



# Creativity in Mechanical Design: Using the Peer Lens to Identify Creativity Traits in Students

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## ABSTRACT

### CONTEXT

Creativity levels in students are measured by methods including, Creative Engineering Design Assessment (CEDA) (Charyton, 2014). Kazerounian and Foley, go further by identifying factors that, 'define, impede, or foster creativity in engineering education' (Kazerounian & Foley, 2007). Still within educational space, (Treffinger, 2002) explored personal creativity characteristics, 'Idea generation, exploring ideas, openness, courage'. This paper explores a methodology for identifying Creativity traits in Creativity focused group work as a peer lens (Brookfield, 2017).

### PURPOSE OR GOAL

The primary goal and outcome of this and future studies is to identify and understand the traits that students perceive to represent Creativity, and whether their perception changes as they progress through their degree. Identified Creativity traits are extracted from student experiences taken from group-work activities that have required the generation of Creative solutions. Understanding student's perception of Creativity is a key step in developing, supporting and assessing learning activities that have a Creativity component.

### APPROACH OR METHODOLOGY/METHODS

A cross-sectional survey is proposed to be adopted as the methodology to examine Creativity traits in engineering students from the School of AMME, University of Sydney. Initial data was drawn from teaching staff to test the methodology before data is formerly collected using the 5-point Likert scale survey method within Qualtrics<sup>®</sup>. Further analysis using the Explorative Factor Analysis (EFA) method within EXCEL<sup>®</sup> Norman and Streiner (2003) (p. 144) will be used to condense the information into a set of factors with a minimum loss of critical information.

### ACTUAL OR ANTICIPATED OUTCOMES

A pilot survey using teaching staff as respondents provided preliminary feedback in two key areas. The first related to the language used in the survey. Many of the traits being examined were presented using words extracted from psychology centred literature. This caused confusion with respondents and led to the replacement of single words with sentences less dependent on psychology focused language. The second area relates to the survey data which enabled the method of EFA to be practiced on a small data set. An initial outcome of this preliminary analysis will enable the identification of the key, dominant Creativity traits.

### CONCLUSIONS/RECOMMENDATIONS/SUMMARY

Previous work on the analysis of Creativity traits in engineering students by authors such as (Cropley & Cropley, 2000) (p. 183) who noted, 'follow up activities' were needed to retain any Creative skills developed. Whereas, (Davis & Woodward, 2020) (pp. 47-55), focused on individuals rather than students. This study aims to identify Creativity traits that are specifically present in current engineering students, rather the broader community.

### KEYWORDS

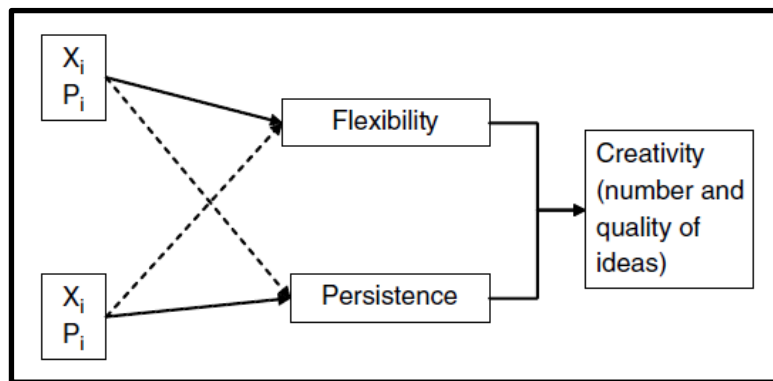
Creativity, Traits, Design, Exploratory Factor Analysis.

## BACKGROUND

The main author has observed during Tutorial sessions in design focused Units of Study that, students undertaking group design assessments demonstrate Creativity traits as part of their idea generation phase in the design process. Better knowledge of what the dominant Creativity traits allow for a more targeted teaching and assessment approach to be developed when teaching Creativity content.

