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AXIOMATIC DESIGN MODEL TO ASSESS INFLUENCES AFFECTING PEDAGOGIC-LEARNING IN THE COURSES ENGINEERING MATERIALS I AND FLUID MECHANICS I (PART 2)

Mirzi D. Llego-Betasolo, Ph.D.
mbetasolo@gmail.com
Department of Civil Engineering
The Papua New Guinea University of Technology
Taraka Campus, Independence Drive
Lae 411, Morobe Province, Papua New Guinea

2.1.2 CE 221 Results of Factor Analysis & Multiple Regression Analysis (DP1's)

The factor analysis used Principal Component Analysis with Rotation and Varimax with Kaiser Normalization. The Rotation converged in 5 iterations, and the component value is rejected below 0.30. Kaiser-Meyer Measure of Sampling Adequacy is 0.936, Bartlett's Test of sphericity has approx. Chi square of 13047.557. The result of factor analysis for CE 221 by using SPSS is presented in Figures 2 (a, b).

Rotated Component Matrix[a]

	Component		
	1	2	3
Q26	.873	.373	
Q30	.844	.416	
Q25	.803	.352	.419
Q46	.791	.334	.434
Q42	.788	.342	.467
Q32	.782	.546	
Q14	.780	.481	
Q24	.779	.333	.458
Q23	.776	.482	.321
Q08	.773	.320	.472
Q21	.767	.480	.331
Q13	.756	.461	.376
Q15	.741	.360	.511
Q06	.731	.494	.380
Q49	.718	.574	.300
Q27	.718	.554	
Q28	.715	.455	.460
Q29	.697	.611	
Q47	.684	.453	.526
Q44	.678	.504	.454
Q45	.665	.629	
Q09	.662	.593	.354
Q10	.653	.616	.343
Q33	.651	.520	.443
Q12	.620	.617	.403
Q40	.447	.791	.378
Q38	.435	.790	.387

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

Figure 2a. Rotated Component Matrix – CE 221

Rotated Component

	Component		
	1	2	3
Q02	.493	.779	.318
Q05	.401	.778	.428
Q41	.453	.773	.368
Q48	.387	.767	.454
Q16	.451	.763	.413
Q35	.462	.761	.385
Q20	.541	.752	.308
Q04	.449	.750	.383
Q11	.365	.742	.504
Q19	.584	.723	
Q34	.581	.709	
Q43	.562	.706	.330
Q31	.628	.691	
Q01	.410	.689	.510
Q17	.372	.684	.567
Q18	.609	.682	.311
Q03	.381	.668	.588
Q36	.552	.664	.423
Q22	.418	.656	.535
Q07	.418	.471	.749
Q39	.403	.486	.742
Q37	.403	.479	.708
Q50	.383	.526	.683

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

Figure 2b. Rotated Component Matrix – CE 221

Figure 2 (a & b) shows the rotated component matrix for CE 221, in which three components comes of relevance on the Pearson R correlation. Interestingly, before the application of the rotation, the most striking behavior found in the study was that student's concentration is in disturbed mode. "Help improve listening skills" and "ability to concentrate" are the first two with the highest R. This shows that a big classroom with 118 students in lecturing mode is pretty good of a challenge to enhance learning without a microphone.

Total Variance Explained

Component	Rotation Sums of Squared Loadings	
	% of Variance	Cumulative %
1	38.467	38.467
2	36.183	74.650
3	18.356	93.006
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		

Extraction Method: Principal Component Analysis.

Figure 3. Total Variance Explained on Rotation sums of squared loadings – **CE 221**

Figure 3 shows the percent of variance of the three (3) components as explained.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	43.364	86.729	86.729	43.364	86.729	86.729	19.234
2	2.036	4.072	90.801	2.036	4.072	90.801	18.091
3	1.102	2.205	93.006	1.102	2.205	93.006	9.178
4	.682	1.364	94.370				
5	.392	.783	95.153				
6	.298	.596	95.749				
7	.289	.577	96.326				
8	.237	.474	96.800				
9	.188	.377	97.177				
10	.183	.365	97.542				
11	.155	.310	97.852				
12	.133	.265	98.118				
13	.106	.213	98.330				
14	.101	.202	98.532				
15	.096	.192	98.725				
16	.072	.144	98.869				
17	.063	.126	98.995				
18	.053	.105	99.100				
19	.047	.095	99.195				
20	.041	.081	99.276				
21	.035	.070	99.346				

Extraction Method: Principal Component Analysis.

