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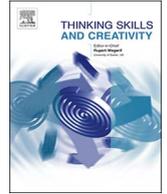
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# Factor structure of the Torrance Tests of Creative Thinking Figural Form A in Kiswahili speaking children: Multidimensionality and influences on creative behavior



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## ABSTRACT

The Torrance Tests of Creative Thinking (TTCT) was developed in 1966 and has been translated into more than 35 languages (Millar, 2002). It is the most used and referenced creativity test (Davis, 1997; Lissitz & Willhoft, 1985). This study carried out in poor areas of Dar es Salaam, Tanzania with 125 Kiswahili speaking children aged 8–12 years old had two aims. First to investigate the structure of creativity in a sample of African children and second to explore any creativity correlations with children's environment and background. These findings could go some way to considering the cross-cultural transferability of the TTCT. Confirmatory factor analysis (CFA) was used to compare four theoretical models originally proposed by Kim (2006) to investigate whether creativity might also be multidimensional in the case of poor African children. Indeed a model of two correlated factors – adaptive and innovative, best explained the creativity construct in this case. The model was then used to explore creativity correlations with children's environment and background factors. The total creativity index score was found to be correlated with the child's birth order, fluency of English in the household and self-perceptions of the child. This research provides some evidence for the valid use of the TTCT in sub-Saharan Africa.

## 1. Introduction

Being creative is a universal human attribute. However, the representation of creative abilities would have both local as well as global cultural influences (Mpofu, Myambo, Mogaji, Mashego, & Khaleefa, 2006). It is unclear whether and how western constructs for creativity translate to African settings (Myambo and Mpofu, 2004; Mpofu et al., 2006). Questions arise as to the context validity of test questions and also the response demands on examinees. There is also evidence to suggest the importance of the cultural-contextual worth of indicators of creative abilities. For instance, in African settings a person's creative abilities may be perceived to be bound to domains of collective living (e.g. social problem solving; networking with others) and less so with achievement on school-like tasks or those that demand responses to hypothetical or decontextualized questions (Mpofu et al., 2006; Serpell, 2011a, 2011b; Sternberg et al., 2001).

Understanding respondents' referent terms for human abilities is critical for appropriate test targeting and guiding the appropriate use of measures (International Test Commission, 2010; Saklofske, van de Vijver, Oakland, Mpofu, & Suzuki, 2015). It is unclear

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whether and how western constructs for abilities like creativity and their measures translate to African settings (Mpofu et al., 2006). Questions arise as to the context validity of the test questions and also the response demands on examinees. There is also evidence to suggest the importance of the cultural worth of specific abilities and their indicators. African respondents may link their abilities to contexts without generalizing them to their own personal qualities. This means one may be perceived to be creative in certain demand settings (social problem solving; networking with others) without the presumption that the person would be creative in how he or she handles school-like tasks or those that demand responses to hypothetical or decontextualized questions (Mpofu et al., 2006; Serpell, 2011a, 2011b; Sternberg et al., 2001). Performance in a particular way on certain tasks would define creative behavior for them. The Torrance Tests of Creative Thinking are more akin to school-like tasks in the type of questions and demands for expressive writing. Evidence is needed, therefore, on whether they would generate expected responses from Kiswahili speaking Tanzanian school children. The children may have psycho-behavioral scripts that are based on previous learning within an opportunity structure (e.g., family, cultural group, community). For instance, social propinquity and the social timeliness with which a child responds to collective needs with others is a valued behavior in sub-Saharan culture (Mpofu et al., 2012; Serpell, 2011a, 2011b). An investigation into the mastery related demands processes would therefore define creativity (Sternberg, 2003) perhaps more than a response to pen and paper test items. In settings in which cultural competencies prioritizes one's own needs in the context of those of others, multi-tasking is a survival skill and evidence to be singularly focused in carrying a certain task through to the end might indicate social immaturity.

## 2. The current study

This study has two aims. The first is to investigate creative abilities among Kiswahili speaking children in Tanzania as measured by the Torrance Tests of Creative Thinking (TTCT). The second to consider the social-contextual factors that may explain the representation of creative abilities among these East African children. As stated in the introduction, owing to the pen and paper nature of the TTCT, evidence is needed to ascertain whether the creativity construct of Divergent Thinking (DT) is dimensionally equivalent in an African as in a western setting. The TTCT was developed in 1966 (Torrance, 1966) and measured fluency, flexibility, originality and elaboration taken from Guilford's DT factors (Guilford, 1959). By 1998 the test had been updated and consisted of six sub-scores:

- Fluency: Showing the ability to produce a number of figural images;
- Originality: Ability to produce uncommon or unique responses;
- Elaboration: The ability to develop and elaborate on ideas;
- Abstractness of Titles: A title for the figure moves beyond concrete labeling;
- Resistance to Premature Closure: An ability to keep an 'open mind' where incomplete figures are not closed by the quickest route, but through irregular lines or not at all;
- Creative Strength: Consisting of thirteen criterion-referenced measures<sup>1</sup>

Translated into more than 35 languages (Millar, 2002) it is the most used and references creativity test (Davis, 1997; Lissitz & Willhoft, 1985). Initially it was proposed by Kirton (1976) that a single dimension, which ranged from an innovative to an adaptive orientation, reflected a person's attitude to creativity, problem solving and decision making (Kirton, 1976; Puccio, Treffinger, & Talbot, 1995). An individual who provides rapid and novel responses can be said to possess a more innovative style of creativity. Those with an adaptive style give more detailed responses with a greater depth of thought (Kim, 2006; Puccio et al., 1995; Oliveira et al., 2009). This unidimensionality was first questioned and investigated by Kim (2006) who postulated that these could indeed be two separate dimensions (Kim, 2006; Kim, Cramond, & Bandalos, 2006). Kim's hypothesis (Kim, 2006; Kim et al., 2006) formed the basis for the first theoretical model (Model 1) regarding the conformation of the creativity construct. Thus, the latent innovative factor (INNO) comprises the abilities of fluency (F) and originality (O), and the latent adaptive factor (ADAP) comprises elaboration (E), abstractness of titles (AT), and creative strengths (CS). The dimension of resistance to premature closure (RPC) is included in both the innovative factor and adaptive factor (Fig. 1). Subsequent research carried out by Krumm, Aranguren, Filippetti, and Lemos (2014) and Krumm et al. (2016) in Argentina undertook a similar study with Spanish speaking children. Krumm et al. (2014, 2016) started with Kim's hypothesis and Model 1 but went on to test three additional theoretical models through Confirmatory Factor Analysis (CFA). As illustrated in Fig. 1, Model 2 is the same as Model 1 in all respects but with the dimension of resistance to premature closure only included in the latent innovative factor. Model 3 is the same as Model 2 but resistance to premature closure has been removed from the innovative factor and is now contained in the adaptive factor. For Model 4 the creative strengths dimension was removed from the model – thus the latent innovative factor comprising of fluency and originality and the adaptive factor consisting of resistance to premature closure, elaboration and abstractness of titles.