This fascinating area of Creativity research has been studied previously by authors such as (Mohammed & Angell, 2003) (Reilly, Lynn, & Aronson, 2002) who deduced that the creativity traits of: extraversion, openness to experience and low levels of conscientiousness lead to a larger number of Creative ideas being generated in a group's idea generation phase. However, in terms of the level of Creativity utilised by a group in generating their ideas, the results are less focused and a need for future research in this area is needed (Toh & Miller, 2015) particularly in the education sector.

Previous work in this area has also been undertaken by authors such as (Förster, Friedman, & Liberman, 2004) and ; (Schooler & Melcher, 1995) who developed a Dual Pathway Model to Creativity as illustrated in Figure 1.0 that includes Environmental conditions ( $X_i$ ) and Personality traits ( $P_i$ ) to examine if Flexibility and Persistence act alone or work in combination as factors when developing Creative solutions.



**Figure 1.0**  
**Dual Pathway Model to Creativity**

The aim of the research proposed in this paper is to expand on this critical work to explore the identification of dominant creativity traits in students taking part in group-based design assessments. The research study uses the student lens to extract the Creativity traits as the student lens is the most dominant lens in group focused design assessments. In this research study, the hypotheses examined may be stated as:

**'The Creativity traits of students taking part in group-based design assessments are identifiable and able to be reduced to a dominant set.'**

## METHODOLOGY

The methodology employed in this survey focused study is defined as a 'cross-sectional' style survey, as it aims to provide a view of the various cohorts surveyed at one point in time (Cohen, Manion, & Morrison, 2018).

The survey instrument is comprised of mixture of questions, four of which are quantitative and a final qualitative open-ended question. The key quantitative question that is used to extract the identifiable personality traits connected to problem-solving uses a conventional Likert scale with six available choices: 'Strongly disagree', 'Somewhat disagree', 'Neither agree nor disagree', 'Somewhat agree', 'Strongly agree' and finally 'Don't know'. The addition of the 'Don't know' option was added to allow for flexible responses and to minimise the likely hood of survey drop out from a respondent that has had little or no connection to the personality trait that is being presented. In addition, it is good practice to provide survey questions which have a valid available answer choice for all respondents.

The survey instrument is currently being pilot testing to confirm the validity of the questions, remove any ambiguity and assess the impact of the questions in regard to both interpretation and fatigue of potential respondents. As this strategy has provided invaluable feedback to improve the survey instrument and informed the chosen method used to present the creativity traits. The original survey presented listed each of the researched Creativity traits in one column with an adjacent Likert scale for respondents to register their level of agreement whether a particular trait was evident in their approach to problem solving. The pilot study feedback indicated that many of the terms used to describe the traits were not familiar to engineering students. A modification involved using a sentence to articulate the trait in order to clarify its meaning. E.g., 'Asocial attitude' was articulated as, 'Failing to conform to social norms'. Table 1.0 illustrates each Creativity Trait and its translation into a sentence for better survey participant coherence, improved validity and to help in minimising survey 'dropout' or respondents not providing an answer due to a potential lack of familiarity with the terminology used.

The final participants to the survey will be drawn from the following Units of Study (UOS) offered at the School of Aerospace, Mechanical and Mechatronic Engineering, University of Sydney: Introduction to Mechanical Engineering (MECH1560), Manufacturing Engineering (MECH3660 8660 9660), Crash Analysis (AMME5912), Mechanical Design 1 (MECH2400 9400), Mechanical Design 2 (MECH3460) and Computer Aided Manufacturing (AMME5902), Mechanical Construction (MECH1400) and one UOS from the School of Biomedical Engineering, Biomedical Design (BMET2400). In total approximately one thousand students will be invited to complete the survey and participate in this research.

A cross-sectional survey instrument was chosen as it will both allow a larger population to be sampled and to facilitate more expedient access to the results compared to alternative methods such as semi structured interviews. However, we expect the results of this study will inform follow-up interviews from a representative sample to more deeply understand the role each creativity trait plays and contributes to individuals undertaking a creative group work exercise.

The Qualtrics® platform was used to design, edit and test the survey questions and structure. Qualtrics® also facilitates the export of data in MS EXCEL® format that was used to both analyse the data and create graphs used to present the results.

