STATISTICAL EFFECTS OF SOCIAL MEDIA AND ICT ON THE ACADEMIC PERFORMANCE: AN APPLICATION OF PRINCIPAL COMPONENT ANALYSIS

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Abstract

The evolution of Information communication Technology (ICT) has cut across all facets of society with its prevailing impacts on both academic and non-academic environments. This evolved Social media which has transformed and impacted on communication, learning, research and education in general due to easy access to devices such as smart phones, iPhones, black berry, tablets, iPod and laptops which are connected to the internet. Thus, the objectives of this research is to identify most prevalent factors responsible for the negative and positive effects of ICT influenced of social media on student academic performance with the aid of Principal Component Analysis. To achieve this objective, survey was carried out using direct questionnaire method that employed five factors which include; 'social media allows exchange of information', 'social media facilitates smooth interaction with the lecturers', 'social media helps to develop research skills through peer collaboration',' Social media facilitate academic activities and coordinate with lecturers', 'group discussion arranged with course mates using social media improves academic performance'. The results revealed that two of the factors i.e social media allow easy exchange of information with peers and social media facilitate smooth interaction with the lecturers are the most prevalent with cumulative variance of 59.21%. These effects are found to be positive on student's academic performance with respective eigenvalues of 1.82 and 1.41.

Keywords: Social Media, Principal Component Analysis, Eigen Values, Cumulative Variance, ICT

1. Introduction

The internet revolution has changed the information world with regard to sharing, speed, storage and retrieval of information in whatever form regardless of the person's location. Through the internet a number of web technologies emerged, and one technology that is making waves with regard to information sharing and communication are the social media networks. The evolution of social media has cut across all facets of society with its positive and negative impacts. Social media has transformed and impacted on communication, learning, research and education in general. Among the vast variety of online tools which are available for communication, social networking sites (SNS) have become the most modern and attractive tools for connecting people throughout the world. (Aghazamani, 2010).

Davis *et al.,* (2012), refer to social media technology (SMT) 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".

An interesting aspect of social media 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. Examples of these social media platforms both on the web and mobile application include Facebook, Twitter, YouTube, Whatsapp, Instagram, blogs etc. Earlier studies, such as Kennedy *et al.,* (2009) examined the general usability of social media among young students in higher level of education. Similarly, Hemmi *et el.,* (2009); Hargittai and Hsieh (2010) examined the use of social media 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 social media in a way to influence educational activities. However, the whole process of adopting a particular social media has not received adequate attention from researchers (Hamid *et al.,* 2011).

Researchers have argued that in teaching and learning, the integration of media to facilitate the process is widely encouraged especially in relation to improving final results of scholars (McLoughlin and Lee, 2008; Tay and Allen, 2012). Social media 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). The favorite in the realm of internet sites are Facebook, Whatsapp and others. 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. 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. 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 social media sites 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 social networking sites, e-mails and maybe instant messaging 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. According to Wheeler *et al.*, (2008) students who multi-task between social networking sites and homework are likely to have 20% lower grades than a student who does not have a social networking site in visual range.

It is against this background that it has become necessary to conduct this research aimed at investigating students' use of social media sites and their impact on academic performance among Polytechnic students in a developing country like ours. This is largely because; no empirical study of this nature has been conducted among polytechnic students in the past.

2. Materials and Methods

2.1 Research Design and Methodology

This research evaluates the variations in student academic performance in the school of Applied Science, Federal Polytechnic Ilaro. Empirical data are collected by examining questionnaire on the final year students of the school. The school of applied science includes mathematics & statistics, computer science, science laboratory technology, office technology management, hospitality and nutrition & dietetics department. This research considered two hundred and seventy six (276) questionnaires, being the total attendance of final year students as at the time of conducting this research. Thereafter, Taro Yamene's formular was employed (Yamene, 1979) to determine the appropriate sample size of 163, which were selected from each departmental population using Proportional Stratification sampling technique.