Figure 4. Total Variance Explained – **CE 221**

Figure 4 shows the total variance of the the 3 components in which component 1 and 2 are closely related. By assessing the influences, it was found a distinct behavior in which cultural values matters most to students followed by the educational values. With a diverse community, so rich in cultural values, the challenges now posed to the researcher is how cultural aspects are addressed and preserved while the educationl values are enhanced so as quality of learning is to achieve. The rest of the figures give visual reprepresentations of the behavior of the predictors.

Component Transformation Matrix

Co...	1	2	3
1	.645	.628	.435
2	.761	-.577	-.297
3	-.064	-.522	.850

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Figure 5. Component Transformation Matrix- CE 221

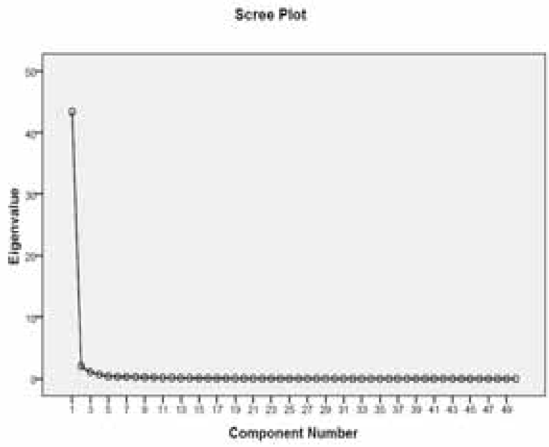

Figure 6. Scree Plot on Factor Analysis – **CE 221**

Figure 6 shows the scree plot of the influential patterns in linearity in which two (2) components prevail, as illustrated by the Eigenvalue of each component number of predictors.

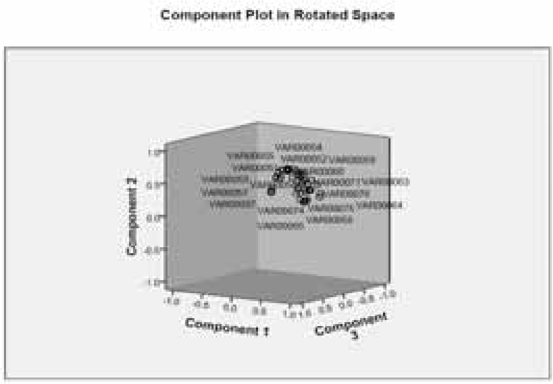

Figure 7. Component Plot on Factor Analysis

The 3D component plot in rotated space is shown in figure 7, where x represents component 1 – the cultural aspect, y depicts component 2 – the educational aspects, and z is component 3. The plot in of figure 8 shows that only a component, the cultural aspect, is strong.

Figures 9 and 10 give a better insight in the problem under analysis.

