IMPACT OF ICT IN ACHIEVING A COMPETENCY-BASED TVET EDUCATION AMONG POLYTECHNIC STUDENTS: A PRINCIPAL COMPONENT ANALYSIS APPROACH

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Abstract

The knowledge of ICT has become a condition sine qua non for attaining satisfactory level of accomplishment especially in technological based education, and this can be attributed to different factors which vary according to individual specialized discipline. It has transformed and impacted on teaching, communication, learning and research in general due to easy access to internet based medium via devices such as laptops, android phones, iPhones, tablets and iPod which are easily affordable. This research thus attempts to evaluate the relevancy of factors that have been found prevalent for the impacts of ICT technology on academic performance of TVET-based students with the aid of Principal Component Analysis. To achieve this objective, survey was carried out using questionnaire instrument that employed five components which include; 'ICT equipment allows for easy exchange of information', 'ICT equipment facilitates smooth interaction with the lecturers', 'ICT helps to develop research skills through peer collaboration', 'ICT facilitate academic activities and coordinate with lecturers', 'group discussion arranged with course mates using ICT equipment improves academic performance'. The results revealed that two of the components which are ICT equipment allows for easy exchange of information and ICT equipment facilitate smooth interaction with the lecturers are the most prevalent with cumulative variance of 68.29%. These effects are found to be positive on student's academic performance with respective eigenvalues of 1.725 and 1.161.

Keywords: Cumulative Variance, Eigen Values, ICT, Principal Component Analysis, TVET

1. Introduction

The evolution of ICT has cut across all facets of academic and professional learning and its compulsory integration into learning has been of tremendous blessings in achieving the needful skills required by graduates of Polytechnic. Despite the burgeoning literature on the merger of ICT and education, discourse between three identified clusters of paradigms namely the technocrat, the reformist and the holistic is surprisingly limited of which their identification are vital for better future educational policies (Aviram and Talmi, 2005). ICT has transformed and impacted on communication, learning, research and education in general. Earlier studies, such as Kennedy *et al.,* (2009) examined the general usability of ICT among young students in higher level of education. Similarly, Hemmi *et al.,* (2009); Hargittai and Hsieh (2010); Meinck and Alkan (2016) examined the use of ICT and maintain that, the appropriation of social technologies is not an easy and straightforward process. At higher level of education more complex academic tasks are handled and the new generation of students is perceived to understand that social media and social technologies are influential to learning. A number of earlier studies have shown evidence that efforts are required in order to start using ICT in a way to influence educational activities. Researchers have argued that in teaching and learning, the integration of ICT to facilitate the process is widely encouraged especially in relation to improving final results of scholars (McLoughlin and Lee, 2008; Tay and Allen, 2012). ICT usage by students is so rampant recently because of easy access to devices such as smart phones, iphones, black berry, tablets, ipad and laptops which are connected to the internet (Brown, 2010). These systems are referred to as social, simply because they allow communication with buddies and coworkers so easily and effectively. It also strengthens the ties between people of those systems. The perils of its effects on the academic performance of the over-involved students are disturbing. Students that spend excessive time on social networks become dependent on it and it is believed that their academic performance diminishes proportionately. It is perceived that school grades will suffer when spending too much time on social sites such as Facebook, Twitter and Whatsapp as valuable study time is lost (Ferdig, 2007). According to Brown (2010); Schroeder, Minocha and Schneider (2010), the driving factors for adoption of these platforms are the progressively ubiquitous access, convenience, functionality, and flexibility of social technologies. Davis *et al.,* (2012), refer to ICT technology as "web-based and mobile applications that allow individuals and organizations to create, engage, and share new user generated or existing content, in digital environments through multi-way communication". Among the vast variety of ICT tools which are available for communication, social networking sites (SNS) have become the most modern and attractive tools for connecting individuals globally (Aghazamani, 2010). Christena, Ncube and Muchemwa (2015) were of the opinion that majority of students are knowledgeable of ICT tools and they mainly used them for social media needs. However, researches have shown that few of them used ICT to accomplish their academic career. McLoughlin and Lee (2008); Schroeder *et al.,* (2010) contended that greater education in social technologies supports social constructivist techniques to learning; they potentially have improved students' construction of understanding and promote interaction.