Contextual factors and their effect on creativity have been explored in various contexts (Akinboye, Fagbami, Majekodunmi, Okafor, & Esezobor, 1989; Csikszentmihalyi, 1988; Khaleefa, Erdos, & Asharia, 1997; Kim, 2009; Mogaji, 1999; Mpofu et al., 2006; Shi, 2004). Indeed Sternberg's investment theory of creativity (Sternberg, 2006; Sternberg & Lubart, 1995) implies that creativity requires a 'confluence of six distinct, but interrelated, resources: intellectual abilities, knowledge, styles of thinking, personality,

<sup>1</sup> Emotional expressiveness, storytelling articulateness, movement or action, expressiveness of titles, synthesis of incomplete figures, synthesis of lines or circles, unusual visualization, internal visualization, extending or breaking boundaries, humour, richness of imagery, colourfulness of imagery, and fantasy.

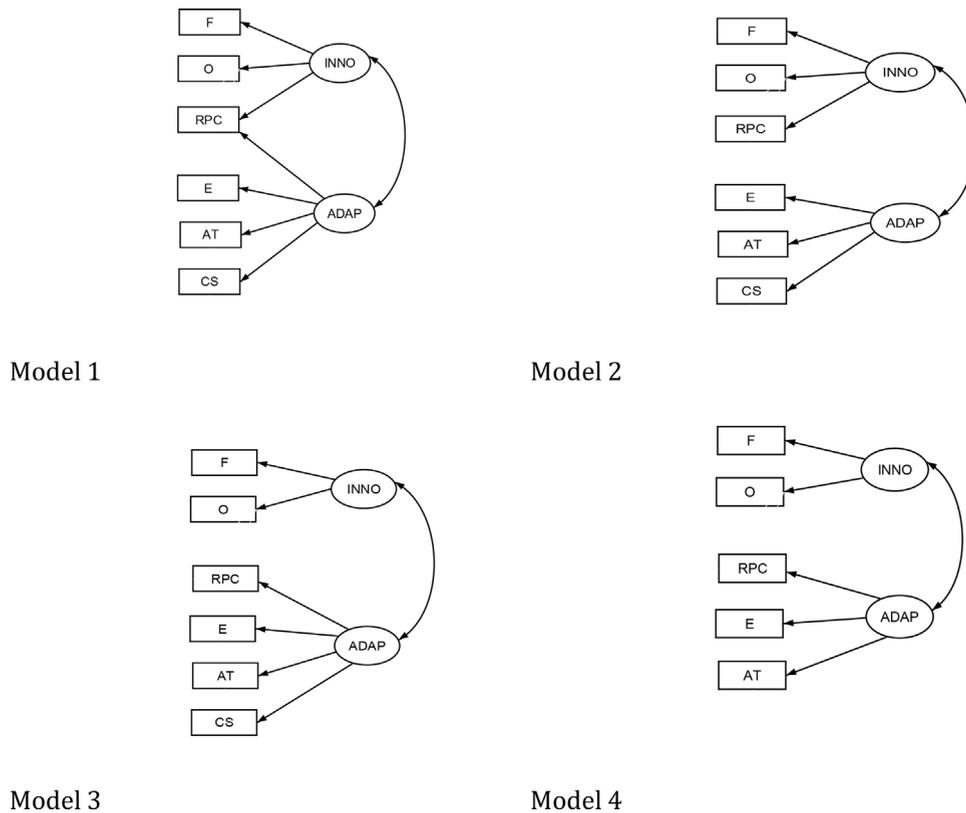


Fig. 1. Hypothesized models of creativity construct.

INNO = Innovative; ADAP = Adaptive; F = Fluency; O = Originality; RPC = Resistance to premature closure; E = Elaboration; AT = Abstractness of titles; CS = Creative strengths. (see Krumm et al., 2016).

motivation, and environment' (Sternberg, 2012). Creativity is not about one thing but about a system of things (Csikszentmihalyi, 1988). In previous studies the socio economic situation of students and the level of education of their parents have been shown to impact on students' divergent thinking abilities (Mpofu et al., 2006). Khaleefa et al. (1997) finds that in Sudan, urbanization has a positive effect on fluency and that modernization improves creativity relative to traditional rural settings. In Nigeria research provides evidence to suggest that highly creative students are usually above average in academic performance, but not necessarily the top (Akinboye et al., 1989; Mogaji, 1999). According to Kim (2009) culture impacts on creativity. Looking at the effects of Confucianism through scores on the TTCT and a measure of Confucianism (Eastern-Western Perspective Scale) she finds that some elements such as 'Unconditional Obedience', 'Gender Inequality', 'Gender role Expectations' and 'Suppression of Expression' provide cultural blocks to creativity in Korean society.

In line with these previous investigations this study proposed to explore whether poor African children's creativity, as measured through the TTCT, would be unidimensional or multidimensional and that the creativity construct of DT is dimensionally equivalent to these studies. Utilising CFA the same four theoretical two-factor models as initiated by Kim (2006) and developed by Krumm et al. (2014, 2016) were tested to explore the underlying construct of creativity. In addition it was then considered how any creative dimensionalities could correlate to an individual's contextual factors including education, social environment, family and personal factors (personality, intelligence, knowledge and experience).

### 2.1. Goals of this study

There were two aims of this study. First to investigate the creativity construct measured by the TTCT-Figural, Form A, and determine whether two factors – innovative and adaptive – would also hold to be true in an African setting as in western settings. Second to explore any correlations between creative dimensionalities and individual's contextual factors, including education, social environment, family and personal factors. This would include considering the perceptions of teachers and parents through interviews, about thoughts on creativity and giftedness. Findings would provide evidence for the cross-cultural transportability of the TTCT to African settings. This work also seeks to build on the findings of studies by Krumm et al. (2014), Kim (2006) and Kim et al. (2006), which were derived from Kirton (1976, 1978, 1982, 1987, 1989).

### 3. Method

#### 3.1. Participants

The overall research project funded by the Economic and Social Research Council (ESRC) was made up of two phases. Reported here are the findings from the second phase. The framework was a multistage convergent mixed methods study. The overall aim was to investigate how the school community regards the ability, commitment and creativity of children living in poor environments and from disadvantaged backgrounds. The first phase set out to consider the influences of family and school environment on children's achievement and the likelihood of being identified for enrichment programmes (Humble & Dixon, 2017). Initially 1857 children living in economically deprived areas of Dar es Salaam, Tanzania studying in grades 4 and 5 from 17 primary schools participated. The aim was to find a subset of children to receive further testing (in phase two) to identify those who were deemed as 'talented', but could also be committed to task and creative. In total 125 children (females = 54%; age range 8- 12 years,  $M = 10.03$ ,  $SD = 0.842$ ) were categorized by two or more indicators as being 'talented' in this first phase:

- 1) Teacher identification (three were named by each teacher);
- 2) Peer identification (three were named by the students in each class);
- 3) Self identification (Student Multiple Intelligences Profile (SMIP));
- 4) Test score (IQ, mathematics, Kiswahili and English reading).

