

From the analysis it can be concluded that:

1. This article focused on creativity research (models and approaches) to extract creativity influences to be used as measuring criteria for creativity at tertiary educational level. Based on the literature study, twenty-eight creativity influences were initially identified and grouped into two groups, namely cognitive psychology and personality characteristics. Eighteen influences were identified in the cognitive psychology group and ten in the personality characteristics group. Based on research support, only eleven influences consisting of 73 items relating to these influences were identified to be used in the measuring instrument after the operationalisation process.
2. The measuring instrument was then purified by employing various statistical tests. Exploratory factor analysis using Varimax rotation was used due to its ability to maximize variance explained which was set in excess of 0.70%. The variance explained indicated that the measuring tool to measure creativity was valid.
3. The Kaiser, Meyer and Olkin (KMO) measure indicated that the sample was adequate. Values of 0.70 and higher are regarded as acceptable. This study had a value of 0.820.
4. The Bartlett's test of sphericity measures if data is suitable for multivariate statistical analysis, such as factor analysis. The approximate Chi-Square for this study was 3859.429, the df was 741 and the Sig. was 000. This indicated that a factor analysis could be used for the data obtained.
5. The measuring criteria required three rounds of purification to eliminate non-loading criteria as well as criteria that dual-load strongly on more than one factor. In total, 34 criteria were eliminated from the measuring instrument.
6. The initial data set, consisting of 11 influences and 73 items, were decreased to achieve a validated measuring instrument. As a result, the original 11 influences and 73 items are discarded and the new validated questionnaire is employed to measure creativity.

7. Twelve factors were identified and 39 items in point 6. These factors are: *Challenging the status quo*, *Detachment*, *Synthesis*, *Cognition*, *Associate and Communicate*, *Awareness*, *Similarity*, *External motivation*, *Sensitivity*, *Experiment and Combine*, *Dimensional Thinking* and *Problem-solving*. These factors were used to create an amended conceptual framework and questionnaire items. These 12 factors explained a cumulative variance of 66% which exceeds the required 60% to represent a good fit to the data.
8. The Cronbach Coefficient Alpha was used to test the reliability of the factors and the overall reliability was good. Factors 1-7 and 9 all have satisfactory reliability coefficients in excess of the required 0.70. Factors 8 and 11 are below the higher reliability coefficient of 0.70, but above the lower limit of 0.57 set by Cortina, and is thus accepted to be reliable factors. Factor 10 is marginally lower than the lower limit of 0.58 set by Cortina, and therefore, this factor might not present itself in repeated research. The Cronbach alpha for factor 12 could not be calculated.

4.10 SUMMARY

This study identified a reliable and valid conceptual framework to measure creativity at tertiary educational level. It is critical to focus on creativity at tertiary educational level due to its impact on how graduates are able to apply their education to resolve challenges creatively now and in the future. The problem at South African tertiary educational institutions appear to be that different disciplinary interpretations of creativity exist, which makes the identification and measurement of creativity difficult. More focus is also placed on creativity in subjects like Arts and less on Sciences.

The amended conceptual framework (CF2) incorporated various approaches, models and common indicators of creativity based on an extensive literature study, thus making it credible to use to measure creativity at tertiary educational level. The conceptual framework combined creative behaviour and thinking and linked it in a sophisticated interrelationship, which is evident from the twelve factors which were identified to measure creativity. These twelve factors are challenging the status quo, separate, synthesis, cognition, associate and communicate, awareness, similarity, external motivation, sensitivity, experiment and combine, dimensional thinking and problem-solving.

The amended conceptual framework (CF2) can play an important role in measuring creativity at tertiary educational institutions. The conceptual framework offers the possibility to be used in future creativity research and to be developed further to play an important role in the development of individuals' creative abilities.

The researcher acknowledges, however, that measuring creativity at tertiary educational level remains challenging. The reasons for this are that psychological factors play a role in fostering or inhibiting creativity at tertiary educational level and social and cultural factors impact on the creative and teaching process in different academic areas.

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CHAPTER 5

ARTICLE 4:

COMPARATIVE ANALYSIS OF TWO CONCEPTUAL FRAMEWORKS TO MEASURE CREATIVITY

Abstract

Two reliable and valid conceptual frameworks were developed to measure creativity. The first measures creativity at a general level and the second measures creativity at tertiary educational level. This article aimed to compare these two conceptual frameworks to determine which one of the models is more suited to measure creativity in the tertiary education application field. This is the primary objective to identify the most reliable and valid conceptual framework to measure creativity at tertiary educational level based on this comparative study. This was achieved through factor comparison between the models, reliability analysis and the cumulative variance explained. The results of this study showed that both conceptual frameworks are different in their own right and both are valid and reliable. Only marginal differences could be observed from the statistical tests used in the comparative analysis. It can, therefore, be concluded that an applied measuring framework for tertiary education can be used to measure creativity, but, the developed general framework is also suitable to be employed in tertiary education.

Keywords: creativity, creativity models, creativity measurement instruments, factors, comparative analysis, pure factors, Pearson correlations, variance explained.

5.1 INTRODUCTION

Creativity plays an important key role in invention, innovation and problem solving that improve human life (Allen, 2012:47). In an effort to understand and develop creative potential, various measurement instruments were developed over the years. All these instruments have merit to explain creativity as a phenomenon. Measuring creativity has however remained problematic due to the fact that a number of instruments were developed without being scientifically tested for reliability and validity.

This article deals with the research that was done thus far in this study. Two conceptual frameworks were developed to measure creativity. One conceptual framework was developed to measure creativity in a general setting and another conceptual framework was developed to measure creativity in a tertiary educational setting. Both frameworks were tested for reliability and validity. The next step is to determine the most reliable and valid conceptual framework to measure creativity as part of this study.

This article utilises a comparative analysis approach and aims to compare the two conceptual frameworks in terms of the factors identified in each to determine how strong the identified factors correlate, to determine how much these conceptual frameworks differ from one another, to determine the variance and the reliability of these factors and to determine the ‘goodness of fit’ of the respective conceptual frameworks.

5.2 RESEARCH OBJECTIVES

The primary objective of this article is to compare the *general framework to measure creativity* (CF1) against an applied *measuring framework for tertiary education* (CF2) in order to determine which of the two frameworks best suit the measurement of creativity in a tertiary education environment.

The primary objective of this article was achieved through the following secondary objectives, namely to:

- Provide an overview of each one of the two conceptual frameworks;
- Compare the empirical results of the two frameworks using a number of statistical criteria; and to

- Recommend a conceptual framework that can be used to measure creativity in the tertiary education environment.

5.3 COMPARATIVE CRITERIA

The two conceptual frameworks are compared by using the following statistical results:

- Factor comparison of factors identified by the two frameworks (CF1 and CF2);
- Factor correlation coefficients;
- Variance explained by the factors;
- Points of inflection of the factors;
- Reliability of the factors within the studies; and to
- Determine the goodness of fit of the respective conceptual frameworks (CF1 and CF2).

5.3.1 Factor analysis

Factor analysis is a procedure used to determine the number of continuous latent variables (referred to as factors) that are needed to explain the correlations among a set of observed variables (referred to as factor indicators) (Darlington, 2005:1). Factor analysis is not a single statistical method, but represents a complex range of structure-analysing procedures which are used to identify the interrelationship among a large set of observed variables. These variables are then reduced through data reduction to a small set of factors that have common characteristics (Nunnally & Bernstein, 1994 in Pett, Lackey & Sullivan, 2003:2). Factor analysis can be used to assess the reliability and validity of measurement scales, according to Carmines and Zeller (1979 in Albright & Myoung Park, 2009:2), which makes this valuable to the study objectives.

A factor (unobserved latent variable) can be described as a linear combination or cluster of related observed variables that represents a specific underlying dimension of a construct, which is different from all the other factors identified (Tabachnick & Fidell, 2001 in Pett et al., 2003:3). A factor is assumed to exert causal influence on observed variables in factor analysis and observed variables are linear combinations of latent variables, according to Hatcher (1994:9-10, 69). Factors account for the common variance (as opposed to unique variance) of a total variance (Brown, 2006:22). Three types of factors can be identified, according to Haasbroek (2008:37). These factors are:

- *Pure factors* which can be identified in all the studies compared and there are a large similarity in the statements;
- Common factors are factors that do not appear in all studies compared and some similarity on the statements can be identified; and
- Study specific factors are factors that are unique to a specific study and could not be identified by any of the other studies when these were compared.

There are two basic types of factor analysis, namely exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) (Albright & Myoung Park, 2009:2; Suhr, n.d.:1). Exploratory factor analysis (EFA) is used when the number of factors that are necessary to explain the interrelationships among a set of variable are not known and the underlying dimensions of the construct being researched need to be determined. Brown (2006:14) indicates that EFA is data driven and there are no restrictions on the pattern of the relationships between observed and latent variables. Harrington (2008:1) states that data is simply explored in an EFA and provides information about the numbers of factors required to represent the data. In exploratory factor analysis, all measured variables are related to every latent variable. An EFA was used in this study to determine the latent constructs underlying a set of variables, to provide a means of explaining variation among variables using a few newly created factors, to define the meaning and content of these factors and to explain variance and covariance among manifest variables. It was also chosen because traditional statistical computer packages (such as SPSS) can be used effectively during data analysis.

Harrington (2008:1) describes confirmatory factor analysis (CFA) as a multivariate statistical procedure that is used to test how well the measured variables represent the number of constructs. A CFA, according to Albright and Myoung Park (2009:3), is theory- or hypothesis driven and with a CFA it is possible to place meaningful constraints on the factor model and it produces many goodness-of-fit measures to evaluate the model. A CFA is used to verify the factor structure of a set of observed variables and allows the researcher to test the hypothesis that a relationship exists between the observed variables and their latent constructs (Suhr, n.d.1). CFA unfortunately does not calculate factor scores. CFA was not used in this study because the aim of the study was to determine the latent constructs underlying a set of variables, to identify factors and to define the meaning and content of these factors to create a conceptual framework to measure creativity. CFA also requires special purpose software

packages such as Mplus, LISREL, Amos, EQS and SAS/STAT CALIS (Albright & Myoung Park, 2009:3). Table 5.1 shows the comparison between EFA and CFA.

TABLE 5.1: EXPLORATORY AND CONFIRMATORY FACTOR ANALYSIS

	EFA (Data-driven)	CFA (Theory-driven)
Constraint	N/A	Yes
Unstandardised solution	N/A	Yes
Standardised solution	Yes	Yes
Factor rotation	Yes	N/A
Factor scores	Yes	N/A
Hypothesis test	N/A	Yes
Goodness-of-fit	N/A	Yes
Software package	General purpose software	Mplus, LISREL, Amos, EQS and SAS/STAT CALIS

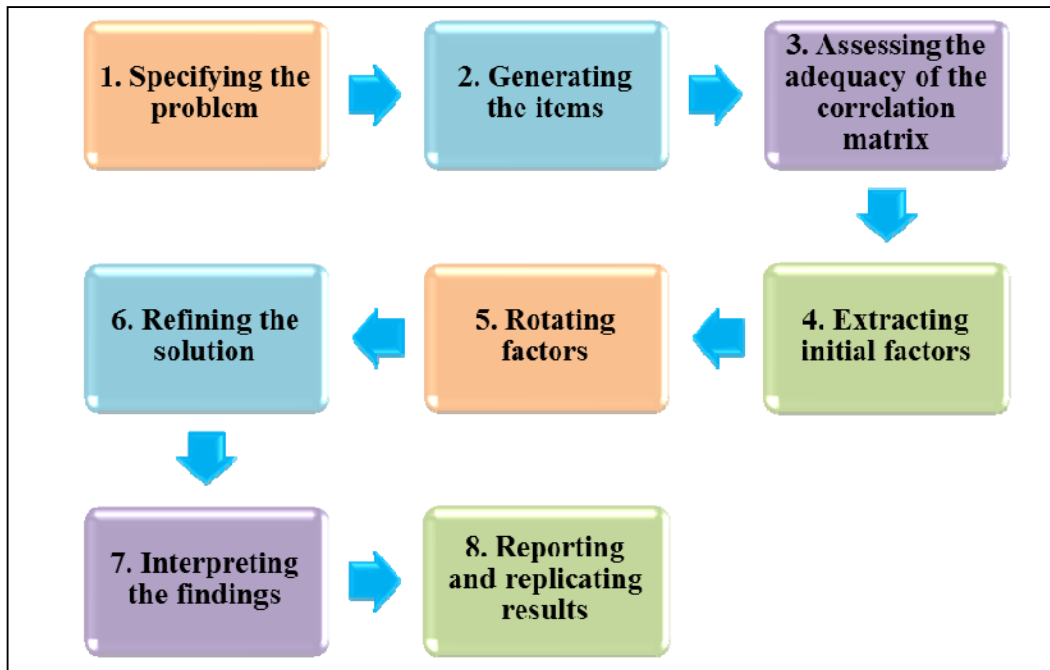
Source: Albright and Myoung Park (2009:3)

An exploratory factor analysis (EFA) consists of different steps. Albright and Myoung Park (2009:10) identify three key steps:

- The creation of a correlation matrix;
- Extraction of factors using a principal factor (PL), maximum likelihood (ML), weighted least squares (WLS) or generalised least squares (GLS) for example; and
- Rotation of the extracted factors to foster interpretability by maximizing factor loadings close to 1.0 and minimizing factor loadings close to 0.

Pett et al. (2003:11-12) identify eight basic EFA steps of which step 3, 4 and 5 corresponds with the steps indicated by Albright and Myoung Park (2009:10). These eight steps are shown in Figure 5.1 below.

FIGURE 5.1: BASIC STEPS IN EXPLORATORY FACTOR ANALYSIS



Source: Pett et al. (2003:11-12)

De Coster (1998:1) provides the following seven steps when conducting an exploratory factor analysis. Step 2, 4 and 5 corresponds with Pett et al. (2003) and Albright and Myoung Park (2009). The steps identified by De Coster are similar to the steps followed in this study. These steps are:

- **Step 1: Collect measurements** – The variables need to be measured on the same (or matched) experimental units.
- **Step 2: Obtain the correlation matrix** – The correlations (or covariances) between each of the variables need to be obtained.
- **Step 3: Select the number of factors for inclusion** – This input correlation matrix is used to determine the number of factors for inclusion. There are a number of methods to determine the “optimal” number of factors by examining the data. The Kaiser criterion states that one should use a number of factors equal to the number of the eigenvalues of the correlation matrix that are greater than one (Brown, 2006:26; Hatcher, 1994:22-23; Nunnally, 1978 in Suhr, n.d.:3). The number of positive eigenvalues determines the number of dimensions needed to represent a set of scores without any loss of information (Rietveld & Van Hout, 1993:259). The number of

positive eigenvalues determines the number of factors to be extracted. The “screen test” can be used to determine factors and states that one should plot the eigenvalues of the correlation matrix in descending order, and then use a number of factors equal to the number of eigenvalues that occur prior to the last major drop in eigenvalue magnitude. Cattell’s scree test can be used because each factor explains less variance than the preceding factor and therefore an imaginary line connecting the markers for successive factors runs from top left of the graph to the bottom right. Factors that appear above the elbow should be retained and the rest rejected (Cattell, 1966 in Suhr, n.d.:3).

