ISSN 2278-3091
Volume 15, No.4, July – August 2026
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse041542026.pdf
https://doi.org/10.30534/ijatcse/2026/041542026

Modelling Internet usage obsession among Computer Science students for improved academic performance: A clustering-based moderation strategy

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Received Date: June 23, 2026 Accepted Date: July 28, 2026 Published Date: August 06, 2026

ABSTRACT
The introductory Computer Science course (COS101) exposes first-year university students to intensive Internet-based learning and digital technologies, which can inadvertently foster excessive engagement in online communication and entertainment at the expense of academic study. This study investigates the moderating effect of COS101 curriculum content on students' Internet usage behaviour and academic performance, grounded in Rachman's cognitive theory of obsession. A mixed-methods quantitative design was employed using survey responses and official academic records of 1,377 Computer Science undergraduates from two Nigerian universities. Unsupervised machine learning clustering techniques were applied to model students' Internet usage patterns across study, entertainment, and communication dimensions. Based on the identified behavioural clusters, a balanced Internet-usage moderation framework was developed and subsequently evaluated through a controlled experimental intervention involving 40 students**.** Results reveal distinct behavioural clusters characterised by imbalanced Internet usage, with excessive entertainment and social communication strongly associated with reduced academic performance. Following the intervention, participants exhibited a statistically significant improvement in grade point averages (GPAs) and a measurable shift toward study-oriented Internet usage. The findings demonstrate that targeted curriculum-based moderation strategies can effectively recalibrate students' Internet engagement patterns and enhance academic outcomes. This study provides empirical evidence to inform institutional digital-wellness policies and curriculum design aimed at optimising students' academic productivity in technology-intensive learning environments.

Key words: Internet, curriculum, social media, cognitive obsession, machine learning

1. INTRODUCTION

A well-planned curriculum plays a vital role in the overall learning content of students. A good curriculum has been attributed to improved studying skills [1]. It has also been linked to improving academic performance [2]. A good curriculum also ensures the cognitive learning and development of students. Learning schemas are guided through the process of assimilation and accommodation, which allows students to schematize content. In higher institutions, the curriculum defines the course content of every course in a discipline. The courses are usually structured to systematically train students in becoming experts in their respective fields. The cognitive learning and development of the students who offer the courses are defined using a systematic training approach contained in their curriculum. In Computer science, for instance, curriculum content aligns with the educational standards and requirements of the discipline [3]. The National University Commission (NUC) is solely responsible for regulating curricula in Nigerian Universities. The recent Core Academic Curriculum and Minimum Standards for Nigerian Universities (CCMAS) require that every student in Computer Science offer COS101, which is titled Introduction to Computing. COS101 is offered as a first-year course. The teaching/learning content of the course is cognitively designed to train the students on computing concepts such as the Internet and digital devices. The course is expected to awaken the interest of the students in the study of computing. However, for some students, the reverse is the case as it rather leads to obsession on the use of Internet time for communication (social media and Entertainment (watching live matches, gambling and so on).

The study of the Internet is very important in the cognitive development of every high school student, especially those in Computer Science disciplines. The Internet is a worldwide network of computers designed specifically for sharing information [4]. Due to high demand for Internet services, the number of connected computers on the Internet has grown to billions [5]. As the usage diversifies, the number continues to grow.

Over the years, the Internet has been the backbone of research as it presents lots of information to researchers across the world [6]. Scholarly articles, research ideas, scientific innovations and breakthroughs are disseminated through the Internet. The authors in [7] avow that the internet has a significant impact on students' academic performance, especially in enabling them to access publications and articles that are otherwise unavailable in physical libraries. Hence, in academia, the Internet is seen as a research companion tool [8]. Internet research has grown in popularity over the years [9], [10]. Studies have shown that Internet research is gradually replacing physical public libraries [11]. The Internet provides several materials that assist students in class work, exercises and assignments. Diligent students take full advantage of the provision as they surf the Internet for clues, guides and solutions to class assignments. The stress of searching through numerous books in the physical library is made easier through Google search toolbars. The Internet also anchors online learning, which is gradually gaining recognition [12]. Considering all these, the prospects of the Internet as a fundamental research tool for students were very bright until Internet usage began to diversify.

In recent times, Internet usage has evolved to include social life. It is estimated that social network platforms' total user base in the last decade grew from 970 million in 2010 to 5.24 billion users in January 2025 [13]. The rate of growth should be a concern, considering that the majority of the subscribers are high school students. Computer Science students offer a compulsory first-year computing course as COS101. The course introduces concepts that motivate the students and elaborates on the strength of mobile phones and laptops as tools for communication, entertainment, as well as studies. The motivation spurs the students to acquire and use the requisite digital gadgets that will prepare them for the requirements of the discipline. However, abuse of Internet usage may lead to considerable disastrous consequences if not controlled [14]. If the motivation and frenzy are not channeled appropriately, it could lead to Internet abuse, poor time management and eventually poor academic performance.