These 125 children then participated in the second phase, which considered task commitment and creativity.

#### 3.2. Measures

During phase one, for all 1857 pupils, data were collected on the children's background (see Table 4), their personal self-perception around multiple intelligences, as well as IQ tests standardised to UK norms, mathematics, English reading and Kiswahili tests (Dixon, Humble, & Chan, 2016; Humble, Dixon, & Schagen, 2016; Humble & Dixon, 2017). The children were given a self perception survey as part of the research, using an adapted version of Chan's *Student Multiple Intelligences Profile* (SMIP), a self report checklist designed to assess student's strengths in eight of Gardner's intelligences (Chan, 2006; Gardner, 1983).

During phase two 125 children completed a questionnaire around their own creativity self-belief (Renzulli & Hartman, 1981) and took the TTCT-Figural (Form A). The TTCT-Figural (Form A), used in this research includes three activities. In the first activity, the subject is asked to draw a picture based on a stimulus that is provided on the test page. This activity is to evaluate originality, elaboration, and abstractness of title. The second activity requires the individual to draw pictures, using ten incomplete figures as a starting point, to which titles are added. Activity two is to evaluate fluency, originality, elaboration, abstractness of title, and resistance to premature closure. Activity three consists of three pages of sets of parallel lines, and the individual must draw using these parallel lines as part of their picture. This activity evaluates fluency, originality, and elaboration (Torrance, Ball, & Safter, 1992). The children are given 10 min to complete each of these three activities. The TTCT-Figural has never been trialed in sub-Saharan Africa. Therefore the constructs are based on western assumptions. Examples of these Tanzanian children's work from the TTCT-Figural can be seen in the Appendix.

#### 3.3. Procedure and ethical aspects

The Education Ministry of Tanzania granted permission for the study. All children volunteered to participate in this project. All children and their parents/guardians were informed through their schools that the purpose of the assessment exercise was to assess the strengths or talent areas of the children, that participation was voluntary, and that the results of the assessment would be kept strictly confidential and for research use only. Letters were sent home and meetings arranged, where requested, to explain the project and the whole procedure that was to occur.

##### 3.3.1. Phase one

For the 1857 children who participated in phase one, testing took place within the children's own class in their own schools, and occurred in the morning for all participants. This overall testing in each school lasted for around three hours.

##### 3.3.2. Phase two

During phase two, 125 children in groups of 10–20 completed the TTCT. Testing took place within the children's own classes in their own schools. Testing was carried out in the morning for all participants. Education Masters students from the University College Dar es Salaam administered the tests. These 'administrators' had been given special training from the research principal and co-investigators specifically for the project. The administrators were given a script utilizing TTCT guidelines translated into Kiswahili.

#### 3.4. Data analysis

The values for the mean, standard deviation, skewness and kurtosis for the six TTCT subscales show multivariate normality, which is an assumption when carrying out structural equation modeling (Table 1). All univariate and joint distributions are normal and

**Table 1**  
Descriptive Statistics.

Subscale	Mean	Standard Deviation	Skewness	Kurtosis
Fluency	103.29	16.60	0.13	–0.13
Originality	103.25	17.89	0.01	–0.51
Elaboration	78.06	14.32	0.83	0.70
Titles	68.31	22.68	–0.36	–1.19
Closure	72.71	18.99	0.58	–0.15
Strengths	4.47	2.67	0.45	0.09

Note: N = 125 Titles = abstractness of titles; closure = resistance to premature closure; strengths = creative strengths.

bivariate scatterplots are linear and homoscedastic. Each variable is normally distributed as no values of the skewness and kurtosis are greater than |2.0| (Field, 2000; Trochim & Donnelly, 2006; Gravetter & Wallnau, 2014).

Exploratory factor analysis was initially conducted in order to determine the number of factors that could adequately represent the data. An initial estimation yielded two factors with eigenvalues exceeding unity, accounting for 57% of the total variance. CFA utilizing STATA was then performed to examine the latent structure of the creativity construct. As set out above the models were as follows: Model 1–“creativity construct with resistance to premature closure as part of the innovative and adaptive latent factors”; Model 2–“creativity construct with resistance to premature closure as part of the innovative latent factor”; Model 3–“creativity construct with resistance to premature closure as part of the adaptive latent factor”; Model 4–“creativity construct without creative strengths” (Fig. 1).

In order to establish which model provided the best fit the  $\chi^2$  test and the fit indices were calculated. A range of fit and comparison-based indices, including chi-square, was used to determine which model provided the best fit for these Africa data (Bentler, 1990; Browne & Cudeck, 1993; Steiger, 1990). The fit indices are shown in the table below and include Root Mean Square Error of Approximation (RMSEA), Standardised Root Mean Square Residual (S-RMR), Coefficient of Determination (CD), Tucker-Lewis Index (TLI) and Comparative Fit Index (CFI). Hu and Bentler (1999) suggest various cut offs for these fit indices. To minimize Type I and Type II errors one should use a combination with S-RMR or the RMSEA. In general good models should have an S-RMR < 0.08 or the RMSEA < 0.06 with the fit index values > 0.9. Information regarding RMSEA, S-RMR, CD, TLI and CFI on these models and the correlations of the individual measures is given in Table 2.

## 4. Results

### 4.1. Confirmatory factor analysis (CFA)

The first aim of the study was to investigate the creativity construct measured by the TTCT-Figural, Form A, and determine whether two factors – innovative and adaptive – would also hold to be true in an African setting as in western settings. Confirmatory factor analysis was therefore used to study the structure of the latent creativity construct. Different models were tested. The fit indices of Model 4 with the pattern of factor loadings held invariant and including covariance shows the best fit with CD, TLI and CFI all greater than 0.90 and the S-RMR less than 0.08. Model 3 was untenable (see Table 2 and Fig. 2). The two factor model (Model 4) was further analysed by evaluating the parameter estimates. The large values of the factor loadings indicated that the creative measures were a good indication of their factors. However the low factor loading for abstractness of titles is relatively low (0.2) implying that it does not relate as highly to the adaptive factor as do elaboration (0.66) and resistance to premature closure (0.53).

Table 3 contains the correlation matrices for each of the creative measures of the TTCT. The correlation coefficients were all significant (either at the 0.01 or 0.05 level of significance) apart from abstractness of title (AT) with elaboration (E) and resistance to premature closure (RPC) with abstractness of title (AT). The correlation coefficients between fluency (F) and originality (O) were very high (0.83).

CFA were also conducted with one general factor (unidimensional construct) in order to compare this with Model 4 (two factors). The chi-square value and the fit indices were poor suggesting that the two-factor model was a much better fit ( $\chi^2(9) = 65.312$ , RMSEA = 0.224, S-RMR = 0.1, CD = 0.913, TLI = 0.66, CFI = 0.796–fit indices for the one factor). Thus the two factor model was retained as the best model of fit. This implies that the creativity construct is best explained by a model of two correlated factors as in Model 4.