2.2 Data Analysis

The analytical technique adopted for this research is a Multivariate analysis technique known as Principal Component Analysis. It is a statistical procedure 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 variablesY_1, Y_2, … 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

$$Z_i = A\,Y_i \tag{1}$$

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.

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

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

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

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

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

thus,

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

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** $\mathbf{X^TX}$ 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. Result and Discussion

3.1 Results

Table 1 Correlation Matrix

	AEEI	SIWL	DRS	FACWL	IAP
social media allow easy exchange of information with peers(AEEI)	1.000				
Social media facilitate smooth interaction with the Lecturers (SIWL)	.385	1.000			
social media help to develop research skills through peer collaboration (DRS)	.075	.251	1.000		
social media facilitate academic activities and coordinate with lecturers (FACWL)	.159	.160	-.120	1.000	
Group discussions arranged with your classmates using social media improve your academic performance(IAP)	.197	.349	.421	.472	1.000

Table 2 Kmo and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.607
Bartlett's Test of Sphericity	Approx. Chi-Square	62.935
	Df	10
	Sig.	.000

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	1.835	36.710	36.710	1.835	36.710	36.710
2	1.141	22.811	59.521	1.141	22.811	59.521
3	.858	17.166	76.687			
4	.619	12.374	89.061			
5	.547	10.939	100.000			

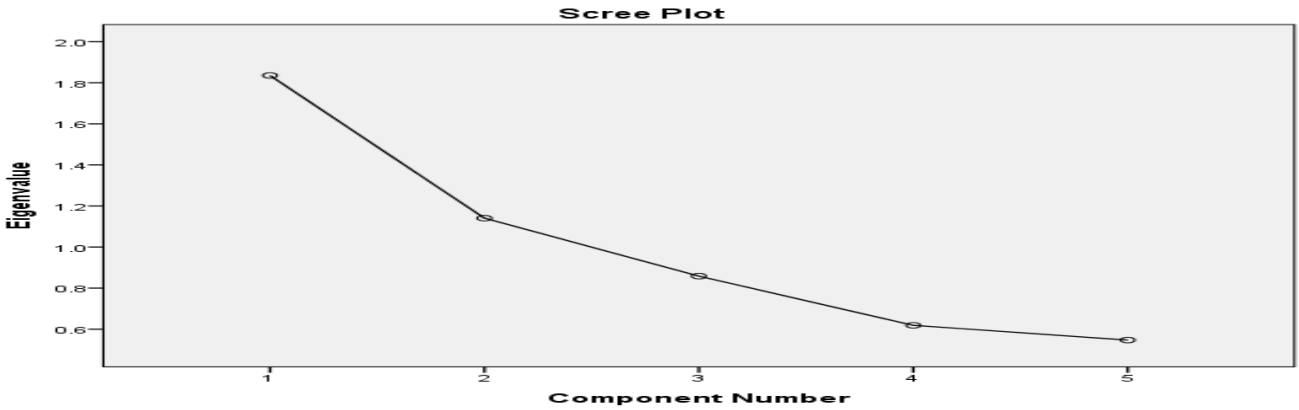

Figure 1: Scree Plot

Table 4 Component Matrix

	Component	
	1	2
social media allow easy exchange of information with peers	.640	-.056
Social media facilitate smooth interaction with the Lecturers	.780	.173
social media help to develop research skills through peer collaboration	.369	.770
social media facilitate academic activities and coordinate with lecturers	.444	-.711
Group discussions arranged with your classmates using social media improve your academic performance	.696	-.096

Table 5 Rotated Component Matrix

	Component	
	1	2
social media allow easy exchange of information with peers	.642	-.026
Social media facilitate smooth interaction with the Lecturers	.771	.210
social media help to develop research skills through peer collaboration	.332	.787
social media facilitate academic activities and coordinate with lecturers	.477	-.689
Group discussions arranged with your classmates using social media improve your academic performance	.699	-.063