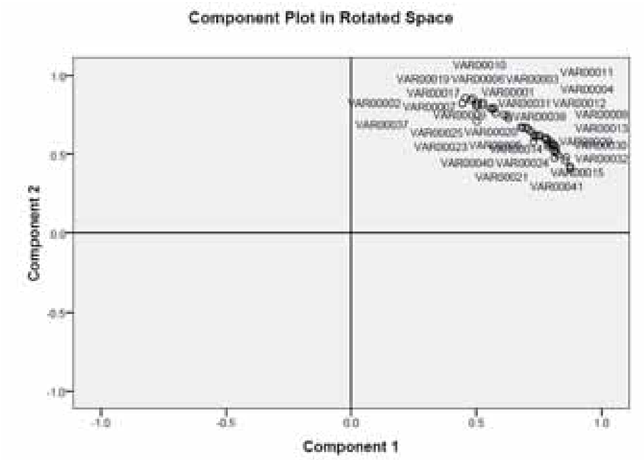

Figure 8. Component Plot on Factor Analysis – **CE 221**

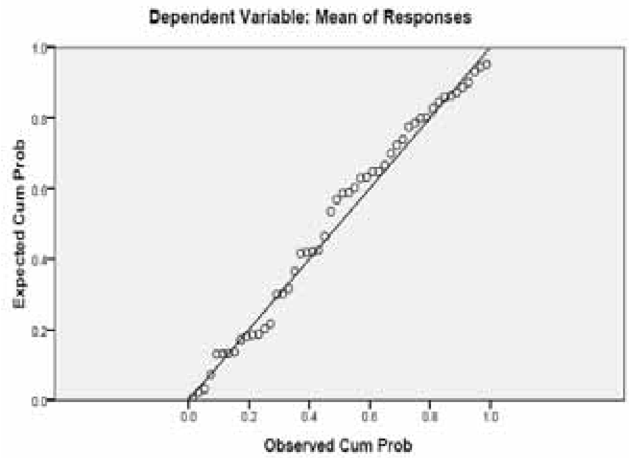

Figure 9. Normal P-P Plot of Regression Standardized Residual – **CE 221**

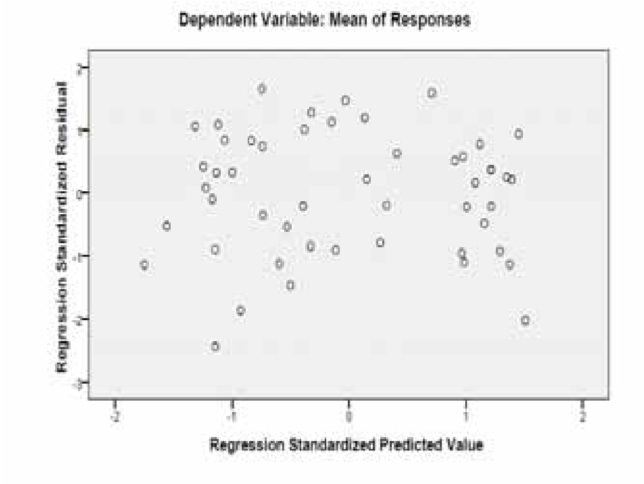

Figure 10. Regression Scatter plot – **CE 221**

Multi regression analysis was made to find out the relationship of the weighted means of each response with the rotated matrix of R values. The results are shown in figures 11 to 14.

Descriptive Statistics

	Mean	Std. Deviation	N
Mean of Responses	4.4648	.20463	50
Influence Factor 1	.6007	.15621	50
Influence Factor 2	.5854	.14591	50

Figure 11. Regression Descriptive Statistics – CE 221

Correlations

		Mean of Responses	Influence Factor 1	Influence Factor 2
Pearson Correlation	Mean of Responses	1.000	-.671	.492
	Influence Factor 1	-.671	1.000	-.718
	Influence Factor 2	.492	-.718	1.000
Sig. (1-tailed)	Mean of Responses	.	.000	.000
	Influence Factor 1	.000	.	.000
	Influence Factor 2	.000	.000	.
N	Mean of Responses	50	50	50
	Influence Factor 1	50	50	50
	Influence Factor 2	50	50	50

Figure 12. Regression Correlation – **CE 221**

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Influence Factor 2, Influence Factor 1[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Mean of Responses

Figure 13. Retained Variable – **CE 221**

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.925	2	.462	19.280	.000[a]
	Residual	1.127	47	.024		
	Total	2.052	49			

a. Predictors: (Constant), Influence Factor 2, Influence Factor 1

b. Dependent Variable: Mean of Responses

Figure 14. ANOVA – CE 221

Figures 13 and 14 show that the variable is a statistically significant *unique* contribution to the equation. This is very dependent on which variables are included, and how much overlap there is among the independent variables. The criterion is that if the Sig. value is less than .05, then the variable gives a significant unique contribution to the prediction of the dependent variable. Thus, if Sig. is greater than .05, then one can conclude the corresponding variable do not give a significant unique contribution and should be rejected. In this case, two components are retained and none is rejected.

