

3rd Business & Entrepreneurial Economics Conference

(BEE, 2018, Croatia)

Šibenik, Croatia

30/05 02/06 2018

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Measuring Creativity and Innovation Abilities of Final Year Undergraduate Students in an Emerging Economy

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Purpose: Creativity and Innovation is an important aspect of entrepreneurial education. Creativity skills enable students to create value that have the potential to commercialise their innovations. Creativity is dependent on the real world exposure of students, and in emerging economies their exposure to problems differ from developed economies.

Methodology: A quantitative methodology was used by the researcher to systematically rate the reports of 42 ventures using the Creative Solution Diagnosis Scale (CSDS) proposed by Cropley, Kaufman and Cropley (2011). Of the 42 ventures, 23 was the control group, and 19 was the experimental group. The experimental group had the option of partnering with technical partners outside of the classroom. To determine the inter-rater reliability and Intraclass Correlation Coefficient was calculated between two expert raters.

Results: It was found that the raters do not agree with the interpretation of the CSDS items and the judging of the ventures. However it would seem that there is indeed a difference between the two groups based on their partnership and skills mix. Therefore, by encouraging the diversification of their partnerships during start-up phase between the necessary technical skills and business skills, from students in other disciplines, may result in more innovative business ideas being generated. By introducing the concepts of dynamic equity models within the programme, enabled the students to negotiate on a fair basis equity with their technical partners which increased their ability to attract necessary technical talent within their partnerships.

Conclusions: Within emerging economies students within universities may not have been exposed to similar lifestyles to those in developed economies. Additionally students in emerging economies are more resource constraint than their counterparts in developed economies. This paper described a teaching and learning intervention, which enhanced the creativity and innovation of students. Critical to the intervention was the explicit introduction of dynamic equity models, and the concept of diversity in partnerships. This research also contributes to the entrepreneurial development dimension of Entrepreneurial Leadership Levels and Associate Complexity (ELLAC) framework.

Introduction

Creativity and innovation is a key factor for in entrepreneurial competitiveness and new venture creation. Additionally there is a higher correlation between the Global Competitive Index and entrepreneurship than between Gross Domestic Product (GDP) per capita (0.83). Further to this, it was reported that a strong significant relationship exist between Global Competitive Index and human development (0.78) correlation between creativity and human development. South Africa is ranked 45th amongst 82 countries based on its Global Creativity Index (Florida et al. 2015).

Practical application of solutions to real world problems can foster the development of creativity amongst students at university (Khalid 2017). There is a link between creativity and new venture creation, and governments increasingly recognize the importance of creativity for economic development and growth (Ko & Butler 2007). However emerging economies are generally resource-constraint economic environments with cultural complex contexts which affects the earlier stages of the innovation process (Lingelbach et al. 2015).

South Africa's 45th place in the Global Creativity Index (Florida et al. 2015) stand in contrast to its Total Early-stage Entrepreneurial Activity (TEA), where South Africa is ranked 51st place amongst 64 countries, with a TEA of 6.9 (Herrington & Kew 2016). Factors that may contribute to this phenomena could relate to various constraints within South Africa as an emerging market, such as resource constraints, public policy, economic factors, culture, and inequality. This research attempts to explore this phenomena with a focus on innovation and resource constraints faced by final year undergraduate Entrepreneurship Students' at university level, with a focus on founding team configurations. In the next section, a literature review of the measurement of creativity and founding team configurations will be briefly explored.

Literature Review

This literature review will include firstly a brief exploration of the field of creativity, and end off with how to measure functional creativity. This prepares the context for the intervention that the present researcher introduced in this experimental research, which were founding team configurations. The methodology section will further elaborate on the intervention, where this literature review will focus on the literature available on the effect of different partnership configurations on new venture creation. First, however, measuring functional creativity will be introduced.

Measuring Functional Creativity

Fields and Bisschoff (2013) argues that creativity in young adults should be measured by looking at the impact of the cognitive psychology and the impact of environmental influences. Through an extensive literature review, they have identified nine factors that influences creativity, namely eight dimensional thinking, motivation, fluency, cognition, originality, communication, synthesis, culture and the environment.

