

THE INFLUENCE OF SOCIAL MEDIA ON THE ACADEMIC PERFORMANCE OF SENIOR SECONDARY SCHOOL STUDENTS IN MATHEMATICS IN GOMBE METROPOLIS GOMBE STATE

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Abstract

The influence of social media on the academic performance of senior secondary school students in mathematics in Gombe metropolis was put into consideration by the study. Self-design questionnaire with positive or negative responses was used to obtain relevant data from three hundred and four (304) respondents of seven (7) co-educational senior secondary schools used for the study from the metropolis. Three research questions were used to obtain relevant data. Using percentages and means to analyze the collected data revealed that, there is high level of social media packages usage by senior secondary school students; there is a significant relationship between the social media packages usage and the performance of senior secondary school students in mathematics; and there is significant difference between the male and female senior secondary school students social media packages usage in mathematics, senior secondary school female students use social media packages more than the male students in mathematics in Gombe metropolis. Recommendations were given based on the findings of the study and if put into consideration will be of great benefit to the senior secondary school students and others in the use of social media packages in learning not only mathematics but other school subjects in secondary school and beyond.

Key words: Influence, Social media, Performance and Secondary School

Introduction

The school is a powerful agency where students are given formal education and held together for the purpose of acquiring knowledge and have opportunity of achieving the objective of

education in the Classroom (Abdullahi, 2019). He further stressed that apart from classroom teaching and learning situation (direct learning), learning can also take place indirectly using text books, films, dictionary and media. With the development in the country technologically, social media has come to supplement other agents of education all over the globe. Today, the method of communication has changed our lives from the era of communicating with pen and paper as a result of social media and its platform which consist of different technologies. One of the sound technology in communication and sharing information is the social media, such as Facebook, 2go, Twitter, You tube, WhatsApp, Instagram, etc with which its development penetrates through almost all part of our societies and contribute positively and negatively in communication, learning, research and education in general (Ishaku, Saidu, Sanda & Muhammad, 2018). Social media began in the late 90s with the first recognized social media network called “Six Degrees” in 1997 and this technology enabled people to upload a profile and make friends (John & Emefa, 2018). From 1997 to 2001 a number of community tools; Asian Avenue, blackplanet and MiGente began supporting various combination of profile and publicly articulated friend (Boyd & Ellison, 2007).

Oxford dictionary 2nd Edition (2011), defines social media as “websites and applications used for social networking”. Social media is a communication channel which is very popular, extremely fast and broad, has proven to be highly effective, as well as trusted by billions of people, to share and discover content concerning individuals, brands, information, entertainment and knowhow (Dearborn, 2014). One theme that all these definitions underpin is that, social media involves some forms of communication between individuals over the internet. Presently, there exist uncountable social media either developed for local use, specific purpose or international use. Kaplan and Haenlein (2010), classified social media into six (6) different categories as follow;

- i. Collaborative project (Wikipedia)
- ii. Blogs and micro blogs (twitter)
- iii. Content communities (Youtube)
- iv. Social networking sites (FB, 2go, BB chat, Instagram, WhatsApp etc.)
- v. Virtual game World (world of war craft)
- vi. Virtual second world (second life)

This classification of social media into classes has been useful to scholars and individuals for proper identification and study of a particular social media type, but today a difficulty may arise because of the high proliferation of social media and one may wonder which group a new developed social media type fits into (John & Emefa, 2018). Social media exploded as a category of online discourse which enables people to create contents, share them, bookmark them and network at a prodigious rate (Jha & Bhardwaj, 2012). This has breached the gap that existed in communication where people had to rely solely on traditional methods such as letters and phone calls as mode of getting in touch with friend, other relatives. Today, communication is as easy as walking to give a piece of information or vice versa through the use of social media. Since the world becomes a global village, social media is fast changing the public discourse in the society and is setting trends and agenda in topics that ranges from the environment and politics to technology and the entertainment industry (Asur & Huberman, 2010).

As we know, nothing interesting is ever completely one-sided, so it is for social media as it comes with both positive and negative effects. There is a correlation between social media

usage and academic performance of students in senior secondary school. Liccardi et al (2010) argued that students are socially connected with one another and therefore share their daily learning experiences and do conversation on various topics through social media whereas, Kuppuswamy & Narayan, (2010), reviewed that social network websites grab students' attention and then diverts it towards non-educational and inappropriate actions including useless chatting.