- **Step 4: Extract the initial set of factors** – A computer program is needed for this step. The computer program (SPSS) is used to capture correlations or covariances before factors can be extracted. There are a number of different extraction methods and the best method is generally maximum likelihood (ML) extraction, unless there is a serious lack of multivariate normality in the measures. Factor extraction basically takes out as much common variance as possible in the first factor and the subsequent factors account for the maximum amount of the remaining common variance until no common variance remains (Suhr, n.d.:3). Direct extraction methods obtain the factor matrix directly from the correlation matrix by using specified mathematical models (Child, 1990 in Suhr, n.d.: 3).
- **Step 5: Rotate factors** – By rotating the factors an attempt is made at finding a factor solution that is equal to that obtained in the initial extraction but which has the simplest interpretation. There are two major categories of rotations, orthogonal rotations, which produce uncorrelated factors, and oblique rotations, which produce correlated factors (Moolla, 2010:161). Orthogonal rotation takes place when the axes are held at 90^0 to each other and oblique rotation takes place when the axes are rotated through different angles (Suhr, n.d.:3). The process of manipulating the reference axes is known as rotation. The axes are turned about the origin until some alternative position has been reached. Varimax rotation is widely viewed as the best and most common orthogonal rotation, because it attempts to maximize the variance of the squared loadings of a factor (column) on all the variables (rows) in a factor matrix, which has the effect of differentiating the original variables by extracted factor (Field, 2007:746). This simplifies the interpretation of factors. Each factor will tend to have

either large or small loadings of any particular variable. A varimax solution yields results which makes it easy to identify each variable with a single factor.

- **Step 6: Interpret the factor structure** — Rotation creates factor loadings which can be interpreted as a standardised regression coefficient, because it regresses the factors on the measures (Moolla, 2010:162). Factors are defined by considering the theoretical constructs that could be responsible for the pattern of positive and negative loadings. To ease interpretation, the option of multiplying all of the loadings for a given factor by -1 exists. This essentially reverses the scale of the factor, turning an “unfriendliness” factor into a “friendliness” factor. Adjustments are often made to the frame of reference by rotation methods that improve the interpretation of factor loadings by reducing some of the ambiguities which accompany the preliminary analysis (Child, 1990 in Suhr, n.d.: 3).
- **Step 7: Construct factor scores for further analysis** – Factor scores need to be constructed if additional analyses are performed using the factors as variables. A factor score is a linear combination of all of the measures, weighted by the corresponding factor loading. Sometimes factor scores are idealised, assigning a value of 1 to strongly positive loadings, a value of 0 to intermediate loadings and a value of -1 to strongly negative loadings. It is important to note that factor scores are strongly collinear with the measures used to generate these factor scores.

Before factor analysis was used in the study, the advantages and disadvantages were considered carefully. The advantages of factor analysis are that:

- The number of variables can be reduced by combining two or more variables into a single factor;
- It can test measurement validity; and
- Groups of inter-related variables can be identified to see how they are related to each other.

Suhr (n.d.:3) identified some limitations of factor analysis as indicated below:

- It is difficult to pick the proper rotation using factor analysis alone. All rotations have different underlying processes but provide equally valid outcomes to optimise factor analysis;
- Same data factored the same way can be interpreted in different ways;
- The correlations describe relationships and no causal inferences can be made from correlations alone;
- A larger sample is needed for a larger correlation and to overcome the problem of missing data;
- Variables could be sample specific; and
- Nonnormal distribution of data may occur.

Tabachnick and Fidell (1996:102 & 636) state that one of the problems with factor analysis is that there is no criterion variable against which to test the solution and interpretation is based on the researcher's judgement and subjectivity. The infinite number of rotations available can lead to different defined factors and disagreement between researchers as to which rotation is the most appropriate.

Although more limitations were identified initially, factor analysis was identified as the best method to meet the objectives of this study. The value of factor analysis in this study is based on the following motivations:

- Factor analysis is “one of the most powerful methods yet for reducing variable complexity to greater simplicity” (Kerlinger, 1979:180).
- Factor analysis is used to explain the most shared variance of measured variables using a smaller set of latent constructs. These parsimonious or reduced set of factors summarizes and describes the structural interrelationships among the items in a concise and understandable manner (Gorsuch, 1983 in Pett et al., 2003:4), which have greater validity and are more likely to replicate (Henson & Roberts, 2006:394).
- Factor analysis can test measurement integrity and can guide further theory refinement at the same time (Hendrick & Hendrick, 1986:393). Therefore, the fact that factor analysis can be used to determine what theoretical constructs underlie a given data set and the extent to which these constructs represent the original variables, as explained by Gorsuch (1983:350), made factor analysis ideal to determine the factors to use in conceptual frameworks in this study.

- Factor analysis, according to Nunnally (1978:112-113), is deeply involved with questions of validity which are very important in this study and is therefore suitable in the development of a conceptual framework to measure creativity.
- Factor analysis can be used for theory and instrument development and assessing construct validity of an established instrument when administering to a specific population (Pett et al., 2003:3-4).
- Factor analysis helped to examine the interrelationships among items or statements that are measuring a specific construct.

Some common assumptions of factor analysis (Moolla, 2010:159) are as follows:

- Factor analysis assumes that the observed variables are a linear combination of some underlying of hypothetical or unobservable factors;
- Some of the factors are assumed to be common to two or more variables and some are assumed to be unique to each variable;
- The factors or unobserved variables are assumed to be independent of one another;
- All variables in a factor analysis must consist of at least an ordinal scale; and
- Nominal data are not appropriate for factor analysis.

Therefore, the main assumption is that there exists a set of underlying factors within a collection of observed variables that are smaller in number than the observed variables and can explain the interrelationships among those variables (Pett et al., 2003:5-6).

Based on De Coster's (1998:1) seven steps, the following was used as a guide to interpret the results of the factor analysis:

- **Step 1: Collect measurements** – Creativity variables identified from literature had to have scientific support of at least five different sources to be included in the study.
- **Step 2: Obtain the correlation matrix** – The correlations (or covariances) between each of the creativity variables were obtained by using SPSS.
- **Step 3: Select the number of factors for inclusion** – When variables are factored, the total number of factors equals the number of variables factored. Some of these factors are not useful to retain in the analysis and can be discarded by the researcher, because the overall aim is to retain the fewest possible factors that explains the most variance of the observed variables. For this study, the following retention rule was used:

- The eigenvalue (latent root) of a factor should be > 1 rule. Factors with an $AV > 1$ were retained and factors with $AV < 1$ were discarded.
- **Step 4: Extract the initial set of factors** – Factor extraction basically takes out as much common variance as possible in the first factor and the subsequent factors account for the maximum amount of the remaining common variance until no common variance remains (Suhr, n.d.:3). If communalities are low, the extracted factors account for only a little part of the variance and more factors should be retained to better account for the variance. Factors which account for 70% or more of the variance were kept in this study.
- **Step 5: Rotate factors** – Orthogonal rotation was used in this study, because Hetzel (1996:194) noted that orthogonal solutions are desirable as fewer parameter matrices are estimated that should lead to more replicable results. Field (2000:439) indicates that there is no correlation between extracted factors in orthogonal rotation, which is important in this study. The aim of using rotation was to increase the size of high loadings and decrease the size of low loadings. Varimax rotation was specifically used in this study, because it attempts to maximize the variance of the squared loadings of a factor (column) on all the variables (rows) in a factor matrix, which has the effect of differentiating the original variables by extracted factor. Factor loadings of 0.40 were set as the minimum factor loading, while the data had to explain a cumulative variance of in excess of 60%.
- **Step 6: Interpret the factor structure** — The default for the threshold value is 0.1, but to get an uncluttered view of the factor structure a value of 0.3 was selected. There was a trade-off between losing some information and ease of interpretation in this study.
- **Step 7: Construct factor scores for further analysis** – Factor scores were assigned based on assigning a value of 1 to strongly positive loadings, a value of 0 to intermediate loadings and a value of -1 to strongly negative loadings.

Factor analysis has proven to be an effective method to use in this study.

5.3.2 Pearson's correlation coefficient

Field (2007:791) describes Pearson's correlation coefficient as a standardised measure of the strength of relationship between two variables which can take any value from -1 (as one variable changes, the other one changes in the opposite direction by the same amount), through 0 (as one variable changes the other doesn't change at all), to +1 (as one variable changes, the other changes in the same direction by the same amount). The Pearson correlation coefficient has the ability to determine the differences in two factors' pattern of loadings and indicate the differences (or similarities) in the magnitude of these loadings, even if dissimilarities exist in the factor loadings (Du Plessis, 2010:121). One should be beware that with factors having a large number of small loadings, those small loadings could cause the Pearson r to be large (if they are similar between factors) even if the factors had dissimilar loadings on the more important variables.

Pearson's correlation coefficient is regarded as a satisfactory correlation measure (Wuensch, 2009:13-14) which makes it valuable in the comparative analysis of two creativity measurement models.

The cut-off correlation for this study was determined to be an absolute Pearson correlation coefficient of 0.30, signifying a medium relationship or correlation between variables (Du Plessis, 2010; Zikmund, 2008:551).

5.3.3 Cumulative variance explained

Variance indicates the dispersion of scores around the mean and is basically the average error between the mean and the observations made. Variance shows how well a model fits the actual data (Field, 2002:6).

Factors account for common variance in a data set. Eigenvalues indicate the amount of variance explained by each factor. Factor scores are calculated with a mean or sum of measured variables that "load" on a factor. Communality is the variance of observed variables accounted for by a common factor. A large communality value indicates a strong influence by an underlying construct (Hatcher, 1994 in Suhr, n.d.:17).

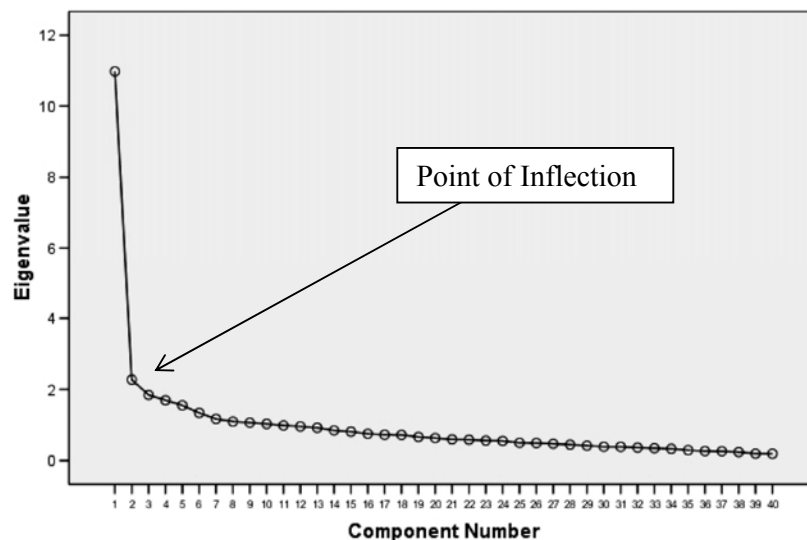
The variance explained was used in this study to compare the strength of the factors in each model, then to identify pure, common and specific factors, to determine the goodness-of-fit of each model and to determine the point of inflection. Variance played an important role in interpreting various aspects and completing various steps in the factor analysis process, as well as in comparing the two creativity measurement models.

The data was required to explain a cumulative variance of in excess of 60%. A cumulative variance in excess of 60% signifies a “good fit” as stated by Field (2007:668).

5.3.4 The point of inflection

The *Point of Inflection* is a scree plot for the Eigenvalues (or the variance explained) by factors (Field, 2007:633). Points of inflection is where a function changes concavity to either concave up to a positive second derivative or to concave down to a negative second derivative, then when the function changes from concave up to concave down (or vice versa) the second derivative must equal zero at that point (Khamsi & Knaust, 1999:1). Concavity changes at the point of inflection, which is normally zero. Figure 5.2 illustrates the Point of Inflection and its use.

Figure 5.2: Illustration of the point of inflection



Source: Rasool (2010:78)

Rasool (2010:78) states that the suitability of a retaining factor is determined by means of the *Point of Inflection* as secondary measure. The *Point of Inflection* examines the *Eigenvalues* of the factors in relation to their declining nature. The Point of Inflection is reached once the next factor's *Eigenvalue* does not significantly decline in its Eigenvalue (Schönrock-Adema, 2009:228 in Rasool, 2010:78-79). The marginal contribution of the next factor to the *Eigenvalue* (or the variance explained) is thus visually displayed.

The point of inflection was used in this study to compare the two models because it displays the distribution of variance explained by the factors in declining order. The *Point of Inflection* is reached when the next factor's contribution to variance explained becomes marginal, and that this factor could be omitted from the analysis. In addition, the analysis also reveals how early the variance explained by each of the two conceptual frameworks (CF1 and CF2). The decision rule favours a model that explains the most variance early in the analysis, thus with the steepest variance curve and earlier *Point of Inflection* in the figure (Rasool, 2010:79).

5.3.5 Reliability of the factors (Cronbach alpha)

Validity and reliability are fundamental elements in the evaluation of a measurement instrument and therefore very important in this study. Validity is concerned with the extent to which a measuring instrument measures what it is intended to measure. Reliability is concerned with the ability of an instrument to measure consistently. An instrument cannot be valid unless it is reliable, however, the reliability of an instrument does not depend on its validity. Cronbach coefficient alpha (α) is the most widely used measure of reliability.

Cronbach coefficient alpha (α) measures the internal consistency of a test or scale, determines if the test or scale is good enough to use and is expressed as a number between 0 and 1 (Tavakol & Dennick, 2011:53, Sprinthall, 2007:314). Cronbach alpha is based on the average correlation of questions within the test or scale (Omni Institute, n.d.:5). Internal consistency describes the extent to which all the items in a test measure the same construct and is connected to the inter-relatedness of the items within the test. Grau (n.d.:3106) explains that Cronbach alpha is generally used as a measure of reliability of a set of questions in a survey instrument and measures the interrelatedness of a set of items, in other words its unidimensionality. Cronbach alpha can also confirm if a sample of items is unidimensional or

not (Tavakol & Dennick, 2011:54). Factor analysis is a method to determine the dimensionality of a scale.

Gliem and Gliem (2003:84) state that Cronbach alpha only requires a single test administration to provide an estimate of the reliability of a given test and provides the average value of the reliability coefficients, which can be obtained from all possible combinations of items when split into two half tests. Split-half is when one single test is treated as two tests by dividing the items into two subsets (Ho Yo, n.d.:1).

Reliability estimates show the amount of measurement error in a test. As the estimates increase, the fraction of a test score that is attributable to error will decrease. Tavakol and Dennick (2011:53) explain that a low value can be due to a low number of questions, poor interrelatedness between items or heterogeneous constructs. A low level of alpha can also be associated with multidimensional data (Grau, n.d.:3106). Cronbach alpha will increase if the items in a test are correlated. A high coefficient alpha, according to Tavakol and Dennick (2011:52), does not always mean a high degree of internal consistency, because Cronbach alpha is also affected by the length of a test. The value will decrease if the test is too short. High values can also indicate that some items are redundant as they are testing the same questions but in a different form (Tavakol & Dennick, 2011:53).

The value of Cronbach alpha is affected by the number of test items, item interrelatedness and dimensionality. There are different acceptable values of Cronbach alpha, ranging from 0.7 to 0.95. An acceptable level of reliability is 0.7 or higher according to Grau (n.d.:3106) and Boshoff & Hoole (1998:77). Field (2007:668) agree with Grau and Boshoff and Hoole that an alpha coefficient of 0.7 is sufficient even though Moss, Prosser, Costello, Simpson, Patel, Rowe, Turner and Hatton (1998:180) suggest that an alpha score of 0.6 is generally acceptable. If all questions are correlated with each other, the Cronbach alpha will be 1.00 and if the questions had no correlation it would be 0.00 (Omni institute, n.d.:5). Values over 0.8 are required for the claim to be made that a scale has high internal consistency. The interpretation of the various levels of Cronbach alpha is shown in Table 5.2 below.

TABLE 5.2: INTERPRETATION OF CRONBACH COEFFICIENT ALPHA

STATISTIC	INTERPRETATION
1.00	Too good to be true – look at the questions, they must be identical
0.90 – 0.99	Incredibly good
0.80 – 0.89	Very good
0.70 – 0.79	Acceptable
0.60 – 0.69	Be worried, the measurement error is high
Below 0.60	You really don't have a scale – stick to the items

Source: Omni Institute (n.d.:6)

Cronbach alpha is also a measure of common variance and when variance is shared with at least some other items in the other test it could show a high value (Ho Yo, n.d.:4). Since Cronbach alpha takes variance into account, it is important to interpret the data in the context of dispersion, because without variance there will be no sensible result (Ho Yo, n.d.:5).

