Testing and Operationalizing a Model to Measure Creativity at Tertiary Educational Level

Ziska Fields[1] and Sulaiman Olusegun Atiku[2]

*School of Management, Information Technology and Governance,
University of KwaZulu-Natal, University Road, Westville, South Africa
Telephone: [1]<27 31 260 8103>, E-mail: [1]<fields@ukzn.ac.za>, [2]<Atiku@ukzn.ac.za>*

ABSTRACT Measuring creativity scientifically seems to be a challenging undertaking at the tertiary educational level. The purpose of the research reported in this paper was to test and operationalize a model to measure creativity at the tertiary educational level using SPSS and AMOS. These software packages were used to run causal path analysis and cause-effect relationships using the Pearson's product correlation coefficient (PPMC), a multiple regression analysis and structural equation modelling (SEM) which included a confirmatory factor analysis (CFA). The Fields Educational Creativity Model (FECM) was the result of the test and operationalization and showed a mediating influence of cognitive psychology on the interplay between motivation and creativity. Creativity can be measured at tertiary educational level and this can positively influence the globalized knowledge economy because graduates will be critical, creative and imaginative thinkers and leaders who can work through complex problems and make creative and purposeful changes and adaptations.

INTRODUCTION

Measuring creativity scientifically seems to be a challenging undertaking. Jones said: "What gets measured gets done. What gets measured and fed back gets done well. What gets rewarded gets repeated" (Williamson 2009: 2). Jones's sentiment also applies to creativity. It is important to measure creativity to ensure it is used properly. It is critical to feed back the shortcomings of creativity to enable the development and enhancement of creativity, and finally to reward progress to ensure that creativity is sustained. Robelen (2013) found however that the focus in education was not on measuring student creativity, but rather determining the extent to which schools provide opportunities to foster creativity.

The primary business of higher education can be summarized as the creation of prepared minds (Fortino n.d.) and to do this, higher education needs to prepare students for a lifetime of uncertainty and constant change (Jackson 2008). Hicks (2015:1) supports the views of Jackson (2008) in that "learning how to be more creative (and thus adaptable) is what prepares students for life beyond the classroom". Graduates need to be critical, creative and practical thinkers. This poses a challenge in higher education because the focus of teaching and learning is on critical and intellectual thinking, rather than creative thinking and problem-solving. This was proven with the Torrance Tests of Creative Thinking (TTCT) which show that since 1990, creativity has been decreasing significantly, although intelligence is increasing. Despite this challenge, higher education institutions, as well as governments and organizations, are realizing that an increasing supply of highly educated and creative workers, as well as creative leadership, is critical to remain competitive in the global knowledge economy (TLRP 2008; Bronson and Merryman 2010; Brevis and Vrba 2014).

An important link also exists between a government's tertiary education strategy and its business growth agenda. However, not all governments, higher education institutions and organizations have been able to understand what creativity really means or what is needed for successful creativity (Christensen et al. 2003) and feel that establishing an environment to nurture and promote creativity is a challenging undertaking (Eppler et al. 2011). In addition to the lack of understanding, Robinson (cited in Vilalba 2008) warns that education seems to be killing creativity. Tertiary education specifically barely seems to acknowledge the existence of creativity in most of the academic programs (Jackson 2008). Hicks (2015) however indicates that academia has started to embrace providing courses in creativity in some countries.

Hadzigeorgiou et al. (2012) believe that a deeper understanding and appreciation of cre-

ativity and scientific creativity are required. Students should be taught to think creatively and transform creative thoughts into creative actions (Tsai 2012). There should also be an appreciation of content knowledge in creative thinking (Rowlands 2011), because fact-finding and deep research are vital stages in the creative process (Bronson and Merryman 2010). So, tertiary education should be aimed at developing both convergent (left-brain thinking) and divergent thinking (right-brain thinking) to prepare students for the unknown future. Creativity cannot be developed if it is not measured to determine the current level of creativity and then to inform teaching and learning interventions to develop, enhance and reward creativity.

The purpose of the research on which this paper is based was to test and operationalize a model to measure creativity at the tertiary educational level using the Statistical Package for the Social Science (SPSS) and Analysis of Moment Structure (AMOS). The paper starts with various views on creativity as a phenomenon and shows how these diverse views create various approaches and tests in an effort to explain creativity. Attempts to explain creativity at an educational level are then highlighted. They show that there is a need for a model to measure creativity at tertiary educational level specifically. A conceptual framework developed by Fields (2012) is subsequently briefly discussed. This discussion is followed by sections on the method, results and discussions, focusing on the testing and operationalizing of the conceptual framework in an effort to propose an improved model to measure creativity at a tertiary educational level.

Literature Study

The phenomenon of creativity appears to be complex and elusive because different perspectives and approaches are used to explain what creativity is (Kerr and Gagliardi 2003; Vilalba 2008). There is some agreement that creativity has to do with the production of something new and has some sort of value and that everybody can be creative to some extent (Vilalba 2008). This view is supported by Bergh and Theron (2009) and Bronson and Merryman (2011). Creativity ultimately depends on the capacity of the individual to generate original solutions to complex problems that call for creative thought

(Christiaans 2002; Barrett et al. 2013). Torrance observed that creativity is "a successful step into the unknown, getting away from the main track, breaking out of the mold, being open to experience and permitting one thing to lead to another, recombining ideas or seeing new relationships among ideas" (Afolabi et al. 2009: 2). From these explanations, it seems that creativity enables people to think differently, thus becoming capable of creating novel, better and sustainable solutions to deal with complex problems. This type of thinking is often expected from graduates at tertiary institutions.

The contemporary approach to 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 (Adams 2005). Heinze (2007 cited in Burbiel 2009) refers to this approach as scientific creativity and identified five types of scientific creativity: (1) the formulation of a new idea that explains and opens a new cognitive frame; (2) the discovery of a new empirical phenomenon that encourages the formulation of new theories; (3) the development of a new methodology to empirically test theoretical problems; (4) the development of a novel instrument that encourages the development of new perspectives and research; (5)the synthesis of existing knowledge into general theoretical laws which enables the analyses of diverse phenomena within a common cognitive frame. These types are closely linked to what tertiary institutions do to create knowledge through various research activities. Scientific creativity skills are also required from PhD students and academics.

In addition, De Brabandere and Ivy (2013) indicate that creativity should not refer to "thinking outside the box" or "without a box", but rather that the new paradigm for creativity is to "think in new boxes". In other words, the brain needs to create new ways of thinking in a structured and multi-dimensional way. This requires specific theoretical knowledge, practical application of theoretical knowledge and the exposure to various ways of thinking, using both divergent and convergent thinking. Tertiary education aims to develop this in students.