Background of the Study

Computer access and use among Nigerian secondary school students have grown exponentially over the past decade, (Becker, 2011). More than 48% of Nigerian youth, twelve (12) to seventeen (17) years of age use the internet, and nearly half log on daily (Lenhart, Madden, & Hitlin, 2012). Once connected, adolescents engage in a wide variety of social media behaviours, including doing schoolwork, playing games, shopping, downloading music, text messaging and chatting and so on and so forth. Secondary school students use the internet primarily for social reasons (Gross, 2010; Roberts, Foehr & Rideout, 2012). The social media has become a virtual meeting place where secondary school students hang out with their peers to pass time.

Research has proved the heavy presence of social media usage among students. It is also found out that, students use social networking sites (SNSs) approximately thirty (30) minutes throughout the day as part of their daily routine life (Nicole, Charles & Cliff, 2013). Studies of students' extracurricular activities instead, suggest that new media, such as Facebook, replace or enhance other leisure activities, but do not take away time from students (Roberts & Foehr, 2013). This shows the level at which students are engaging in these sites and this may bring along both positive and negative effects on students' performance. Therefore, this too much engagement by students on social media motivated the researchers to conduct a research on the topic Influence of Social Media on the Academic Performance of Senior Secondary School students in mathematics in Gombe metropolis.

Statement of the Problem

Today, internet is the most important source of information and so the use of social media by students cannot be underestimated. Osharie (2015), observed that students devote more attention and time to social media than they do for their studies and they cannot pass their examinations well if they do not learn. Also, the study conducted by Maya (2015), revealed that media use contributes to lower academic performance, low self-perceptions and less interest in college-oriented carriers. Academic excellence plays an important role in an individual's life; be it in the family, at social gatherings, at workplace, in an institution or even among peers. Much emphasis is placed on academic excellence because of the role it plays in an individual's life as far as a successful life and respect is concerned in every part of the world. Due to this, many people are concerned with the ways that they can improve their academic performance (Kyoshaba, 2010). Studies have also revealed that social media affects students' use of English. They tend to use short-handwriting in chatting and get used to it thereby replicating the same errors during examinations (Obi, Bulus, Adamu & Sala'at, 2012). Today, students at all levels have been engaged in the use of social media on the school subjects such as English Language/Literature, Biology, Chemistry, Agricultural science and Mathematics.

Mathematics plays important roles in our daily life as its knowledge is applied in every facet of our daily activities such as tailoring, commerce, farming and many other diverse fields. Mathematics can be referred to as an essential tool for thoughts, logical reasoning and for overall development. Mathematics remains important to all disciplines and fields of human work and study as it has continued to play significant role in the development of individuals and the nations. Hence, for any nation to survive and develop scientifically and technologically, there is need to improve of her teaching and learning of mathematics which is the basis for the development. This research therefore seeks to determine the influence of social media on the academic performance of senior secondary school students in mathematics in Gombe metropolis.

Purpose of the Study

The purpose of this study is to determine the influence of social media on the academic performance of senior secondary school students in mathematics in Gombe metropolis, specifically, the following are the objectives of this study:

- i. To determine the level of usage different social media packages by the senior secondary school students in mathematics in Gombe metropolis.
- ii. To determine the relationship between the usage of social media packages and the academic of senior secondary school students in mathematics in Gombe metropolis?
- iii. To find out the extent of usage of social media by the male differ from that of female students in senior secondary school mathematics in Gombe metropolis?

Research Questions

The following research questions were used to guide the study: -

- i. What is the level of usage of different social media packages by the senior secondary school students in mathematics in Gombe metropolis?
- ii. What is the relationship between of usage of different social media packages and the performance of senior secondary school students in mathematics in Gombe metropolis?
- iii. To what extent does the use of social media packages by male differ from that of female students in mathematics in Gombe metropolis?