## Survey Structure

The five main survey questions and the reasons why they have been asked are listed below to both inform and assist researchers interested in undertaking a similar study.

### *Question 1 of 5: Participant Information Statement*

- I have read the Participant Information Statement and wish to proceed with the survey.
- I have read the Participant Information Statement and do NOT wish to proceed with the survey.
- I do NOT wish to proceed with the survey.

Question 1 allows the participant to acknowledge that they have read the participant Information Statement and that they are either willing or not to proceed in completing the survey.

### *Question 2 of 5: In which year are the majority of the Units of Study that you are currently enrolled in? This question is asked to establish at what stage of your degree you are at.*

- First Year – First Semester
- First Year
- Second Year
- Third Year
- Fourth Year
- Fifth Year
- I am enrolled in a Postgraduate Program

Question 2 serves to categorise the participant data collected into separate cohorts separated by year of candidature. First Year – First Semester students differ from First-year students as the latter incorporate mid-year enrolment students or students that have already been in a stream for one semester.

### *Question 3 of 5: What gender do you identify as? This is a standard demographic question.*

- Prefer not to say
  - Non-Binary / third gender
  - Female
  - Male
  - Prefer to explain
- 
- <free text box>

Question 3 is a standard demographic question to categorise the participant data by gender for potential future studies

### *Question 4 of 5: The list below (refer to Table 1.0 overleaf) represents identified personality traits of people in their approach to problem-solving. From your personal work experiences and or working on group assignments, how strongly do you disagree or agree that each of the traits listed below was important in a group member's approach to problem-solving? (If you aren't confident that you know what the trait means, or you do not know, then you can answer "don't know")*

Question 4 is the key question of the survey study and contains the researched Creativity traits that the student undertaking the survey needs to respond to by the use of a standard Likert scale.

### *Question 5 of 5: Thank you very much for being a part of this survey on categorising the traits of people involved in problem-solving. If there are any other areas of Creativity in group work you wish to comment on, please feel free to comment in the text box below.*

 <free text box>

Question 5 of the survey study acknowledges the participation of the student undertaking the survey and provide a free text box to allow for feedback on Creativity that they wish comment on.

**Table 1.0**

The identified personality traits of people in their approach to problem-solving expressed as a sentence.