Yo Ho (n.d.:1-2) indicates that there are certain assumptions that need to be met to avoid error scores. These assumptions are that:

- A reliability test should minimize the measurement error so that the error is not highly correlated with the true score;
- The mean of the measurement error should be zero; and
- The true scores for any two items must be within a constant of each other to be examined.

If the second assumption is not met, it can lead to an over-estimation of Cronbach alpha, even if in practice this assumption cannot be fully met. If the third assumption is not met, Cronbach alpha may underestimate reliability. These are the potential problems with this measurement technique and was taken note of in this study and avoided (Yo Ho, n.d.:3).

It is important to remember that although Cronbach alpha is fairly easy to compute using SPSS, as in this study, its application requires conceptual understanding of true score,

observed score, measurement error, variance, covariance matrix, consistency and dimensionality (Ho Yo, n.d.:5).

Cronbach alpha was used in this study to compare the reliability of the factors of the two models and to determine which of the two models was more reliable to measure creativity. According to Suhr (n.d:2), the model with the higher reliability coefficient normally provides a more consistent measurement. An acceptable level of reliability for the study was set as 0.7.

5.3.6 Kaiser, Meyer and Olkin (KMO) analysis and the Bartlett test of sphericity

The Kaiser-Meyer-Olkin (KMO) measure is used to measure the sampling adequacy and to examine the appropriateness of factor analysis based on the sample characteristics. KMO, according to Schwarz (2011:25), has become the standard test procedure for factor analysis.

The KMO measure of sample adequacy tests whether or not the partial correlations among variables are small (Schwarz, 2011:25). KMO provides an index (between 0 and 1) of the proportion of variance among the variables that might be common variance (Darlington, 2005:58). The value for KMO should be greater than 0.5 for the sample to be regarded as adequate for a pair of variables (Field, 2002:445). Values of 0.70 and higher are regarded to be acceptable, according to Field (2007:666).

KMO indicates the degree to which variables are related, and it helps in evaluating if using factor analysis makes sense. To examine the appropriateness of factor analysis, using the KMO measure, judgements are based on the recommendations by Hutcheson and Sofroniou (2009:233) who indicate that a value close to 1 indicates that patterns of correlations are relatively compact and so factor analysis should yield distinct and reliable factors. Field (2007:66) indicates that values between 0.5 and 0.7 are mediocre and values between 0.7 and 0.8 are good, values between 0.8 and 0.9 are great and values above 0.9 are superb. Schwarz (2011:25) agrees with Field (2007), but has indicated interpretation of the values slightly different, which are shown in Table 5.3 below.

TABLE 5.3: INTERPRETATION OF KAISER-MEYER-OLKIN (KMO)

STATISTIC	INTERPRETATION
0.00 – 0.49	Unacceptable
0.50 – 0.59	Miserable
0.60 – 0.69	Mediocre
0.70 – 0.79	Middling
0.80 – 0.89	Meritorious
0.90 – 1.00	Marvellous

Source: Schwarz (2011:25)

As a rule of thumb, KMO should be 0.60 or higher in order to proceed with factor analysis according to Schwarz (2011:25), but Kaiser (1970:401-415) suggests and explains that 0.5 should be the cut-off value and 0.8 is the desirable value to use when applying the KMO measure.

The KMO measure was used in this study to compare the two conceptual frameworks and to determine which framework's sample was more adequate and which framework was more appropriate for using factor analysis. Values of 0.70 and higher were set as the minimum required KMO value for this study.

The Bartlett test of sphericity is a statistical test used to examine the hypothesis that the variables are uncorrelated in the population (Shukla, n.d.:4). This means that the population correlation matrix is an identity matrix, each variable correlates perfectly with itself ($r = 1$) or has no correlation with the other variables ($r = 0$). A prerequisite, according to Schwarz (2011:24), is that the variables should be normally distributed.

Field (2007:724) explains that Bartlett's test examines whether a variance-covariance matrix is proportional to an identity matrix, in other words, it tests the null hypothesis that the original matrix is an identity matrix. Bartlett's test is used to test whether the diagonal elements of the variance-covariance matrix are equal and that the off-diagonal elements are approximately zero. If the correlation matrix is an identity matrix there would be no correlations between the variables. Bartlett's test therefore is used to determine if each set of variables correlates.

Bartlett's test is also able to detect multi-collinearity via the determinant of the correlation matrix and if it is greater than 0.00001 there is no multi-collinearity evident (Field, 2000:445).

Bartlett's test renders a verdict on the suitability of the data to be used in multivariate statistical techniques (such as factor analysis), and favourable values (sufficient for factor analysis) are those that are below the 0.000 level (Du Plessis, 2009:58).

Bartlett's test of sphericity was used in this study to compare the two conceptual frameworks and to determine which framework was best suited for factor analysis. If the correlations among the variables are too low, the framework will not be appropriate. The value for this study was set 0.000 and below.

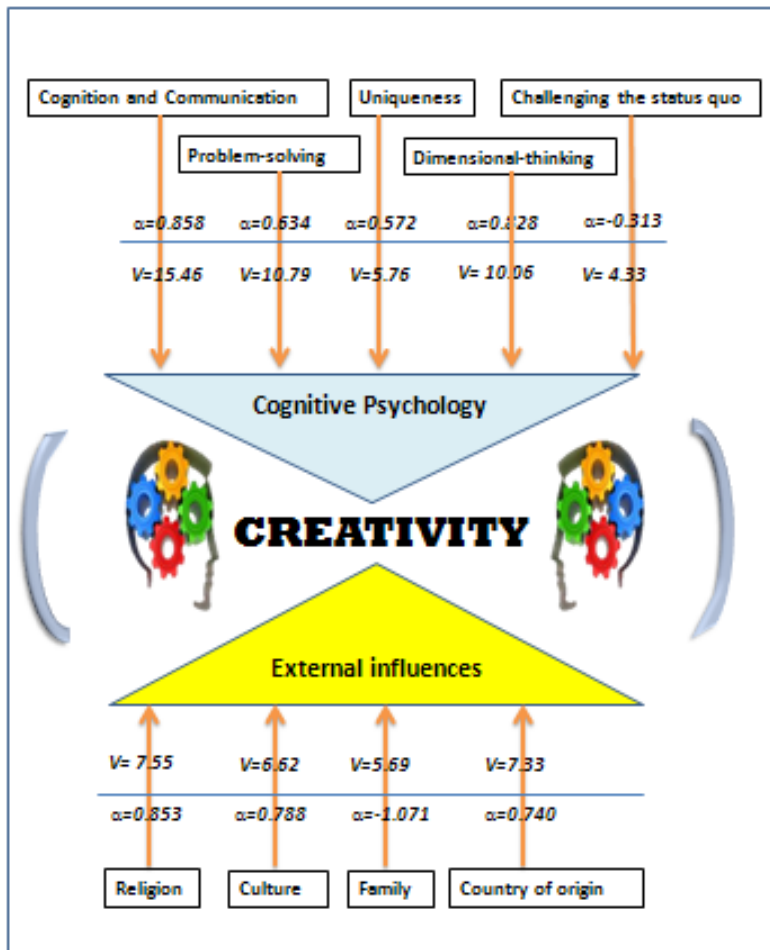
5.4 CREATIVITY MEASUREMENT FRAMEWORKS

Two conceptual frameworks were developed to measure creativity. The first framework (CF1) is a *general framework* to measure creativity and the second framework (CF2) is an applied measuring *framework for tertiary education*. As indicated above, the objective of this article is to determine which one of these two frameworks are best suitable to measure creativity in tertiary education, a general framework or an applied framework. These two frameworks are shortly discussed below.

5.4.1 Framework 1 (CF1)

This framework is a general framework to measure creativity and consists of nine factors. The framework is illustrated in Figure 5.3.

FIGURE 5.3: FRAMEWORK 1 (CF1)



The framework illustrates the nine factors and the variance per factor. According to this framework (CF1), nine factors need to be measured to determine creativity in a general setting. These factors are:

- Factor 1, *Cognition and Communication*, is the most important factor with a favourable variance of 15.46%. This factor indicates that it is very important to consider and find different links and relationships when looking at a variety of information sources, as well as the ability to cope with complexities, the motivation to tear down barriers to creative thinking and the ability to use communication effectively to reveal creative ideas to others and to persuade others that these ideas are valuable. Cronbach's coefficient alpha (α) is 0.858 and shows a very satisfactory reliability coefficient well in excess of the required 0.70 for this factor.

- Factor 2, *Problem-solving*, is the second most important factor to consider when one is measuring creativity in a general setting. This factor explains a favourable variance of 10.79% and points to the ability to produce solutions to problems by looking at a variety of solutions in a novel way, solving problems in a short period of time and using experimentation to find the best creative solution. Cronbach's coefficient alpha (α) is 0.634 which is marginally below the upper limit of 0.70 and above the lower limit of 0.57 and therefore can be seen as acceptable.
- Factor 3, *Dimensional Thinking*, explains a favourable variance of 10.06% and points to the ability to look for similarity in concepts, processes and patterns to find creative ideas, and the ability to consider the dimensionality of an issue in terms of space. Cronbach's coefficient alpha (α) is 0.828 and shows a very satisfactory reliability coefficient.
- Factor 4, *Religion*, points specifically to the impact religion has on an individual's creative output and creative thinking and explains a favourable variance of 7.55%. Cronbach's coefficient alpha (α) is 0.853 and shows a very satisfactory reliability coefficient.
- Factor 5, *Country of origin*, points to the impact the country of origin has on beliefs, values and self-expression and its impact on the creative thinking of people living in a certain country. This factor explains a favourable variance of 7.33%. Cronbach's coefficient alpha (α) is 0.740 and shows a satisfactory reliability coefficient.
- Factor 6, *Culture*, explains a variance of 6.62% and points to the impact of society and community on people's creativity in a general setting. Cronbach's coefficient alpha (α) is 0.788 and shows a very satisfactory reliability coefficient.
- Factor 7, *Uniqueness*, points to the ability to find solutions or generate ideas by looking at the uniqueness in features and processes and to separate objects to find creative solutions. The factor explains a variance of 5.76%. Cronbach's coefficient alpha (α) is 0.572 and shows an acceptable reliability coefficient as it is slightly below the lower limit of 0.58.
- Factor 8, *Family*, points to the role of family members to encourage and value creativity while growing up and explains a variance of 5.69%. Cronbach's coefficient alpha (α) is -1.071 and shows a negative reliability coefficient and care should be taken as this factor is less likely to represent itself in repetitive studies.

- Factor 9, *Challenging the status quo*, points to the need to intentionally engage in unpopular ideas and explains a variance of 4.33%. Cronbach's coefficient alpha (α) is -0.313 and shows a negative reliability coefficient and care should be taken as this factor is less likely to represent itself in repetitive studies.

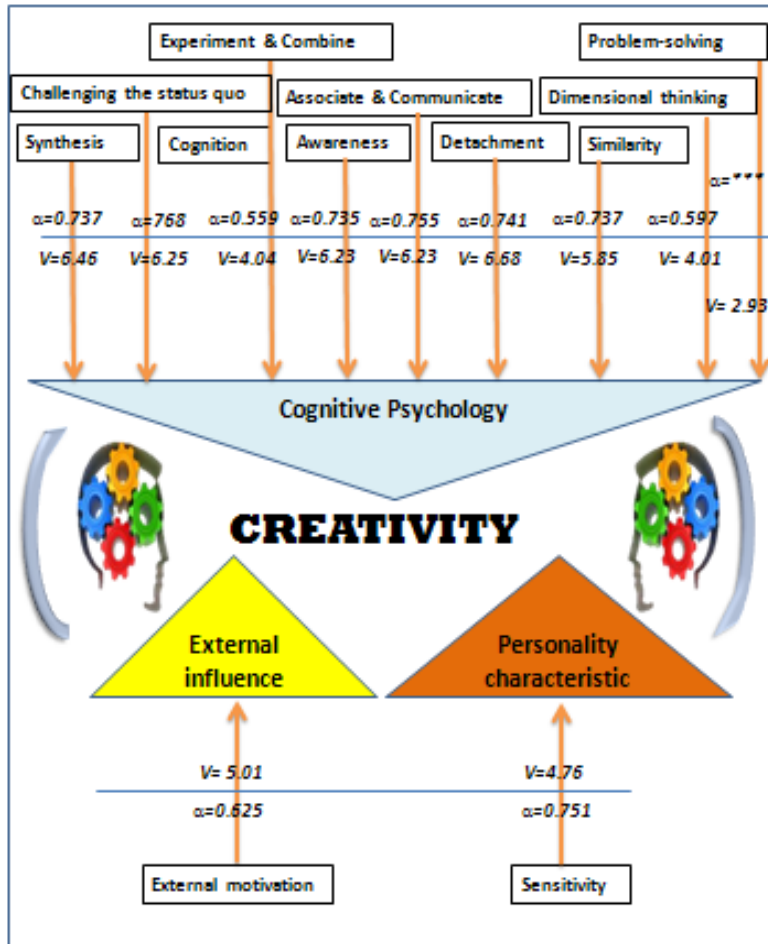
These factors can be grouped into two groups:

- Factors 1, 2, 3, 7, 9 fall into the cognitive psychology group
- Factors 4, 5, 6, 8 fall into the external influences group.
- No personality characteristics were specifically identified during the data analysis and exploratory factor analysis stages. External influences appeared to have a much greater impact on creativity in a general setting than personality characteristics.

5.4.2 Framework 2 (CF2)

This framework is an applied measuring framework for tertiary education and consists of twelve factors. This framework is illustrated in Figure 5.4.

FIGURE 5.4: FRAMEWORK 2 (CF2)



The framework illustrates the twelve factors and the variance per factor. According to this framework (CF2), twelve factors need to be measured to determine creativity for tertiary education. These factors are:

- Factor 1, *Challenging the status quo*, is the most important factor with a favourable variance of 7.72%. This factor points to an individual's willingness and motivation to challenge assumptions, to take initiative, to consider at the big picture, being creative

in an environment that tears down personal barriers to creative thinking and being motivated to be creative in his/ her own interest areas. Cronbach's coefficient alpha (α) is 0.753 and shows a satisfactory reliability coefficient.

- Factor 2, *Detachment*, is the second most important factor and explains a variance of 6.68%. Factor 2 points to the ability to separate processes, resources, objects and dimensions in an effort to be creative. Cronbach's coefficient alpha (α) is 0.741 and shows a satisfactory reliability coefficient.
- Factor 3, *Synthesis*, is the third most important factor and explains a variance of 6.46%. This factor points to the ability to combine processes and to look for uniqueness and similarity in processes to help find solutions or generate ideas, as well as the ability to combine concepts to find creative solutions. Cronbach's coefficient alpha (α) is 0.737 and shows a satisfactory reliability coefficient.
- Factor 4, *Cognition*, points to the ability to discover links and relationships by looking at different and at a variety of information sources, as well as the ability to cope with complexities when a problem needs to be solved. This factor explains a favourable variance of 6.25%. Cronbach's coefficient alpha (α) is 0.768 and shows a satisfactory reliability coefficient.
- Factor 5, *Associate and Communicate*, points to the ability to generate new ideas by looking actively for associations among concepts, the use of brainstorming to make associations, to propose new ideas regularly and the ability to persuade others that creative ideas generated are valuable. This factor explains a favourable variance of 6.23%. Cronbach's coefficient alpha (α) is 0.755 and shows a satisfactory reliability coefficient.
- Factor 6, *Awareness*, points to the ability to recognise gaps and contradictions in existing knowledge, to see different aspects of a problem and the ability to not get stuck on a set of rules to solve a problem. This factor also explains a variance of 6.23%. Cronbach's coefficient alpha (α) is 0.735 and shows a satisfactory reliability coefficient.
- Factor 7, *Similarity*, explains a variance of 5.85% and points to the ability to look for similarities in problems, solutions, patterns and concepts. Cronbach's coefficient alpha (α) is 0.737 and shows a satisfactory reliability coefficient.
- Factor 8, *External motivation*, points to the impact of external pressures and people to solve problems and to intentionally engage in unpopular ideas. This factor explains a

variance of 5.01%. Cronbach's coefficient alpha (α) is 0.625 which is marginally below the upper limit of 0.70 and above the lower limit of 0.57, and therefore, can be seen as satisfactory.