Significance of the Study

The following are the significance of the study:

- i. The outcome of this study will educate the educational administrators on the relationship between social media and the academic performance of senior secondary school student in mathematics.
- ii. The study will help parents in identifying the influence of social media on the academic performance of their senior secondary school students in mathematics.
- iii. It will be useful and of importance to state government to make policy on the use of social media for the secondary students.
- iv. It would benefit the school authority to know whether the graduate of institution can compete favorably with their contemporary's country.
- v. This research would contribute to the body of educational research in that it explores mathematics students' academic performance with multiple indicators of learning, which is satisfaction, learning style, and performance.

Theoretical framework

The study is based on the system theory, a general system concepts, a functional analysis of all sub-units interacting and interesting to function as a whole system. Synergy is one of the system concepts; it is collective efforts that is more than a single effort and connotes a derive demand function where it's sub-units of the system is dependent on one another to function.

A system is only ordered interrelated set of throngs and their attributes, liked by flow of everything and matter, as a distinct from the surrounding environment outside the system. The elements within a system may be arranged in series or interwoven with one another. A system comprised of any number of sub systems (Junco, 2012). Within Earth's systems, both matter and energy are stored and retrieved, and energy is transformed from one type to another specifically, the systematic approach to school as formal organization sees the organization as a purposeful system composed of interactive parts, rather than dealing separately. Therefore, the system theory is the best to describe the school as formal organization via the students learning directly through the teacher instructions of lessons and indirectly through the influence of social media on the academic performance of secondary school students in mathematics and all other school subjects.

Research Methodology

This section describes the methodology and procedure used for the study and include research design, population of the study, sample and sampling techniques, instrumentation, validity and reliability of the instrument, data collection procedure and method of data analysis.

Research Design

The study adopted a survey research design. The method involved sampling from the population of the study and generalizing the findings obtained. The reason for choice of survey research is in line with the submission made by Awotunde and Ugodulunwa (2011), who says "survey method is appropriate for any study on investigation of the problem that involves a large population of respondents". The researchers designed the questionnaire which contained thirty (30) itemized questions, responses option; designed to determine positive or negative feelings towards the various issues in the questionnaire.

Population of the Study

The population of this study consisted of all the students in Gombe state senior secondary schools. However, the target population consisted of seven (7) co-educational schools in Gombe metropolis with the number of students nine thousand and forty-seven (9,047). The tabular break down of all the co-educational secondary schools purposively and randomly selected and used for the study as shown in the table I below:

Table 3.1: Enrolment of Senior Secondary School Students in Gombe metropolis

NAME OF SCHOOL	MALE AGE	FEMALE AGE	TOTAL ENROLMENT
Government Day Secondary School Bolari East	581	508	1089
Government Science Secondary School Gombe	328	221	549
Government Day Secondary School Gandu	724	765	1489
Government Day Secondary School Pantami	1957	506	2463
Government Day Secondary School Gabukka	1331	1327	2658
Government Science and Technical College Gombe	188	210	398
Government Comprehensive Day Secondary School	180	221	401
TOTAL	5289	3758	9047

SOURCE: Gombe State Ministry of Education, (2020).

The choice of this population is necessary because of the ability to provide desirable outcome in the study.

Sample and Sampling Techniques

Due to the nature of the population, the researchers considered each school as different strata and then randomly selected the proportionate sample from each school. To select from the population, purposive and simple random sampling was used in this research. The sample comprises of seven (7) schools with Nine thousand and forty-seven (9,047), both male and female students. Therefore, according to Krejcie and Morgan (2010), revealed that, if the total population is ten thousand (10,000) it implies that the required sample size is three hundred and seventy (370). This is to say that, the researcher made use of three hundred and seventy (370) respondents from the target population and consisted of some selected senior secondary schools of Gombe metropolis as shown in the table II below:

Table II: Analysis of Sampled Size School by School.

S/N	NAME OF SCHOOL	TOTAL ENROLMENT	SAMPLE SIZE
1.	Government Day Secondary School Bolari East	1089	46
2.	Government Science Secondary School Gombe	549	22
3.	Government Day Secondary School Gandu1	489	60
5.	Government Day Secondary School Pantami	2463	96
6.	Government Day Secondary School Gabukka	2658	105
7.	Government Science and Technical College Gombe	398	18
8.	Government Comprehensive Day Secondary School	401	23
TOTAL		9545	370

Instrumentation

In order to obtaining the required information for this study, questionnaire was used and contains thirty (30) items of ten (10) per research questions. The instrument was used to gather data from many subjects within a short period of time (Arnoid, N, 2010). The questionnaires

were structured into section "A" which contained a Bio-Data of the respondents, and Section "B" which consisted items intended to elicit responses from the respondents. The researchers developed items to which responses were expected in various degree of "close ended questionnaire" which encouraged the entire participant responded either negatively or positively to all the items of the instrument.