The different views regarding the nature of creativity led to the development of five approaches. Each approach offers unique insights, understanding and application of creativity at a

personal, organizational and educational level (Petrowski 2000). The five approaches are the psychometric approach, the contextual approach, the experimental approach, the biographical approach and the biological approach.

The psychometric approach assumes that creativity is a measurable mental trait and focuses on developing tests which measure divergent thinking (Plucker and Renzulli 1999 cited in Petrowski 2000). Instruments measure aspects of divergent thinking such as ideational fluency and word association, as well as personality traits of creative individuals (Feist 1999 cited in Petrowski 2000). The contextual approach explains creativity as a systematic process involving individuals, gatekeepers (representing the field or society) and the culture (or domain), rather than an individual trait (Csikszentmihalyi 1999 cited in Petrowski 2000). Csikszentmihalyi (1999 cited in James et al. 2009) 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. The experimental approach shows how creative thinking is dependent on generative processes, which include memory retrieval, association and mental synthesis (Petrowski 2000). The biographical approach is aimed at identifying developmental experiences and environmental factors that contribute to extraordinary creative achievement such as birth order, childhood trauma, family background and education (Simonton 1999 cited in Petrowski 2000). The biological approach is based on the view that psychological traits have a biological basis and explains behaviors in terms of the physiology and structure of the brain (cortical brain activity) (Petrowski 2000). These five approaches influenced the development of a variety of measurement instruments in an effort to determine whether an individual is creative or not, and to find the so-called creativity quotient (CQ).

Torrance and Goff (1989 cited in Cropley 2008) identified 255 different creativity tests. These tests 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). All these tests have

merit; however, many reviewers have questioned their usefulness, usually on the grounds of technical shortcomings (Cropley 2008) and the multidimensional nature of creativity (Fryer 2012). However, despite these objections, it is important to determine a person's level of creativity before plans can be put in place to develop or enhance creative ability and potential.

The problem at tertiary educational institutions appears to be that different disciplinary interpretations of creativity exist, which makes the identification and measurement of creativity difficult. In the arts there is a greater focus on creativity than in the sciences, and it is a challenge to find agreement on how to measure creativity. In addition, there does not seem to be a specific tool to measure the creativity of students at higher education specifically.

Some researchers have attempted to explain creativity at educational and tertiary educational level. The Enrichment Triad Model (ETM) was developed by Renzulli in the 1970s. It is a program for infusing high-end learning strategies into existing educational programs to promote excellence, enhance self-confidence, and nurture creativity in students (Garcia-Cepero 2008: 295). The program 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. A conceptual map of creativity in teaching and learning was also created from Phenomenography in 2004 (Tan and Prosser 2004). The conceptual map focuses on the ways in which individuals experience, perceive, apprehend, understand and conceptualize various phenomena. The central part of the research consisted of in-depth, semi-structured, face-to-face interviews undertaken with 12 academics from a range of disciplines. A phenomenographic analysis was also done on business students by Petocz et al. (2009). They found 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 et al. 2009). Research seems to still be emergent and requires further analysis, but it offers helpful clues regarding creativity in the context of learning and teaching at tertiary educational level. Despite some research attempts, a model to test creativity at tertiary educational level specifically has not been fully developed to meet the complex and diverse needs of tertiary institutions.

The Model

Fields (2012) made an attempt to develop a conceptual framework to measure creativity at tertiary educational level. An exploratory factor analysis using Varimax rotation was used and the variance explained indicated that the measuring tool to measure creativity was valid. Cronbach's coefficient alpha (α) was used to test the reliability of the factors identified as part of the measuring tool and the overall reliability was good. Kaiser, Meyer and Ohlin (KMO) also indicated that the sample that was used to generate data was adequate and the set of variables considered by the study are factorable. So it appears that the proposed conceptual framework can be a good tool to use. 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). Values of 0.70 and higher are regarded to be acceptable, according to Field (2007).

Fields and Bisschoff (2013) explain that the conceptual framework to measure creativity at the tertiary educational level consists of 12 factors. Figure 1 illustrates the 12 factors and the variance per factor pertaining to creativity at tertiary educational level.

According to this conceptual framework, 12 factors are needed to measured creativity at tertiary educational level. Factor 1, challenging the status quo, is the most important factor with a favorable variance of 7.72 percent. This factor points 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 or her own interest areas. Factor 2, detachment, is the second most important factor and points to the ability to separate pro-
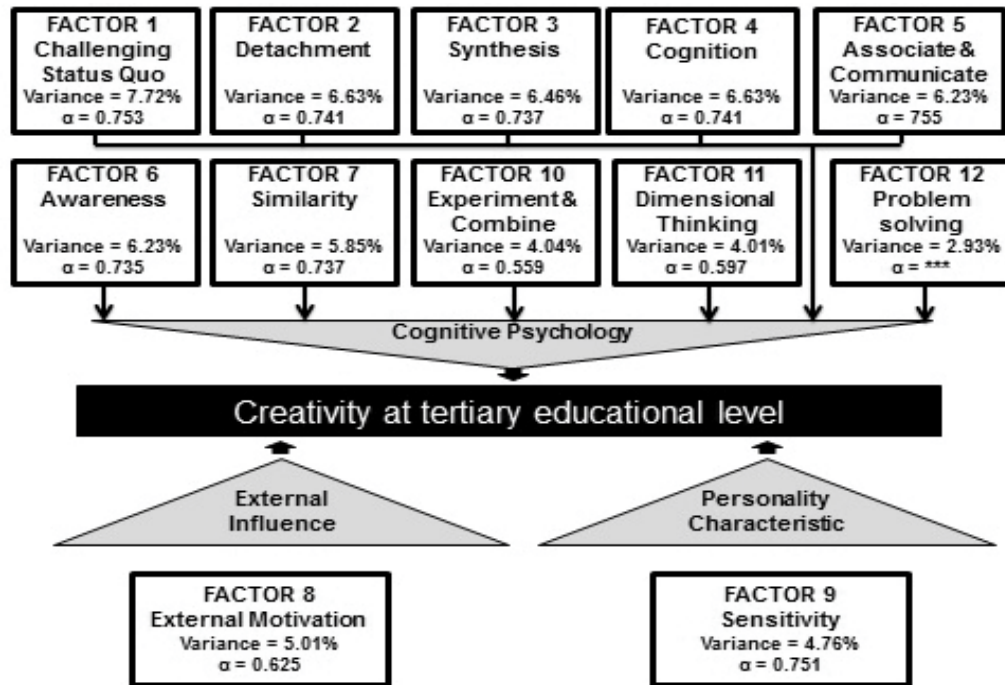