<b>Traits</b>	<b>Trait translated into a sentence</b>
1. <i>Independence</i>	<i>Having the confidence, focus and flexibility to solve problems.</i>
2. <i>Dominance</i>	<i>Having an assertive position in a group.</i>
3. <i>Introversion</i>	<i>Being concerned with one's own thoughts and feelings.</i>
4. <i>Openness to Stimuli</i>	<i>Having reduced inhibitions.</i>
5. <i>Wide Interests</i>	<i>Being knowledgeable in a range of diverse interests.</i>
6. <i>Self-acceptance</i>	<i>Being accepting of their own good and bad points.</i>
7. <i>Intuition</i>	<i>Have the ability to make quick decisions based on experience rather than analysis.</i>
8. <i>Flexibility</i>	<i>Have a willingness to try new ideas and experiences.</i>
9. <i>Asocial attitude</i>	<i>Failing to conform to social norms.</i>
10. <i>Lack of Concern for Social Norms</i>	<i>Having a lack of concern for normal social behaviour.</i>
11. <i>Neuroticism</i>	<i>Having degrees of anger, anxiety, self-consciousness, irritability, emotional instability, and depression.</i>
12. <i>Ego-strength</i>	<i>Being able to maintain their identity and sense of self in the face of pain, distress, and conflict.</i>
13. <i>Nonconformity</i>	<i>Failing or refusing to conform to a generally accepted pattern of thought or action.</i>
14. <i>Originality</i>	<i>Being able to think independently and creatively.</i>
15. <i>Openness</i>	<i>Being fundamentally open to ideas.</i>
16. <i>Risk Taking</i>	<i>Willing to take risky action in the hope of a desired result.</i>
17. <i>Intelligence</i>	<i>Possessing the ability to acquire and apply knowledge and skills.</i>
18. <i>Knowledge</i>	<i>Being well informed or read.</i>
19. <i>Thinking Styles</i>	<i>Having a characteristic way of processing information.</i>
20. <i>Personality</i>	<i>Having a characteristic pattern of thought, behaviour or feelings.</i>
21. <i>Motivation</i>	<i>Having a level of desire to take action in order to achieve a goal.</i>
22. <i>Environment</i>	<i>Having consideration for the environment that the concept needs to operate in.</i>
23. <i>Fluency of Thinking</i>	<i>Possessing the ability to generate many ideas.</i>
24. <i>Comprised of Word</i>	<i>Being well spoken.</i>
25. <i>Ideational</i>	<i>Possessing the ability to change the method that others use to form ideas.</i>
26. <i>Expressional</i>	<i>Having the ability to vividly express ideas or sentiments.</i>
27. <i>Associational Fluency</i>	<i>Having the ability to make a wide range of connections when presented with a concept.</i>
28. <i>Flexibility of Thinking</i>	<i>Having the ability to think about a problem in a different way.</i>
29. <i>Composed of Spontaneous &amp; Adaptive</i>	<i>Being able to be spontaneous and adaptive to situations.</i>
30. <i>Originality</i>	<i>Being able to present a fresh or new aspect, design, or style when examining a problem.</i>
31. <i>Sensitivity to Problems</i>	<i>Being able to identify differences between the actual situation and the desired situation.</i>
32. <i>Redefinition</i>	<i>Being able to define a problem in different ways.</i>
33. <i>Figural and Semantic Elaboration</i>	<i>Being able to make a detailed contribution to an idea using words and images.</i>
34. <i>Emotional Instability</i>	<i>Demonstrate an abrupt change in mood or emotional state.</i>
35. <i>Ambition</i>	<i>Possessing a strong desire to do or to improve themselves from their current state.</i>
36. <i>Associative Orientation</i>	<i>Being imaginative, playful and have many ideas.</i>
37. <i>Motivation</i>	<i>Possess the drive to achieve set goals or needs.</i>
38. <i>Need for Originality</i>	<i>Able to identify a need for imagination and creativity.</i>
39. <i>Agreeableness</i>	<i>Able to put others needs before their own.</i>
40. <i>Flexibility</i>	<i>Able to cope with changes in circumstances and think about problems in novel, creative ways.</i>

The Creativity traits listed in Table 1.0 have been extracted from a literature review which identified references from authors in the area of Creativity and Creativity traits. Authors such as (Kaufman & Baer, 2004) identified creativity traits such as, 'Nonconformity, Originality, Openness and Risk Taking' as part of a study into engineering student's group work when presented with a design orientated task. Outside of the educational space, (Sternberg & Lubart, 1991) identified a tolerance to 'ambiguity', an ability to 'surmount obstacles', 'perseverance' and possessing a, 'willingness to grow and take risks' are all key identifiable creativity traits in individuals.

A different approach is taken by (Davis & Woodward, 2020) who categorise traits into three distinct areas: 'Personality traits', which focus on personal motivation, 'Cognitive abilities' which includes different information processing styles and, 'Biographical traits' which centre on personal experiences. When focusing on the creative nature of the individual (Dellas & Gaier, 1970) designated an organisational structure that is broken up into two definite trends. One is the 'cognitive orientation' which focus on singular intellectual and cognitive functions in Creativity. The second position is the 'personological approach' which focuses on personality and motivational traits in broad Creativity domains such as: 'intellectual, cognitive styles', 'intelligence', 'personality', 'potential and motivational'. A similar statistical methodology to this study was carried out by (Martinsen, 2011) who began with a pool of thirty eight creativity traits and identified seven key traits using the instrument of 'The Creative Person Profile (CPP)' that include: 'flexibility, emotional instability, agreeableness, ambition, originality, associative orientation and motivation.'