**Table 2**  
Table of Fit Indices of Models.

Competing Model	$\chi^2$	df	Fit Index				
			RMSEA	S-RMR	CD	TLI	CFI
Model 1	36.962	7	0.185	0.099	0.993	0.767	0.891
Model 2	37.995	8	0.173	0.102	0.993	0.796	0.891
Model 3	Untenable						
Model 4	8.444	4	0.094	0.047	0.981	0.945	0.978

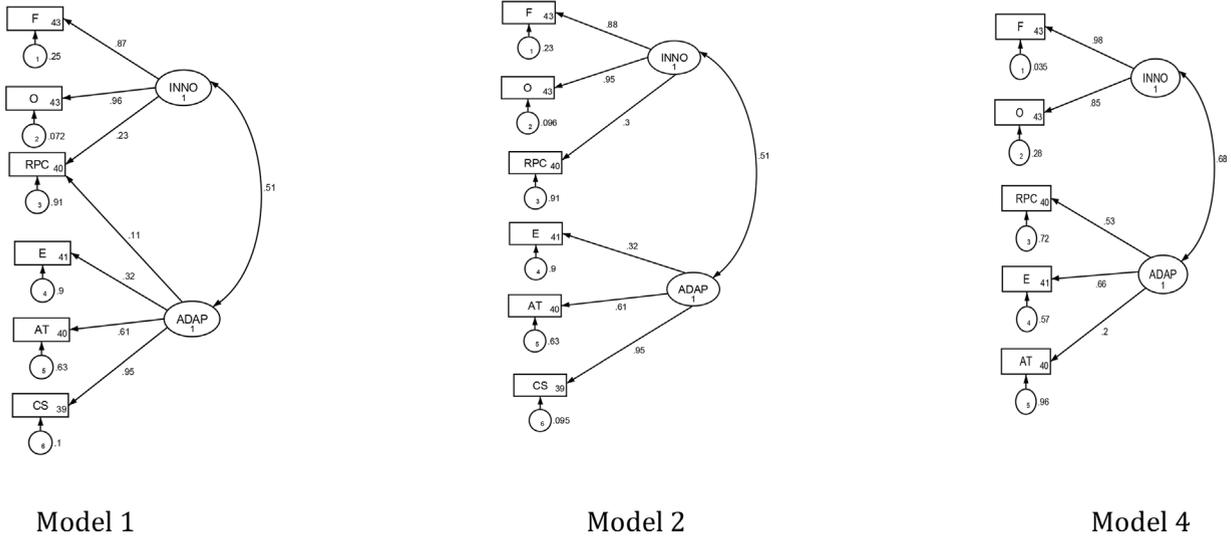


Fig. 2. Estimated Models of creativity construct.

Note: INNO = Innovative; ADAP = Adaptive; F = Fluency; O = Originality; RPC = Resistance to premature closure; E = Elaboration; AT Abstractness of titles; CS = Creative strengths

Table 3  
Correlations of creative measures.

	F	O	E	AT	RPC	CS
F						
O	.83**					
E	.44**	.38**				
AT	.22*	.28**	0.06			
RPC	.34**	.25**	.37**	0.07		
CS	.37**	.47**	.30**	.58**	.21*	

Note. F = fluency, O = Originality, E = Elaboration, AT = Abstractness of title, RPC = Resistance to premature closure, CS = Creative strength.

\* p < 0.05.

\*\* p < 0.01.

4.2. Regression

The second aim of the study was to explore any correlations between creative dimensionalities and individual’s contextual factors, including education, social environment, family and personal factors. The two creativity dimensions – innovative and adaptive – were used to explore the context of, and investigate the interaction between, the individual personnel background factors and creative behavior. It can be conjectured that the background and the environment in which a person lives play an important role in helping to form personality and behavior.

Prior analyses have been carried out on the whole data set utilizing regression analyses. This was done in order to consider associations between student ability, learning outcomes, school data, teacher data and background/family data.<sup>2</sup> Certain factors were found to be statistically significantly correlated to student ability and outcomes. This analyses retained only those significant variables as it was hypothesized they were more likely to show any correlation with creativity. These contextual factors of educational, social and family were examined to consider their influence on creativity measures. Table 4 provides the variables and their meaning.

A model was constructed to examine how innovative and adaptive creativity measures correlated with these factors. Literature indicates that, although creative thinking is partially hereditary, the context in which an individual grows up, and in which they live, plays a major role in whether their latent potential will be expressed (Isaksen, Dorval, & Treffinger, 2000). Multiple regression was carried out using SPSS and the results are provided in Table 5 showing any correlations with the creativity measures – fluency, originality, elaboration, abstractness of title, resistance to premature closure – and the total creativity index. The table shows the variables with significant correlations only (p < 0.001), their impact size and their quasi effect size related to the TTCT measure.

In Model 4 (Fig. 2) the latent innovative factor (INNO) consisted of only the two most highly correlated items fluency and originality. It can be seen from the results set out in Table 5 that there are 5 independent variables that have a significant effect related only to the latent innovative factor. These are average age in students class (avage), average standardized reading score in

<sup>2</sup> Reported elsewhere (Humble & Dixon, 2017)

**Table 4**  
List of variables.

Variable name	Label
peer15	Identified by at least 15% of your peers as gifted
tiden	Identified by the teacher as gifted
ciden	Identified by at least 1 peer as gifted
selfpercep	Self perception score
creativity	Score on a creativity survey
IQss	IQ standardized score
readss	English reading standardized score
maths	Mathematics score
kiswahili	Kiswahili score
ptr	Pupil teacher ratio
schfact1	The school has a tv and a computer
schfact2	The school has desks and musical instruments
teachera	The teacher's age
classsize	The size of the class
avage	Average age in the class
avIQss	Average IQ standardized score in the class
avreadss	Average reading standardized score in the class
teachex	Teacher experience
teachqual	Teacher qualification
gender	Child's gender
age	Child's age
eldest	The child is the eldest child in the family
englishw	A member of the family is fluent in English
brosis	Number of brothers and sisters
fathered	The father's education level
mothered	The mother's education level
wealth	Wealth as determined by a wealth index
looinside	The family home has a toilet inside the home
electric	The family home has electricity in the home.

students class (avreadss), teacher qualification i.e., certificate, degree, diploma (teachqual), you are the eldest in the family (eldest) and an elder member of the family can speak or write English fluently (englishw). With two of these factors 'eldest' and 'englishw' featuring heavily in the overall Creativity Index. There is one negative and four positive factors. In terms of the negative factor (teachqual), the more qualified your teacher the more likely you will tend to have a lower innovative score. With respect to the positive independent variables (avage, avreadss, eldest, englishw), if your class is older, if your classes average English reading score is higher, if you are the eldest in your family and someone in your family can speak English then the more likely you are to obtain a higher innovative score. The analysis implies that if you are older or you are in an environment whether at home or at school where people excel in English you are more likely to have greater ability to produce more uncommon or unique responses. Looking at the quasi effect size (Quasi ES), this gives the average change in the outcome expressed as a percentage of the outcomes standard deviation for an average change in the background variable. To show the meaning of this, when considering the child being the 'eldest' in the family and looking at the corresponding quasi effect size, it can be said that being the eldest increases your innovative score by 41% of the originality standard deviation.