Fig. 1.Conceptual framework to measure creativity at the tertiary educational level
Source: Adapted from Fields 2012

cesses, resources, objects and dimensions in an effort to be creative. Factor 3, synthesis, is the third most important factor and 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. Factor 4, cognition, points to the ability to discover links and relationships by looking at a variety of information sources, as well as the ability to cope with complexities when a problem needs to be solved. 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 and to propose new ideas regularly and the ability to convince others of the value of the creative ideas that have been generated. Factor 6, awareness, points to the ability to recognize gaps and contradictions in existing knowledge, to see different aspects of a problem and the ability not to get stuck on a set of rules to solve a problem. Factor 7, similarity, points to the ability to look for similarities in problems, solutions, patterns and concepts. Factor 8, external motivation, points to the impact of external pressures and people to solve problems and to intentionally engage in unpopular ideas. Factor 9, sensitivity, points to the sensitivity of a person to various aspects of a problem. Factor 10, experiment and combine, points to the ability to find the best creative solution by experimenting and combining objects. Factor 11, dimensional thinking, points to the ability to consider the dimensionality of an issue to create ideas in terms of cost and time. Factor 12, problem-solving, points to random attempts to solve a difficult problem. Cronbach's coefficient alpha (á) could not be calculated for this factor and this factor might therefore not be present in repeated studies. Only one item loaded onto Factor 12, albeit with a high loading of 0.88. This factor explains a variance of 2.93 percent.

The above-mentioned factors were grouped into three groups. Factors 1-7 and 10-12 fall into the cognitive psychology group. Tertiary education requires more cognitive processes; therefore it is not surprising that more cognitive psychological factors were identified in the model. Factor 8 falls into the external influences group. Motivation can be seen as a cognitive psychology influence as well, but the model focuses on external motivation specifically and therefore the impact of the external environment on creativity needs to be considered and measured. Factor 9 falls into the personality characteristics group. This factor too has a link to cognitive psychology even though it can be linked to personality traits.

The purpose of the research reported in this paper was to test and operationalize a model to measure creativity at the tertiary educational level using structural equation modeling (SEM). The method used to do this is described below.

RESEARCH DESIGN AND METHODOLOGY

The research was done in two stages. In stage one, the main objective was to develop a conceptual framework to measure creativity at tertiary educational level using a survey research design in testing and operationalizing a model and an exploratory factor analysis (EFA). An EFA was used because the number of factors that were necessary to explain the interrelationships among the set of variables were not known and the underlying dimensions of the construct being researched needed to be determined.

A university in South Africa was used as the target population and a total of 500 questionnaires were distributed, using the convenience sampling technique. Of these, 322 were completed (a response rate of 64.4%). The data were analyzed with the SPSS version 18 (SPSS 2009). The collected data were analyzed, purified and tested.

Stage one consisted of six steps. In step 1 the creativity influences were extracted and selected from literature. In step 2 the measuring criteria for each creativity influence was identified. A measuring instrument (a closed-ended questionnaire) was constructed from the literature to test creativity using the influences identified in step 3. In step 4 the questionnaire was distributed at one university and 322 were completed (a 64.4% response rate). The data collected were subjected to a principal component factor analysis using a Varimax normalized rotation in step 5. The measuring instruments were revised to enhance the reliability (Cronbach's coefficient alpha (α)) of the scales in the questionnaire. For the study a reliability coefficient of 0.70 was set to conform to the general norm as explained by Schmitt (1996). It is important to note that the lower limit set by Cortina of above

0.57 was also set as a secondary acceptable reliability coefficient. The reliability of the 12 factors is shown in Table 1.

Table 1: Reliability of the factors

Factor	Cronbach's coefficient alpha (á)
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 are thus accepted to be reliable factors. Factor 10 is marginally lower that the lower limit of 0.57 set by Cortina with a secondary acceptable reliability coefficient of 0.56; 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).

The Kaiser-Meyer Olkin (KMO) measure and the Bartlett test of sphericity were applied to determine whether thedata were suitable for a factor analysis. Both the KMO and the Bartlett test showed very favorable 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.The result of these steps was a conceptual framework to measure creativity at tertiary education (Fields and Bisschoff 2014). This paper focuses on what was done after the development of the conceptual framework (stage two).

An additional analysis was conducted using the SPSS version 21 and AMOS 21. These software packages were used to run causal path analysis or cause-effect relationships using the Pearson's product correlation coefficient (PPMC) and structural equation modeling (SEM) which included a confirmatory factor analysis (CFA).

The direction, strength and significance of bivariate associations among the constructs were examined utilizing Pearson's correlation coefficients via the IBM statistical package for the SPSS version 21. This was done before introducing the latent variables into the measurement and structural models in AMOS.

SEM (with AMOS) was instrumental in analyzing the theoretical framework developed in stage one to determine the extent to which cognitive psychology mediates the relationship between motivation and creativity. AMOS is designed to evaluate or test structural equation models and determine the linear relationships among latent and manifest (observed) variables (Sekaran and Bougie 2009). In this context, latent and manifest variables are synonyms of unobserved and observed variables respectively.

The construct validity of the proposed model was assessed by appraising the percentage of the overall variability described by each dimension attained via CFA (Duff and Duffy 2002). CFA is instrumental in examining the fitness of a proposed model as a form of structural equation modelling (Williams et al. 2012). Construct validity was determined using various model fit indices. It is illustrated in the section in which the results are discussed.

RESULTS

The results (represented as four models) are discussed after the statistical techniques, used as the indices to determine model fit, are briefly explained. The indices used to interpret the results were: chi-square (CMIN), normed-chi-square value (CMIN/DF), goodness of fit index (GFI), adjusted goodness of fit index (AGFI), Root mean square error of approximation (RMSEA), normed fit index (NFI), comparative fit index (CFI), Tucker-Lewis Index (TLI), Incremental Fit Index (IFI) and p-value.It is advised that once at least four indices are good, one can conclude a good model fit (Hooper et al. 2008).

The CMIN forms one of the criteria for assessing the general fitness of the model, as well as the degree of inconsistency between the sample and covariance matrices (Hu and Bentler 1999). This is reported using the chi-square value, degree of freedom and the corresponding P value. In cases of large chi-square values and degree of freedoms, the normed-chi-square test was adopted, which is the chi-square value divided by the degree of freedom. The standard rule is that the CMIN/DF must not be greater

than 5. If the CMIN/DF falls in the range of 2 to 1 or 3 to 1, it indicates acceptable fit between the hypothetical model and the sample data (Carmnines and McIver 1981 cited in Anon 2007).

The GFI was developed by Joreskog and Sorbom as an alternative criterion for measuring the degree of variance that emanates from the estimated population covariance (Hooper et al. 2008). The AGFI is another criterion for assessing the fitness of a measurement or structural model. The value for GFI and AGFI ranged between 0 and 1. An acceptable indicator of good model fit starts from 0.8 to a cut-off point of 0.95 (Hooper et al. 2008).