## METHOD

The proposed method to analyse and test the hypothesis, 'The Creativity traits of students taking part in group-based design assessments are identifiable and able to be reduced to a dominant set.' is Exploratory Factor Analysis (EFA). EFA is a statistical method that is used to analyse the interrelationships between variables. In the case of this study the number of variables is reasonably large and not easily analysed using 'hand-calculation' methods, hence the use of EXCEL® is trialled to perform the analysis required. A pilot study using randomised data and a reduced number of Creativity traits as illustrated in Table 2.0 was conducted in order to establish the functionality of the method.

**Table 2.0**  
Reduced data set

Respondent	Independence	Dominance	Introversion	Openness to Stimuli	Wide Interests	Self acceptance	Intuition	Flexibility	Asocial attitude	Lack of Concern for Social Norms
1	5	1	1	4	4	4	5	5	2	3
2	5	1	2	2	4	5	5	5	4	4
3	2	1	1	3	5	3	2	5	1	2
4	4	5	2	4	5	5	5	5	5	3
5	4	3	3	5	5	5	5	5	2	2
6	4	2	3	5	5	5	5	4	3	3
7	5	4	5	3	4	2	3	3	4	5
8	5	3	3	4	5	5	5	4	3	1

Table 3.0 applies some basic statistics to the data set including the: mean or average, standard deviation (a measure of how data is dispersed from the mean or average), skew (a measure of the lack of similarity of the probability distribution) and kurt – (a measure of the shape of the probability distribution or 'tailedness').

**Table 3.0**  
Descriptive Statistics

	Independence	Dominance	Introversion	Openness to Stimuli	Wide Interests	Self acceptance	Intuition	Flexibility	Asocial attitude	Lack of Concern for Social Norms
mean	4.25000	2.50000	2.50000	3.75000	4.62500	4.25000	4.37500	4.50000	3.00000	2.87500
stdev	1.03510	1.51186	1.30931	1.03510	0.51755	1.16496	1.18773	0.75593	1.30931	1.24642
skew	-1.67456	0.49608	0.76376	-0.38644	-0.64406	-1.35536	-1.65191	-1.32288	0.00000	0.30432
kurt	3.13600	-0.99531	0.87500	-0.44800	-2.24000	0.62050	1.35491	0.87500	-0.70000	0.14649

Table 4.0 describes a covariance matrix which defines how the variable sets vary together. The formula for covariance multiplies the difference from the average or mean values taken from Table 3.0.

**Table 4.0**  
Covariance Matrix

1.0714	0.2857	0.5714	-0.0714	-0.3214	0.2143	0.7500	-0.2857	0.7143	0.4643
0.2857	2.2857	1.1429	0.4286	0.2143	0.0000	0.2143	-0.4286	1.2857	0.2143
0.5714	1.1429	1.7143	0.1429	-0.0714	-0.4286	-0.0714	-0.8571	0.7143	0.6429
-0.0714	0.4286	0.1429	1.0714	0.3214	0.5000	0.5357	0.0000	-0.2857	-0.6071
-0.3214	0.2143	-0.0714	0.3214	0.2679	0.2500	0.0179	0.0714	-0.1429	-0.4821
0.2143	0.0000	-0.4286	0.5000	0.2500	1.3571	1.1786	0.4286	0.2857	-0.6786
0.7500	0.2143	-0.0714	0.5357	0.0179	1.1786	1.4107	0.2143	0.5714	-0.2321
-0.2857	-0.4286	-0.8571	0.0000	0.0714	0.4286	0.2143	0.5714	-0.2857	-0.3571
0.7143	1.2857	0.7143	-0.2857	-0.1429	0.2857	0.5714	-0.2857	1.7143	0.8571
0.4643	0.2143	0.6429	-0.6071	-0.4821	-0.6786	-0.2321	-0.3571	0.8571	1.5536

Table 5.0 notes the correlation between variables with negative or very low values noting a weak correlation between data and large positive values noting a strong correlation between variables.