The present researcher however argues that originality is an outcome variable that are influenced by the other eight factors that were identified above. This is also evident from the various creativity tests, for example:

The Torrance Tests of Creative Thinking, Wallach and Kogan (1965), Sternberg's Triarchic Abilities Test (Grigorenko et al. 2002) and the Creative Reasoning Test attempts to measure creativity through detecting elements of originality. However these tests and many other creativity tests do not measure the product of creativity, but attempt to predict creativity. The objective of this research is however to evaluate functional creativity of an innovation. Therefore instruments that measures the creativity of products are explored in this section. One approach to evaluate the creativity of a product is the Consensual Assessment Technique (CAT), however it is a cumbersome and expensive process and requires experts to do the evaluation (Baer & Mckool 2009). The use of novices with this technique will require good inter-rater reliability (Kaufman et al. 2009). It is not possible to create a standardised scoring instrument based on the CAT, as it relies on levels of creativity within a particular group (Baer & Mckool 2009).

Contrary to the CAT, a creativity assessment technique that can be applied easily and quickly by an observer, irrespective of whether the observer is an expert or novice is necessary. In that way, creativity can be reliably judged by any observer. The functional creativity model measured by the Creative Solution Diagnosis Scale (CSDS) is such a system. The inter-rater reliability of the CSDS scale was found to be high amongst 268 raters across the entire dataset, and the scale reliability was found to be above .90 for all the scales. The CSDS can be used to evaluate products, systems, concepts, procedures and the like, and can be used to measure the creativity utility of innovation (Cropley et al. 2011). This instrument is therefore suitable for the purpose of the present research, which is to compare the functional creativity between two groups to in order to evaluate the impact of the intervention.

The five constructs of the CSDS are Relevance & Effectiveness, Problematization, Propulsion, Elegance and Genesis. Cropley et al. (2011) is defined in Table 1 below:

Table 1: The Five CSDS Constructs

Construct	Definition
Relevance & Effectiveness	“The product solves the problem it was intended to solve” (Cropley & Cropley 2005)
Problematization	“Recognition of weaknesses of what exists” (Cropley et al. 2011)
Propulsion	“The product is original and ‘surprising’” (Cropley et al. 2011)
Elegance	“The product is ‘beautiful’ or pleasing, and goes beyond a simple mechanical solution for instance, by introducing a ‘bonus’ such as being cost effective.” (Cropley & Cropley 2005)
Genesis	“The product is original and surprising” (Cropley & Cropley 2005)

Therefore, creativity as an outcome variable can be measured using the five constructs of the CSDS. Cropley et al. (2011) measured each construct with specific items which were subjected to a confirmatory factor analysis which produced factor loadings per item which were >0.4 for each construct. The majority of items however had ‘very good’ (>0.63) or ‘excellent’ (>.7) loadings. These items are indicated in Table 2 below next to each construct.

Table 2: CSDS Constructs and Items

Construct	Items
Relevance & Effectiveness	Performance, Appropriateness, Correctness, Operability, Durability
Problematization	Prescription, Prognosis, Diagnosis
Propulsion	Redefinition, Reinitiation, Generation, Redirection, Reconstruction
Elegance	Pleasingness, Completeness, Sustainability, Gracefulness, Convincingness, Harminiousness, Recognition
Genesis	Vision, Transferability, Seminality, Pathfinding, Germinality, Foundationality

Examples of item statements in the CSDS scale that were used by Cropley et al. (2011) are for example:

Performance: “the solution accurately reflects conventional knowledge and/or techniques”

Redefinition: “the solution helps the beholder see new and different ways of using the solution”

These items are rated on a 5-point likert scale that ranges from “not at all” to “very much” (Cropley et al. 2011).

The CSDS scale were also successfully used in a number of recent studies, such as Cropley and Cropley (2016), Pereme et al. (2016) and Diedrich et al. (2015). For this reason the present research will also make use of the CSDS scale to measure the functional creativity of the solutions of new ventures that were created. In the next section, the literature of partnerships and its potential impact on creativity will be briefly explored.

New Venture Funding Team Configuration

The composition of the founding team appears to have an impact on the success of the new venture. This may include the mix of technical and business skills amongst the founding team members (Marmer et al. 2012). Hoegl and Parboteeah (2007) found that teams with the appropriate technical skill are likely to present improved creativity if other factors such as cohesiveness and collaboration do not negatively moderate the effectiveness of the team. To place this into perspective of the Entrepreneurial Leadership Levels and Associated Complexity (ELLAC) model, Hewitt and Janse van Rensburg (2017) proposed that founding teams need to be established in the early stages of new venture creation so that team dynamics can follow its due process. This perspective is a derivative of Tuckman’s model of small group development, in that all teams will go through these five stages, namely forming, storming, norming, performing and adjourning (Bonebright 2010). The researcher therefore argues that the choice of partners in a new venture will have an effect on the trajectory of the business during its lifetime and the speed in progressing through the levels as defined within the ELLAC model.