The RMSEA is seen as "one of the most informative fit indices" (Diamantopoulos and Siguaw 2000: 85) based on the RMSEA's sensitivity to the number of estimated parameters in the model (Hooper et al. 2008). It shows how well a model is suited to the population covariance/correlation matrix. A RMSEA less than 0.05 indicates good fit, 0 indicates exact fit, from 0.08 to 0.10 indicates mediocre fit, and greater than 0.10 indicates poor fit. Katou and Budhwar (2010) indicated that values less than 0.08 suggest a model fit approximation.

The NFI is one of the incremental fit indexes used to examine the fitness of models, measures the fitness of the model by comparing the chi-square values of the model and those of the null model (Hooper et al. 2008). The values also range from 0 to 1 and Bentler and Bonnet (1980 cited in Hooper et al. 2008) recommend that the values must be greater than 0.9 before a model can be regarded as a good model fit.

The CFI was designed as a revised form of NFI by Bentler with reasonable consideration of sample size appropriateness (Hooper et al. 2008). The values expected of incremental indexes also range from 0 to 1. However, a CFI value of greater than or equal to 0.9 is an acceptable indicator of good model fit, while a CFI value of greater than or equal to 0.95 is regarded as an indicator of perfect model fit (Hu and Bentler 1999). Other incremental fit indexes used to assess the fitness of models are the TLI (Tucker and Lewis 1973) and the IFI (Bollen 1989) and both should be equal to or greater than 0.90 for the modelto be accepted as a good model fit.

The results of the model fit indices are indicated directly below after each of the four models. Once at least four indices are good, one can conclude a good model fit. The latent variables are represented by circles, while the manifest variables are represented by boxes in the measurement and structural models.

Figure 2 (Model 1) shows the results of the CFA model appraising the percentage of the overall variability described by each dimension. The indexes, listed below Figure 2, suggest a good fit of the constructs to the data set. Statistically, all factor loadings in the measurement model were found positive, large (0.40 to 0.97) and highly significant (p < 0.001), which also confirmed the validity of the measurement model. This confirmed that the CFA of the constructs utilized in this study were led by the theoretical propositions, modification indices and factor loadings (Maiyaki 2012). This suggests why all the indicators of goodness of fit reported below in Figure 2 were evidence of good model fit indices. *Note: DT = dimensional thinking, CSQ = challenging the status quo and PS = problem solving*

Chi-square (CMIN) = 147.385; DF = 62;and p-value = 0.000.

CMIN/DF = 2.377 (<5); GFI = 0.938 (>.90); NFI = 0.919(>.90); IFI = 0.951(>.90); TLI = 0.927(>.90); CFI = 0.950 (>.90); RMSEA = 0.065 (slightly above .05)

Having established that all model fit indices presented above are good, this implies that the underlined dimensions of the various factors considered in the measurement model are valid.

The structural model as illustrated in Figure 3 shows that cognition has an impact on challenging the status quo (0.97), problem-solving (0.88) and fluency (0.70). Motivation has an impact on cognition (0.87) and dimensional thinking (0.70).

Chi-square = 155.917; DF = 72; p-value = 0.000;

CMIN/DF = 2.166(<5); GFI = 0.935(>.90); AGFI = 0.905(>.90); NFI = 0.914(>.90); IFI = 0.952(>.90); TLI = 0.938(>.90); CFI = 0.951(>.90); RMSEA = 0.060(slightly above .05)

The model fit indices, listed Figure 3, suggest a good model fit.

Figure 4 shows the link between cognitive psychology and creativity. Cognitive psychology impacts on challenging the status quo (0.97), problem-solving (0.87), fluency (0.70) and dimensional thinking (0.63).

Chi-square = 122.250; DF = 50; p-value = 0.000;
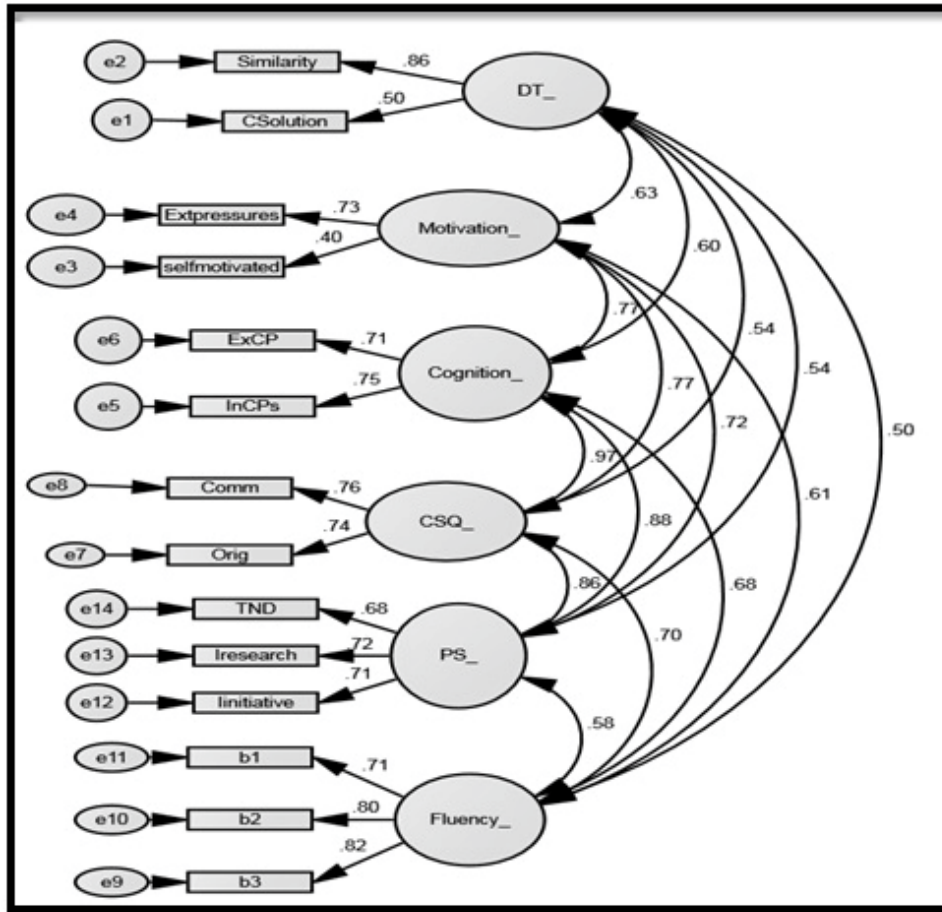
CMIN/DF = 2.445(<5); GFI = 0.941(>.90);

Fig. 2 Measurement model (confirmatory factor analysis)

AGFI = 0.908(>.90), NFI = 0.924(>.90); IFI = 0.954(>.90); TLI = 0.938(>.90); CFI = 0.953(>.90); RMSEA = 0.067(slightly above .05)

The indices, listed Figure 4, suggest a good model fit.