**Table 5.0**  
Correlation Matrix

1.0000	0.1826	0.4216	-0.0667	-0.6000	0.1777	0.6100	-0.3651	0.5270	0.3599
0.1826	1.0000	0.5774	0.2739	0.2739	0.0000	0.1193	-0.3750	0.6495	0.1137
0.4216	0.5774	1.0000	0.1054	-0.1054	-0.2810	-0.0459	-0.8660	0.4167	0.3939
-0.0667	0.2739	0.1054	1.0000	0.6000	0.4146	0.4357	0.0000	-0.2108	-0.4706
-0.6000	0.2739	-0.1054	0.6000	1.0000	0.4146	0.0290	0.1826	-0.2108	-0.7474
0.1777	0.0000	-0.2810	0.4146	0.4146	1.0000	0.8518	0.4867	0.1873	-0.4673
0.6100	0.1193	-0.0459	0.4357	0.0290	0.8518	1.0000	0.2387	0.3675	-0.1568
-0.3651	-0.3750	-0.8660	0.0000	0.1826	0.4867	0.2387	1.0000	-0.2887	-0.3790
0.5270	0.6495	0.4167	-0.2108	-0.2108	0.1873	0.3675	-0.2887	1.0000	0.5252
0.3599	0.1137	0.3939	-0.4706	-0.7474	-0.4673	-0.1568	-0.3790	0.5252	1.0000

Table 6.0 illustrates the eigenvalues and their corresponding eigenvectors was extracted from the correlation matrix described in Table 5.0 using the online matrix calculator (Yandex, 2022). Native EXCEL statistical functions and the use of external statistical libraries (Zaiontz, 2022) was trialed but found to be cumbersome in comparison with dedicated matrix manipulation software. Table 6.0 is structured to note the eigenvalue, in the first column,  $\lambda_1 \approx -0.0001$  with its corresponding eigenvalue vector elements located in the cells beneath. It is these coefficients of the eigenvectors that serve as the regression coefficients of the (in this pilot data set) ten creativity traits.

**Table 6.0**  
Eigenvalues and Eigenvectors of the Correlation Matrix

	$\lambda_1$	$\lambda_2$	$\lambda_3$	$\lambda_4$	$\lambda_5$	$\lambda_6$	$\lambda_7$	$\lambda_8$	$\lambda_9$	$\lambda_{10}$
	$\approx -0.0001$	$\approx 0.0000$	$\approx 0.0001$	$\approx 0.1225$	$\approx 0.2842$	$\approx 0.412$	$\approx 0.9521$	$\approx 1.9586$	$\approx 2.7193$	$\approx 3.5512$
<b>1. Independence</b>	-0.7140	48.3440	1.3560	-0.716	-0.8660	-0.3390	-2.2310	1.7550	-2.4260	0.736
<b>2. Dominance</b>	1.0350	-62.9230	0.2920	3.3940	-1.2080	0.2590	2.7100	-2.0360	-2.6260	0.4860
<b>3. Introversion</b>	-0.5980	28.8570	-0.5400	16.2270	0.5830	-0.2420	-1.4080	-1.9200	-1.3380	0.9010
<b>4. Openness</b>	-1.6660	3.5950	-0.1040	-4.8960	-0.0160	1.1170	-2.3230	-1.6940	-2.8330	-0.4880
<b>5. Interests</b>	1.0390	88.5230	1.0910	-1.9990	0.5790	-0.3440	1.3020	-2.4540	-1.5280	-0.7940
<b>6. Acceptance</b>	-0.8640	-102.3650	0.6330	3.9050	0.9050	-0.3660	0.4590	1.2900	-3.6360	-0.6040
<b>7. Intuition</b>	2.7860	31.1010	-0.9900	-0.2720	0.0980	0.1610	-0.9670	1.7920	-4.1580	-0.1470
<b>8. Flexibility</b>	-0.9790	59.2580	0.0310	13.1470	-0.4980	0.5090	2.1820	1.9300	0.1980	-0.9040
<b>9. Asocial</b>	-1.8490	47.1120	-0.7430	-8.4360	0.3380	-0.1610	3.3720	0.5690	-2.5380	0.7710
<b>10. Social Norms</b>	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