The latent adaptive factor (ADAP) consists of the following creativity measures: resistance to premature closure, elaboration and abstractness of titles. The table above shows there are 2 negative and 3 positive independent variables that have a significant effect related to only the children's adaptive factor. These are the highest education qualification the mother obtained (mothered), age of the child (age), average standardized IQ for the whole class (avIQss) and standard of school equipment provision (schfact1). The fifth factor relates to a questionnaire given to the students around their own creativity self-belief (creativity) (this survey was adapted from creativity questions created by [Renzulli & Hartman \(1981\)](#)). The average standardized IQ in the class seems to have mixed effects on the adaptive factor showing both positive and negative quasi effect size. The other factor showing a negative effect is that of the school's equipment provision, saying this decreases your resistance to premature closure (RPC) score by 63% of the RPC standard deviation. With respect to the positive independent variables, if you are older, if your mother has had more education and if you think you are creative, then the more likely you are to obtain a higher adaptive score. Being older is significant to two items in the adaptive factor, both abstractness of titles (AT) and resistance to premature closure (RPC), and having a similar level of effect on both. Your own self perception of your creativity effects both elaboration (E) and resistance to premature closure (RPA), with the largest quasi effect size increasing your elaboration score by 32% of your elaboration's standard deviation.

Other factors that have a positive significant effect on the creativity score across both innovative and adaptive factors are the number of years your class teacher has been teaching (teachex), if you are a girl (gender) and self-perception of giftedness (selfpercep). There is a positive correlation between confidence (self perception score) and two of the creativity items as well as the overall creative index. Teacher experience also affects positively the total creativity index. In terms of negative factors, there is only one, the school factor that stipulates that the school has available desks and musical instruments only (schfact2), and hence not as 'affluent' a school compared with others (schfact1). It is interesting to note that pupil achievement, other identifiers and family

**Table 5**  
Ordinary Linear Regression on Personal Background and Creativity Measures.

Outcome	Significant odds multiplier					Creativity Index
	Innovative Latent Factor		Adaptive Latent Factor			
	F	O	E	AT	RPC	
<b>AchievementOutcomes</b>						
IQss						
readss						
maths						
kiswahili						
<b>Other-Identifiers</b>						
peer15						
tiden						
ciden						
<b>Self-Identifiers</b>						
selfpercep		0.267 (0.24)		0.313 (0.30)		5.212 (0.30)
creativity			0.348 (0.32)		0.282 (0.25)	
<b>School factors</b>						
ptr						
schfact1						
schfact2		–0.325 (–0.3)	–0.396 (–0.36)	–0.424 (–0.41)	–0.721 (–0.63)	
teacherage						
teachex		0.735 (0.67)		0.792 (0.76)	0.325 (0.28)	10.875 (0.62)
teachqual		–0.339 (–0.31)				
classsize						
<b>Peer factors</b>						
avage		1.499 (1.38)				
avIQss				0.829 (0.80)	–0.634 (–0.55)	
avreadss		1.148 (1.05)				
<b>Family</b>						
gender		0.349 (0.32)		0.279 (0.27)		
age				0.315 (0.30)	0.411 (0.36)	
eldest		0.452 (0.41)				7.259 (0.41)
englisw	0.618 (0.56)	0.473 (0.43)				8.181 (0.47)
brosis						
fathered						
mothered					0.324 (0.28)	
wealth						
looinside						
electric						

Numbers in the above table are – Impact size (quasi effect size Schagen & Elliot, 2004).

factors relating to wealth did not relate to any of the creativity measures or constructs.

#### 4.3. Thoughts on creativity and giftedness

Interviews with parents and teachers were carried out in order to consider in more depth thoughts around creativity and giftedness in such an Africa setting.

##### 4.3.1. Teacher identification

In practical situations, teacher nomination is one of the most common methods for identifying gifted students. However, teachers tend to prefer gifted children who are low in creativity to those who are highly creative (Anderson, 1961). Research has shown that teachers tend to identify students who are ‘achievers’ and ‘teacher pleasers’ as gifted rather than creative students who may be disruptive or unconventional (Davis & Rimm, 1994; Oliphant, 1986; Rimm & Davis, 1976; Ritchie, 1980).

Our subgroup of 125 ‘talented’ children had been selected from 1857 students by a range of identification methods including school based tests, IQ, peer recommendation, teacher recommendation and self perception of giftedness. In total, out of the 125, the teachers had named 18 as being ‘gifted’. To see if teachers recognized the children whose creativity or IQ score was statistically significantly different from those not identified an independent sample *t*-test was carried out. The results show no significant difference between the means of the students’ creativity index [ $t(123) = 0.426, p > 0.05$ ] nor the means of IQ standardized scores [ $t(123) = 0.772, p > 0.05$ ] between the teacher identified and non-teacher identified children. This seems to imply that teachers did not recognize either of these skills in their students. In fact when considering all the test results it is only the children’s English reading standardized score that gives a significant difference [ $t(123) = -3.575, p = 0.001$ ](Table 6).

**Table 6**  
Identified and not by teacher.

	Teacher identified the child as gifted	N	Mean	Std. Deviation
IQss	no	107	87.74	12.242
	yes	18	85.28	14.024
Creativity Index	no	107	93.85	17.593
	yes	18	91.94	17.461
Maths	no	107	24.55	2.194
	yes	18	24.39	3.071
Readss	no	107	84.85	10.053
	yes	18	94.00	10.006
Kiswahili	no	107	6.78	1.254
	yes	18	6.89	1.605

When teachers were asked why they had nominated a specific child as gifted<sup>3</sup> (they were asked to nominate three in their class) typical responses were very focused on classroom performance saying ‘does well in class/daily work/exams’ or ‘controls the class when I’m not there’ ‘leads others in the lesson’ ‘gives help to weak pupils’ ‘good at reading’ ‘good at English’ ‘quick, confident and smart’ ‘self-respect and clean’. No teacher used the word ‘creative’ or ‘creativity’ as a reason for nomination.

#### 4.3.2. Comments from parents

Interviews with the parents revealed the complete opposite view regarding giftedness to the teachers’ in relation to creativity. Parents (N = 174) were taken from the original 1857 children tested in Dar es Salaam. Children from 3 schools took home a household survey and returned them the following day. When surveying a sample of 174 parents about what they understood to be meant by being ‘gifted’,<sup>4</sup> about one third used the word, without being prompted, ‘creative’ or ‘creativity’ in their responses. Some examples included:

‘Is innovative, creative and inquisitively curious to know more’.