Validity and Reliability of the Instrument

After the construction of the questionnaire by the researchers, copies were given to experts in measurement and evaluation to assess and adjust, using the corrections made by them, the questionnaire was reconstructed before using it for the study. The researchers administrated the instrument to four hundred students in Gombe with same characteristics as the intending respondents. The results obtained were analyzed using Cronbach's alpha and it yielded coefficient of 0.72. This provides strong basis for the reliability of the instrument for the study.

Method for Data Collection

In the course of collecting data, three hundred and seventy (370) copies of questionnaire were distributed to both male and female students and they were asked to tick the appropriate responses to the given questions. Thereafter, the questionnaire copies were retrieved by the researchers for the appropriate analysis.

Procedure for Data Analysis

The study employed the use of a statistical package for social science (SPSS) to run the analysis. The data collected were analyzed using means and percentages to answer the research questions of the study.

Results

A total of three hundred and seventy (370) copies of questionnaire were administered to the respondents, but only three hundred and sixty-five (365) questionnaires were returned and three hundred and four (304) questionnaire were properly completed and used for the analysis. The data was analyzed using Statistical Package for Social Science (SPSS). Each research question was treated one after the other.

Research Question One

What is the level of usage of different social media packages by the senior secondary school mathematics students in Gombe metropolis?

Table III Mean and Percentage of the respondents with answers Yes of No

Question Number	Percentage Yes	Mean	Percentage No	Mean
1	67		36	
2, 3, 5, & 6	91	1.87	9	1.69
4 & 7	95		5	
8, 9, & 10	91		3	

From the table III above, the percentage of those in paramount of usage of usage of different social media packages by the senior secondary school mathematics are higher with percentage of 90% and means of 1.87, while those not in favors of the usage in low with percentage 10%

and mean of 1.69 therefore, the level of usage of social media packages by senior secondary school students in mathematics is high.

Research Question Two.

What is the relationship between the usage of different social media packages and the academic performance of senior secondary school students in mathematics in Gombe metropolis?

Table IV: mean and percentage of respondents who answered YES or NO to the questions.

Question No	Percentage Yes	Mean	Percentage NO	Mean
11	55		45	
12, 13, 14 & 17	80	1.75	20	1.65
9 & 16	85		15	
15, 19, & 20	95		5	

From the above table IV, those in support of high relationship between the usage of social media packages and the academic performance of secondary school students in mathematics are more with percentage of 85% and mean 1.75, while those not in favor are less with percentage of 15% and mean of 65%. Therefore, there is a significant relationship between the social media packages and the academic performance of secondary school students in mathematics in Gombe metropolis.

Research Question Three:

To what extent does the use of social media packages by male differ from that of female senior secondary school students in Gombe metropolis?

Table V: mean and percentages of male and female senior secondary school YES or No to the question.

Question Number	Male Percentage		Mean	Female Percentage		Mean
	Yes	No		Yes	No	
21 & 25	40	60		75	25	
22, 24, 25, & 27	35	65	1.35	80	20	1.85
23, & 28	10	90		55	45	
24 & 30	25	75		50	50	

It could be observed from the above table V that, the percentage of usage of social packages of male students is low with 20% and 80% positive and negative response respectively: while the percentage usage of social media packages by female is high with 85% and 15% positive and negative responses respectively, hence, it can be put that, the level of usage of social media packages by female is higher than that of their counterpart male senior secondary students in mathematics in Gombe metropolis. Difference in the usage of social media packages, between

male and female secondary school students in Mathematics in Gombe metropolis differs very high..