The focus of the research is therefore on the aspect of creativity with respect to the type of partners within a partnership. In the next section the methodology employed as well as a description of the population and sample will be discussed.

Methodology

The discussion of the design of the study will commence with a brief description of the context within which the sample operates. This will be followed with the remainder of the methodology discussion.

The sample of this study consisted of final year Diploma in Small Business Management students who were required, as part of their work-integrated learning module to start a business without any monetary assistance. The module was facilitated by the present researcher over a 28 academic weeks which spanned over two 6 month semesters. The students had to submit two interim reports and one final report. The present research evaluated only the final reports of two separate groups (cohorts). These cohorts were the 2015 and 2017 cohorts. The only difference between the two cohorts was a single intervention to increase creativity. The intervention was to introduce the concept of partnership beyond their own field of study, and students could voluntarily choose to enter such partnerships.

My students had to prepare a report, where they documented and described their new business ventures. These reports had to include evidence of the existence of their ventures, as well as products or services that they have created and provided. I kept these reports electronically for both the control group, and the experimental group. In total 42 reports were evaluated, of which the control group consisted of 23 reports, and the experimental group of 19 reports. This is a relatively small sample, and therefore generalisation beyond these cohorts are limited.

I have used the revised CSDS scale which were researcher-administrated by evaluating each report and allocating the appropriate score for each criteria. I also indicated the founder-partnership mix of each respective venture on the CSDS evaluation instrument. This included whether each specific venture had partner with partners outside of the classroom, as well as whether their partnership contained a mix of business and technical founders. Statistics were then generated from this data using SPSS version 25, and descriptive statistics were generated, including comparisons between means and Nonparametric Tests namely Mann-Whitney U Tests between the aforementioned groupings. This enabled conclusions to be drawn on the effect of the founder-partnership mix on their creativity, which were based on their business ideas in terms of the product/service or creativity with regards to their specific business model employed.

In order to measure inter-rater reliability, a randomised sample of ten of the reports were rated by a second qualified and experienced observer, and inter-rater reliability was analysed between the ratings of the two expert raters by means of the Intra Class Correlation Coefficient (ICC). The present researcher is the one rater, who is an academic in the field of Entrepreneurship, and the second rater is peer academic in the field of Entrepreneurial Leadership. A high correlation between the ratings of novices and experts are essential for the instrument to be deemed reliable, and it is recommended to be of about .90 (Anastasi & Urbina 1998). However if the ICC is negative, then it can be interpreted that there is disagreement between the raters (Shrout & Fleiss 1979). The ICC was

calculated based on the Functional Creativity measure for each case. The Functional Creativity is calculated based on the mean of each factor, which are the mean of the means of Relevance & Effectiveness, Problematization, Propulsion, Elegance and Genesis for each case. Next the findings will be reported on.

Findings and Discussion

Since the ICC Coefficient will affect the integrity of the findings, this statistic will be presented first before the remainder of the descriptives is explored. Since a sample of the same ten cases between the two raters are used for the calculation of the ICC, the “Two-Way Random” or ICC(2) is calculated in SPSS. The result of the ICC(2,2) = -.617. Therefore 61.7% of the variance in the mean of these raters are in disagreement. A conclusion of this finding in this research could be that it is possible that the raters disagree on their understanding of the application of the CSDS scale and how each item of the CSDS scale guides their judgement of the innovation or solution presented in the report of each case. The implication of this is that the CSDS items may be subject to bias between raters.

However, even though the reliability of the following findings are affected by the above disagreement, the findings on the following descriptives will be presented. The following descriptives are based on the ratings of a single rater (the researcher), and the limitations of these findings will be presented after all the findings have been discussed.

It is important to note that the five-point likert scale started at zero and ended at four. Thus all means based on the likert scale could have a maximum of four. This decision was a logical decision by the researcher as the lowest point on the likert scale was labelled as “not at all” which implies zero, and if the Functional Creativity is calculated across all factors then the “not at all” point will not have a cumulative effect.

In Table 3 below, the descriptives of the functions of creativity for both cohorts is presented, the means will be briefly explained.