‘By looking at the way they do things differently’.

‘Is a child that does lots of great things which are creative using their brain and cooperating with other children’.

‘Creative and intelligent’.

‘Likes to create things’.

‘Write creative poems’.

Parents tended to link the word ‘creative’ with children being able to do things by themselves and acting as an individual. One quoted that the child who is gifted would ‘go into work that was creative’ when they grew up; another that ‘the child will be self reliant and create new ideas when they grow up’. When asked if gifted children should be treated differently at school a variety of answers around the same theme included, ‘yes, because they need to have time to show their creativeness and develop their creativity’, ‘yes, to increase their knowledge, creativeness and increase their ability to study more’, ‘yes, to help them in school activities and allow them to become more creative and understanding’.

## 5. Discussion

This work was partly based on the studies by Krumm et al. (2014), Kim (2006) and Kim et al. (2006), which were derived from Kirton (1976, 1978, 1982, 1987, 1989). The work aimed to investigate the creativity construct measured by the TTCT-Figural, Form A, and determine whether two factors – innovative and adaptive – would also hold to be true in an African setting as in western settings. In this study the model that best fits the data (Model 4) includes resistance to premature closure in the adaptive factor and excludes creative strengths from the model. This is in line with previous studies (Krumm et al., 2014; Krumm et al., 2016). This study therefore shows that creativity as measured by the TTCT is a two dimensional construct made up of innovative and adaptive factors. Indeed Kim (2006) first questioned the assumption of unidimensionality and postulated there could be two separate dimensions. A more innovative style would imply rapid and novel responses with an adaptive style providing more detail and greater depth of thought (Kim, 2006; Kim et al., 2006).

In this study we analysed the TTCT to understand its latent structure and to learn more about the cognitive function of creativity. Analysis of the latent structure is one useful way of examining construct validity. Data obtained with factor analysis in this study shows consistency of the creativity construct as in other studies (Kim et al., 2006; Krumm et al., 2014; Krumm et al., 2016). The results also provide evidence that the TTCT is some way transportable cross culturally. This result in an African setting demonstrates again that the TTCT is not unidimensional, as proposed by various authors for western settings (Chase, 1985; Clapham, 1998; Heausler & Thompson, 1988; Hocevar, 1979a, 1979b; Hocevar & Michael, 1979; Runco & Mraz, 1992; Treffinger, 1985). These results also do not coincide, with the theoretical proposal of Torrance et al. (1992) that the TTCT is composed of five separated abilities (i.e., fluency, originality, elaboration, resistance to premature closure and abstractness of titles) and creative strengths.

<sup>3</sup> Instruction to teachers “Who are the three most gifted children in your class. Please give reasons why”.

<sup>4</sup> The instruction to parents was “What do you understand by high ability or gifted children?”

Of particular interest is the finding that African learners with material poverty conceived ideational fluency and originality to strongly define creativity. Trustworthiness of this finding is supported by the fact that these learners come from a cultural template in which ease and aptness of participation is a valid ability to achieving social ends (Mpofu, Oakland, Ntinda, & Maree, 2015). One surprising aspect is that fluency and originality were reliably measures with school like tasks in what is a predominantly performance or practical oriented culture. This is also an unexpected finding from school learners who are unaccustomed to being asked to use their imagination and think differently to others. The pedagogical approach of teaching in these schools is rote learning. Children are never asked to voice their own opinions or think for themselves but just regurgitate information provided by the teacher. Adaptation was relatively weakly operationalized in this sample compared to innovation; and in particular the abstractness of title appears to lack in ecological validity for these learners. It is unclear why generating labels for drawing configurations may have been a different creative expression demand for these learners. Future studies could consider qualitative inquiry to unravel how these learners interpreted this abstraction task. Findings could inform the design or selection of a more credible abstraction task for the Kiswahili speaking learners.

The sample was rather homogenous in socio-cultural background, which could constrain variability of responses from an undetermined restriction of range of response effects. Nonetheless, findings from the regression analysis show some connections between family background, school, achievement and self-perceptions and the innovative and adaptive factors of creativity. These analyses show that there are significant correlations (some positive and some negative) regarding one's background, environment and creative ability. The child's relative age position in the family, peers in the class, the level of English reading ability, and mother's education seem to have a significant effect on creativity. In particular being the eldest child in the family was associated with higher innovation and adaptation scores. This finding is expected in a cultural setting in which children substitute-parent their siblings as part of the family division of labor in what is essentially a substance economy setting. Previous studies (Serpell, 1993, 2011a, 2011b; Sternberg et al., 2001) have documented the cultural importance of "child-parenting" in sub-Saharan cultural settings. Older children have much expected of them by family and community as they play "adults" to siblings and learn to creatively interpret and apply social practices for their welfare and that of the collective. Similarly children with literate family would be expected to score higher on school like tasks from the advantage of both home and school exposure to pen and pencil type activities.

Interviews with teachers and parents indicated that parents were more likely to use the word 'creative' or 'creativity' when asked what it meant for a child to be gifted or be of high ability. This finding may be explained by the fact that the teachers value maintenance of an orderly or structured learning environment in a discipline enforcement way than the creative expression potential of students. As a matter of fact students with creative expression may be (mis)perceived by teachers having behavior compliance problems (Torrance, 1962) compared with peers who are more compliant. Nonetheless, students who know how to "please the teacher" in a way are creative in their social impression management. That being the case, being teacher compliant per se would not in itself rule out significant creative potential in individual students. Often teachers also have a smaller scope of context of learner observations compared to parents, which also would add to their comparative unreliability in identifying students with higher measured creativity. Parents are advantaged in that regard, and the fact that parent endorsement of creativity in their children tended to be supported by TTCT data suggests that the creativity constructs measured by the TTCT have validity in the Tanzanian context.

Limitations of the study include the fact that participants were selected from high ability scores, which constrains the generalizability of the findings. There is also a limitation from the common method of assessment restricting the variance of observations. Future studies may benefit from the use of indigenous tasks for assessing creativity as external validation measures. The sample size is relatively small and as already highlighted the group is quite homogenous in socio-cultural background. The way forward could be to carry out this work in both urban and rural setting across sub-Saharan Africa.

## 6. Conclusion

This study shows that the Torrance Tests of Creative Thinking are in some ways transportable cross culturally. The work aimed to investigate the creativity construct measured by the TTCT-Figural, Form A, and has determined that two factors – innovative and adaptive hold true in an African setting just as in western settings. Therefore this study provides evidence to support that the creativity construct could be multi-dimensional consisting of two factors. Using the two creativity dimensions – innovative and adaptive – it can be conjectured that the background and environment in which a person lives correlate with creative performance.

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## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.tsc.2017.11.005>.