Discussion

This study examined the “Influence of Social Media on the Academic Performance of Senior Secondary School Students in Mathematics in Gombe Metropolis. Three research questions were used to guide the study; questionnaire was used to elicit relevant data from three hundred and four (304) respondents of senior secondary school mathematics students in Gombe metropolis. The finding from the study reveals that:

The level of usage of social media packages by senior secondary school students in mathematics is high. In a similar study, Ijeoma and Burke (2013), opined that many students use social media packages like, Facebook, My space, Twitter, WhatsApp and 2go to supplement what they have learnt from the class. On the other hand, Kuh, (2013), in his study revealed that, the students who do not use social media packages perform better than those who use them constantly.

It was also shown from the study that, the relationship between the usage of social media packages and the performance of senior secondary school students is high. The use of social media packages is of great assistance to the academic performance of senior secondary school students in mathematics. The finding is similar to that of Beeker (2011), opined that, social media packages use by the students have served as motivational factor for good academic activities. Students are encouraged to work very hard within short time. On the contrary, Abdullahi, (2019), put it that, lack of constant electricity supply, rural area palavers and over population of students have contributed highly to the problem of using social media packages in schools by students.

Lastly, it was discovered that, there is significant different in the usage of social media packages between the male and female secondary school students in mathematics in Gombe metropolis. This is in line with the finding of Osharie (2015), who showed that, the female students spend more time in using social media packages than their male students’ counter part due to their nature of living. On the other hand, Abdullahi, (2019), in this study reveal that, the use of social median packages differs by gender and depend on time factors, location and the availability of data.

Conclusion

From the study, it can be concluded that, the level of usage of social media packages by the male and female secondary school students in learning mathematics is very high; there is significant relationship between the usage of social median packages and the performance of senior secondary schools in mathematics; and there is significant difference on the usage of social media packages between the senior secondary school male and female students in mathematics in Gombe metropolis.

Recommendations

The following recommendations were made based on the finding of the study: -

- i. Students should make sure that they use social networking sites judiciously to ensure that they do not affect their academic work negatively.

- ii. Seminars and workshops should be organized for students on the used and impact of social media on their academic performance in their studies.
- iii. Guidance and counselling should be given to the students the appropriate ways of using social media in their studies and generally.
- iv. More researches should be conducted in this field to find out if social media facilities can be used to teach mathematics.
- v. Teachers and parents should guide students in the use of social media so that it will boost their academic performance.

References

- Abdullahi S. M. et al. (2019). Effect of Computer Simulation Instruction on the Achievement of Secondary School Students in Mathematics in Gombe Local Government Area of Gombe State. *Journal of Teacher Education Vol. 12, Nol, 2019*.
- Arnold, N., & Paulus, T. (2010). Using a Social Networking Site for Experiential Learning: Appropriating, Lurking, Modeling and Community Building. *Internet and Higher Education, 13*, 188-196. DOI:10.1016/j.iheduc.2010.04.002. V
- Asur, S. & Huberman, B. A. (2010). Predicting the Future with Social Media. WI-IAT'10 Proceedings of the 2010 IEEE/WIC/ACM International Conference on Web Intelligence and Intelligent Agent Technology, 1. DOI:10.1109/WI-IAT.2010.63.
- Awotunde, P. O., & Ugodulunwa, C. A. (2011). *Research method in Education*. Jos: Fab Anieh (Nig) Ltd. Gombe State Ministry of Education. (2019). List of Senior Secondary Schools 2018 – 2019 Annual School Census Report.
- Becker, H. J. (2011). *Who's wired and who's not: Children's access to and use of computer technology. Future of Children, 10*, 44–75.
- Bjornsen, B., & Archer, R. (2015). Does Math Achievement h'APP'en when iPads and Game-Based Learning are Incorporated into Fifth-Grade Mathematics Instruction? *Journal of Information Technology Education: Research, 11*(1), 269--286.
- Boyd, D. M., & Ellison, N. B. (2011). Social network sites: definition, history and scholarships. *Journal of computer-mediated communication, 13*(1) (2007) pp.210-230. DOI:10.1111/j.1083-6101.2007.00393.x.
- Dearborn, E. (2014). My official definition of social media. Retrieved from <https://www.linkedin.com/pulse/20140929215745-47165795>
- Gross, E. F. (2010). Adolescent Internet use: What we expect, what teens report? *Journal of Applied Developmental Psychology, 25*, 633-649.
- Ijeoma, A. G., & Burke, M. (2013). *Effect of Social Media on Post Graduate Students during lectures and library session. A case study of Salford University Manchester, United Kingdom*.
- Ishaku A., Saidu B. M., Sanda A., & Muhammad A. B. (2018). Mathematical Assessment of Social Media Impact on Academic Performance of Students in Higher Institution. *IOSR Journal of Mathematics (IOSR-JM) e-ISSN: 2278-5728, p-ISSN: 2319-765X. Volume 14, Issue 1 Ver. I (Jan. -Feb. 2018), PP 72-79* www.iosrjournals.org.
- Jha, V., & Bhardwaj, R. (2012). The new marketing renaissance: Paradigm shift in social networks. *International Journal of Engineering and management Sciences, 3*(3), 384-387. Retrieved from www.scienceandnature.org
- John, B.K., & Emefa, P.D. (2018). Effect of Social Media on Academic Performance of Students in Ghanaian Universities: A Case Study of University of Ghana, Legon: *Library Philosophy and Practice (e-journal)*, 1637.