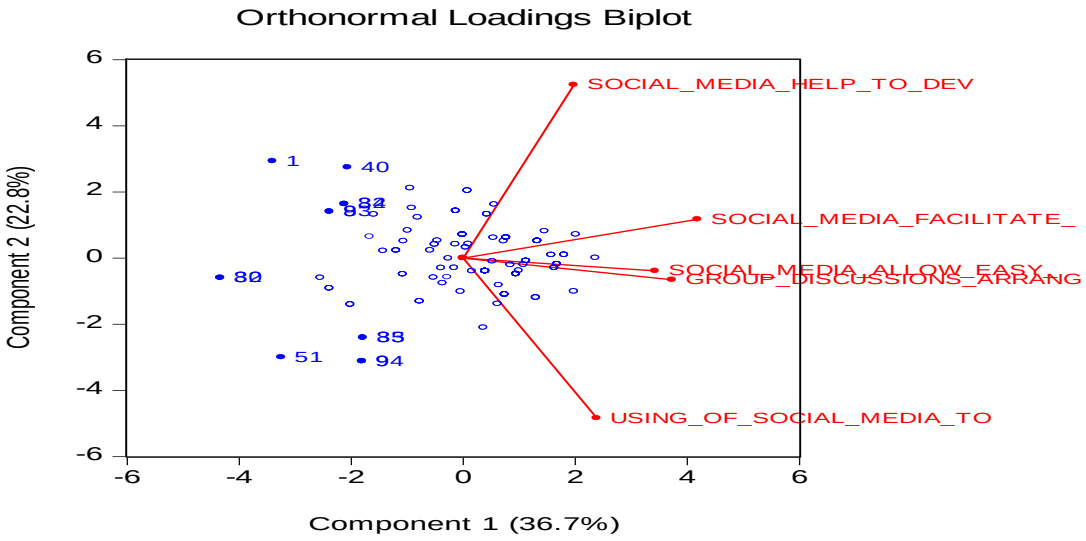

Figure 2: Component Plot in Rotated Space (Orthonomal loadings)

3.2 Discussion

The starting point for all factor analysis techniques is the correlation matrix. Looking at the correlation matrix of the five factors examined in table 1 above, it shows that there exist positive degrees of relationship between the five factors considered. However, factors 1 and 2, 2 and 5, 3 and 5, and 4 and 5 have estimated correlations above 0.3 coefficients. 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 0.607 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 indicates that we can proceed on the research study.

Table 3 above shows the importance of each of the five principal components. Only the first two have eigenvalues over 1.00 (component 1 and 2 with eigen values 1.835 and 1.141), and together these explain about 60% of the total variability in the data. This leads us to the conclusion that a two factor solution will probably be adequate. Therefore, there exist only two important components in the factor.

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 in the horizontal axis while the eigenvalue is in 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 factor.

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

PC1 = 0.64AEEI + 0.78SIWL + 0.369DRS + 0.444FACWL + 0.696IAP (5)

PC2 = -0.056AEEI + 0.173SIWL + 0.77DRS - 0.711FACWL - 0.096IAP (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 (0.642, 0.771, and 0.699) on the first factor and low loadings on the second, while 3 and 4 have high positive loadings (0.787) and high negative loadings (-0.689) on the second factor and low loadings on the first. 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 social media has impacted more positively on student's academic performance in terms of learning and productivity as reflected in the two factors solution, i.e social media allow easy exchange of information with peers and Social media facilitate smooth interaction with the Lecturers. The first principal component exhibited positive correlations with all other factors which is an indication of positive impacts of ICT on students' learning and productivity.

4.2 Recommendation

Since there is a high positive correlation between the factors under study, it is therefore recommended that this project be embarked upon on a broader scope to study the global effects on student's academic performance.

In proposition for future work, the following are recommended;

1. More studies and additional factors will showcase broader effects/ways to engage in collaborative learning in order to improve students' academic performance.
2. Taking into account demographic factors, a larger sample to clarify more and find more elements to measure the factors that affect student's academic performance through collaborative learning in higher institutions.
3. Social networking sites should be expanded and new pages should be created to enhance academic activities to avoid setbacks in the students' Academic performance.
4. There should be management restriction and guidelines on the usage of ICT devices by students while within the school premises.

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