## References

- Akinboye, J. O., Fagbami, D., Majekodunmi, S. O., Okafor, C. N., & Esezobor, S. O. (1989). *Psychological foundations of education*. Ibadan, Nigeria: Heinemann Education Books.
- Anderson, K. E. (1961). *Research on the academically talented student*. Washington, DC: National Education Association Project on the Academically Talented Student.
- Bentler, P. M. (1990). Comparative fit indices in structural models. *Psychological Bulletin*, *107*(2), 238–246. <http://dx.doi.org/10.1037/0033-2909.107.2.238>.
- Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K. A. Bollen, & J. S. Long (Eds.). *Testing structural equation models* (pp. 136–162). Newbury Park, California: Sage.
- Chan, D. W. (2006). Perceived multiple intelligences among male and female chinese gifted students in Hong Kong: The structure of the student multiple intelligences profile. *Gifted Child Quarterly*, *50*(4), 325–338. <http://dx.doi.org/10.1177/001698620605000405>.
- Chase, C. I. (1985). Review of the Torrance tests of creative thinking. In J. V. Mitchell (Ed.). *The ninth mental measurements yearbook* (pp. 1631–1632). Lincoln: University of Nebraska, Burors Institute of Mental Measurements.
- Clapham, M. M. (1998). Structure of figural forms a and B of the Torrance tests of creative thinking. *Educational and Psychological Measurements*, *58*, 275–283. <http://dx.doi.org/10.1177/0013164498058002010>.
- Csikszentmihalyi, M. (1988). Society, culture and person: A systems view of creativity. In R. J. Sternberg (Ed.). *The nature of creativity* (pp. 325–339). New York, NY: Cambridge University Press.
- Davis, G. A., & Rimm, S. B. (1994). *Education of the gifted and talented* (3rd ed.). Needham Heights, MA: Allyn and Bacon.
- Davis, G. A. (1997). Identifying creative students and measuring creativity. In N. Colangelo, & G. A. Davis (Eds.). *Handbook of gifted education* (pp. 269–281). Needham Heights, MA: Viacom.
- Dixon, P., Humble, S., & Chan, D. W. (2016). How children living in poor areas of Dar es Salaam, Tanzania perceive their own multiple intelligences. *Oxford Review of Education*, *42*(2), 230–248.
- Field, A. (2000). *Discovering statistics using SPSS for windows*. London-Thousand Oaks-New Delhi: Sage Publications.
- Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. New York, NY: Basic Books.
- Gravetter, F., & Wallnau, L. (2014). *Essentials of statistics for the behavioral sciences* (8th ed.). Belmont, CA: Wadsworth.
- Guildford, J. P. (1959). Three faces of intellect. *American Psychologist*, *14*, 469–479.
- Heausler, N. L., & Thompson, B. (1988). Structure of the Torrance Tests of creative thinking. *Educational and Psychological Measurement*, *48*, 463–468. <http://dx.doi.org/10.1177/0013164488482021>.
- Hocevar, D., & Michael, W. (1979). The effects of scoring formulas on the discriminant validity of tests of divergent thinking. *Educational and Psychological Measurements*, *39*, 917–921. <http://dx.doi.org/10.1177/001316447903900427>.
- Hocevar, D. (1979a). Ideational fluency as a confounding factor in the measurement of originality. *Journal of Education Psychology*, *71*, 191–196. <http://dx.doi.org/10.1037/0022-0663.71.2.191>.
- Hocevar, D. (1979b). The unidimensional nature of creative thinking in fifth grade children. *Child Study Journal*, *9*, 273–278.
- Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*, 1–55. <http://dx.doi.org/10.1080/10705519909540118>.
- Humble, S., & Dixon, P. (2017). The effects of schooling, family and poverty on children's attainment, potential and confidence – evidence from Kinondoni, Dar es Salaam, Tanzania. *International Journal of Educational Research*, *83*, 94–106.
- Humble, S., Dixon, P., & Schagen, I. (2016). *Assessing intellectual potential in tanzanian children in poor areas of dar es salaam, assessment in education: Principles, policy and practice*. [Epub ahead of print].
- International Test Commission (2010). *Guidelines for translating and adapting tests*. [Retrieved from <http://www.intestcom.org>].
- Isaksen, S. G., Dorval, K. B., & Treffinger, D. J. (2000). *Creative approaches to problem solving: a framework for change*. Dubuque, Iowa: Kendall/Hunt.
- Khaleefa, O. H., Erdos, G., & Asharia, I. H. (1997). Traditional education and creativity in an Afro-Arab Islamic culture: The case of the Sudan. *The Journal of Creative Behaviour*, *31*, 201–211.
- Kim, K. H., Cramond, B., & Bandalos, D. L. (2006). The latent structure and measurement invariance of scores on the Torrance tests of creative thinking-Figural. *Educational and Psychological Measurement*, *66*(3), 459–477. <https://doi.org/10.1177/0013164405282456>.
- Kim, K. H. (2006). Is creativity unidimensional or multidimensional? analyses of the Torrance tests of creative thinking. *Creativity Research Journal*, *18*(3), 251–259. <http://dx.doi.org/10.1207/s15326934crj1803>.
- Kim, K. H. (2009). Cultural influence on creativity: The relationship between asian culture (Confucianism) and creativity among korean educators. *Journal of Creative Behavior*, *43*(2), 73–93.
- Kirton, M. J. (1976). Adaptors and innovators: A description and measure. *Journal of Applied Psychology*, *61*, 622–629. <http://dx.doi.org/10.1037//0021-9010.61.5.622>.
- Kirton, M. J. (1978). Have adaptors and innovators equal levels of creativity? *Psychological Reports*, *42*, 695–698. <http://dx.doi.org/10.2466/pr0.1978.42.3.695>.
- Kirton, M. J. (1982). *Kirton adaption-Innovation inventory (KAI)*. St. Albans: Occupational Research Centre, Hatfield Polytechnic.
- Kirton, M. J. (1987). *Kirton adaption-Innovation inventory manual* (2nd ed.). Hatfield, UK: Occupational Research Centre.
- Kirton, M. J. (Ed.). (1989). *Adaptors and innovators: Styles of creativity and problem solving*. New York: Routledge.
- Krumm, G., Aranguren, M., Filippetti, V. A., & Lemos, V. (2014). Factor structure of the Torrance tests of creative thinking figural from B in spanish speaking children: Measurement invariance across gender. *Creativity Research Journal*, *26*(1), 72–81. <http://dx.doi.org/10.1080/10400419.2013.843908>.
- Krumm, G., Aranguren, M., Filippetti, V. A., Lemos, V., Koval, J., & Balabanin, C. (2016). Construct validity and factorial invariance across sex of the Torrance Test of Creative Thinking-Figural From A in Spanish-speaking children. *Thinking Skills and Creativity*, *22*, 180–189. <http://dx.doi.org/10.1016/j.tsc.2016.10.003>.
- Lissitz, R. W., & Willhoft, J. L. (1985). A methodological study of the Torrance Tests of Creativity. *Journal of Educational Measurement*, *22*, 1–11. <http://dx.doi.org/10.1111/j.1745-3984.1985.tb01044.x>.
- Millar, G. W. (2002). *The Torrance kids at mid-life*. Westport, CT: Ablex.
- Mogaji, A. (1999). *Measuring the creative personality*. Nigeria: University of Logos [Unpublished manuscript].
- Mpofu, E., Myambo, K., Mogaji, A. A., Mashego, T.-A., & Khaleefa, O. H. (2006). African perspectives on creativity. In J. C. Kaufman, & R. J. Sternberg (Eds.). *The international handbook of creativity* (pp. 456–489). Cambridge: Cambridge University Press.
- Mpofu, E., Ntinda, K., & Oakland, T. (2012). *Understanding human abilities in sub-Saharan african settings. online readings in psychology and culture, unit 4*. [ISBN 978-0-9845627-0-1 Retrieved from <http://scholarworks.gvsu.edu/orpc/vol4/iss3/2>].
- Mpofu, E., Oakland, T., Ntinda, K., Maree, J. G., Seeco, & EG (2015). Locality, observability and community action (LOCUM) in test development and use in emerging education settings. In P. Dixon, S. Humble, & C. Counihan (Eds.). *Handbook of international development and education* (pp. 326–342). Cheltenham: Edward Elgar.
- Myambo, K., & Mpofu, E. (2004). Implicit theories of creativity in Africa. In M. Farag (Ed.). *Proceedings of the 11th american university at cairo research conference* (pp. 41–49).
- Olipant, C. C. (1986). *A descriptive study of factors associated with teacher identification of gifted students (Doctoral dissertation, Temple University)*. *Dissertation Abstracts International*, *47*, 1691.
- Oliveira, E., Almeida, L., Ferrándiz, C., Ferrando, M., Sainz, M., & Prieto, M. D. (2009). Test de pensamento criativo de Torrance (TTCT): Elementos para la validez de constructo en adolescents portugueses. [Torrance Test of Creative Thinking (TTCT): Elements for construct validity in Portuguese adolescents]. *Psicothema*, *21*, 562–567.
- Puccio, G. J., Treffinger, D. J., & Talbot, R. J. (1995). Exploratory examination of relationships between creativity styles and creative products. *Creativity Research Journal*, *8*, 157–172. [http://dx.doi.org/10.1207/s15326934crj0802\\_4](http://dx.doi.org/10.1207/s15326934crj0802_4).
- Renzulli, J. S., & Hartman, R. K. (1981). Scale for rating behavioral characteristics of superior students. In W. B. Barbe, & J. S. Renzulli (Eds.). *Psychology and education of the gifted* (pp. 151–164). New York: Irvington Publishers, Inc.