- Factor 9, *Sensitivity*, points to the sensitivity of a person to various aspects of a problem. This factor explains a variance of 4.76%. Cronbach's coefficient alpha (α) is 0.751 and shows a satisfactory reliability coefficient.
- Factor 10, *Experiment and Combine*, points to the ability to find the best creative solution by experimenting and combining objects. This factor explains a variance of 4.04%. Cronbach's coefficient alpha (α) is 0.559 which is marginally lower than the lower limit of 0.57 set by Cortina and therefore, this factor might not present itself in repeated research.
- Factor 11, *Dimensional Thinking*, points to the ability to consider the dimensionality of an issue to create ideas in terms of cost and time. The factor explains a variance of 4.01%. Cronbach's coefficient alpha (α) is 0.597 and shows an acceptable reliability coefficient slightly above the lower limit of 0.570.
- Factor 12, *Problem-solving*, points to random attempts to solve a difficult problem. The factor explains a variance of 2.93%. Cronbach's coefficient alpha (α) could not be calculated for this factor and this factor might therefore not be present in repeated studies.

These factors can be grouped into three groups:

- Factors 1, 2, 3, 4, 5, 6, 7, 10, 11, 12 fall into the cognitive psychology group. Tertiary education requires more cognitive processes therefore this is not surprising that more cognitive psychology factors were identified in the framework.
- Factor 8 falls into the external influences group. Motivation can be seen as a cognitive psychology influence as well, but the framework focuses on external motivation specifically and therefore the impact of the external environment on the creativity needs to be considered and measured.
- Factor 9 falls into the personality characteristics group.

Both frameworks have merit. It is important however to determine the most reliable and valid framework to measure creativity as part of this study. Before this can be done, the criteria for the comparative analysis need to be clarified.

5.5 RESEARCH METHODOLOGY

Phase one of this research study was to develop two conceptual frameworks to measure creativity. This entailed an extensive literature study with the aim to extract and select creativity influences and to identify measuring criteria for each of these influences. A total of twenty-eight creativity influences were identified from literature and grouped in two groups, namely cognitive psychology (eighteen influences) and personality characteristics (ten influences). These influences were then rated based on research support. Influences with the support of five or more researchers were then operationalized to form part of the research instruments (questionnaires). Based on this research, two questionnaires were constructed in an effort to identify factors and to create conceptual frameworks to measure creativity. The questionnaires consisted of a 7-point Likert scale to capture the various degrees of views of the respondents.

A total of 1000 questionnaires (500 to develop a conceptual framework at a *general setting* and 500 at a *tertiary educational level*) were distributed to undergraduate students from the North-West University in Potchefstroom (NWU). A total of 644 questionnaires (322 per each conceptual framework) were completed, signifying a response rate of 64.4%. Kaiser, Meyer and Olkin (KMO) analysis was used to determine if the sample employed were adequate for analysis.

Data was collected, analysed, purified and tested. The reliability measure, Cronbach alpha was used to test the reliability and internal stability of the two questionnaires. The data was subjected to a principle factor analysis using a Varimax, normalized rotation. The rotated factor matrix was used to identify the strength of the factor loadings per survey item and per underlying factor. The higher the factor loading the more strongly the specific item was associated with the corresponding factor. Data was purified by means of exploratory factor analysis. Low factor loadings or strongly dual-loadings on more than one factor were omitted from the measuring instrument. The variance was calculated to determine if the cumulative variance was favourable and if it signified a “good fit”. The Bartlett test of sphericity was employed to test the data’s suitability for factor analysis. Based on these findings, two conceptual frameworks (CF1 and CF2), as discussed in point 5.4, was developed.

The data was captured by the Statistical Consultation Services of the North-West University and analysed with the Social Package for Social Sciences Version 18 (SPSS, 2009).

Phase two of this research study and the primary objective of this article, is to compare the *general framework to measure creativity* (CF1) against an applied *measuring framework for tertiary education* (CF2) in order to determine which of the two frameworks best suit the measurement of creativity.

The comparative analysis used in this study followed the following steps:

- Step 1:** Comparing the identified factors and Pearson's correlation coefficient between the common factors;
- Step 2:** Comparing the cumulative variance explained by the factors and determining and comparing the goodness of fit measures for each framework;
- Step 3:** Comparing the points of inflection in the factors;
- Step 4:** Comparing the reliability of the factors (Cronbach Alpha); and
- Step 5:** Comparing the Kaiser, Meyer and Olkin (KMO) analysis and the Bartlett test of sphericity.

The results of the comparative analysis are discussed below.

5.6 RESULTS

5.6.1 Factor comparison

As part of this comparative study, a factor comparison was done and the identified factors are shown in Table 5.4 below.

TABLE 5.4: FACTORS IDENTIFIED

FACTOR NO.	CONCEPTUAL FRAMEWORK (CF1)		CONCEPTUAL FRAMEWORK (CF2)	
	FACTOR LABEL	% VARIANCE EXP	FACTOR LABEL	% VARIANCE EXP
1	Cognition and communication	15.46%	Challenging the status quo	7.72%
2	Problem-solving	10.79%	Detachment	6.68%
3	Dimensional thinking	10.06%	Synthesis	6.46%
4	Religion	7.55%	Cognition	6.25%
5	Country of origin	7.33%	Associate and communicate	6.23%
6	Culture	6.62%	Awareness	6.23%
7	Uniqueness	5.76%	Similarity	5.85%
8	Family	5.69%	External motivation	5.01%
9	Challenging the status quo	4.33%	Sensitivity	4.76%
10	***	***	Experiment and combine	4.04%
11	***	***	Dimensional thinking	4.01%
12	***	***	Problem-solving	2.93%
Cumulative variance explained (%)		73.59%		66.18%

*** Not identified

Closer comparative analyses of the factors were done to identify:

- *Pure factors* are factors that appear in both conceptual frameworks and showed a large similarity on the questionnaire statements regarding these factors;

- *Common factors* which are factors that appear to be common to both conceptual frameworks but the questionnaire statements are not largely similar; and
- *Study specific factors* which are factors that are unique to a specific conceptual framework.

5.6.1.1 Pure factors

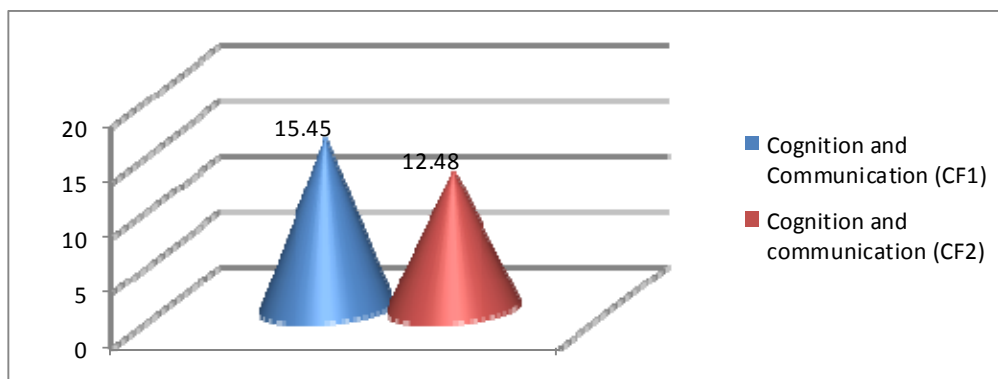
There are no pure factors that could be directly compared.

5.6.1.2 Common factors

There are four common factors between the frameworks. The comparative analyses of these factors are shown in Figures 5.5 to 5.8.

Figure 5.5 shows the variance explained by the factor *cognition and communication*.

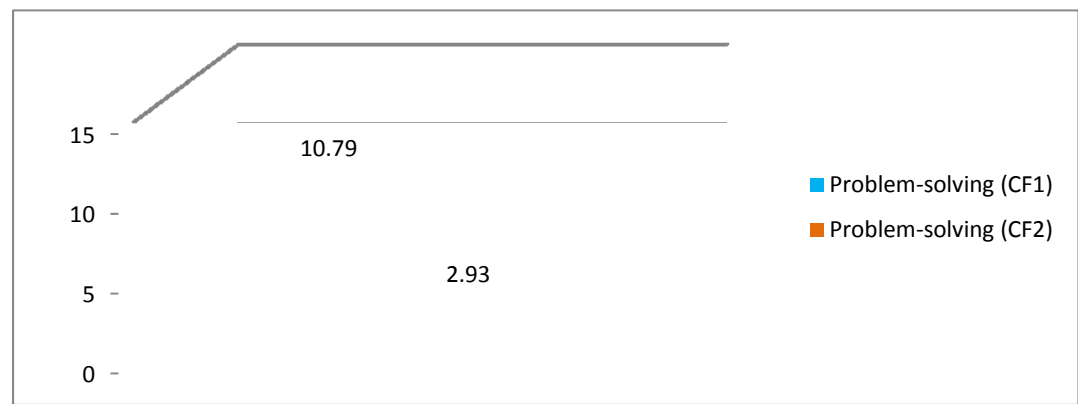
FIGURE 5.5: COGNITION AND COMMUNICATION



This factor's variance in the conceptual framework to measure creativity at a general level (CF1) is 15.45%. This factor also appears in the conceptual framework for tertiary education (CF2) and shows a variance of 6.25% for cognition specifically and 6.23% for communication (12.48% in total). A cumulative variance difference of 3.1% can be observed. Four questionnaire items in the amended questionnaires (CF1 and CF2) correspond, but four questionnaire items differ in CF1 and four questionnaire items in CF2. *Communication and cognition* is therefore a common factor and not a pure factor due to the fact that not all the questionnaire items correspond.

Figure 5.6 shows the variance explained by the factor *problem-solving*.

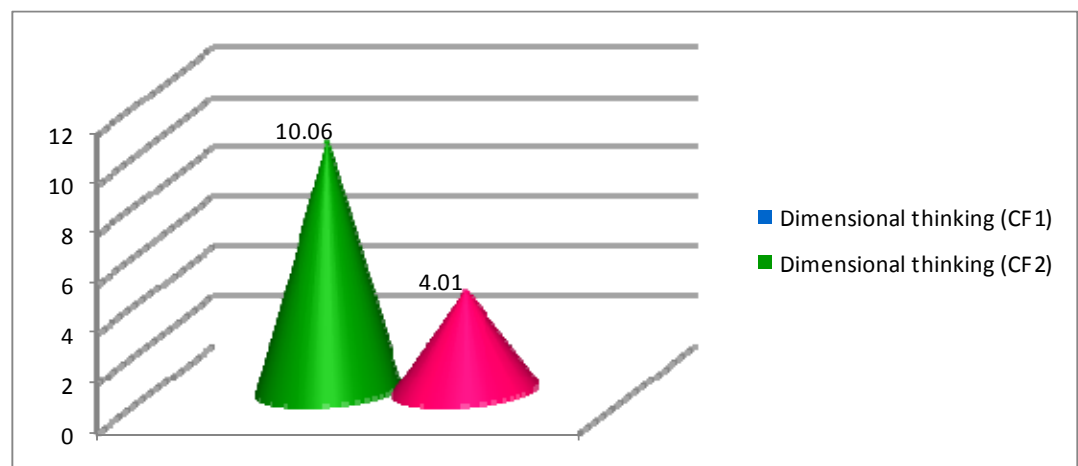
FIGURE 5.6: PROBLEM-SOLVING



This factor's variance in the conceptual framework to measure creativity at a general level (CF1) is 10.8%. This factor also appears in the conceptual framework for tertiary education (CF2) and shows a much lower variance of 2.9%. A cumulative variance difference of 7.9% can be observed. No questionnaire items in the amended questionnaires correspond. Five questionnaire items appear in CF1 and one questionnaire item in CF2 which differ from one another. *Problem-solving* is therefore a common factor and not a pure factor.

Figure 5.7 shows the variance explained by the factor *dimensional thinking*.

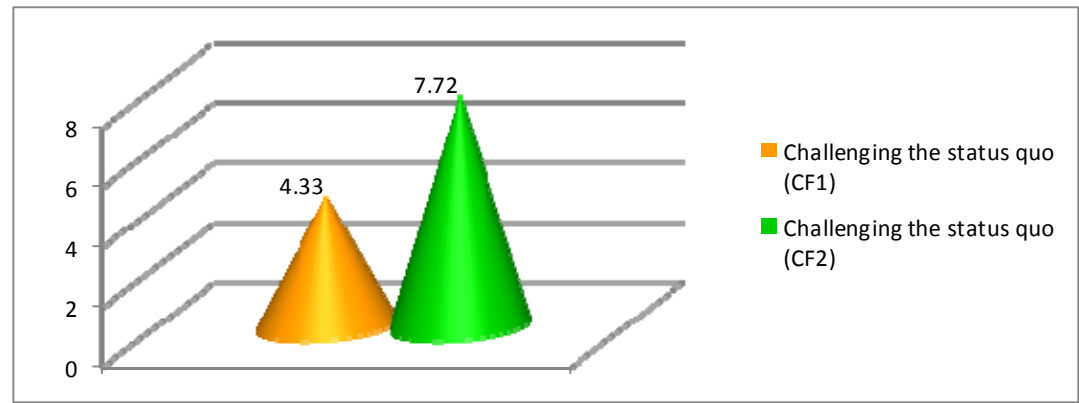
FIGURE 5.7: DIMENSIONAL THINKING



This factor’s variance in the conceptual framework to measure creativity at a general level is 10%. This factor also appears in the conceptual framework for tertiary education and shows a much lower variance of 4%. A cumulative variance difference of 6% can be observed. No questionnaire items in the amended questionnaires correspond. Four questionnaire items appear in CF1 and two questionnaire items in CF2 which differ from one another. *Dimensional thinking* is therefore a common factor and not a pure factor.

Figure 5.8 shows the variance explained by the factor *challenging the status quo*.

FIGURE 5.8: CHALLENGING THE STATUS QUO



This factor’s variance in the conceptual framework to measure creativity at a general level is 4%. This factor also appears in the conceptual framework for tertiary education and shows a much higher variance of 8%. A cumulative variance difference of 4% can be observed. No questionnaire items in the amended questionnaires correspond. One questionnaire item appear in CF1 and five questionnaire items in CF2 which differ from one another. *Challenging the status quo* is therefore a common factor and not a pure factor.

Table 5.4 shows the different factors as identified by each conceptual framework. There are no pure factors identified by this comparative study thus far. Only four factors are common factors.

Pearson correlation coefficient was used to compare the four common factors and the results are shown in Table 5.5 below.

TABLE 5.5: PEARSON CORRELATION COEFFICIENTS BETWEEN COMMON FACTORS

Factors	Cognition & Communication		Problem-solving		Dimensional thinking		Challenging the status quo	
Frameworks	CF1	CF2	CF1	CF2	CF1	CF2	CF1	CF2
Factor loadings	0.82	0.769	0.785	0.882	0.834	0.749	0.701	0.729
	0.814	0.728	0.778		0.834	0.662	-0.572	0.729
	0.76	0.715	0.768		0.755			0.674
	0.697	0.724	0.56		0.628			0.546
	0.68	0.636	0.491					0.528
	0.678	0.622						
	0.611	0.526						
	0.577	0.46						
r	0.927		no value		no value		no value	

From the table above, it is clear that only one of the common factors between CF1 and CF2 could be tested statistically for correlation due to dissimilarities within these factors. The factor Cognition and Communication shows a strong positive correlation of almost 0.93 between the two frameworks.