The coefficients of the eigenvectors may now be used as the regression coefficients of the ten creativity traits and may be illustrated by equation below.

$$y_1 = -0.714x_1 + 1.035x_2 - 0.598x_3 - 1.666x_4 + 1.039x_5 - 0.864x_6 + 2.786x_7 - 0.979x_8 - 1.849x_9 - 1.000x_{10}$$

or more explicitly,

$$y_1 = -0.714_{\text{Independence}} + 1.035_{\text{Dominance}} - 0.598_{\text{Introversion}} - 1.666_{\text{Openness}} + 1.039_{\text{Interests}} - 0.864_{\text{Acceptance}} + 2.786_{\text{Intuition}} - 0.979_{\text{Flexibility}} - 1.849_{\text{Asocial}} - 1.000_{\text{Social Norms}}$$

It is therefore possible to calculate (for the  $x_j$  terms) the corresponding principal component coefficients to allow for the examination of the correlations between creativity traits. Table 7.0 notes the calculation of the ten principal components which use the matrix formula,

$$Y = BX'$$

**Table 7.0**

Calculation of PC<sub>1</sub> for the initial Creativity trait

	$\lambda_1 \approx$	$\lambda_2 \approx$	$\lambda_3 \approx$	$\lambda_4 \approx$	$\lambda_5 \approx$	$\lambda_6 \approx$	$\lambda_7 \approx$	$\lambda_8 \approx$	$\lambda_9 \approx$	$\lambda_{10} \approx$			
	-0.0001	0.0000	0.0001	0.1225	0.2842	0.4120	0.9521	1.9586	2.7193	3.5512	X	X'	Y
1. Independence	-0.714	48.344	1.356	-0.716	-0.866	-0.339	-2.231	1.755	-2.426	0.736	5	0.725	-2.225
2. Dominance	1.035	-62.923	0.292	3.394	-1.208	0.259	2.710	-2.036	-2.626	0.486	1	-3.140	-464.350
3. Introversion	-0.598	28.857	-0.540	16.227	0.583	-0.242	-1.408	-1.920	-1.338	0.901	1	-3.1398	4.611
4. Openness	-1.666	3.595	-0.104	-4.896	-0.016	1.117	-2.323	-1.694	-2.833	-0.488	4	-0.242	-13.174
5. Interests	1.039	88.523	1.091	-1.999	0.579	-0.344	1.302	-2.454	-1.528	-0.794	4	-0.242	3.793
6. Acceptance	-0.864	-102.365	0.633	3.905	0.905	-0.366	0.459	1.290	-3.636	-0.604	4	5.333	-2.810
7. Intuition	2.786	31.101	-0.990	-0.272	0.098	0.161	-0.967	1.792	-4.158	-0.147	5	0.725	-10.667
8. Flexibility	-0.979	59.258	0.031	13.147	-0.498	0.509	2.182	1.930	0.198	-0.904	5	0.725	21.827
9. Asocial	-1.849	47.112	-0.743	-8.436	0.338	-0.161	3.372	0.569	-2.538	0.771	2	-2.174	-6.210
10. Social Norms	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	-1.208	-10.378

The column with the heading 'eValue' in Table 8.0 notes the eigenvalues previously listed in the first row of Table 6.0 with each cell in the '%' column contains the variance encountered expressed as a percentage for the corresponding eigenvalue. The final column '%Cumulative' contains the sum of each weighting. The first five key weightings account for 95.9% of the variance.