Table 2 highlights the standardized regression weights for latent and manifest variables. The table shows all standardized regression path estimates or beta loading from cognitive psychology to the factors measuring creativity.

The highest contribution in the structural model is the direct influence of cognitive psychology on challenging the status quo (0.973). The next highest contribution in the structural model is the mediating influence of cognitive psychology on problem-solving (0.874).

The purpose of this paper was to test a model to measure creativity at the tertiary educa-

Table 2: Standardized Regression Weights: (Group number 1 – Default model)

Estimate			
DT_	<—-	CPsychology_	.634
PS_	<—-	CPsychology_	.874
Fluency_	<—-	CPsychology_	.697
CSQ_	<—-	CPsychology_	.973
InCPs	<—-	CPsychology_	.745
ExCP	<—-	CPsychology_	.707
Similarity	<—-	DT_	.796
CSolution	<—-	DT_	.541
Comm	<—-	CSQ_	.772
Orig	<—-	CSQ_	.728
b1	<—-	Fluency_	.711
b2	<—-	Fluency_	.805
b3	<—-	Fluency_	.823
TND	<—-	PS_	.668
Iresearch	<—-	PS_	.732
Iinitiative	<—-	PS_	.710

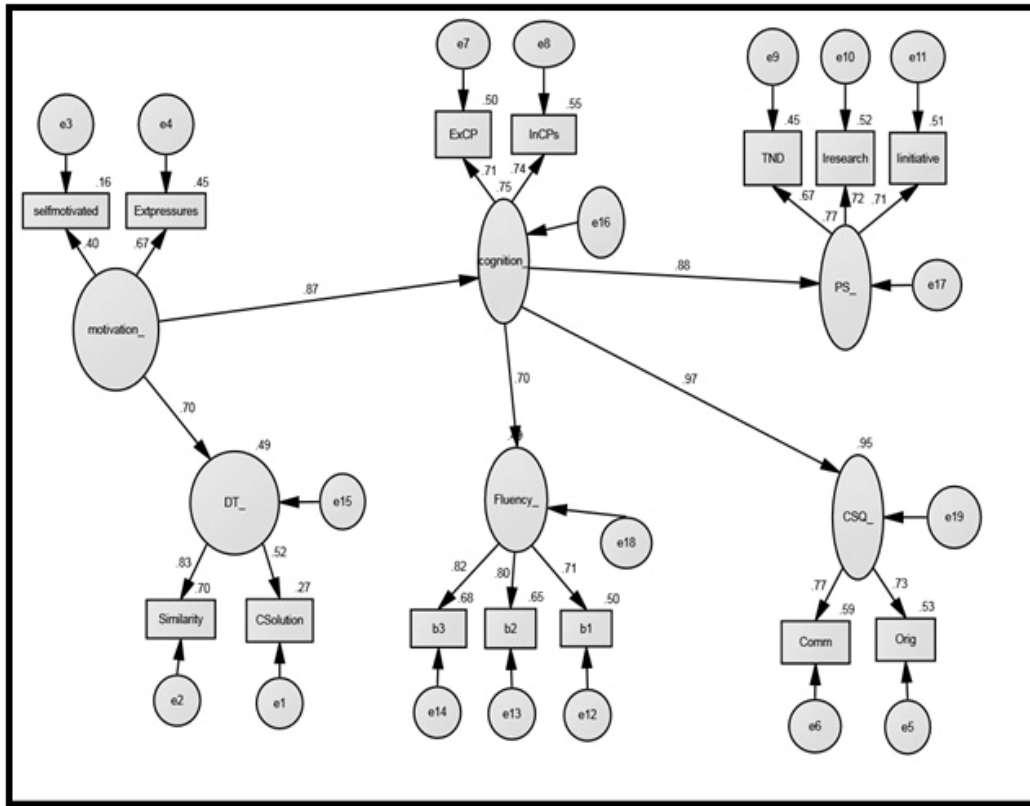**Fig. 3.Structural model indicating the direct impact of cognition and motivation on outcomes variables**

Fig. 3. Structural model indicating the direct impact of cognition and motivation on outcomes variables

tional level using SPSS and AMOS. The Fields Educational Creativity Model (FECM) was the result of the test and operationalization and shows the mediating influence of cognitive psychology on the interplay between motivation and creativity. The new model, called the Fields Educational Creativity Model (FECM), is shown in Figure 5.

Chi-square (CMIN) = 31.548; DF = 17; p value= .017;

CMIN/DF = 1.856(<5); GFI = 0.976(>.90);AGFI=0.949(>.90);NFI=0.966(>.90);

IFI = 0.984(>.90); TLI = 0.973(>.90); CFI = 0.984(>.90); RMSEA = 0.052(slightly above .05).

Only focusing on the three main concepts of the model (motivation, cognitive psychology and creativity), the following exogenous and endogenous variables were identified. Exogenous variables have an external origin and these show that causes are not included in the model. In Figure 5, the exogenous variable is motivation, so it is not clear what causes motivation.