5.6.2 Cumulative variance explained by the factors and goodness-of-fit measures

From Table 5.1, it is evident that the conceptual framework to measure creativity at a general level (CF1) explains the most variance (almost 74%), while the conceptual framework to measure creativity at tertiary educational level (CF2) explained 66%.

It is important to note that the conceptual framework to measure creativity at a general level (CF1) is able to declare almost 74% of the variance by the factors that can be used to measure creativity. Resultantly, only 26% variance could not be explained to measure creativity. The conceptual framework to measure creativity at tertiary educational level (CF2) was able to declare 66% of variance by the factors that are used to measure creativity. Resultantly, 34%

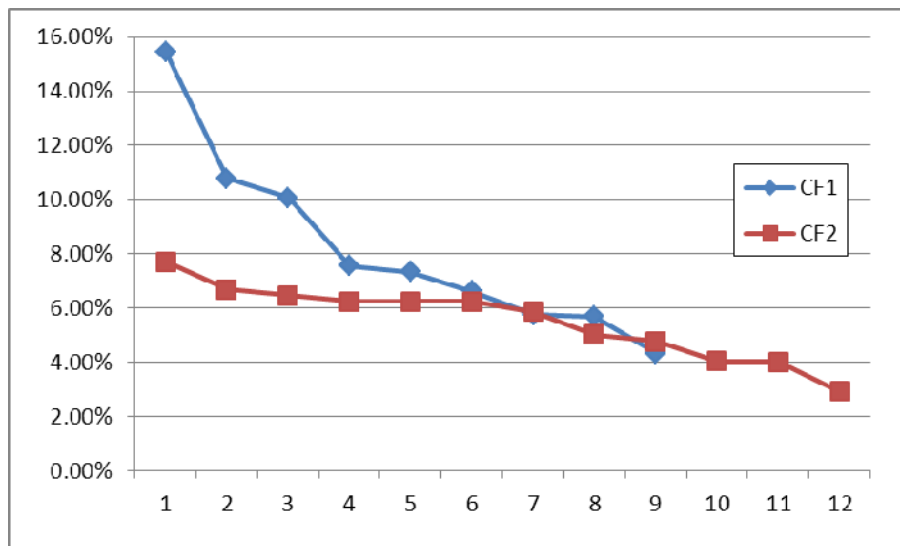
of variance cannot be explained by the factors. This comparison refers to the goodness-of-fit of the study and the data for both conceptual frameworks has a cumulative variance of more than 60% which is regarded to be satisfactory (Hair et al. in Haasbroek, 2008:53; Field, 2007:634; Field, 2002:7). Therefore, in this regard, the goodness-of-fit of the factor analysis of the conceptual framework to measure creativity at general level (CF1) is regarded to be good (74%), while the conceptual framework to measure creativity at tertiary educational level (CF2) is satisfactory (66%). There is only 8% difference between the cumulative variance which strengthens the view of goodness-of-fit.

Although both the frameworks exceed the required 60% goodness of fit measure with ease, CF1 clearly explains much more variance, and is, therefore, a better choice based on this criterion.

5.6.3 Point of inflection of factors

The point of inflection displays the distribution of variance explained by the factors, thus the more variance explained by the first factors could prove beneficial as the variance explained are more localised and less complicated to measure. The point of inflection is where the next factor explains almost the same variance as the one before, thus the marginal difference becomes negligible.

FIGURE 5.9: POINT OF INFLECTION



The analysis of the variance explained via the point of inflection shows that neither variance patterns reach the point of inflection. This means that none of the factors could be omitted from the analysis. CF1 explains much more of its variance at an early stage than CF2 does. In this regard, CF1 is a more suitable choice as measuring framework.

5.6.4 Reliability of the factors

Table 5.6 below compares the reliability of the factors identified in the two conceptual frameworks. Cronbach Alpha was used to determine the reliability of each factor.

TABLE 5.6: RELIABILITY OF FACTORS IN THE TWO CONCEPTUAL FRAMEWORKS

CONCEPTUAL FRAMEWORK (CF1)			CONCEPTUAL FRAMEWORK (CF2)		
FACTOR		CRONBACH ALPHA	FACTOR		CRONBACH ALPHA
1	Cognition and communication	0.858	1	Challenging the status quo	0.753
2	Problem-solving	0.635	2	Separate	0.741
3	Dimensional thinking	0.828	3	Synthesis	0.737
4	Religion	0.853	4	Cognition	0.768
5	Country of origin	0.740	5	Associate and communication	0.755
6	Culture	0.788	6	Awareness	0.735
7	Uniqueness	0.572	7	Similarity	0.737
8	Family	-1.071	8	External motivation	0.625
9	Challenging the status quo	-0.313	9	Sensitivity	0.751
			10	Experiment and combine	0.559
			11	Dimensional thinking	0.597
			12	Problem-solving	***

*** Not identified

Factors 1, 3, and 4-6 (in CF1) and factors 1-7, and 9 (in CF2) have satisfactory reliability coefficients in excess of the required 0.70 (Field, 2007:666; George & Mallery, 2003:231).

Factor 2 (in CF1) and factor 8 and 11 (in CF2) are below the set reliability coefficient of 0.70 as set by Field (2007:666), but above the lower limit of 0.57 set by Cortina (in Field, 2007:666) with an acceptable reliability coefficient of 0.64, 0.63 and 0.60, respectively.

Factor 7 (in CF1) and Factor 10 (in CF2) is marginally lower than Cortina with an acceptable reliability coefficient of 0.57 and 0.56 respectively. Schmitt (1996:350) indicates that satisfactory levels of relatively low reliability coefficients (e.g. 0.50) does not seriously reduce reliability as it depends on the test use and the interpretation, and as such, these marginal factors are retained for comparative reasons.

Factor 8 and 9 (in CF1) show a negative reliability coefficient and the data regarding these two factors is regarded as unreliable. There were no negative reliability coefficients in CF2. These two factors are thus omitted as they are less likely to present themselves in repeat studies.

This means that CF1 in reality consists of 7 and not 9 factors, and thus explains a reliable variance of 63.57% and not 73.59%. However, the fact remains that this variance still exceeds the required 60% goodness-of-fit measure, and does so with only 7 factors. In comparison, CF2 employs 12 reliable factors to explain 66.18% of the variance. Taking the number of factors in account, CF1 proves to be a better measuring framework, even with 2 unreliable and discarded factors.

5.6.5 KMO and Bartlett tests

In addition to the communalities and specific nature of the factors, the following comparisons were also made:

- KMO test of sampling adequacy;
- Bartlett's test of Sphericity.

Table 5.7 below compares the KMO and Bartlett tests of the two conceptual frameworks.

TABLE 5.7: COMPARISON OF KMO AND BARTLETT TESTS

APPLIED TEST	CONCEPTUAL FRAMEWORK (CF1)	CONCEPTUAL FRAMEWORK (CF2)
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	.751	.820
Bartlett's Test of Approx. Chi-Square Sphericity	3203.071	3859.429
Df	465	741
Sig.	.000	.000

Table 5.7 shows favourable Kaiser, Meyer and Olkin (KMO) and both conceptual frameworks had acceptable values higher than 0.70 (Field, 2007:666). CF1 had a value of 0.75 and CF2 had a value of 0.82. The favourable KMO indicated that the sample used was adequate in CF1 and CF2. The sample used in CF2 was, therefore, slightly more adequate (difference of 0.07) than the sample used in CF1.

The Bartlett's test of sphericity for both conceptual frameworks indicated that a factor analysis could be used for the data obtained as it remains below the 0.000 level (Field, 2002:431). CF1 had an approximate Chi-Square of 3202.071, the degrees of freedom (df) was 465 and significance (Sig.) was 000. CF2 had an approximate Chi-Square of 3859.429, the degrees of freedom (df) was 741 and significance (Sig.) was 000. CF2 was, however, slightly more suitable than CF1 for a factor analysis (difference of 656.358). Overall, both CF1 and CF2 were suitable for multivariate statistical analysis such as factor analysis.

Based on this comparison, both frameworks are highly acceptable, however, CF1 seems to be the better choice.

5.7 SELECTION OF CONCEPTUAL FRAMEWORK

The results from the comparative analysis is summarised in the table below.

TABLE 5.8: SUMMARY OF COMPARATIVE RESULTS

CRITERIA	CF1	CF2	SELECTED CF
Cumulative variance explained	73.59%	66.18%	CF1
Point of inflection	Steep curve	Flat curve	CF1
Number of factors	9	12	CF1
Reliability (Variance explained after omitting unreliable factors)	7 63.57%	12 66.18%	CF2
Number of factors to measure	7	12	CF1
KMO	Acceptable	Acceptable	No preference
Bartlett	Acceptable	Acceptable	No preference

Table 5.8 shows that although both conceptual frameworks performed well and could be employed to measure creativity in the tertiary education environment, CF1 is the better choice to do so.

5.8 CONCLUSIONS

From the analysis it can be concluded that:

1. This article focused on a comparative analysis of the two conceptual frameworks to measure creativity that was developed in the previous articles. The aim was to determine how strong the identified factors of these conceptual frameworks correlate and to determine how much these conceptual frameworks differ from one another. The primary objective was to identify the most reliable and valid conceptual framework to measure creativity at tertiary educational level.
2. A comparative factor analysis was done on the measuring instruments (CF1 and CF2) based on the % variance explained by each factor, and the cumulative variance explained was compared. CF1 had less factors but explained the most variance (almost 74%), while CF2 explained 66% of the variance. CF1 therefore has a better

‘good fit’ than (CF2) as it explains more variance with less factors. CF2 however has a satisfactory ‘goodness-of-fit’. The difference between the cumulative variance explained in CF1 and CF2 is 8%.

3. A closer comparative analysis indicated that there were no pure factors between CF1 and CF2. There were, however, four common factors – *cognition and communication*, *problem-solving*, *dimensional thinking* and *challenging the status quo*. The factor *cognition and communication* was the only factor that had questionnaire items that corresponded. The variance of cognition and communication was slightly higher in CF1 (15.5%) than CF2 (12.4%) and the cumulative variance difference was 3.1%. No questionnaire items corresponded in terms of problem-solving, dimensional thinking and challenging the status quo and the variances differed much more. The variance of *problem-solving* was higher in CF1 (10.8%) than CF2 (2.9%) and the cumulative variance difference was 7.9%. The variance of *dimensional thinking* was higher in CF1 (10%) than CF2 (4%) and the cumulative variance difference was 6%. The variance of *challenging the status quo* was higher in CF2 (8%) than CF1 (4%) and the cumulative variance difference was 4%.
4. Only one of the common factors between CF1 and CF2 could be tested for Pearson’s correlation. The factor *Cognition and Communication* shows a strong positive correlation of almost 0.93 between the two frameworks.
5. Five specific factors were identified in CF1 that do not appear in CF2 and explain a cumulative variance of 32.95%. These factors are *religion*, *country of origin*, *culture*, *uniqueness* and *family*.
6. Seven specific factors were identified in CF2 that do not appear in CF1 and explain a cumulative variance of 30.03%. These factors are *separate*, *synthesis*, *awareness*, *similarity*, *external motivation*, *sensitivity* and *experiment and combine*.
7. The Kaiser, Meyer and Olkin (KMO) measure indicated that the sample was adequate in CF1 and CF2. Both conceptual frameworks had acceptable values higher than 0.70. CF1 had a value of 0.751 and CF2 had a value of 0.820.
8. The Bartlett’s test of sphericity for both conceptual frameworks indicated that a factor analysis could be used for the data obtained. CF1 had an approximate Chi-Square of 3202.071, the degrees of freedom (df) was 465 and significance (Sig.) was 000. CF2 had an approximate Chi-Square of 3859.429, the degrees of freedom (df) was 741 and significance (Sig.) was 000. CF2 was therefore slightly more suitable than CF1 for a factor analysis (difference of 656.358).

9. The Cronbach Coefficient Alpha was used to test the reliability of the factors. The reliability for both conceptual frameworks was good. All the factors in CF2 had satisfactory reliability coefficients. In CF1, Factor 8 (Family) and 9 (Challenging the status quo) showed a negative reliability coefficient and the data regarding these two factors is regarded as unreliable.
10. It was concluded that both conceptual frameworks are different in their own right. Both conceptual frameworks showed a good fit. CF1, however, was viewed as having a better 'good fit' than (CF2) as it explains more variance with less factors. Both conceptual frameworks are reliable, unbiased and correlate only with their own factors. CF2, however, was viewed as slightly more reliable than CF1 due to the fact that no negative reliability coefficients were identified for the factors.

5.9 SUMMARY

A comparative analysis was used in this article to compare two conceptual frameworks in terms of the factors identified in each, to determine if these factors are pure, common or specific factors, to determine how strong the identified factors, mentioned above, correlate and to determine how much these conceptual frameworks differ from one another. The aim was to determine the variance and the reliability of these factors and to determine the 'goodness of fit' of the respective conceptual frameworks.

Based on the comparative analysis it was concluded that both conceptual frameworks are different in their own right. It is evident therefore that it remains a challenge to identify a standardised measure to measure creativity due to the various combinations of personal characteristics, cognitive processes and environmental settings needed to measure creativity at a general and tertiary educational level. The comparative study also indicated that the basic resources needed for creative thought, as identified by the confluence approach, are also evident in the two conceptual frameworks, although not all of these resources appear in each conceptual framework specifically. CF1 included external factors that influence creative potential and CF2 focused more on cognitive and thinking processes which are necessary at tertiary educational level. CF1 has a better 'good fit' than CF2 as it explains more variance with fewer factors. Both conceptual frameworks are reliable, unbiased and correlate only with their own factors. CF2 however was viewed as slightly more reliable than CF1 due to the fact that no negative reliability coefficients were identified for the factors. It can therefore be

concluded that CF2 has more merit to measure creativity at tertiary educational due to its focus on cognitive and thinking processes required at tertiary educational level.

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CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

This chapter contains the overall conclusions and recommendations of the study, as well as the limitations of the research and recommendations regarding future research. The focus of this study was largely to develop a reliable and valid conceptual framework to measure creativity at tertiary educational level based on a theoretical framework and understanding of the concept creativity. The search was conducted using a combination of a literature study and an empirical study. The literature study focused on creativity definitions, models, tests and tools to identify factors to measure creativity at a general (CF1) as well as at a tertiary educational level (CF2). Finally, the study offered a comparative analysis of the two conceptual frameworks that were developed to determine which measuring instrument is more suitable to measure creativity at a tertiary educational level. It was concluded that the conceptual framework to measure creativity at a tertiary educational level (CF2) has more merit to measure creativity at tertiary educational due to its focus on cognitive and thinking processes required at tertiary educational level.

In relation to the primary goal of this study, namely to develop a reliable and valid conceptual framework to measure creativity at tertiary educational level, the research objectives were to:

- Clarify the concept of creativity by performing an in-depth theoretical study thereof;
- Theoretically examine creativity research approaches since 1929 in an effort to determine how creativity can be measured;
- Extract and select creativity influences from literature;
- Identify measuring criteria for each creativity influence;
- Construct a measuring instrument from the literature to test creativity at a general and tertiary educational level;
- Purify the measuring instrument and determine the reliability of the data;
- Test the measuring instrument for validity;
- Compare the two conceptual frameworks by means of a comparative analysis; and to

- Recommend a valid and reliable conceptual framework to measure creativity at tertiary educational level.

These objectives were addressed via a series of articles and led to the formulation of two conceptual frameworks to measure creativity and finally to identify the most suitable conceptual framework that could be used to measure creativity at tertiary educational level specifically. The integrated results are discussed below and are based on the conceptual frameworks as shown in Figure 5.8 and Figure 5.9 in the previous chapter.

6.2 CONCEPTUAL FRAMEWORK TO MEASURE CREATIVITY AT TERTIARY EDUCATIONAL LEVEL

Figures 5.8 and 5.9 provide a comprehensive view of factors that contribute to measuring creativity. These factors were explored in detail in various articles in chapters 2 to 5.