- Junco, R. (2012). The relationship between frequency of Facebook use, participation in Facebook activities, and student engagement. Department of Academic Development and Counseling, Lock Haven University, 104 Russell Hall, Lock Haven, PA 17745, USA. *Computer & Education*, 58, (2012) 162-171.
- Kaplan, A.M. & Haenlein, M. (2010). Users of the world, unite: The challenges and Opportunities of social media. *Business Horizons*, 53(1), 59-68.
- Kuh, G. D. (2012). The National survey of student engagement: conceptual empirical foundations. *New direction for institutional research*. DOI:10.1002/ir.283. www.interscience.wiley.com
- Kuppuswamy, S., & Narayan, P. (2010). The impact of Social Networking Websites on the Education of Youth. *Internal journal of virtual Communities and Social Networking(IJVCNS)*, 2(1) 67-79.
- Kyoshaba, M. (2010). Factors affecting academic performance of undergraduate students at Uganda Christian University. Retrieved from <http://mak.ac.ug/documents/Makfiles/theses/kyoshaba%2520Martha.Pdf>.
- Lenhart, A., Madden, M., & Hitlin, P. (2012). Teens and technology: Youth are leading the transition to a fully wired and mobile nation. Retrieved October 13, 2005, from <http://www.pewInternet.org/pdfs/>
- Liccardi, I., Ounnas, A., Pau, R., Massey, E., Kinnunen, P., Lewthwaite, S., Midy, A., & Sakar, C. (2010). The role of social networks in students learning experiences. *ACM SIGCSE Bull* 39(4), 224-237. Retrieved from citeseerx.ist.psu.edu
- Maya, k. G. (2015). Achievement scripts, media influences on Blacks students' academic performance, self-perceptions and carrier interests. *Journal of Black psychology*, 42(3), 195-220. DOI: 10.1177/0095798414566510.
- Nelson, T. F., & Kuh, G. D. (2011). Student experiences with information technology and their relationship to other aspects of student engagement. *Research in Higher Education*, 46, 211-233. DOI: 10.1007/s11162-004-1600-y.
- Nicole, B. E., Charles, S., & Cliff, L. (2013). The benefits of Facebook "friends", Social Capital and College students' Use of Online Social Networks Sites. *Journal of Computer-Mediated Communication*, 12 (2) 1143-1168. DOI: 10.1111/j.1083-6101.2007.00367.x.
- Obi, N.C., Bulus, L. D., Adamu, G. M., & Sala'at, A. B. (2012). The need for safety consciousness among Youths on social Networking Sites. *Journal of Applied Science and management (JASM)*, 14(1).
- Osharie, P. (2015). Social media and academic performance of students, conference paper of January 2015. Retrieved September, 2016 from <https://www.researchgate.net/publication/273765340>. Pappas, C. (2013). The role of social media in E-learning. Retrieved from <http://elearningindustry.com/role-of-social-media-in-elearning>
- Roberts, D. F., & Foehr, U. G. (2013). When net effects are gross products? The power of influence and the influence of power in computer-mediated communication. *J. Soc. Issues*, 58(1), 91—107.
- Tokunaga, R. S. (2010). Following you from home: a critical review and synthesis of research on cyberbullying victimization. *Computer Human Behavior*, 26(3). DOI: 10.1016/j.chb.2009.11.014.