Endogenous variables have an internal origin and are represented as the effects of other variables. In Figure 5, the endogenous variables are cognitive psychology and creativity. The figure shows that motivation has an effect on cognitive psychology and creativity. Cognitive psychology also effects creativity. The direct path from motivation to creativity (0.16) in the structural model is statistically insignificant (p value = 0.319). This was also established by the standardized direct effect – two-tailed insignificant value (p = 0.534).Hence, cognitive psychology fully mediates the relationship between motivation and creativity. Judging from the model fit indices listed in Figure 5, one can conclude a good fit and that the model can be used to measure creativity at tertiary educational level. The standardized regression weights of latent and manifest variables in FECM are presented in Table 3.
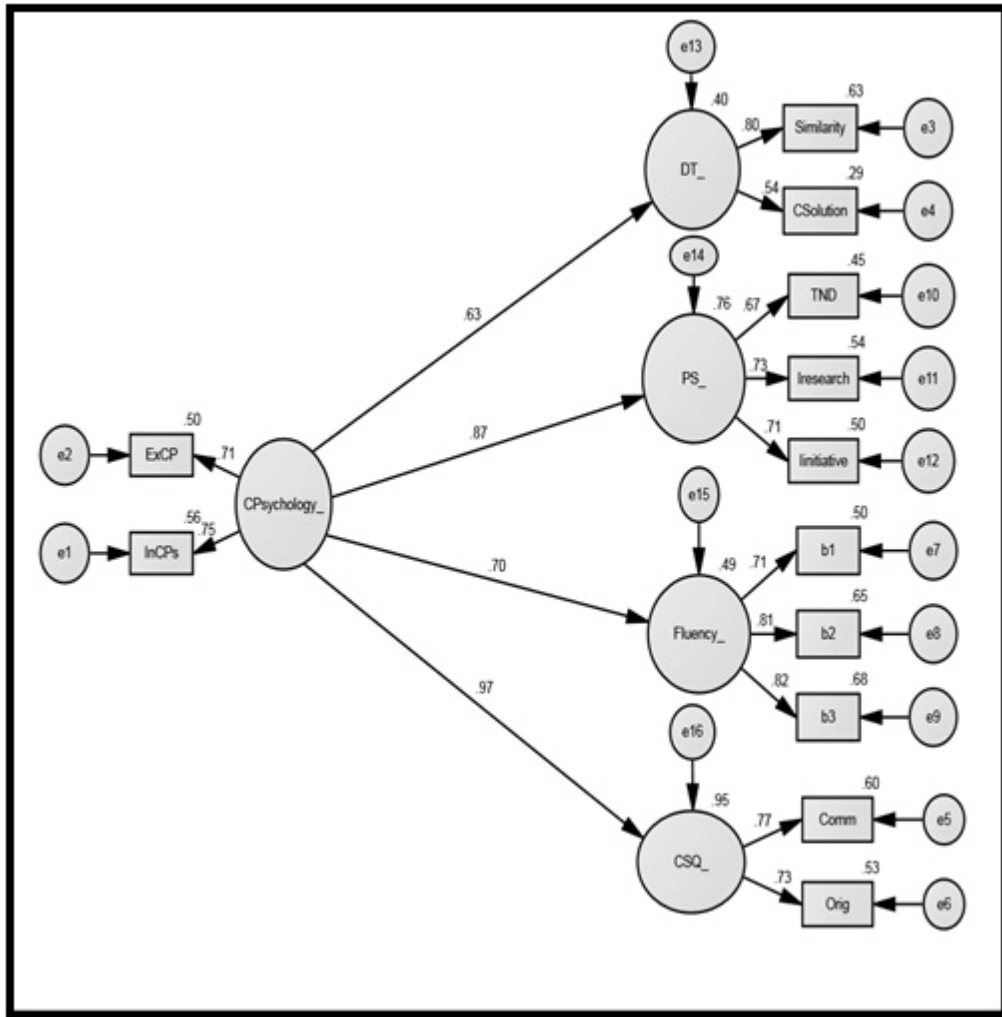
Fig. 4. Structural model indicating the link between cognitive psychology and creativity

Table 3: Standardized Regression Weights: (Group number 1 – Default model)

			Estimate
Cpsychology_	<—-	Motivation_	.788
Creativity_	<—-	Cpsychology_	.871
Creativity_	<—-	Motivation_	.160
InCPs	<—-	Cpsychology_	.743
ExCP	<—-	Cpsychology_	.715
D T	<—-	Creativity_	.516
PS	<—-	Creativity_	.754
CSQ	<—-	Creativity_	.822
Fluency	<—-	Creativity_	.641
Self-motivated	<—-	Motivation_	.412
Extpressures	<—-	Motivation_	.711

DISCUSSION

In the knowledge economy, graduates need to be critical, creative and imaginative thinkers who can work through complex problems and make creative and purposeful changes and adaptations. "Creativity and innovation have become important commodities in the world's marketplace. Universities that ignore this fact risk becoming irrelevant and of graduating students qualified only for second- and third-tier jobs" according to the Texas Institute for Creativity and Innovation (SFA 2015). It is therefore important to measure creativity at tertiary educational
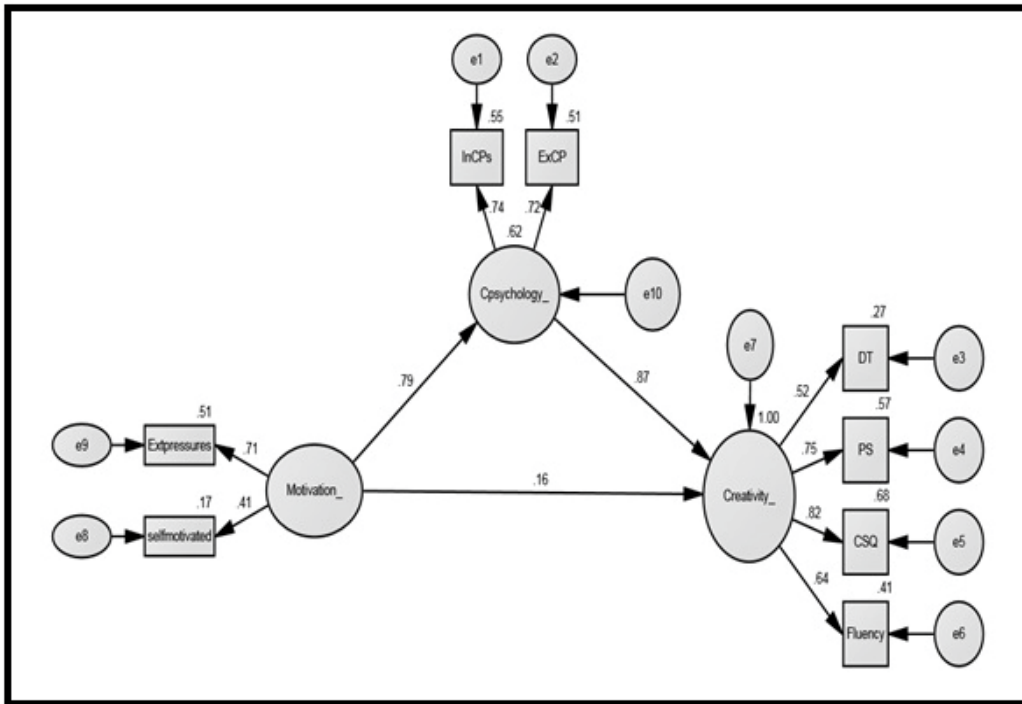
Fig. 5. The Fields Educational Creativity Model (FECM)

level to determine how it can be developed, enhanced and rewarded. This aspect is currently lacking because measuring creativity and innovation is hard to do according to Thomas (2015). The purpose of the research on which this paper is based was to test and operationalize a model to measure creativity at the tertiary educational level using the structural equation modelling. This should be helpful to try and measure creativity at tertiary educational level.

The purpose of this paper was to test and operationalize a model to measure creativity at the tertiary educational level using SPSS and AMOS. The results showed that the conceptual framework can be used to identify creativity; however the results from FECM are even better to measure creativity at tertiary educational level. This is due to the additional statistical methods used which include the PPMC, a multiple regression analysis, SEM and confirmatory factor analysis (CFA). The FECM (Fig. 5) showed a good model fit and it can therefore be seen as a reliable and valid model to use to measure creativity at the tertiary educational level. The model shows the link between cognitive psychology,

creativity and motivation. The strongest link exists between cognitive psychology and creativity and the weakest link exists between motivation and creativity.

The FECM revealed that cognitive psychology has a mediating influence on motivation and creativity at tertiary education level. Cognitive psychology focuses on the way humans process information and how behaviour is consequently influenced (McLeod 2007). This means that motivation has an impact on creativity through cognitive psychology.