The literature study was used to examine various definitions, models, tests and instruments to explore creativity and to identify influences to measure creativity. The influences identified in literature were then applied in the empirical research. The results of the empirical research were then combined to provide two conceptual frameworks to measure creativity.

6.2.1 Article 1

The first article provided a historical overview of some prominent process- and systems orientated models, as well as psychology-based approaches. The article analysed twenty five models between the period 1929 to 2009, the Hermann Brain Dominance Instrument (HBDI) and the Neethling Brain Instrument (NBITM) to provide a theoretical framework to understand creativity. The analysis showed that there is a link between the creative person, the creative process and the product of creativity which is an important starting point for measuring creativity. The article also showed that there are four levels of creativity which explains the complex nature of creativity. These levels are: personal (P-creativity) level, the historic/ societal (H-creativity) level, the organisational (O-creativity) level and the animal (A-creativity) level.

6.2.2 Article 2

This article identified key influences that were used to create a conceptual framework to measure creativity at a general level. A literature study was undertaken and followed by empirical research. A total of nine factors were identified to measure creativity at a general level. These factors are:

- Cognition and communication;
- Problem-solving;
- Dimensional thinking;
- Religion;
- Country of origin;
- Culture;
- Uniqueness; Family; and
- Challenging the status quo.

It became evident from the explained variance of each factor that *cognition and communication*, *problem-solving* and *dimensional thinking* are very important to measure creativity as it explained the highest variance of the nine factors (above 10%). The high factor loadings (which ranges from .908 to .425) for the first seven factors and the goodness-of-fit as depicted by the cumulative variance of the above factors (in excess of 70%) confirm the preceding findings. Although *family* and *challenging the status quo* had negative factor loadings for some statements, the variance was in excess of 4%.

6.2.3 Article 3

This article identified key influences that were used to create a conceptual framework to measure creativity at a tertiary educational level. A literature study was undertaken and followed by empirical research. A total of twelve factors were identified to measure creativity at tertiary educational level. These factors are:

- Challenging the status quo;
- Detachment;
- Synthesis;
- Cognition;

- Associate and communicate;
- Awareness;
- Similarity;
- External motivation;
- Sensitivity;
- Experiment and combine;
- Dimensional thinking; and
- Problem-solving.

It became evident from the explained variance of each factor that challenging the status quo and cognitive processes like detachment, synthesis, cognition, awareness and associate and communicate are very important to measure creativity as it explained the highest variance (above 6%). The high factor loadings (which ranges from .882 to .460) and the goodness-of-fit as depicted by the cumulative variance of all twelve factors (in excess of 60%) confirm the preceding findings.

6.2.4 Article 4

This is the final article of the study. The article focuses on the comparative study of the two conceptual frameworks to measure creativity developed in this study. The comparative analysis found that there are no pure factors and identified four common factors in the conceptual frameworks namely:

- Cognition and communication;
- Problem-solving;
- Dimensional thinking; and
- Challenging the status quo.

The results of this empirical study indicated that *cognition and communication* explained the highest variance (CF1 15.5% and CF2 12.4%) and that it was the only factor that had questionnaire statements that corresponded.

The Pearson correlation coefficient was used to compare the four common factors. Three factors showed a favourable correlation (between 0.88 to 0.65, respectively). Challenging the

status *quo* showed a low correlation due to the negative factor loading in the conceptual framework to measure creativity at a general level (CF1).

Five specific factors were identified in CF1 and explained a cumulative variance of 32.95%. Seven specific factors were identified in CF2 and explained a cumulative variance of 39.03%. These specific factors indicate that there is a difference between the two conceptual frameworks and unique factors were identified.

The conceptual framework to measure creativity at a general level (CF1) explains the most variance (almost 74%), while the conceptual framework to measure creativity at tertiary educational level (CF2) explained 66%. There is only 8% difference between the cumulative variance which strengthens the view of goodness-of-fit for both conceptual frameworks. CF1 has a better goodness-of-fit than CF2 due to explaining the most variance with the least factors.

CF1 had a KMO value of 0.75 and CF2 had a KMO value of 0.82. The favourable KMO indicated that the sample used was adequate in CF1 and CF2. The sample used in CF2 was, however, slightly more adequate (difference of 0.069) than the sample used in CF1.

The Bartlett's test of sphericity for both conceptual frameworks indicated that a factor analysis could be used for the data obtained as it remains below the 0.000 level. The suitability for multivariate statistical analysis such as factor analysis seems slightly more suitable (difference of 656.358) for CF2 than CF1.

Cronbach Alpha coefficient was used to determine the reliability of each factor in CF1 and CF2. The data used in CF1 and CF2 is reliable. Due to the fact that CF2 had no negative reliability coefficients, CF2 can be viewed as more reliable than CF1.

6.3 CONCLUSIONS

The conclusions and recommendations are formulated in numerical order under the research methodology. This means that *Recommendation 1* relates to the conclusion drawn in *Conclusion 1*. This order changes under results due to the fact that the two conceptual

frameworks have specific conclusions, but similar recommendations. The respective conclusion and recommendation will be indicated under results.

6.3.1 Research methodology

The research methods and statistical analysis utilised in all four articles of this study were appropriate and the results yielded were tested for validity by the Statistical Consultation Services at the North-West University. The discussion that follows substantiates why the research methodology was effective.

CONCLUSION 1:

Firstly, an extensive literature study provided the theoretical base for the development and execution of the study (as in the case of the four articles). The literature study provided an in-depth understanding of the research problem and provided the theoretical framework and understanding of the concept creativity.

CONCLUSION 2:

The literature study and research theory were used to aid in the construction of two measuring instruments (questionnaires) in an effort to identify factors that could be used to measure creativity. The literature study proved invaluable to assist in identifying various items which needed to be measured. Research theory guided the researcher towards better understanding the scientific use and analysis of the data, as well as the structure of the questionnaires. It is concluded that the use of literature and research theory is imperative in empirical research and the scientific application of a questionnaire.

CONCLUSION 3:

The statistical analysis revealed that the identified creativity influences (grouped in cognitive psychology and personality characteristics) (see Figure 3.1 and Figure 4.2) could be validated. The factor analysis either confirmed the influence and its measuring items, or identified sub-factors within the construct. In all cases relative importance was calculated (variance explained and factor loadings), while reliability (Cronbach Alpha), suitability for multivariate analysis (Bartlett) and sample adequacy (Kaiser, Meyer and Olkin) added to conclude that the research instruments compiled from the literature provided two valid questionnaires. Specifically, the empirical validation of the data consisted of:

1. The Kaiser-Meyer-Olkin (KMO) values in this study indicated that the sample size was appropriate and adequate. Therefore, a factor analysis for this particular sample size was suitable to determine the validity of the results.
2. The Bartlett's test of sphericity was appropriate for this study as it yielded p-values smaller than 0.000. This test concluded that the correlation between the variables was sufficient for factor analysis and the strength of the relationship among variables is strong.
3. Cronbach Alpha coefficients were calculated for each factor. The results indicated a moderate to high degree of reliability and internal consistency amongst the items. The implication of this is that the results were not only reliable but appropriate to use this test in similar studies undertaken. It can be concluded that the questionnaire and the data is reliable and valid.

CONCLUSION 4:

The sample that was selected and the eventual gathering of the data for the study which was in the form of two questionnaires proved effective (see Chapter 1: Research methodology). The data collection allowed for the collection of data from the tertiary educational sector in South Africa (population).

The sample (undergraduate students at the NWU Potchefstroom Campus) was statistically proven to be adequate by the KMO analysis. It is thus concluded that this method of data gathering methodology is successful.

CONCLUSION 5:

The use of a statistical analysis programme (SPSS Version 18), consultation with a statistical specialist and invaluable advice throughout the study (from design to final results) by a professional statistician at the Statistical Consultation Services of the North-West University, enhanced the confidence and security that the advanced statistical calculations and the interpretation thereof are correct. The specialised statistical software added much value to the research process.

6.3.2 Results

6.3.2.1 Conceptual framework to measure creativity at a general level (CF1)

With regard to the results the following conclusions can be made regarding the *conceptual framework to measure creativity at a general level (CF1)*:

CONCLUSION 6:

Based on research support and after the operationalisation process, only 9 influences consisting of 51 items relating to these influences were identified to be used in the measuring instrument to measure creativity at a general level. The measuring instrument was then purified by employing various statistical tests. The variance explained indicated that the measuring tool to measure creativity at general level was able to explain more than 70% of the items that measure creativity, and as such the retained items could be regarded to be valid in measuring what they are intended to measure and is regarded to a “good fit to the data”.

CONCLUSION 7:

The factor analysis identified 9 factors and retained 29 items of the original 51 items. These factors are *Cognition and communication, Problem-solving, Dimensional thinking, Religion, Country of origin, Culture, Uniqueness, Family and Breaking the status quo*. These factors were used to create an amended conceptual framework and questionnaire items. These 9 factors explained a cumulative variance of 73% which exceeds the required 60% to represent a good fit to the data.

6.3.2.2 Conceptual framework to measure creativity at a tertiary educational level (CF2)

With regard to the results the following conclusions can be made regarding the *conceptual framework to measure creativity at a tertiary educational level (CF2)*:

CONCLUSION 8:

In addition, based on research support and after the operationalisation process, only 11 influences consisting of 73 items relating to these influences were identified to be used in the measuring instrument to measure creativity at a tertiary educational level. The measuring instrument was then purified by employing various statistical tests. The variance explained

indicated that the measuring tool to measure creativity at tertiary educational level was able to explain more than 60% of the items that measure creativity, and as such the retained items could be regarded to be valid in measuring what they are intended to measure and is regarded to be a “good fit to the data”. Note that Recommendation 6 is applicable to this conclusion.

CONCLUSION 9:

The factor analysis identified 12 factors and retained 39 items of the original 73 items. These factors are *Challenging the status quo*, *Detachment*, *Synthesis*, *Cognition*, *Associate and Communicate*, *Awareness*, *Similarity*, *External motivation*, *Sensitivity*, *Experiment and Combine*, *Dimensional Thinking* and *Problem-solving*. These factors were used to create an amended conceptual framework and questionnaire items. These 12 factors explained a cumulative variance of 66% which exceeds the required 60% to represent a good fit to the data. Note that Recommendation 7 is applicable to this conclusion.

6.3.2.3 Conceptual frameworks CF1 and CF2

With regard to the results the following conclusions can be made regarding the *both conceptual frameworks (CF1 and CF2)*:

CONCLUSION 10:

Almost all the factors are reliable and should present itself in similar studies. In CF1, Factor 8 (Family) and 9 (Challenging the status quo) showed a negative reliability coefficient and the data regarding these two factors is regarded as unreliable. It is thus concluded that, apart from these two factors, the results obtained from the analysis could be regarded as reliable. Note that Recommendation 8 is applicable to this conclusion.

CONCLUSION 11:

The core of the research, as summarised by Figure 6.1 and Figure 6.2, provides a visual representation of the newly created conceptual frameworks to measure creativity. Figure 6.2 is however the most suitable conceptual framework to measure creativity at a tertiary educational level due to its focus on cognitive processes which are critical in education. Note that recommendation 9 is applicable to this conclusion.

6.4 RECOMMENDATIONS

The recommendations follow the numerical indicators as per the conclusions. These should be interpreted with the matching conclusion in mind.

6.4.1 Research methodology

Unless otherwise referred to, the numbers of the conclusions refer to the numbers of the recommendations. This means that, for example, that Recommendation 1 is made based on Conclusion 1.

RECOMMENDATION 1:

An extensive literature study is invaluable as it provides the solid theoretical base and understanding of the research problem and phenomenon necessary in this thesis. It is recommended that the same research methodology is adopted by future researchers as it sets the scene for scientific founded research to follow in the case of an article-format research document (such as a doctoral or master's thesis or dissertation).

RECOMMENDATION 2:

The success of the questionnaires employed and researched by means of a literature study is evident from the statistical analysis thereof. As such, the use of theory to create and analyse a measuring instrument is highly recommended. This approach assisted greatly in better understanding and analysing the questionnaires that were employed in this study.

RECOMMENDATION 3:

The fact that the statistical analysis empirically tested and confirmed the two questionnaires to be a scientific data-gathering tool to measure creativity, leads to the following recommendations:

1. Questionnaires should be strongly based on theory, as it provides both structure and content;
2. The 7-point Likert-scale proved to be a valuable rating scale; and
3. The statistical techniques employed are a scientific method to determine the reliability of the data and validity of the sample.

RECOMMENDATION 4:

The correct sampling method and sample size are very important to gather useful data and the recommendation is that:

1. Convenience sampling as data collection methodology (as employed in this research) can be used to collect data successfully and can assist to overcome possible financial and time constraints that researchers are often subjected to; and
2. Sample adequacy should be statistically confirmed by means of the Kaiser, Meyer and Olkin test for sample adequacy.

RECOMMENDATION 5:

It is highly recommended that future researchers make use of a specialised statistical software package and an expert in statistical analysis to ensure accurate analysis of data and to safeguard the research against flaws that may slip into the empirical research.

6.4.2 Results

With regard to the results the following recommendations can be made:

RECOMMENDATION 6:

In dealing with the influences (constructs) of a phenomenon, it is important to determine each one's significance and order of importance. As such, it is recommended that:

1. A measuring instrument should be purified to employing various statistical tests, improve the cumulative variance and indicates a goodness-of-fit; and
2. Recognise that each influence is important and the only difference is that some are more important than others and to decide which will be used in the study.

RECOMMENDATION 7:

A factor analysis is very useful to identify interrelationships among variables to discover if those variables can be grouped into a smaller set of underlying factors. This method was specifically successful to develop conceptual frameworks to measure creativity. It is recommended that a factor analysis is adopted by future researchers to identify specific factors to be used to create a measurement tool and is specifically helpful in the case of an article-format research document (such as a doctoral or master's thesis or dissertation).

RECOMMENDATION 8

Refer to Recommendation 6 because the recommendation for this conclusion is similar to the one made in Recommendation 6.

RECOMMENDATION 9

Refer to Recommendation 7 because the recommendation for this conclusion is similar to the one made in Recommendation 7.

RECOMMENDATION 10

Although most influences and factors have high reliability coefficients, two of them do not have satisfactory reliability (CF1's Factor 8 (Family) and 9 (Challenging the status quo)). It is recommended that these two factors be the last to use in measuring creativity as these are less likely to present themselves as influences in future analyses.

RECOMMENDATION 11:

The final recommendation is that the conceptual framework (CF2) be:

1. employed as a tool to measure creativity at tertiary educational level;
2. put to practical use in addressing the development of creative potential at tertiary educational level (measuring creative potential at enrolment and at graduation to serve as guide and further development);
3. assist in the designing and introduction of creativity education and creative ways of teaching and developing creative skills; and
4. the focus of further research.

6.4.3 General observations and recommendations

Tertiary educational institutions and government do not focus enough on measuring and developing creative potential in South Africa. Policies regarding the need to develop and measure creative potential in South Africans need to become a prominent debate at government and tertiary educational institutions levels to ensure that South African meet the global and knowledge economy demands. This would, in reality, signal a paradigm shift in addressing the importance of creativity and specifically, creativity at tertiary educational

level, which has already taken place in a number of countries (for example, China and European countries).