2.1.3 CE 211-F Results of Factor Analysis & Multiple Regression Analysis (DP1's)

The factor analysis uses Principal Component Analysis as extraction method, while rotation method uses Varimax with Kaiser normalization. The rotation converged after 5 iterations. Kaiser-Meyer measures rotation above 0.30, the rest are rejected. The result of factor analysis for CE 211-F is presented below.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	44.807	89.614	89.614	44.807	89.614	89.614	24.264
2	1.657	3.314	92.928	1.657	3.314	92.928	22.200
3	.693	1.386	94.314				
4	.567	1.133	95.447				
5	.525	1.051	96.498				

Extraction Method: Principal Component Analysis.

Figure 15. Total Variance Explained – **CE 211-F**

Figures 15, 16 and 17 shows the total variance of the two components in which components 1 and 2 are closely related. By assessing the influences, it was found a distinct behavior where cultural values matters the most to students, followed by the educational values. Similar results were found for CE 221.

With a diverse community, in which the country is so rich in cultural values, the challenges now posed are how cultural aspects are addressed and preserved while educationl values are enhanced so as quality of learning is to achieve. The rest of the figures give visual reprepresentations of the behavior of the predictors.

What was so intriguing in the data of the correlation matrix before they were rotated was the rejection of a predictor that requires the application of outlying principles and concepts in Engineering Fluid Mechanics. The strongest components show that the relevance of cultural aspects is greater than that of the educational aspects. However, when rotation is applied, the said predictor is included but with a reduced value for R. It is thus imperative that teaching Engineering Mechanics & Engineering Materials to a diverse group in which no one comes from Lae City, where the University is located, requires a strategy that best suit their particular preferences to motivate participation. Interestingly, it was found that the respondents do not like to be instructed by the lecturer because only 2.38 percent responded. Many of them said they wanted to prepare for their career as Civil Engineers, but they wanted to do it their own way, according to their own cultural beliefs. Indeed, teaching these groups of students is so challenging.

Figure 18 shows the scree plot of the influential patterns where two (2) components prevail, as illustrated by the Eigenvalue of each component number of predictors.

Rotated Component Matrix[a]

	Component 1	Component 2
Q47	.874	.421
Q43	.874	.410
Q32	.858	.480
Q15	.855	.459
Q21	.826	.492
Q48	.819	.507
Q44	.818	.546
Q29	.817	.525
Q41	.811	.476
Q30	.811	.557
Q24	.809	.521
Q49	.805	.558
Q26	.800	.574
Q45	.798	.559
Q46	.786	.587
Q42	.786	.564
Q40	.785	.550
Q14	.779	.600
Q12	.772	.598
Q13	.772	.598
Q08	.753	.619
Q33	.745	.617
Q22	.733	.610
Q34	.732	.625
Q27	.727	.576
Q23	.717	.643
Q36	.717	.643

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 3 iterations.

Figure 16. Rotated Component Matrix – CE 211-F

Rotated Component Matri

	Component 1	Component 2
Q05	.705	.660
Q11	.696	.670
Q20	.683	.668
Q39	.678	.670
Q19	.456	.857
Q10	.485	.856
Q28	.476	.842
Q07	.504	.827
Q06	.525	.827
Q17	.443	.822
Q02	.443	.822
Q18	.502	.814
Q03	.524	.813
Q50	.501	.802
Q09	.571	.794
Q16	.556	.791
Q01	.556	.791
Q35	.566	.784
Q31	.577	.759
Q25	.610	.748
Q04	.625	.744
Q38	.627	.726
Q37	.592	.708

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 3 iterations.

Figure 17. Rotated Component Matrix – CE 211-F

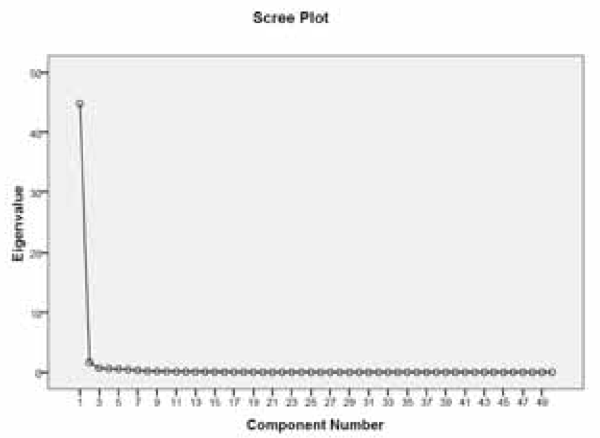

Figure 18. Scree Plot on Factor Analysis – **CE 211-F**

Descriptive Statistics

	Mean	Std. Deviation	N
Mean of Responses	4.1918	.32252	50
Factor Comp 1	.6840	.13422	50
Factor Comp 2	.6542	.12804	50

Figure 19. Descriptive Statistics for Regression model – **CE 211-F**

Figures 19 and 20 show the descriptive statistics of the predictors for CE 211-F.