There are two types of motivation: extrinsic and intrinsic. The results (Fig. 3) showed that motivation has an impact on cognition (0.87) and dimensional thinking (0.70). The contextual approach supports this result and indicates that creative people are intrinsically motivated to be creative in a specific domain (Petrowski 2000). Hennessey's (2003: 266) view is that "intrinsic motivation is a primary driving force behind the creative process" and Mumford (2000: 324) argues that "creative work calls for both intrinsic and extrinsic motivation". Initially, the conceptual framework developed by Fields (2012) indi-

cated that the external influences affect creativity, but the FECM model indicates that external pressures have a greater impact on motivation to be creative than inner drives (self-motivation) among students at tertiary institutions.

Creativity, according to Figure 4, is a result of challenging the status quo, problem-solving, fluency and dimensional thinking. The results indicate that cognitive psychology has a direct influence on challenging the status quo (0.97), problem-solving (0.87), fluency (0.70) and dimensional thinking (0.63). This supports Torrance's view that creativity is "breaking out of the mold, being open to experience and permitting one thing to lead to another, recombining ideas or seeing new relationships among ideas" (Afolabi et al. 2009: 2). The conceptual framework developed by Fields (2012) placed a lesser focus on problem-solving that the FECM model. In the conceptual framework problem-solving was identified as the 12th factor and it was indicated that this factor might not be present in repeated studies. This was not supported in the FECM model. While validating the data, sensitivity was excluded in the models because Cronbach's coefficient alpha (α) was less than 0.700 and a creative mind set was also excluded in the models because Cronbach's coefficient alpha (α) was less than 0.700. Manifest variables included in the models as factors measuring problem-solving (latent variable) were: (1) Thinking of a new development (TND), (2) Imagination – research (Iresearch) and (3) Imagination –initiative (Iinitiative). Creative problem-solving is critical in creativity to generate novel solutions. Osborn-Parnes developed the Creative Problem Solving (CPS) model in 1963 to show the importance of creative problem-solving and this model is used extensively (Mitchell and Kowalik 1999). Creative problem-solving is also important at tertiary educational level and can even be linked to Heinze's scientific creativity (Heinze 2007 cited in Burbiel 2009).

CONCLUSION

The result of the testing and operationalization was the Fields Educational Creativity Model (FECM) which is proposed as a model to measure creativity at tertiary institutions. The FECM showed a good overall model fit and showed that cognitive psychology fully mediates the relationship between motivation and creativity.

To ensure that graduates are creative, tertiary institutions need to develop cognition in an effort to make students more creative. This involves the development of divergent thinking (for example, conceptual skills) and convergent thinking (for example, analytical skills). A whole-brain approach is therefore necessary to be creative and it requires using divergent and convergent thinking simultaneously.

The contribution of this research is the FECM model that was developed as a proposed measure to determine the creativity of students. The model can assist in identifying ways of developing and enhancing students' creativity. This is a very important contribution due to the impact creativity has on the competitiveness of nations and organizations in the global knowledge economy.

There are, however, limitations to all research activities and the FECM model is no exception. The research was done in South Africa and one university was used to collect data. However, the use of various statistical packages and techniques, as well as the result of a good model fit, confirmed that the FECM model is a reliable and valid model to propose. It is suggested that future research include more universities and various countries to compare results and to modify the model if needed.

Creativity can be measured and when creativity is measured and feedback is provided, it is developed, done better, done well and gets repeated. This starts a ripple effect which will open more students' minds to new depths, richness and presence which will have a positive influence on the global knowledge economy and human existence.

RECOMMENDATIONS

It is recommended that the FECM be tested at various tertiary institutions and used to inform teaching and learning interventions to develop, enhance and reward creativity. Students should be taught to think creatively and transform creative thoughts into creative actions. This can be done by developing external cognitive processes where students can expand their normal cognitive processes with external aids (for example, visualization, work spaces) and internal cognitive processes, which involve perception, attention, language, memory and thinking. Teaching methods and assessment should fo-

cus on developing whole-brain thinking and learners should be encouraged to challenge the status quo, use dimensional thinking, creative problem-solving and fluency to generate viable and sustainable ideas. Progress should be measured to determine creative development of all the students at tertiary institutions. This approach can further be supported if educators align teaching-learning materials with methods of testing that will promote memory, comprehension, skills for practical work and creativity. In addition to developing cognition and knowledge creation, tertiary institutions should develop creativity boosters for students to help develop creativity, especially at undergraduate level. This could involve nurturing mental health; investing in teaching environments that enhance creativity (for example, by using green in lecture venues to activate creative thinking and having a space where students can take 'creative time out' to allow for the incubation of ideas as part of the teaching and learning process); and stimulating curiosity by using different teaching techniques (for example, exploration and conceptual conflict).

REFERENCES

Adams K 2005.The Sources of Innovation and Creativity.From<http://www.ncee.org/wp-content/uploads/2010/04/Sources-of-Innovation-Creativity.pdf> (Retrieved on 20 February 2014).

Afolabi MO, Dionne S, Lewis H 2009. Are We There Yet? A Review of Creativity Methodologies. From <http://www.cs.cornell.edu/Conferences/ASEE2006/ASEE%20Papers/Session%204/ASEE%20Final%20vs%203_Afolabi.pdf> (Retrieved on 20 February 2014).

Anon 2007. Assess Whole SEM Model—Chi Square and Fit Index. From <http://zencaroline. blogspot.com/2007/04/global-model-fit.html> (Retrieved on 25 February 2014).

Barrett JD, Peterson DR, Hester KS, Robledo IC, Day EA, Hougen DP, Mumford MD 2013. Thinking about applications: Effects on mental models and creative problem-solving. *Creativity Research Journal,* 25(2): 199-212.

Bergh ZC, Theron AL 2009. *Psychology in the Work Context.* 4th Edition. Cape Town: Oxford University Press.

Bollen KA 1989. A new incremental fit index for general structural equation models. *Sociological Methods and Research,* 17(3): 303-316.

Brevis T, Vrba M (Eds.) 2014. *Contemporary Management Principles.* Cape Town: Juta

Bronson P, Merryman A 2010. The Creativity Crises. Newsweek. From <http://www. newsweek. com/creativity-crisis-74665> (Retrieved on 20 February 2014).

Burbiel J 2009. Creativity in research and development environments: A practical review. *International Journal of Business Science and Applied Management,* 4(2): 35-51.

Christensen CM, Raynor ME, Anthony SD 2003. Six keys to creating new-growth businesses. *Harvard Management Update,* 8(1): 2-6.

Christiaans HHCM 2002. Creativity as a design criterion. *Creativity Research Journal,* 14: 41-54.

Cropley DH2008. Fostering and measuring creativity and innovation: Individuals, organisations and products. *Mendeley Issue,* 1942: 267-278.