Internet usage trend has evolved to the era of communication and entertainment. Today, we have several social media platforms that thrive on the provisions of the Internet. These platforms include Facebook, Twitter, Snapchat, LinkedIn, Reddit, TikTok, WhatsApp, Telegram, Instagram and many more. These platforms promote social communication and the sharing of information among registered users. Most users of these platforms are high school students, including those studying Computer Science. Unfortunately, some of these students abuse the use of the Internet, which has shifted to social media. As a result, the students are distracted from their studies [15]. The United States survey report on adult usage of different social media platforms shows that young men and women in the age range of 18 to 29 are the most ardent users of social media, with YouTube and Instagram having the highest numbers [16]. In addition, it is a known fact that 63.9% of the global population uses social media, and the highest percentage is young people aged 18 and above [13]. Apart from distracting their academic pursuit, other aspects of their life which are bound to be affected by this current trend in social media usage are their social life [17], [18], career development [19] and promotion of violence [20], [21]. Instead of using the Internet as a source for academic research, some students have turned it into a source for idle gossip on social media platforms as they spend hours in senseless conversations and trying to catch up on the latest information on social life.

Another recent trend in Internet usage which is of great concern is the use of the Internet for entertainment. Current trends show that youths are making money on the Internet through funny skits and short clips popularly known as content creation [22],[23]. Students in higher institutions are not exempted from this entertainment trend. In addition to content creation, several students are involved in sports gambling such as Bet9ja, BetKing, 1xBet, 22Bet, Betwinner, Betano, Melbet, and Betway. These fast-growing and attractive platforms lure students to part with their time and resources as they struggle to predict the winners of matches yet to be played. These are done to the detriment of their assignments and research work. In addition to sports betting, most music, fashion and movie sites are frequented by youths, probably in higher schools. Some students spend their data surfing the Internet or live-streaming to catch up on these entertainment trends. Some other students devote time to the Internet, trying to learn about Forest trading, doing cryptocurrency and patronising other online business platforms at the detriment of their studies. This usually leads to loss of focus, loss of vision and misplaced priority. It is therefore pertinent to examine the effect of Internet abuse on the academic performance of students, especially in higher schools. It is even more apt to study the behaviour of Internet usage among Computer Science students who make use of computers a lot as a teaching/learning tool.

The study of the Internet is rooted in the Computer Science discipline. The COS01 course providesan introduction to the use of the Internet and its benefits. It also encourages the use of digital devices such as computers, notebooks, desktops, mobile phones, smart watches, iPads and several others.The course is designed for first-year students in the faculty and generally awakens the sense of exploration in the field of computing. The fresh students in this faculty are usually charged and challenged after the course to try out some of the things they have learnt. This can lead to prolonged Internet usage time and negligence in their studies as they get more attached to the use of the Internet for social media communications and entertainment rather than for studies. Smart phones provide a primary and continuous source of Internet and could also lead to distractions. Due to the distraction posed by smart phones, many high schools have banned their use at

school [24]. The digital world is growing, and the use of the Internet is also diversifying to other aspects of life which are equally important [25]. Internet usage trend among Computer Science students is expected to be on the rise due to COS101 training. They make use of the Internet a lot for their studies. One application of the Internet in Computer Science isthe use of Artificial Intelligence Models for programming, which has been shown to have some merits [26]. Apart from their studies, the students also use the Internet for entertainment and communication, which also plays a major role in their lives as it promotes cognitive development [27], [28]. However, abuse of Internet usage time affects the academic performance of the students.The first-year students of the faculty are fresh, naïve and inexperienced; they lack proper time management and directives. They are vulnerable and can easily misinterpret the purpose of the training in COS101. If these fresh students are not properly guided, they may be focusing on using the Internet for entertainment, social media and financial gains rather than on using it for their studies. There is therefore a need to moderate how they use the Internet and digital devices available to them, which the discipline requires. This paper, therefore, investigates the impact of Internet usage on the academic performance of first-year students of Computer Science with a view to presenting an Internet usage plan that moderates excesses.The argument is that if the Internet usage time of students for studies, entertainment and communication activities is known, they could be modelled to moderate obsession and abuse of Internet usage time that affects their academic performance. The research objectives are to (i) Map COS101 course content to Rachman's theory of cognitive obsession, and (ii) present an Internet usage plan that generally improves the academic performance of first-year students in the faculty.The results obtained in this paper are expected to reveal the weaknesses within the learning environment, especially with the use of the Internet. It will also give some clues as to why some excellent students decline in performance when they enter higher schools. Finally, the paper will provide a foundation for academic counselling for students in higher institutions of learning.