Table 3: Descriptives of Functions of Creativity

Functions of Creativity	N	Min	Max	Mean	Std. Dev	Skewness		Kurtosis	
						Stat	Std. Error	Stat	Std. Error
Relevance & Effectiveness	42	1.67	4.00	3.452	0.577	-1.221	0.365	1.440	0.717
Problematization	42	0.00	3.33	0.595	0.903	1.697	0.365	2.106	0.717
Propulsion	42	0.00	3.20	0.595	0.913	1.962	0.365	2.808	0.717
Elegance	42	0.14	3.14	1.693	0.707	0.038	0.365	0.090	0.717
Genesis	42	0.00	3.17	0.413	0.884	2.229	0.365	3.657	0.717
Functional Creativity	42	0.50	3.08	1.350	0.641	1.494	0.365	1.680	0.717

The researcher found that the relevance & effectiveness score for both groups were $M=3.452$ on the five point likert scale, which are very high, and in terms of Problematization and Propulsion, the students scored overall on the low end ($M=0.595$) of the likert scale. Elegance ($M=1.693$) and Genesis ($M=0.413$) was also considered to be low. This implies that the researcher was of the opinion that the functional creativity of the students was overall low ($M=1.350$). In order to understand how the two cohorts differ from each other, the researcher compared the means of each functional creativity factor. Therefore Table 4 was produced presenting the Mann-Whitney U Test for each factor of Functional Creativity.

Table 4: Cohort Mann-Whitney U Test

Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Relevance & Effectiveness is the same across categories of Year.	Independent-Samples Mann-Whitney U Test	.354	Retain the null hypothesis.
2	The distribution of Problematization is the same across categories of Year.	Independent-Samples Mann-Whitney U Test	.018	Reject the null hypothesis.
3	The distribution of Propulsion is the same across categories of Year.	Independent-Samples Mann-Whitney U Test	.005	Reject the null hypothesis.
4	The distribution of Elegance is the same across categories of Year.	Independent-Samples Mann-Whitney U Test	.080	Retain the null hypothesis.
5	The distribution of Genesis is the same across categories of Year.	Independent-Samples Mann-Whitney U Test	.008	Reject the null hypothesis.
6	The distribution of Functional Creativity is the same across categories of Year.	Independent-Samples Mann-Whitney U Test	.039	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

From Table 4 it was found that there are no statistical differences between the two cohorts with regards to the two factors: Relevance & Effectiveness and Elegance. The intervention was introduced in the 2017 cohort (experimental group). During the intervention the researcher encouraged the students to enter into partnerships outside of the classroom in order to recruit the necessary technical skills. Since it was presented as optional to the students, the experimental group in Table 4 and Table 5 contains a mix between those partnerships which had technical partners outside of the classroom and those who did not.

Table 5: Compare Means between Control and Intervention Groups

Functions of Creativity	Control			Experimental			Total		
	Mean	N	Std. Dev.	Mean	N	Std. Dev.	Mean	N	Std. Dev.
Relevance & Effectiveness	3.507	23	0.600	3.386	19	0.556	3.452	42	0.577
Problematization	0.246	23	0.405	1.018	19	1.147	0.595	42	0.903
Propulsion	0.243	23	0.381	1.021	19	1.172	0.595	42	0.913
Elegance	1.558	23	0.575	1.857	19	0.826	1.693	42	0.707
Genesis	0.058	23	0.139	0.842	19	1.183	0.413	42	0.884
Functional Creativity	1.123	23	0.289	1.625	19	0.829	1.350	42	0.641

For this reason, the means will not be further explored, but is presented in Table 5 for informational purposes.

The researcher then regrouped the students into new groups, those who implemented the intervention (Business and Technical Mix Partnerships) N= 5 and those who did not (Business Only Partnerships) N=37.

Table 6: Partnership Mix Mann-Whitney U Test

Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Relevance & Effectiveness is the same across categories of Partnership Mix.	Independent-Samples Mann-Whitney U Test	1.000 ¹	Retain the null hypothesis.
2	The distribution of Problematization is the same across categories of Partnership Mix.	Independent-Samples Mann-Whitney U Test	.000 ¹	Reject the null hypothesis.
3	The distribution of Propulsion is the same across categories of Partnership Mix.	Independent-Samples Mann-Whitney U Test	.000 ¹	Reject the null hypothesis.
4	The distribution of Elegance is the same across categories of Partnership Mix.	Independent-Samples Mann-Whitney U Test	.002 ¹	Reject the null hypothesis.
5	The distribution of Genesis is the same across categories of Partnership Mix.	Independent-Samples Mann-Whitney U Test	.000 ¹	Reject the null hypothesis.
6	The distribution of Functional Creativity is the same across categories of Partnership Mix.	Independent-Samples Mann-Whitney U Test	.000 ¹	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

¹Exact significance is displayed for this test.