Correlations

		Mean of Responses	Factor Comp 1	Factor Comp 2
Pearson Correlation	Mean of Responses	1.000	-.547	.484
	Factor Comp 1	-.547	1.000	-.968
	Factor Comp 2	.484	-.968	1.000
Sig. (1-tailed)	Mean of Responses	.	.000	.000
	Factor Comp 1	.000	.	.000
	Factor Comp 2	.000	.000	.
N	Mean of Responses	50	50	50
	Factor Comp 1	50	50	50
	Factor Comp 2	50	50	50

Figure 20. Regression Correlation – **CE 211-F**

Multi regression analysis was performed to find out the relationship of the weighted means of each response with the rotated component matrix R values. The results are shown in figures 21 to 29.

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Factor Comp 1	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a. Dependent Variable: Mean of Responses

Figure 21. Retained Variable – **CE 211-F**

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.527	1	1.527	20.529	.000[a]
	Residual	3.570	48	.074		
	Total	5.097	49			

a. Predictors: (Constant), Factor Comp 1

b. Dependent Variable: Mean of Responses

Figure 22. ANOVA – **CE 211-F**

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Correlations	
		B	Std. Error	Beta	t	Sig.	Zero-order	Partial
1	(Constant)	5.091	.202		25.173	.000		
	Factor Comp 1	-1.315	.290	-.547	-4.531	.000	-.547	-.547

a. Dependent Variable: Mean of Responses

Figure 23. Correlation Coefficients – **CE 211-F**

Looking at figures 21 to 23, one can see that the variables included in the model contributed to the prediction of the dependent variable. We find this information in the output box labeled **Coefficients**, in the column labeled **Beta** under **Standardized Coefficients**. The *standardized* coefficients are used to compare the different variables, not the *unstandardized* ones. 'Standardized' means that these values for the different variables have been converted to the same scale so that one can compare them. If there is a need for constructing a regression equation, unstandardized coefficient values, which are labeled as B, should be used. In this case, the researcher is interested in *comparing* the contribution of each independent variable; therefore, we will use the beta values, in which the Beta column has the largest beta values (ignoring any negative signs). The largest beta coefficient is -.547, which is related to Component 1. This means that this variable makes the strongest unique contribution to explain the dependent variable when the variance explained by all other variables in the model is controlled.

Coefficients[a]

Model		Correlations	Collinearity Statistics	
		Part	Tolerance	VIF
1	(Constant)			
	Factor Comp 1	-.547	1.000	1.000

a. Dependent Variable: Mean of Responses

Figure 24. Collinearity Coefficients – **CE 211-F**

Figure 24 shows the collinearity of the coefficients of the predictors for CE 211-F, along with factor component 1, while figure 25 relates to the excluded variable.

Excluded Variables[b]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	Factor Comp 2	-.710[a]	-1.506	.139	-.214	.064	15.653	.064

a. Predictors in the Model: (Constant), Factor Comp 1

b. Dependent Variable: Mean of Responses

Figure 25. Excluded Variable – **CE 211-F**

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions	
				(Constant)	Factor Comp 1
1	1	1.982	1.000	.01	.01
	2	.018	10.392	.99	.99

a. Dependent Variable: Mean of Responses

Figure 26. Collinearity Diagnostics – **CE 211-F**

Figure 26 shows the collinearity diagnostics for CE 211-F for the regression.

Figure 27 shows a statistically non-significant *unique* contribution to the equation. The criterion is if the Sig. value is less than .05 (.01, .0001, etc.), then the variable is a significant unique contribution for the prediction of the dependent variable. The criterion is if Sig. is greater than .05 (in this case Sig is 0.139), then one can conclude that that variable is not making any significant unique contribution and is rejected. In this case, one component is retained and one is rejected.