Hence, the following general recommendations are made:

1. Emphasis should be placed on measuring and developing creativity at all levels of society and all levels of education (for example, from pre-school to tertiary educational level);
2. Progress in creativity development should be measured and monitored to determine the nation's Creativity Quotient (CQ) every five to ten years;
3. The implementation of national awareness campaigns should be considered to highlight the importance and benefits of creativity and overcome the myths of creativity in society (for example, a South African Year (or month) of Creativity and Innovation);
4. The implementation of more South African forums, associations and conferences focusing on creativity and innovation should be considered to create awareness, discussion and further research (for example, more exposure should be given to the International Creativity Conference in SA and South African Creativity Foundation, and possibly the South African Association for Creativity & Innovation should be created);

6.5 AREAS FOR FUTURE RESEARCH

The following areas have been identified for future research:

1. Further development of the measuring instrument should focus on testing the framework at various tertiary educational institutions (through surveying, interviewing and focus groups) to compare results and the importance of the identified factors;
2. Based on the results in point 1, an interpretation component to the framework should be developed. The development of an interpretation component will help students to identify strengths and weaknesses. It will also help educators to assist students practically to develop creative problem-solving skills in various disciplines;
3. The interpretation component should be easy to implement and provide practical advice to help students to develop creativity skills; and

4. The tool should be tested, amended and applied to existing and potential entrepreneurs to enhance creative ideas and the identification of business opportunities as this could enhance the competitive environment in a knowledge-based economy and create more jobs in South Africa; and
5. The tool should be tested and applied in various business settings and at various levels in organisations to help organisations to meet the demands of the complex and demanding global business environment. The instrument should be used to measure and develop the creative potential of employees and utilise the human capital in organisations.

Although various other areas of research are probable, the hope is expressed that this serves as a point of departure in measuring creativity at tertiary educational level and that it allows for future studies in other countries.

6.6 SUMMARY

This study analysed creativity as phenomenon and the measurement of creativity at a general and tertiary educational level. The study was performed in article format and dealt with the sub-topics as scientific articles ready for publication in scientific journals. The overall aim of this study is to make a useful scientific contribution and to add to the body of knowledge in creativity research and the educational sector specifically. The study consists of four articles.

Chapter 2: Article 1

The objective of the first article was to provide a theoretical framework to understand the concept of creativity. The theoretical framework consisted of defining creativity and examining the historical development, levels of creativity and research approaches of creativity. The article also examined how creativity can be measured, research models to measure creativity and two methods to measure creativity, namely on a general level and on a tertiary educational level. The article set the scene for better analysis and interpretation of the other articles that followed.

Chapter 3: Article 2

The objective of the second article was to provide a reliable and valid conceptual framework to measure creativity in a general application setting.

This article focused on creativity research (models and approaches) to extract creativity influences to be used as measuring criteria for creativity. Based on the literature study, twenty-eight creativity influences were initially identified and grouped in two groups, namely cognitive psychology and personality characteristics. Eighteen influences were identified in the cognitive psychology group and ten in the personality characteristics group. Based on research support, only 9 influences consisting of 51 items relating to these influences were identified to be used in the measuring instrument after the operationalisation process.

The factor analysis identified 9 factors and retained 29 items of the original items. These factors are *Cognition and communication*, *Problem-solving*, *Dimensional thinking*, *Religion*, *Country of origin*, *Culture*, *Uniqueness*, *Family* and *Challenging the status quo*. These factors were used to create an amended conceptual framework and questionnaire items. These 9 factors explained a cumulative variance of 73% which exceeds the required 60% to represent a good fit to the data.

Chapter 4: Article 3

The objective of the third article was to provide a reliable and valid conceptual framework to measure creativity at tertiary educational level.

This article aims to explain the importance and challenges of creativity and creativity measurement at tertiary educational level. The literature study focused on creativity research and approaches, as well as common indicators and barriers to creativity measurement at tertiary educational level. Based on the literature study, twenty-eight creativity influences were initially identified and grouped in two groups, namely cognitive psychology and personality characteristics. Eighteen influences were identified in the cognitive psychology group and ten in the personality characteristics group. Based on research support, only 11 influences consisting of 73 items relating to these influences were identified to be used in the measuring instrument after the operationalisation process.

Twelve factors were identified and 39 items in point 6. These factors are: *Challenging the status quo*, *Detachment*, *Synthesis*, *Cognition*, *Associate and Communicate*, *Awareness*, *Similarity*, *External motivation*, *Sensitivity*, *experiment and Combine*, *Dimensional Thinking* and *Problem-solving*. These factors were used to create an amended conceptual framework and

questionnaire items. These 12 factors explained a cumulative variance of 66% which exceeds the required 60% to represent a good fit to the data.

Chapter 5: Article 4

The objective of the final article was to make a comparative study of the two conceptual frameworks which were developed in this study. A comparative factor analysis consisted of the following:

- A comparison based on the % variance explained by each factor and the cumulative variance explained. The conceptual framework to measure creativity at a general level (CF1) had less factors but explained the most variance (almost 74%), while the conceptual framework to measure creativity at tertiary educational level (CF2) explained 66% of the variance. CF1 therefore has a better ‘good fit’ than (CF2) as it explains more variance with fewer factors. CF2 however has a satisfactory ‘goodness of fit’.
- A closer comparative analysis that indicated that there were no pure factors between CF1 and CF2. There were, however, four common factors – *cognition and communication, problem-solving, dimensional thinking and challenging the status quo*. Pearson correlation coefficients were used to compare these common factors and three had favourable results, namely *cognition and communication, problem-solving and dimensional thinking*. Only *challenging the status quo* in CF1 had an unfavourable correlation of 0.06.
- A comparison of specific factors which indicated that five specific factors were identified in CF1 that do not appear in CF2 and explain a cumulative variance of 32.95%. These factors are *religion, country of origin, culture, uniqueness and family*. Seven specific factors were identified in CF2 that do not appear in CF1 and explain a cumulative variance of 30.03%. These factors are detachment, synthesis, awareness, similarity, external motivation, sensitivity and experiment and combine.
- The Kaiser, Meyer and Olkin (KMO) comparison indicated that the sample was adequate in CF1 and CF2. CF2 had a higher value than CF1 which was 0.820.
- The Bartlett’s test of sphericity comparison indicated that a factor analysis was suitable to obtain data for both conceptual frameworks. CF2 was, however, slightly more suitable than CF1 for a factor analysis (difference of 656.358).

- The Cronbach Coefficient Alpha comparison showed that all the factors in CF2 had satisfactory reliability coefficients. In CF1, Factor 8 (Family) and 9 (Challenging the status quo) showed a negative reliability coefficient and the data regarding these two factors is regarded as unreliable.
- It was concluded that both conceptual frameworks are different in their own right. Both conceptual frameworks showed a good fit. CF2, however, was viewed as most suitable to measure creativity at tertiary educational level due to the factors focusing on cognitive processes which are critical in higher education.

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APPENDIX A

Creativity Models and Theories

Year	Researcher/s	Model	Phases of creativity	Type of model (Process or systems orientated)	Sources
1926	Graham Wallas seen as the pioneer in creativity research	Wallas model for the process of creativity	Consists of four phases: 1) Preparation (definition of issue, observation and study) 2) Incubation (laying the issue aside for a time) 3) Illumination (the moment when a new idea finally emerges) 4) Verification (checking it out)	Process orientated model	Plsek (1996:3); Daneshy (no date:2)
1931	Rossman	Rossman's creativity model	Consists of seven phases: 1) Observation of a need or difficulty 2) Analysis of the need 3) A survey of all available information 4) A formulation of all objective solutions 5) A critical analysis of these solutions for their advantages and disadvantages 6) The birth of the new idea – the invention 7) Experimentation to test out the most promising solution, and the selection and perfection of the final embodiment	Process orientated model	Plsek (1996:3, 6); Daneshy (no date:2); Bergh & Theron (2009:124); Forex (2010:1)
1950	Joy Paul Guilford	Guilford's concept of Divergent Thinking	Model indicated that divergent thinking has four characteristics, namely: 1) Fluency (the ability to produce great number of ideas or problem solutions in a short period of time); 2) Flexibility (the ability to simultaneously propose a variety of approaches to a specific problem); 3) Originality (the ability to produce new, original ideas); 4) Elaboration (the ability to systematize and	Process orientated model	Forex (2010:1), Creative Creativity (2007:1), Plsek (1996:3-4), Bergh & Theron (2009:124, 141), Runco (2007:95, 402)

			organise the details of an idea in a head and carry it out). Guilford constructed several tests to measure creativity in 1967: 1) Plot titles 2) Quick responses 3) Figure concepts 4) Unusual uses 5) Remote associations 6) Remote consequences		
1953	Alex Osborn	Seven-step model to creative thinking	Consists of seven steps: 1) Orientation: pointing up the problem 2) Preparation: gathering pertinent data 3) Analysis: breaking down the relevant material 4) Ideation: piling up alternatives by way of ideas 5) Incubation: letting up, to invite illumination 6) Synthesis: putting the pieces together 7) Evaluation: judging the resulting idea	Process orientated model	Plsek (1996:3-4,6); Davis (1998:1); Bergh & Theron (2009:115, 414); Daneshy (no date:2); Forex (2010:1); James, Gerard & Vagt-Traore (2004:3); Runco (2007:402); Vilalba (2008:13)
1961	Mel Rhodes	Four P's to creativity	The model is used to explain: 1. What the actors in the creative process do (Process) in each phase; 2. What they think and feel (Person) in each phase; 3. What they generate at each phase (Product); and 4. How the organisational environment impacts on them (Press) in each phase.	Systems orientated model	Runco (2007:315); Brunn (2009:2); Bergh & Theron (2009:415); Cropley (2008: 262, 264); Scritchfield (1999:1); Hanna (2008:1)
1966	Ellis Paul Torrance	Torrance Tests on Creative Thinking (TTCT)	Model involves simple tests of divergent thinking and other problem-solving skills, which were scored on four scales: 1) Fluency – the total number of interpretable, meaningful and relevant ideas generated in response to the stimulus. 2) Flexibility – the number of different categories of relevant responses	Process orientated model	Forex (2010:1), Creative Creativity (2007:1), Plsek (1996:3-4), Bergh & Theron (2009:414); Villalba (2008:17)

			3) Originality – the statistical rarity of the responses 4) Elaboration – the amount of detail in the responses		
1981	Kolberg and Bagnall	Kolberg and Bagnall's universal traveller model	Consists of seven phases: 1) Accept the situation (as a challenge) 2) Analyse (to discover the “world of the problem”) 3) Define (the main issues and goals) 4) Ideate (to generate options) 5) Select (to choose among options) 6) Implement (to give physical form to the idea) 7) Evaluate (to review and plan again)	Process orientated model	Plsek (1996:4); Sharma (2004:333)
1983	Amabile	Amabile's Model	Model indicates that creativity is “culturally and historically bound”. The relevant factors working together are: 1) Domain relevant skills (or expertise) can be considered as the basis for any performance in a given domain. This component includes factual knowledge, technical skills and special talents in the domain in question; 2) Creative thinking skills include cognitive style, application of heuristics for the exploration of new cognitive pathways, and working style; and 3) Task motivation that includes motivational variables that determine an individual's approach to a given task.	Systems orientated model	Baer & Kaufman (2005:4-6), Bergh & Theron (2009:414), Runco (2007:403)
1985	Bandrowski	Model for creative strategic planning	Consists of five phases: 1) Analysis (standard planning; insight development) 2) Creativity (creative leaps; strategic connections) 3) Judgement (concept building; critical judgement) 4) Planning (action planning; creative contingency planning) 5) Action (flexible implementation; monitoring	Process orientated model	Plsek (1996:5)

			results)		
1985, 1992	Parnes, Isaksen and Trefflinger	Creative problem-solving (CPS) model	Consists of six phases: 1) Objective finding 2) Fact finding 3) Problem finding 4) Idea finding 5) Solution finding 6) Acceptance finding	Process orientated model	Kotelnikov (2010:1)
1988	Barron	Barron psychic creation model	Consists of four phases: 1) Conception (in a prepared mind) 2) Gestation (time, intricately coordinated) 3) Parturation (suffering to be born, emergence of light) 4) Bringing up the baby (further period of development)	Process orientated model	Plsek (1996:1-2)
1989	Kirton	Adaptors versus Innovators	Two types of creative people: 1) Adaptors are people who seek to solve problems by making use of what they already know and can do. 2) Innovators are people who try to re-organise and restructure the problem Five psychological characteristics affects creativity in individuals: 1) Originality (cognition) 2) Conformity (social) 3) Efficiency (cognition) 4) Risk-taking (motivation) 5) Self-confidence (personality)	Process orientated model	Mudd (1996:1)
1991	Fritz	Model for the process for creation	Consists of eight phases: 1) Conception 2) Vision 3) Current reality 4) Take action 5) Adjust, learn, evaluate, adjust 6) Building momentum 7) Completion 8) Living with your creation	Process orientated model	Plsek (1996:6)
1995-1996	Sternberg & Lubart	Sternberg & Lubart's Systems Orientated	Six distinct but interrelated resources that contribute to creativity:	Systems orientated model	Forex (2010:1), Creative Creativity (2007:1), Runco

		Model	1) Intellectual processes; 2) Knowledge; 3) Intellectual styles; 4) Personality; 5) Motivation; and 6) Environmental context. Four critical elements in thinking styles and the assumption is that some styles are more conducive to creativity than others: 1) Legislative (invent rules) versus executive (follow rules) 2) Conservative (old approaches) versus liberal (new approaches) 3) Global (general aspects) versus local (detail-oriented) 4) Monarchic style (sequential completion)		(2007:95); James, Gerard & Vagt-Traore (2004:5), Bergh & Theron (2009:116, 414), Vilalba (2008:13),
1996	Plsek	Directed Creativity Cycle	Consists of a four phase cycle: 1) Preparation 2) Imagination 3) Development 4) Action	Process orientated model	Plsek (1996:6); Bergh & Theron (2009:115, 414), Runco (2007:95); Daneshy (no date:2)
1996, 1999	Csikszentmihalyi	Csikszentmihalyi' Model	Creativity is seen as a social construct that is the result of an "interaction between the producer and the audience". Model consists of three components: 1) The individual (personal background) draws information in a domain and transforms or extends it via cognitive processes, personality traits, and motivation; 2) The field (society) consists of people who control or influence a domain and evaluates and selects new ideas; and 3) The domain (culture) is a culturally defined symbol system which preserves and transmits creative products to other individuals and future generations	Systems orientated model	Brunn (2009:2), Bergh & Theron (2009:114, 415), Runco (2007:396, 403), Csikszentmihalyi (1999:314)
2000	Min Basadur	Creative Problem Solving Profile (CPSP) Inventory,	Measures an individual's unique blend of preferences for the four stages of the creative process:	Systems orientated model	Basadur (2007:1)

		also called the 'New Mental Model'	1) Generating 2) Conceptualizing 3) Optimizing 4) Implementing It is a tool to help an individual, team or organization understand how to increase creativity and innovation in a supportive environment. No one profile, or style, is considered more "creative" than any other. All styles require creativity, merely different kinds of creativity, each one contributing uniquely to the overall creative process and innovative results.		
2001	Unsworth	Unsworth's Model of Creativity Tasks	Four kinds of creativity: 1) Responsive Creativity – person is driven by external pressure to solve problems defined by other people 2) Expected Creativity – a person is motivated by external pressure to solve self-discovered problems 3) Contributory Creativity – a person is self-motivated but the problem is defined externally 4) Proactive Creativity – a person is self-motivated to solve self-defined problems	Systems orientated model	Unsworth (2001: 289-297), Runco (2007:403)
2002	Florida	Florida's Creativity Index	Creativity is the “ultimate economic resource”, because creative people are attracted to places that are characterised by a “culture that’s open-minded and diverse” which ultimately turn into economic value. The characteristics of these places are: 1) Technology 2) Tolerance 3) Talent The 3T's represent economic development and the approach represents a comprehensive strategy for organizations, cities, regions and countries to compete and prosper in the creative age	Systems orientated model	Florida (2010:1); Brunn (2009:2); Bergh & Theron (2009:114, 415); Runco (2007:396, 403); Vilalba (2008:20-21); Baer & Kaufman (2005:4-6)
2003	Mark Runco	Parsimonious	1) Creativity Potential	Systems orientated	Sharma (2004:335); Baer &