Karamti (2016) measured the impact of ICTs on academic performance of students of higher education in Tunisia and was of the opinion that these impacts relate mainly to developed countries. An interesting aspect of ICT technology is that, it is not limited to desktop or laptop computers but could be accessed through mobile applications and smart phones making it very accessible and easy to use..

Hambira *et al.*, (2017) emphasized on the emotional and cultural impacts of ICT on learners in disadvantaged and marginalized communities and suggested careful planning of ICT curriculum as a beneficial tool. An additional benefit of social technologies provided on the internet is that they are frequently free or require marginal investment, eliminating a potential barrier to adoption (Brown, 2010). Social networking websites provide tools by which people can communicate, share information, and create new relationships. With the popularity of social networking websites on the rise, our social interaction is affected in multiple ways as we adapt to our increasingly technological world. According to Asur and Huberman (2010), Social networking websites have affected our social interaction by changing the way we interact face-to-face, how we receive information, and the dynamics of our social groups and friendships.

Communicating through the internet and social networking websites is quite different from communicating in one-on-one situation. When users communicate through these websites, they use things like instant message (IM) and chatting as well as status or Twitter updates to talk to friends and express themselves. Most of these studies by scholars like Choney (2010), San Miguel (2009) Karpinski and Duberstein (2009) are conducted on students' use of the ICT based medium and its impact on academic performance focused on students in the developed world. According to McLoughlin *et al.* (2008), most students have Facebook, Whatsapp or other ICT based medium constantly running in the background while receiving lectures, doing homework or reading in the library. It is assumed that these circumstances could lower a student's grade.

It is against this background that it has become necessary to conduct this research aimed at investigating students' use of ICT technology and their impact on academic performance among Polytechnic students in a developing country like ours and to equally identify principal factors responsible for the usage of ICT in technology based education.

Materials and Methods

2.1 Research Design and Methodology

This research evaluates the variations in student academic performance in the school of Engineering, Federal Polytechnic Ilaro. Empirical data are collected by examining questionnaire on the final year Higher National Diploma (HND) students of the school. The school of engineering which currently runs HND programs includes Mechanical, Electrical, Civil and Computer Engineering departments. This research considered two hundred and forty five (245) questionnaires, being the total attendance of final year students as at the time of conducting this research. Yamene (1967) was then employed to determine the appropriate sample size of 145, which were selected from each departmental population using Proportional Stratification sampling technique. Thereafter, a Cronbach's Alpha reliability test was carried out on the responses gathered and this gives a statistic of 0.739 which implies 73.9% reliability on the survey.

2.2 Data Analysis

The analytical technique adopted for this research is a Multivariate analysis technique known as Principal Component Analysis. It is a data reduction technique that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. This transformation is defined in such a way that the first principal component has the largest possible variance (that is, accounts for as much of the variability in the data as possible), and each succeeding component in turn has the highest variance possible under the constraint that it is orthogonal to the preceding

components. The principal components are orthogonal because they are the Eigen vectors of the covariance matrix, which is symmetric. If the variables $Y_1, Y_2, \ldots Y_p$ in Y are correlated, the ellipsoidal swarm of point is not oriented parallel to any of the axis. The axes can be rotated by multiplying each $\mathbf{y}_i$ by an orthogonal matrix A and thus obtain

$$Z_i = A\,Y_i \qquad (1)$$

Since A is an orthogonal matrix, A'A=I and the distance to the origin is unchanged. Thus we want a sample covariance matrix of $Z\,S\,Z = A\,S\,A'$ to be diagonal.

$$Z\,S\,Z = A\,S\,A' = \begin{Bmatrix} \mathbf{S^2z} & \mathbf{0} \ldots\ldots\ldots\ldots \mathbf{0} \\ \mathbf{0} & \mathbf{S^2z} \ldots\ldots\ldots\ldots \mathbf{0} \\ \mathbf{0} & \mathbf{0} \ldots\ldots\ldots\ldots S^2z \end{Bmatrix} \qquad \mathbf{(2)}$$

Thus the orthogonal matrix A that diagonalizes S is the transpose of the matrix C.

$$\mathbf{A = C^I} = \begin{Bmatrix} a_1 \\ \mathbf{a_2} \\ \cdot \\ \cdot \\ \mathbf{a_p} \end{Bmatrix} \qquad \mathbf{(3)}$$

2.3 Eigenvalues and Eigenvectors

For every square matrix **A**, a scalar λ and a nonzero vector **x** can be found such that $\mathbf{Ax} = \lambda\mathbf{x}$. It should be known that λ is called an eigenvalue of **A**, and **x** is an *eigenvector* of **A** corresponding to λ. To find λ and **x**, we write the equation as as $(\mathbf{A} - \lambda\mathbf{I})\mathbf{x} = \mathbf{0}$.