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	3.9419	4.5088	4.1918	.17652	50
Std. Predicted Value	-1.416	1.796	.000	1.000	50
Standard Error of Predicted Value	.039	.080	.053	.011	50
Adjusted Predicted Value	3.9213	4.5180	4.1925	.17772	50
Residual	-.66924	.44031	.00000	.26992	50
Std. Residual	-2.454	1.615	.000	.990	50
Stud. Residual	-2.498	1.631	-.001	1.009	50
Deleted Residual	-.69369	.44931	-.00073	.28079	50
Stud. Deleted Residual	-2.651	1.661	-.008	1.031	50
Mahal. Distance	.000	3.224	.980	.855	50
Cook's Distance	.000	.114	.020	.028	50
Centered Leverage Value	.000	.066	.020	.017	50

a. Dependent Variable: Mean of Responses

Figure 27. Residual Statistics – **CE 211-F**

To check whether an unexpected case has any undue influence on the results for our model as a whole, we can check the value of the Cook's Distance, which can be found close to the bottom of the Residuals Statistics table of figure 27. According to Tabachnick & Fidell (2001), cases with values larger than 1 are a potentially problematic. In our case, the maximum value for the Cook's Distance is 0.114, which suggests no major problems.

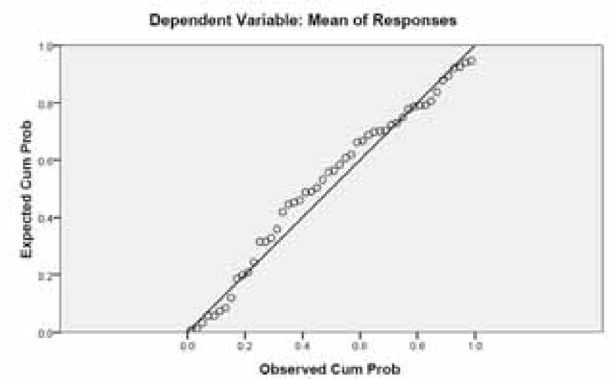

Figure 28. Normal P-P Plot of Regression **Standardized** Residual – **CE 211-F**

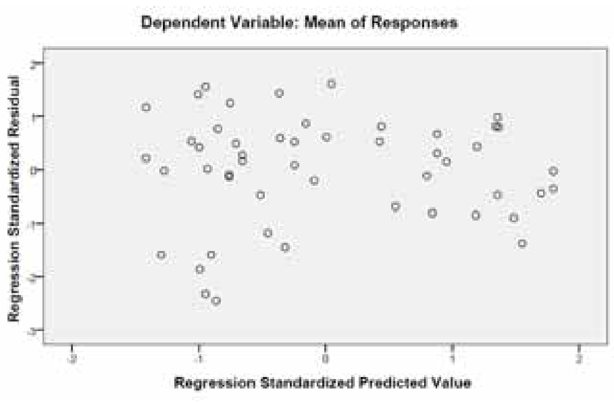

Figure 29. Regression Scatter – **CE 211-F**

Figures 28 and 29 give a better insight to the problem under analysis.

2.1.4 DP3 - Student Support Tools

From the results of factor analysis, two striking relationships of the students' influences were found for both courses: 1) cultural aspects (self-concept and self-efficacy belief) and 2) educational aspects (academic behavior and attitude). A support mechanism is needed to address these issues, taking into account that PNG students usually favor the cultural aspects rather than educational values.

As a background to understand the preferred support tools, a review on the Papua New Guinea people's daily lives is useful and can be found at Culture of Papua New Guinea (2014).

Briefly, PNG people lives vary enormously because their great majority of the population lives in diverse rural landscapes in villages or hamlets. Rituals to ensure success and prosperity accompany many of their activities. The clan forms the major unit of social organization. Almost all Melanesian societies are patrilineal, and even matrilineal societies remain patriarchal, i.e., male-dominated. In some areas, lineage and land rights can be claimed through either parent, so people can belong to both their parents' clans. Large tribes are not usual, but when they exist, they have a certain degree of political unity and they can be viewed as federations of clans. They may share origin myths, and in such cases clans can be seen as being like "brothers," sons of a founding father. These social structures form the lines of conflicts expressed in the inter-clan warfare that persists in the Highland provinces, and in those areas they often form the lines of political competition in contemporary elections.