- Rimm, S. B., & Davis, G. A. (1976). GIFT: An instrument for the identification of creativity. *Journal of Creative Behavior*, 10, 178–182. <http://dx.doi.org/10.1002/j.2162-6057.1976.tb01021>.
- Ritchie, S. P. (1980). *Creativity and risk-taking in young children. (Doctoral dissertation, university of north carolina at greensboro). Dissertation abstracts international*, 42, 539.
- Runco, M. A., & Mraz, W. (1992). Scoring divergent thinking tests using total ideational output and a creativity index. *Educational and Psychological Measurement*, 52, 213–221. <http://dx.doi.org/10.1177/001316449205200126>.
- Saklofske, D. H., van de Vijver, F. J. R., Oakland, T., Mpofu, E., & Suzuki, L. A. (2015). Intelligence and culture: History and assessment. In D. Princiotta (Ed.), *Handbook of intelligence: Evolutionary theory, historical perspective and current concepts* (pp. 341–366). New York, NY: Springer.
- Schagen, I., & Elliot, K. (2004). *What does it mean? The use of effect sizes in educational research*. Slough Berks: National Foundation for Educational Research.
- Serpell, R. (1993). Chapter 2 Wanzelu ndani? A Chewa perspective on child development and intelligence. In R. Serpell (Vol. Ed.), *The significance of schooling: Life-journeys in an African society: 2*, (pp. 24–71). Cambridge, MA: Cambridge University Press.
- Serpell, R. (2011a). Social responsibility as a dimension of intelligence, and as an educational goal: Insights from programmatic research in an African society. *Child Development Perspectives*, 5, 126–133. <http://dx.doi.org/10.1111/j.1750-8606.2011.00167.x>.
- Serpell, R. (2011b). Peer group cooperation as a resource for promoting socially responsible intelligence: ku-gwirizana ndi anzache. In A. B. Nsamenang, & T. M. Tchombe (Eds.), *African educational theories and practices: A generative teacher education handbook* (pp. 195–204). Bamenda, Cameroon: Human Development Resource Centre/Presses Universitaires d'Afrique.
- Shi, J. (2004). Intelligence current in creative activities. *High Ability Studies*, 15(2), 173–187.
- Steiger, J. H. (1990). Structural model evaluation and modification: An interval estimation approach. *Multivariate Behavioral Research*, 25(2), 173–180. [http://dx.doi.org/10.1207/s15327906mbr2502\\_4](http://dx.doi.org/10.1207/s15327906mbr2502_4).
- Sternberg, R. J., & Lubart, T. I. (1995). Ten keys to creative innovation. *R and D Innovator*, 4(3), 8–11.
- Sternberg, R. J., Nokes, C., Geissler, P. W., Prince, R., Okatcha, F., Bundy, D. A., et al. (2001). The relationship between academic and practical intelligence: A case study in Kenya. *Intelligence*, 29, 401–418. [http://dx.doi.org/10.1016/S0160-2896\(01\)00065-4](http://dx.doi.org/10.1016/S0160-2896(01)00065-4).
- Sternberg, R. J. (2003). *Wisdom, intelligence and creativity crystallized*. New York, NY: Cambridge University Press.
- Sternberg, R. J. (2006). Creative is a habit. *Education Week*, 25(24), 47–64.
- Sternberg, R. J. (2012). The assessment of creativity: An investment-based approach. *Creativity Research Journal*, 24(1), 3–12.
- Torrance, E. P., Ball, O., & Safter, H. T. (1992). *Torrance test of creative thinking streamlined scoring guide figural a and B*. Bensenville, Illinois: Scholastic Testing Service, Inc.
- Torrance, E. P. (1962). *Guiding creative talent*. Englewood Cliffs NJ: Prentice Hall.
- Torrance, E. P. (1966). *The Torrance tests of creative thinking-Norms-Technical manual research edition-Verbal tests, forms a and B-Figural tests, forms a and B*. Princeton NJ: Personnel Press.
- Treffinger, D. J. (1985). Review of the Torrance tests of creative thinking. In J. V. Mitchell (Ed.), *The ninth mental measurements yearbook* (pp. 1632–1634). Lincoln: University of Nebraska, Buros Institute of Mental Measurements.
- Trochim, W. M., & Donnelly, J. P. (2006). *The research methods knowledge base* (3rd ed.). Cincinnati, Ohio: Atomic Dog.