If $|\mathbf{A} - \lambda\mathbf{I}|$ _= 0, then $(\mathbf{A} - \lambda\mathbf{I})$ has an inverse and $\mathbf{x} = \mathbf{0}$ is the only solution. Hence, in order to obtain nontrivial solutions, we set $|\mathbf{A} - \lambda\mathbf{I}| = 0$ to find values of λ that can be used to find corresponding values of **x**. Thus, in $(\mathbf{A} - \lambda\mathbf{I})\mathbf{x} = \mathbf{0}$, the matrix $\mathbf{A} - \lambda\mathbf{I}$ must be singular in order to find a solution vector **x** that is not **0**.

Suppose we have a 3 × 3 matrix A with eigenvectors X_1, X_2, X_3, and eigenvalues $\lambda_1, \lambda_2, \lambda_3$ so that

$\mathbf{Ax_1} = \lambda_1\,\mathbf{x_1}$ $\quad\quad$ $\mathbf{Ax_2} = \lambda_2\,\mathbf{x_2}$ $\quad\quad$ $\mathbf{Ax_3} = \lambda_3\mathbf{x_3}$

thus,

$$\mathbf{A} = \begin{Bmatrix} \mathbf{X_1} & \mathbf{X_2} & \mathbf{X_3} \end{Bmatrix} \begin{Bmatrix} \lambda_1 & 0 & 0 \\ 0 & \lambda_2 & 0 \\ 0 & 0 & \lambda_3 \end{Bmatrix} \qquad \mathbf{(4)}$$

The eigenvalues will then be used to compute the variance of the principal components and we can speak of the proportion of variance explained by the first K component.

2.3.1 Eigenvectors of Covariance Matrix

We will derive our first algebraic solution to PCA using linear algebra. This solution is based on an important property of eigenvector decomposition. The sample correlation between the *j*th and

*k*th variables is defined as **Covariances $\mathbf{X}^T\mathbf{X}$** itself and can be recognized as proportional to the empirical sample covariance matrix of the dataset **X**.

2.3.2 Deciding on How Many Components to Retain

In every application, a decision must be made on how many principal components should be retained in order to effectively summarize the data. Retain sufficient components to account for a specified percentage of the total variance, say, 80%. Retain the components whose Eigen values are greater than the average of the eigenvectors, $\sum_{i=1}^{p} \frac{\lambda_i}{\lambda_P}$ for a correlation matrix.

2.3.3 Scree graph

A plot of λ_i versus the number of component that looks for a natural broad between the large and small eigenvalues and also test the significance of the 'larger' components, that is, the components corresponding to the larger eigenvalues.

3. Results and Discussion

3.1 Results

Table 1 Correlation Matrix

	EEI	SIWL	DRS	ACWL	IAP
ICT allows for easy exchange of information with peers (EEI)	1.000				
ICT facilitates smooth interaction with the Lecturers (SIWL)	.575	1.000			
ICT help to develop research skills through peer collaboration (RSPC)	.475	.651	1.000		
ICT facilitates academic activities and coordinate with lecturers (AACWL)	.159	.160	-.420	1.000	
Group discussions arranged with classmates using ICT improve academic performance (IAP)	.797	.349	.421	.472	1.000

Table 2 Kmo and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.664
Bartlett's Test of Sphericity	Approx. Chi-Square	72.035
	Df	10
	Sig.	.001

Table 3: Eigen Values and Total Variance Explained

Component	Initial Eigenvalues	Extraction Sums of Squared Loadings

	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.723	38.510	38.510	1.835	38.510	38.510
2	1.161	29.781	68.291	1.141	29.781	68.29
3	.858	15.146	80.437			
4	.619	11.374	91.811			
5	.547	8.189	100.000			