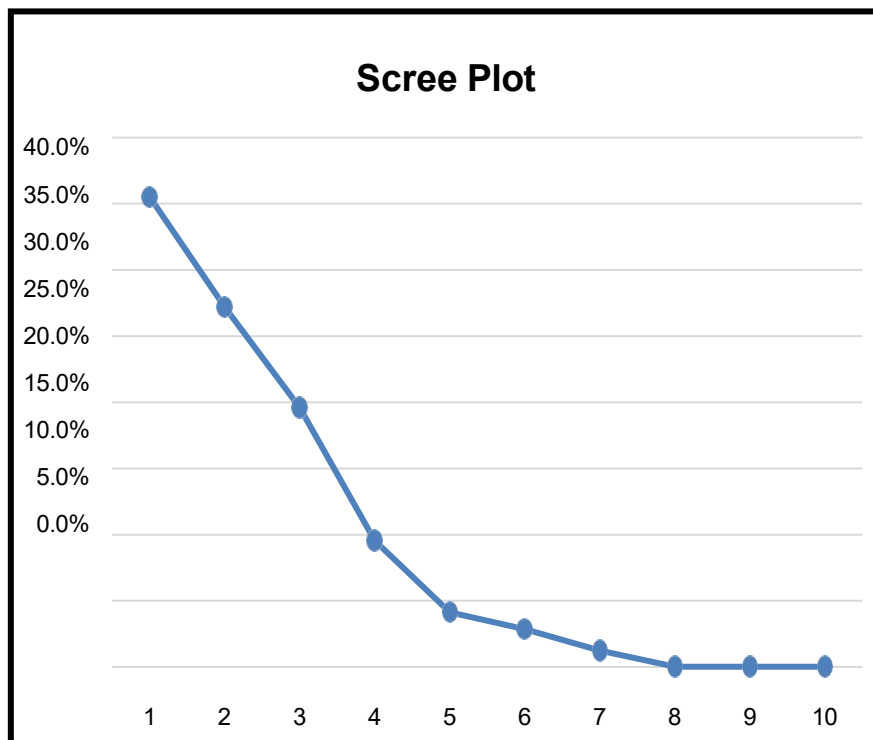
**Table 8.0**

Variance for each eigenvalue

eValue	%	%Cumulative
3.5512	35.5%	35.5%
2.7193	27.2%	62.7%
1.9586	19.6%	82.3%
0.9521	9.5%	91.8%
0.4120	4.1%	95.9%
0.2842	2.8%	98.8%
0.1225	1.2%	100.0%
0.0001	0.0%	100.0%
0.0000	0.0%	100.0%
0.0000	0.0%	100.0%
10.0000		

## RESULTS

The method described has yielded results, which although based on a small data set, have given the researchers confidence to continue to use and develop EFA and EXCEL<sup>®</sup> as an analysis tool. Although the data which seeded the method was taken from a pilot study, interesting results have been generated from the method used and are graphical illustrated in Figure 2.0, which describes the dominant Creativity traits by the use of a 'Scree Plot'.



**Figure 2.0**

Scree Plot of Dominant Creativity Traits vs % variance for each eigenvalue

The slope of data provides a subjective overview to indicate that, '1-Independence', '2-Dominance', '3-Introversion', '4-Openness' and '5-Interests' are the dominant eigenvalues to retain for:

1. Future analysis in areas such as examining the correlation between these principal components.
2. Provide a lens to focus on targeting specific future teaching initiatives that could be integrated into group tasks that have a Creativity component attached and potentially lead to better teaching outcomes.

## CONCLUSIONS

The method of using EXCEL<sup>®</sup> to process results for the data supplied, has provided a rudimentary and readily accessible method as outlined by (Zaiontz, 2022) for the extraction of dominant eigenvalues. Few shortcomings were encountered when working with a small pilot data set particularly when additional statistical libraries could potentially be used. Matrix manipulation is one notable area where EXCEL is more challenging to use than other external methods such as that provided by (Yandex, 2022).

The examination of the hypothesis, 'The Creativity traits of students taking part in group-based design assessments are identifiable and able to be reduced to a dominant set', is achievable by utilising EFA as a methodology and EXCEL<sup>®</sup> as a method incorporating the much larger student data pool into the method described to examine the full forty researched Creativity traits.

The implications of this and future research studies are meaningful for academics and engineering educational researchers who are keen to better understand how Creativity tasks within a student group-based paradigm are approached and solved.

The next phase of this research study is to incorporate the student data pool into the method described in this paper, to examine forty researched Creativity traits.

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