When people migrate from rural villages to urban areas or to rural resettlement areas, they carry their languages and traditions with them and re-create their original social structures. Social bonds and obligations form the so-called *wantok* system, which can provide support for struggling in their new locations and create heavy demands to the more wealthy people who feel obliged to support their kin. The demands of *wantok* are often considered as root cause of corruption. Intergenerational tensions reflect the stresses of rapid social change in rural and urban contexts. In both villages and cities, music and dance celebrations often mark important life-cycle events such as birth, death, initiation, menarche, economic transactions (even the opening of a roadway), peacemaking, and religious observances. It is in this context that mapping the PV's from the DP's is essential as it addresses relevant facts that support the students' effective pedagogic learning. How the PV's are applied will be shown in the following discussion.

2.2 APPLICATION OF PV'S

The intervention applied during the study time is the merit system or extra marks scheme to support the students' needs of escalating self-efficacy. The results are shown in figure 30 and were used as means to increase the percentage of passing without the content wise of the coursework. Thus, applications of the best strategy or solution to the challenges revealed by this study inspired on the Axiomatic Design approach.

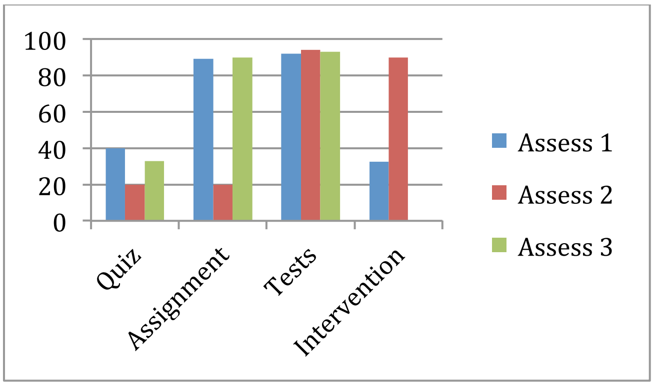

Figure 30. CE 211-F Assessment

The figure shows the students' difficulty in understanding the course is relevant. To raise the students' performance, an intervention was incorporated in the assessment process, as shown in figure 31.

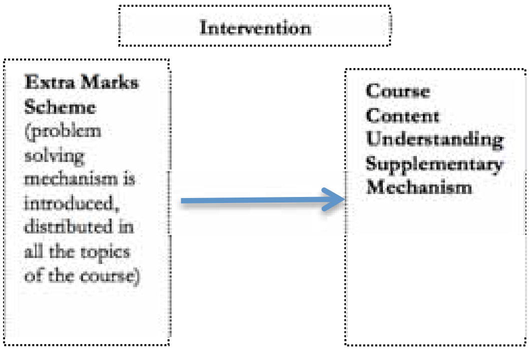

Figure 31. Intervention Mechanism

Section 2.2.1 below shows the result of the intervention.

2.2.1 The students' performance

2.2.1.1 CE 221 – Engineering Materials

The results of student performance in the Engineering Materials class are presented in figure 32.

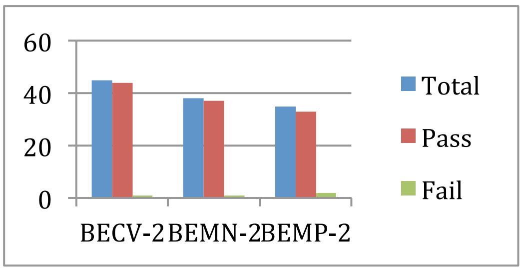

Figure 32. Engineering Materials **(CE 221) Student Performance**

The graph of figure 33 shows the achievements (A's, B's, C's, D's, E's and F's grades). The result is pretty good, but the researcher finds that it is not content rich, thus another intervention should be sought.