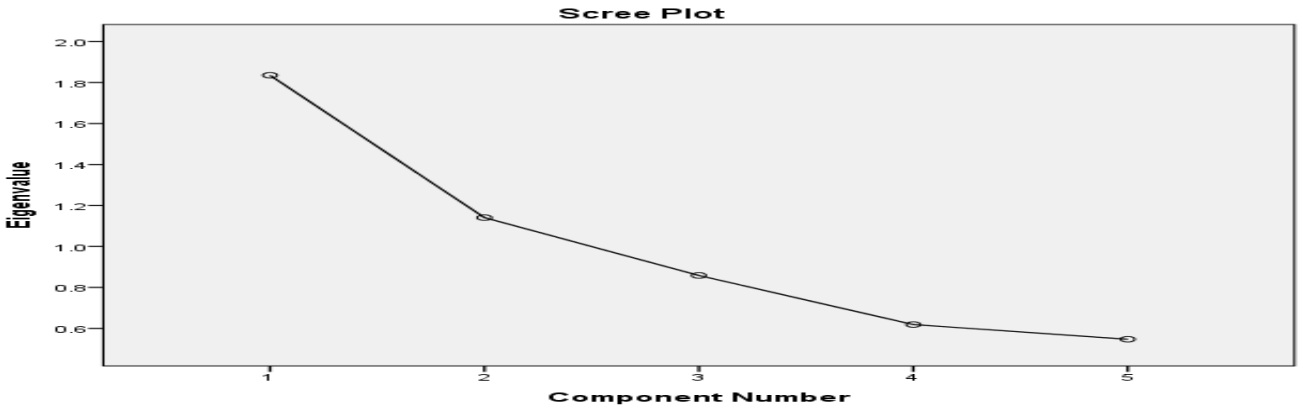

Figure 1: Scree Plot

Table 4 Component Matrix

	Component	
	1	2
ICT allows for easy exchange of information with peers	.740	.356
ICT facilitates smooth interaction with the Lecturers	.710	.473
ICT helps to develop research skills through peer collaboration	.569	.770
ICT facilitates academic activities and coordinate with lecturers	-.344	- .311
Group discussions arranged with classmates using ICT improve academic performance	.796	.396

Table 5 Rotated Component Matrix

	Component	
	1	2
ICT allows for easy exchange of information with peers	.742	.126
ICT facilitates smooth interaction with the Lecturers	.771	.210
ICT helps to develop research skills through peer collaboration	.332	.787
ICT facilitates academic activities and coordinate with lecturers	.477	.689
Group discussions arranged with classmates using social media improve academic performance	.699	.063