		Creativity Model (Based on Rhodes' 4 P's)	- Person – personality traits, characteristics - Process – cognitive, social, historical - Press (climate & environmental influences) – digical and immediate 2) Creative Performance - Products – inventions, patents, publications, ideas - Persuasion – systems (individual – field – domain) 3) Interactions – person x environment x state x trait	model	Kaufman (2005:4-6); Runco (2007:315); Bergh & Theron (2009:116, 414); Creative Creativity (2007:1); Forex (2010:1); Basadur & Gelade (no date:8)
2003	Luecke and Katz's	Luecke and Katz's Innovation Model	Two stages in the process of innovation: 1) Invention that are mainly creative 2) Exploitation	Process orientated model	Cropley (2008:258); Forex (2010:1); Ford & Cioia (2000:1); Bergh & Theron (2009:115, 124); Runco (2007:396)
2005	Park & Jang	Cognitive motives	Three cognitive motives to be creative: 1) Incompleteness (Recognition of gaps in existing knowledge) 2) Development (A drive to round out recent emerging novelty) 3) Conflict/ Discrepancy (Identification of contradictions in accepted knowledge)	Process orientated model	Cropley (2008:262); Sharma (2004:335); Baer & Kaufman (2005:4-6); Runco (2007:403)
2005	Ruth Byrne	Rational Imagination	People create alternatives to reality and imagine how events might have turned out "if only" something had been different. Byrne explores the "fault lines" of reality (aspects of reality that are more readily changed in imaginative thoughts). Explore tendencies to imagine alternatives to actions, controllable events, socially unacceptable actions, causal and enabling relations, and events that come last in a temporal sequence provide clues to the cognitive processes upon which the counterfactual imagination depends. The explanation of these processes rests on the idea that imaginative thought and rational thought have much in common.	Process orientated model	Byrne (2005:1-3)
2005	John Baer & James	Amusement Part	The metaphor of an amusement part is used to	Systems orientated	Kaufman (2003:2); Cropley

	Kaufman	Theoretical (APT) model of creativity	explore creativity. Metaphor consists of four aspects: 1) Initial requirements that must be present at some level for all creative work are: • Intelligence • Motivation • Environment 2) The next area are general thematic areas in which someone could be creative (e.g. the arts, science) 3) Specific domains 4) Micro-domains that represent specific tasks associated with each domain	model	(2008:262); Baer & Kaufman (2005:4-6); Runco (2007:403); Unsworth (2001: 289-297); Bergh & Theron (2009:415); Zusman and Zlotin (1998:1)
2009	Collaboration with Jack Chung, Shelley Evenson, and Paul Pangaro	A model of the creative process	Consists of six phases: 1) Quality cycle • Plan • Op (operate) • Check 2) Self-regulating system • Measure • Compare it to a goal • Act to eliminate any difference 3) Scientific method • Forming a hypothesis • Experimenting • Observation 4) Clinical process • Examine • Diagnose • Treat 5) Design process • Analyse • Synthesize • Evaluate 6) Interaction loop • What do you sense? (feel?) • How do you learn + plan? (know?) • How do you change things? (do?)	Process orientated model	Dubberly.com (2009:1)

APPENDIX B



Potchefstroom Business School
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Tel: 018 299 1411
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Dear Student

Re: PhD study

My name is Ziska Fields. I am currently busy with my PhD at NWU which aims to investigate the creativity influences on a general- and tertiary educational level as identified by undergraduate students.

I require your valuable input in identifying the key creativity influences. To do this, I need you to complete the survey questionnaire attached which is 7 pages long and should take only 20 minutes to complete. The survey questionnaire comprises of two sections.

- *Section A* consists of seven questions to gather the necessary demographical information. Please mark the appropriate block with a cross next to the demographic that describes you. Please be honest.
- *Section B* consists of nine headings which contain various statements. Please read the statements carefully and then indicate, on a scale from 1 to 7, if you agree or disagree with the statement by placing a cross in the appropriate column. Please write the first answer that comes into your head and be honest in your response. Try to avoid using “undecided” as far as possible.

Please note that your privacy is very important and that this questionnaire does not ask any unnecessary information.

The survey questionnaire has been approved by the Ethics Committee of NWU.

After you completed the survey questionnaire, hand it to the research coordinator (the person who handed the questionnaire to you in the lecture room) who will then collect all questionnaires and return it to Prof. Christo Bisschoff at the Potchefstroom Business School.

Please note that you are under no obligation to answer the survey questionnaire, however your input will be greatly appreciated.

Thank you very much. I greatly appreciate your time and effort in completing this survey questionnaire.

Kind regards

Mrs. Ziska Fields

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 +27 86 607 8163

 +27 71 130 4246

 ziska.fields@mancosa.co.za

Research Questionnaire to determine creativity influences

SECTION A: DEMOGRAPHICS

1. My age is between ...	MARK WITH X
18 – 21 years	
22 - 25 years	
26 – 29 years	
30 – 35 years	
Older than 35 years	

2. I am a ...	MARK WITH X
Male	
Female	

3. My mother tongue is ...	MARK WITH X
Afrikaans	
English	
Zulu	
Xhosa	
Ndebele	
Sotho	
Northern Sotho	
Swazi	
Tonga	
Twana	
Other: _____	

4. I permanently reside in	MARK WITH X
Gauteng	
Kwa-Zulu Natal	
Eastern Cape	
Western Cape	
Northern Cape	
North West	
Limpopo	
Mpumalanga	
Free State	
Other: _____	

5. I am a ...	MARK WITH X
First Year student	
Second year student	
Third year student	
Other : _____	

6. I am studying ...	MARK WITH X
Full time	
Part time	

7. I am studying at the	MARK WITH X
Faculty of Economic and Financial Sciences	
Faculty of Health Sciences	
Faculty of Science	
Faculty of Education	
Faculty of Humanities	
Faculty of Law	
Faculty of Engineering and the Built Environment	
Faculty of Management	
Faculty of Art, Design and Architecture	
Other (Specify): _____	

SECTION B: KEY INFLUENCES

A. Eight-dimensional thinking

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	EIGHT01	To help me find solutions or generate ideas I look for the uniqueness in:							
		1.1 processes							
		1.2 objects							
		1.3 features							
2	EIGHT02	I consider the dimensionality of an issue to create ideas in terms of:							
		2.1 space							
		2.2 time							
		2.3 cost							
3	EIGHT03	I determine if things can be done from different points of view							
		4.1 objects							
		4.2 concepts							
		4.3 processes							
5	EIGHT05	To find creative solutions, I separate:							
		5.1 concepts							
		5.2 processes							
		5.3 resources							
6	EIGHT06	I like to modify my creative solutions							
		7.1 concepts							
		7.2 problems							
		7.3 solutions							
7	EIGHT07	I look for similarity in:							
		7.4 patterns							
		7.5 processes							
		To find the best creative solution, I:							
8	EIGHT08	8.1 estimate							
		8.2 simulate							
		8.3 experiment							

B. Fluency

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	FLUE01	I have the ability to produce a great number of ideas							
2	FLUE02	I have the ability to produce solutions to problems in a short period of time							
3	FLUE03	I can simultaneously propose a variety of solutions to a specific problem							

C. Motivation

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	MOT01	I am driven by external pressures (including other people) to solve problems							
2	MOT02	I am driven by external pressures (including other people) to solve self-discovered problems							
3	MOT03	I am self-motivated to resolve externally defined problems							
4	MOT04	I am self-motivated to solve self-defined problems							
5	MOT05	I am always motivated to be creative in my own interest areas							
6	MOT06	I am motivated to be creative in an environment that tears down my barriers to creative thinking.							
7	MOT07	I am always motivated by other people to use my creative skills							

D. Cognition

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	COG01	I attain understanding from a variety of information sources without difficulty							
2	COG02	I can discover different links and relationships (obvious and not so obvious) when I look at different information sources							
3	COG03	I can cope with complexities when I need to resolve a problem							
4	COG04	I do not get stuck on a set of rules to solve a problem							
5	COG05	I can easily see different aspects of a problem							
6	COG06	I can recognise gaps in my existing knowledge							
7	COG07	I can identify contradictions in accepted knowledge							
8	COG08	I can predict appropriate creative solutions to a problem after analysing the contradictions in a problem							
9	COG09	I agree that the use of scientific approaches outside a specific field of study can be helpful to develop creative solutions							

E. Communication

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	COMM01	I am able to persuade others that my ideas are valuable							
2	COMM02	I use communication as a tool to reveal my creative ideas to knowledgeable others							

F. Originality

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	ORIG01	I propose new ideas on a regular basis							
2	ORIG02	I intentionally engage in unpopular ideas							
3	ORIG03	I am able to redefine a known problem from a completely different perspective							

G. Synthesis

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	SYN01	I can find the connection between items							
2	SYN02	I find new solutions by using associations between items							
3	SYN03	I like to combine various concepts to find solutions to problems							
4	SYN04	I am able to see problems in a novel way							

H. Culture

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	CUL01	My culture provides the defined symbol system which enables me to be creative							
2	CUL02	My culture is open-minded to novel ideas							
3	CUL03	My culture supports my creative thoughts							

I. Environment

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	ENV01	My family influences the way I think about my own creative ability							
2	ENV02	My family encouraged me to be creative when I was growing up.							
3	ENV03	My family did not value my creative output when I was growing up.							
4	ENV04	My community encourages creativity in people							
5	ENV05	Society stimulates novelty in me							
6	ENV06	Society selects what novelty is							
7	ENV07	My religion encourages my creative thinking							
8	ENV08	My religion encourages my creative output							
9	ENV09	My country recognizes self-expression values							
10	ENV10	My university/ institution provides a climate that stimulates creativity in me							
11	ENV11	My country is based on beliefs that are passed down from generation to generation							
12	ENV12	My country is based on values that are necessary to the functions and fulfillment of intellect and will.							

THANK YOU FOR COMPLETING THE QUESTIONNAIRE

APPENDIX C



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Thank you very much. I greatly appreciate your time and effort in completing this survey questionnaire.

Kind regards

Mrs. Ziska Fields

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 ziska.fields@mancosa.co.za

APPENDIX A

Research Questionnaire to determine creativity influences in tertiary education

SECTION A: DEMOGRAPHICS

1. My age is between ...	MARK WITH X
18 – 21 years	
22 - 25 years	
26 – 29 years	
30 – 35 years	
Older than 35 years	

2. I am a ...	MARK WITH X
Male	
Female	

3. My mother tongue is ...	MARK WITH X
Afrikaans	
English	
Zulu	
Xhosa	
Ndebele	
Sotho	
Northern Sotho	
Swazi	
Tonga	
Twana	
Other: _____	

4. I permanently reside in	MARK WITH X
Gauteng	
Kwa-Zulu Natal	
Eastern Cape	
Western Cape	
Northern Cape	
North West	
Limpopo	
Mpumalanga	
Free State	
Other: _____	

5. I am a ...	MARK WITH X
First Year student	
Second year student	
Third year student	
Other : _____	

6. I am studying ...	MARK WITH X
Full time	
Part time	

7. I am studying at the	MARK WITH X
Faculty of Economic and Financial Sciences	
Faculty of Health Sciences	
Faculty of Science	
Faculty of Education	
Faculty of Humanities	
Faculty of Law	
Faculty of Engineering and the Built Environment	
Faculty of Management	
Faculty of Art, Design and Architecture	
Other (Specify): _____	

SECTION B: KEY INFLUENCES

A. Eight-dimensional thinking

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	EIGHT01	To help me find solutions or generate ideas I look for the uniqueness in:							
		1.5 processes							
		1.6 objects							
		1.7 features							
2	EIGHT02	1.8 situations							
		I consider the dimensionality of an issue to create ideas in terms of:							
		2.1 space							
		2.2 time							
3	EIGHT03	2.3 cost							
		2.4 colour							
4	EIGHT04	I determine if things can be done from different points of view							
		To find creative solutions, I combine:							
		4.1 objects							
5	EIGHT05	4.2 concepts							
		4.3 processes							
		To find creative solutions, I separate:							
6	EIGHT06	5.1 concepts							
		5.2 processes							
		5.3 resources							
7	EIGHT07	5.4 objects							
		5.5 dimensions							
		I like to modify my creative solutions							
8	EIGHT08	I look for similarity in:							
		7.1 concepts							
		7.2 problems							
8	EIGHT08	7.3 solutions							
		7.4 patterns							
		7.5 processes							
8	EIGHT08	To find the best creative solution, I:							
		8.1 estimate							
		8.2 simulate							
8	EIGHT08	8.3 experiment							

B. Fluency

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	FLUE01	I have the ability to produce a great number of ideas							
2	FLUE02	I have the ability to produce solutions to problems in a short period of time							
3	FLUE03	I can simultaneously propose a variety of solutions to a specific problem							

C. Motivation

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	MOT01	I am driven by external pressures (including other people) to solve problems							
2	MOT02	I am driven by external pressures (including other people) to solve self-discovered problems							
3	MOT03	I am self-motivated to resolve externally defined problems							
4	MOT04	I am self-motivated to solve self-defined problems							
5	MOT05	I am always motivated to be creative in my own interest areas							
6	MOT06	I am motivated to be creative in an environment that tears down my barriers to creative thinking.							
7	MOT07	I am always motivated by other people to use my creative skills							

D. Cognition

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	COG01	I attain understanding from a variety of information sources without difficulty							
2	COG02	I can discover different links and relationships (obvious and not so obvious) when I look at different information sources							
3	COG03	I can cope with complexities when I need to resolve a problem							
4	COG04	I do not get stuck on a set of rules to solve a problem							
5	COG05	I can easily see different aspects of a problem							
6	COG06	I can recognise gaps in my existing knowledge							
7	COG07	I can identify contradictions in accepted knowledge							
8	COG08	I can predict appropriate creative solutions to a problem after analysing the contradictions in a problem							
9	COG09	I agree that the use of scientific approaches outside a specific field of study can be helpful to develop creative solutions							

E. Communication

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	COMM01	I am able to persuade others that my ideas are valuable							
2	COMM02	I use communication as a tool to reveal my creative ideas to knowledgeable others							

F. Originality

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	ORIG01	I propose new ideas on a regular basis							
2	ORIG02	I intentionally engage in unpopular ideas							
3	ORIG03	I am able to redefine a known problem from a completely different perspective							

G. Synthesis

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	SYN01	I can find the connection between items							
2	SYN02	I find new solutions by using associations between items							
3	SYN03	I like to combine various concepts to find solutions to problems							
4	SYN04	I am able to see problems in a novel way							

H. Sensitivity

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	SYN04	I am a sensitive person							
2	SYN04	I can recognise difficulties within a task easily							
3	SYN04	I am sensitive to the various aspects of a problem							

I. Four-dimensional thinking

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	FOUR01	I consider the consequences for humanity when I look for solutions to a problem							
2	FOUR02	I consider immediate personal gains when I look for solutions to a problem							
3	FOUR03	I think about the consequences of my ideas							
4	FOUR04	I can anticipate consequences							

J. Development

		Rating Scale	1	2	3	4	5	6	7
No	Code	 Question	Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	DEV01	I do not prematurely judge ideas							
2	DEV02	I think ideas through carefully and developing on it							
3	DEV03	I develop ideas to find the best solutions for a given situation							
4	DEV04	I make random attempts to solve a difficult problem							
5	DEV05	I prefer to break away from preconceived perceptions to find solutions to problems							

K. Imagination

			Rating Scale						
No	Code	Question	1	2	3	4	5	6	7
			Strongly Disagree	Disagree	Disagree somewhat	Undecided	Agree somewhat	Agree	Strongly Agree
1	IMAG01	I generate new ideas by actively searching for associations among concepts							
2	IMAG02	I use brainstorming to make associations regarding a given concept.							
3	IMAG03	I make the effort to actively search for associations							
4	IMAG04	I generate ideas by finding as much alternatives as possible							
5	IMAG05	I always look at the big picture							
6	IMAG06	I like to take initiative and challenge assumptions							
7	IMAG07	I like to challenge assumptions							

THANK YOU FOR COMPLETING THE QUESTIONNAIRE