De Brabandere L, Ivy A 2013.*Thinking in Boxes: A New Paradigm for Business Creativity.* New York: Random House.

Diamantopoulos A, Siguaw JA 2000. *Introducing LISREL.* London: Sage Publications.

Duff A, Duffy T 2002. Psychometric properties of Honey and Mumford's Learning Styles Questionnaire (LSQ). *Personality and Individual Differences,* 33: 147-163.

EpplerMJ, Hoffmann F, Resciani S 2011. New business models through collaborative idea generation. *International Journal of Innovation Management,* 15(6): 1323-1341.

Epstein R, Schmidt SM, WarfeL R 2008. Measuring and training creativity competencies: Validations of a new test. *Creative Research Journal,* 20(1): 7-12.

Field A 2002. *Discovering Statistics Using SPSS.* London: Sage.

Field A 2007. *Discovering Statistics Using SPSS.* London: Sage.

Fields Z 2012. *A Conceptual Framework to Measure Creativity at Tertiary Educational Level.* PhD Thesis, Unpublished. Potchefstroom: North-West University.

Fields Z, Bisschoff C 2013. A theoretical model to measure creativity at a university. *Journal of Social Sciences,* 34(1): 47-59.

Fields Z, Bisschoff C 2014. Comparative analysis of two conceptual frameworks to measure creativity at a university. *Problems and Perspectives in Management,* 12(3): 46-58.

Fortino A (n.d.). The Purpose of Higher Education: To Create Prepared Minds. From<http://www. evolllution. com/opinions/the-purpose-of-higher-education-to-create-prepared-minds/> (Retrieved on 22 February 2014).

Fryer M 2012. Some key issues in creativity research and evaluation as soon from a psychological perspective. *Creativity Research Journal,* 24(2): 21-28.

Garcia-Cepero MC2008. The Enrichment Triad Model: nurturing creative-productivity among college students. *Innovations in Education and Teaching International,* 45(3): 295-302.

Hadzigeorgiou Y, Fokialis P, Kabouropoulou M 2012. Thinking about creativity in Science Education. *Creative Education,* 3(5): 603-611.

Hennessey BA 2003. The social psychology of creativity. *Scandinavian Journal of Educational Research,* 47(3): 253-271.

Hicks K 2015. Why Creativity in the Classroom Matters More Than Ever. Edudemic. From <http://www.edudemic.com/creativity-in-the-classroom/> (Retrieved on 20 May 2015)

Hooper D, Coughlan J, Mullen M 2008. Structural equation modelling: Guidelines for determining model fit. *Electronic Journal of Business Research Methods,* 6(1): 53-60.

Hu LT, Bentler PM 1999. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling,* 6(1): 1-55.

Jackson NJ 2008. Tackling the Wicked Problem of Creativity in Higher Education. From <http://imaginativecurriculumnetwork.pbworks.com/f/WICKED+PROBLEM+OF+CREATIVITY+IN+HIGHER+EDUCATION.pdf> (Retrieved on 20 February 2014).

James V, Gerard RL, Vagt-Traone B 2009. Creativity from Emerging Perspectives on Learning, Teaching and Technology. From <http://projects. coe. upa.edu/epltt/index.php?title=Creativity> (Retrieved on 20 February 2014).

Katou AA, Budhwar PS 2010. Causal relationship between HRM policies and organisational performance: Evidence from the Greek manufacturing sector. *European Management Journal,* 28(1): 25-39.

Kerr B, Gagliardi C 2003. Measuring creativity in research and practice. *Mendeley,* 4(1): 155-169.

Maiyaki AA 2012. Influence of service quality, corporate image and perceived value on customer behavioral responses: CFA and Measurement Model. *International Journal of Academic Research in Business and Social Sciences,* 2(1): 403-414.

McLeod S 2007. Cognitive Psychology. From <http://www.simplypsychology.org/cognitive.html> (Retrieved on 22 February 2014).

Mitchell WE, Kowalik TF 1999.Creative Problem Solving Workbook. 3rd Edition. From <http://www.roe11.k12.il.us/GES%20Stuff/Day%204/Process/Creative%20Problem%20Solving/CPS-Mitchell%20and%20Kowalik.pdf> (Retrieved on 21 February 2014).

Mumford MD 2000. Managing creative people: Strategies and tactics for innovation. *Human Resources Management Review,* 10(3): 313-351.

Petocz P, Reid A, Taylor P 2009. Thinking outside the square: Business students' conceptions of creativity. *Creativity Research Journal,* 21(4): 409-416.

Petrowski MJ 2000. Creativity research: Implications for teaching, learning and thinking. *Emerald,* 28(4): 304-312.

Robelen E 2013. Measuring Student Creativity Topic of New Report. Education Week. From <http://blogs.edweek.org/edweek/curriculum/2013/02/measuring_creativity_of_studen.html> (Retrieved on 24 February 2014).

Rowlands S 2011. Discussion paper: Disciplinary boundaries for creativity. *Creative Education,* 2: 47-55.

Sekaran U, Bougie R 2009. *Research Methods for Business: A Skill Building Approach.* 5th Edition. New York: John Wiley and Sons Ltd

Stephen F Austin State University (SFA) 2015. Texas Institute for Creativity and Innovation: Purpose. From <http://www.sfasu.edu/tici/purpose.asp> (Retrieved on 20 May 2015).

Tan HK, Prosser M 2004. Qualitatively different ways of differentiating student achievement: A phenomenographic study of academics' conceptions of grade descriptors. *Assessment and Evaluation in Higher Education,* 29: 267-282.

Thomas W 2015. Measuring Creativity and Innovation. From <http://alumni.virginia.edu/hoosnetwork/2015/04/measuring-creativity-and-innovation/> (Retrieved on 20 May 2015).

TLRP (Teaching and Learning Research Programme) 2008. *Education, Globalisation and the Knowledge Economy: A Commentary by the Teaching and Learning Research Programme.* London: Institute of Education.

Tsai KC 2012. The value of teaching creativity in adult education. *International Journal of Higher Education,* 1(2): 84-91.

Tucker L, Lewis C 1973. A reliability coefficient for maximum likelihood factor analysis. *Psychometrika,* 38(1): 1-10.

Vilalba E 2008. *On Creativity – Towards an Understanding of Creativity and its Measurement.* Luxembourg, Italy: Office for Official Publications of the European Communities.

Williams B, Brown T, Onsman A 2012. Exploratory factor analysis: A five-step guide for novices. *Australasian Journal of Paramedicine,* 8(3): 1-13.

Williamson RM 2009. What Gets Measured Gets Done: Are You Measuring What Really Matters? From <http://www.swspitcrew.com/papers/What% 20Gets%20Measured%201106.pdf> (Retrieved on 20 February 2014).