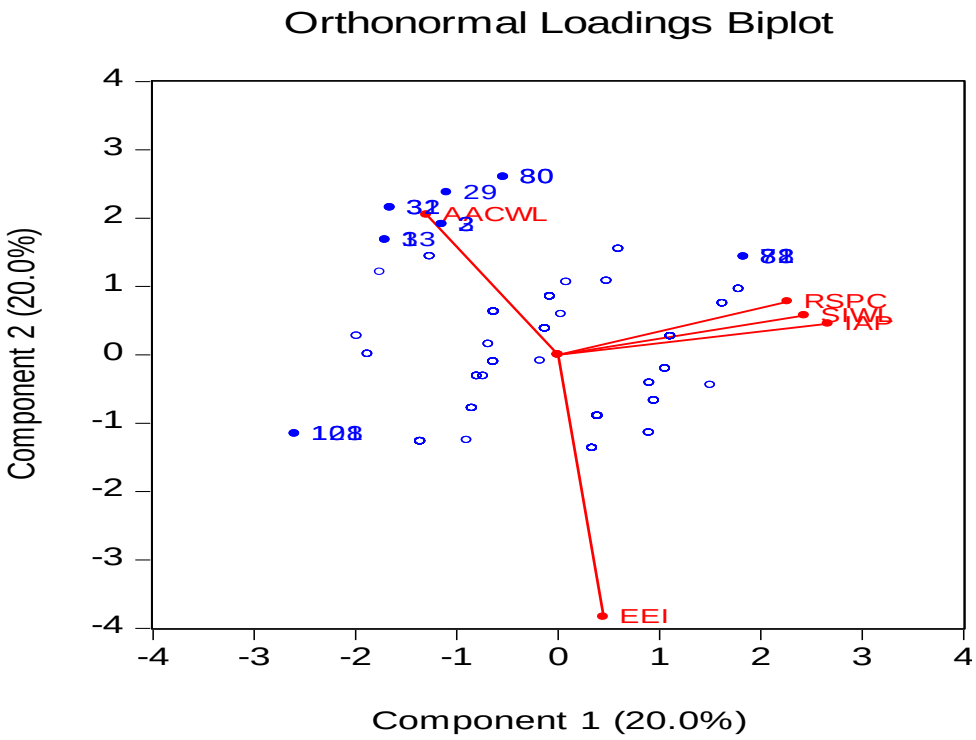

Figure 2: Component Plot in a Rotated space

3.2 Discussion

The starting point for all factor analysis techniques is the correlation matrix. According to the correlation matrix of the five components examined in table 1 above, it shows that there exist positive degrees of relationship between the five factors considered. All the components have estimated pair correlations above 0.3 coefficients with the exception of components 4 and 1; 4 and 2. This is in conformity with Norman and Streiner (2001) that if there are few or no correlations above 0.3, it is a waste of time carrying on with the analysis. The KMO value of 0.664 in table 2 indicates that the interrelationship of the variables is poor. However Bartlett's test of sphericity with an associated p value of 0.001 which is less than 0.05 indicates that the research can be proceeded with.

Table 3 shows the importance of each of the five principal components. Only the first two have eigenvalues well above 1.00 (component 1 and 2 with eigenvalues 1.725 and 1.161), and together these explain about 68% of the total variability in the data. This leads to the conclusion that a two factor solution will probably be adequate. Therefore, there exist only two important components among the researched factors.

The two factors solution can also be evidenced from the scree plot in figure 1 above indicating the number of eigenvalues greater than 1.00. The component number is on the horizontal axis while the eigenvalue is on the vertical axis.

The component matrix in table 4 above shows unrotated factor loadings. These indicate an expected pattern, with high positive, high and low negative loadings on the two components.

The two factor score equations as deduced by the component matrix can be written as;

PC1 = 0.74EEI + 0.71SIWL + 0.57RSPC - 0.34AACWL + 0.79IAP (5)

PC2 = 0.36EEI + 0.47SIWL + 0.77RSPC - 0.31AACWL + 0.40IAP (6)

The rotated component matrix in table 5 shows the factors that has high and low positive/negative loadings on the two components. It shows in the rotated factors that, variables

1,2 and 5 have high positive loadings (0.742, 0.771, and 0.699) while variables 3 and 4 have low loadings on the first component. Variables 2 and 3 have high positive loadings (0.787 and 0.689) while the remaining variables have low loadings on the second component. In furtherance to these rotations, Figure 2 shows the components plot in rotated space. The factors have been rotated through five different degrees. The angle can be calculated by treating the correlation coefficient as a cosine.

4. Conclusion and Recommendation

4.1 Conclusion

Based on the empirical analysis of this research, there is a strong indication that ICT has impacted more positively on student's academic performance in achieving a competency-based TVET education among polytechnics students in terms of quality and productivity as reflected in the two factors solution, i.e ICT allow easy exchange of information with peers and ICT facilitates smooth interaction with the Lecturers. The first principal component exhibited positive correlations with all the factors save for AACWL which exhibited a negative effect. This is an indication of positive impacts of ICT on students' education which may however bring a negative impact in the rate of assimilation if its use is not put under check. The same opinion can also be deduced of the 2nd principal component.

4.2 Recommendation

Since the two specified equations exhibited positive relationships with only four of the factors of which there correlations coefficients are equally positive, then it is recommended that there should be management restriction and guidelines on the usage of ICT devices by students while within the school premises, especially during lectures to ameliorate the negative impact of the fourth factor i.e . ICT facilitates academic activities and coordinate with lecturers.

This research should be embarked upon on a broader scope to study the global effects on student's academic performance in a TVET based discipline.

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