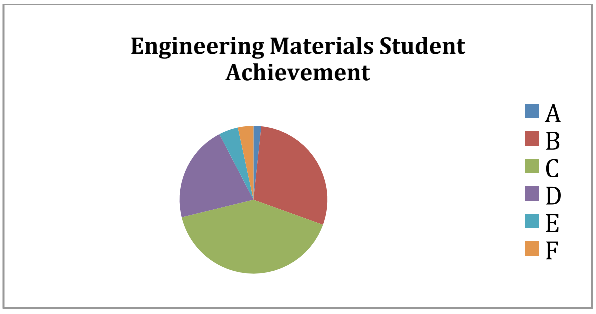

Figure 33. Engineering Materials **(CE 221) Student Achievement**

2.2.1.2 CE 211-F – Fluid Mechanics

The Engineering Fluid Mechanics (CE 211-F) class achievement result is shown in figure 34.

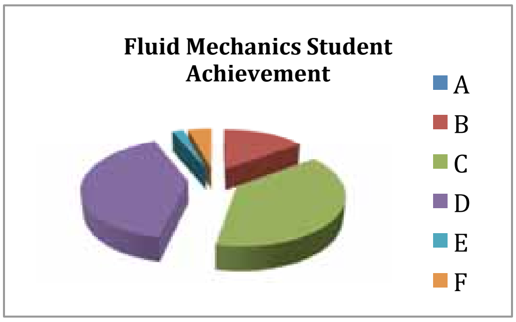

Figure 34. Fluid Mechanics **(CE 211-F) Student Achievement**

2.2.2 Course Content Bridging Framework

Figure 34 depicts the conceptual framework of the challenge posed by the assessment of the students' pedagogic learning using the AD Model. In this case, the PV's are part of the AD Model. The conceptual framework has the shape of a funnel that induces the learner to achieve the maximum pedagogic learning in content-wise courses such as Engineering Materials and Engineering Fluid Mechanics, in culture-friendly environments, without sacrificing the quality of the required educational wealth that usually results from the use of the inductive technique.

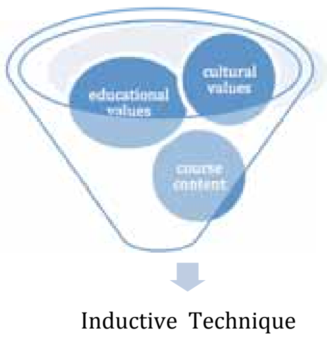

Figure 34. Culture-Educational Paradigm Shift **Framework**

The cultural value of the figure is over the course content and above the educational values. This illustration describes the findings of the study. Students want an experience where their self-concept and self-efficacy is maintained, and where behaviors are supported by cultural values, and the academic behavior and attitude is embodied in the educational values. The researcher will call this phenomenon as culture-educational paradigm shift since it best describes the figure.

Two very distinct and opposing instructional approaches are the inductive and the deductive ones (Inductive and Deductive Instruction, 2014). Both approaches can offer certain advantages, but the biggest difference is the role of the teacher. In a deductive classroom, the teacher conducts the lessons by introducing and explaining concepts to the students (this is the instructional method used by the researcher, of which most of the students responses are opposing), and then expecting students to complete tasks to practice the concepts; this approach is very teacher-centered. Conversely, inductive instruction is a much more student-centered approach and makes use of a strategy known as 'noticing'. Instead of explaining a given concept and following this explanation with examples, the teacher presents students with many examples showing how the concept is used. The intent is that the students "notice", by way of examples, how the concept works.

3 CONCLUSION

The conclusion is that the pedagogical framework should include four groups: *Recognition of Difference* and *Social support* were rated 'very important' influencing factors to students both in CE 221 and CE 211-F. In addition, *Connectedness* and *Intellectual quality* were rated 'very important' and 'essential' for CE 221 and CE 211-F respectively. Because of the diversity of the population, the students who are enrolled in the above mentioned courses perform differently. However, when a multivariate analysis was applied, the pedagogical framework earlier posed was changed to address the challenge of the culture-rich and educational-poor values. In addressing these challenges, a new concept is realized and come up with a Culture-Education Paradigm Shift Framework by adopting the Inductive Instructional Methodology.

It is hereby recommended that the next delivery of the courses should be conducted in a Culture-Educational Paradigm Shift framework to address the challenges that were found by using the Axiomatic Design Model in the assessment of the pedagogic-learning results of Engineering Materials (CE 221) and Engineering Fluid Mechanics I (CE 211-F).

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