A Mann-Whitney U test was repeated on the new groups and is presented in Table 6.

The results of the Mann-Whitney U test indicates that a statistical significant difference is present between all the Functions of Creativity, except for the Relevance & Effectiveness factor. This can be explained by the researcher that most basic business ideas and solutions likely to be relevant and effective that are taken to the market, as all students had to test the market acceptance of their solutions in the market prior to reporting on it, and if it is not accepted by the market, then they had to pivot as early as possible. The means for Relevance & Effectiveness (M=3.452) is very high.

Table 7, presents a comparison of means for the two groupings. It is evident that for those ventures that had a mix in partnerships between business and technical skills, and a significantly higher means than the ventures with only business skills. For example, the mean for problematization were M=2.400 versus M=0.351, Propulsion M=2.480 versus M=0.341, Elegance M=2.543 versus M=1.578 and Genesis were M=2.200 versus M=0.171. This resulted in an overall functional creativity of M=2.625 for the ventures with partners that had a mix of Business and Technical skills, and a functional creativity of M=1.177 for ventures with business only skills.

Table 7: Compare Means between Business and Technical Partnership Mix

Functions of Creativity	Business Only			Business and Technical Mix			Total		
	Mean	N	Std. Dev.	Mean	N	Std. Dev.	Mean	N	Std. Dev.
Relevance & Effectiveness	3.446	37	0.595	3.500	5	0.471	3.452	42	0.577
Problematization	0.351	37	0.577	2.400	5	0.863	0.595	42	0.903
Propulsion	0.341	37	0.571	2.480	5	0.756	0.595	42	0.913
Elegance	1.578	37	0.658	2.543	5	0.445	1.693	42	0.707
Genesis	0.171	37	0.487	2.200	5	1.157	0.413	42	0.884
Functional Creativity	1.177	37	0.428	2.625	5	0.506	1.350	42	0.641

From this it is found that the solutions presented within the reports of the students were higher for those who consisted of a partnership mix that had a technical partner and a business partner. In order to reduce bias and subjectivity, the researcher had only categorised the cases according to the partnership mix after rating all the cases on the CSDS scale.

The next section will discuss the limitations and recommendations for this research.

Limitations and Recommendations

This research and sample is limited to two cohorts with a total sample of 42 reports of new ventures created by undergraduate students in a single university. Inter-rater reliability was not achieved which can be due to the manner in which the CSDS is worded and configured. Without inter-rater reliability, this study may contain bias and subjectivity, and therefore findings are limited. This study is therefore not generalisable, and conclusions made from this study are limited.

It is however recommended that the CSDS scale be improved to include clear statements specific to the item for each criteria on the likert scale, similar to a rubric, instead of a generalised likert scale. The researcher expect that this would reduce the variation of interpretations between raters of both the solution being evaluated and the scale itself. It can then be expected that the inter-rater reliability will be improved. This improved CSDS scale will then need to be subjected to rigorous testing between experts and novice raters in order to determine its suitability for use as a peer evaluation instrument. The original argument by Cropley et al. (2011) was to create an instrument with inter-rater reliability that can be used by novices to rate business solutions, and overcome the limitations of CAT, which were that it is timeous and expensive to use expert judges. If, like in the case of this present research, two expert raters do not agree on the interpretation of the CSDS scale, how would novice raters agree? For this reason the present researcher are unable to support the usefulness of the CSDS scale as an objective instrument that can be used by novices. However the researcher do acknowledge that this research was limited to only two expert raters on a very small sample.

Summary

This research contributes to the creativity measurement literature and to the CSDS scale, in that the instrument used for the CSDS scale needs to be improved to reduce inter-rater disagreement and to develop an instrument that has inter-rater reliability between novice and expert raters. Additionally, this research contributes to new venture creation literature and especially to the first level of the ELLAC model as defined by Hewitt and Janse van Rensburg (2017), in that it was found that the right partnership mix with respect to the skills necessary in the new venture have some effect on the creativity that materialise in that venture. This however needs to be confirmed with more rigorous methodology and a larger sample to overcome the limitations of this research.

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