2. LITERATURE REVIEW

There are pros and cons opinions on the effect of the Internet on students' academic performance. However, most research on the subject focuses on the relationship, effect and impact of the Internet on students' learning. There doesn't seem to be adequate literature that looks at the trends in the Internet and relates it to training received in a specific discipline. [29] studied the relationship between internet browsing and students' achievement in Agricultural Science. A sample of 300 students drawn from 10 schools in the five local government areas of Ogbomoso was used for the research, while descriptive statistics and Pearson product-moment correlation approaches were used to analyse data. Their findings show that although the relationship between internet browsing and students' achievement in Agricultural Science was positive, it was not significant. Their findings show that no matter how much browsing is done by a student, it will not promote performance in Agricultural science. Although this study focused on finding the relationship between browsing time and Agricultural academic performance, it did not give insight into the Internet needs of the students. It did not also consider that a greater percentage of the browsing time was devoted to social media and entertainment rather than to studies. Furthermore, the study focused on Secondary education and did not consider the higher schools.

The authors in [30] also investigated the impact of the Internet on the academic performance of students in some selected tertiary institutions in Nigeria. Using the Questionnaire as the instrument for data collection, information was elicited from six thousand (6000) students, drawn from the University of Benin, Benin City, Delta State University, Abraka, Western Delta University, Oghara and the Delta State Polytechnic, Otefe. Findings show that most of the students were computer literate and that their main Internet source was from cyber centres within the school. The majority of the students affirmed that the Internet was helpful in their academic performance, as they mainly sought E-journals and E-books, which assisted them a lot. However, the approach employed in the research was qualitative as the assessment was left solely in the hands of the students themselves and not necessarily on the data collected on academic performance.

In a similar study that explored the use of the internet and its impact on the academic performance of Senior High School (SHS) students in the Cape Coast Metropolis by [31], a questionnaire was used to gather data from 105 second-and third-year students through random sampling. The data were subsequently analysed using descriptive statistics and an independent samples t-test. Results revealed that Internet outlets for SHS students include school ICT labs, mobile phones, internet facilities for families, and public Internet cafes. In addition, it was also found that internet access influences academic standards among students, as those with internet access have shown a higher improvement in academic performance than those without. The study gave more insight into the importance of the Internet in education but did not specifically address the relationship between Internet time and academic performance.

The work of the authors in [32] also focused on studying the effect of the Internet on academic performance by looking at how students of University of Calabar used the Internet to improve their academic performance. The authors employed a correlation research design for the investigation using a total of 171 first-year students of Social Studies at the University of Calabar. Their findings also reveal that students performed better when they used the Internet than when they did not. Their

result also showed that students were using the Internet for chatting more than for studying. However, the research approach did not provide the requisite numerical results that show the effect of the various Internet purposes on academic performance.

The authors in [33] also examined the perceived impact of internet usage on the academic performance of students at Foso College of Education. The study adopted the quantitative approach, which used a sample of 300 students from Foso College of Education selected using a proportional stratified random sampling procedure. A descriptive statistics approach of frequency, percentage, mean and standard deviation was used for the analysis. Findings show that the students used the internet mostly for entertainment purposes, while educational usage was considered an afterthought. Once again, the research revealed nothing on the rated effect of using the Internet for studies as an afterthought, nor did it proffer an Internet usage plan for the students.

The author in [34] acknowledged that the Internet provides a basic research tool for students. However, little is known about how it affects University students in Pakistan. Hence, the author conducted a study to see how Internet usage affects students' academic performance, especially as it affects their grades. The objective of the research was primarily to determine the type of internet use and the impact of the internet on students' academic achievement. A total of one hundred (100) students were selected systematically across five (5) departments, and data were collected through a questionnaire. The research findings revealed a positive impact of Internet use on the academic performance of students. The research did not explain the effect of other Internet use on the academic performance of the students.

The authors in [35] applied machine learning in their study, which looked at the relationship between Internet usage behaviours and academic performance, and to predict undergraduate academic performance from the usage data. They employed machine learning algorithms such as Support vector machines, Decision trees and Neural networks to predict the student's performance in terms of success or failure. Hence, features such as online duration, Internet traffic volume, and connection frequency were extracted, calculated and normalised from the real Internet usage data of 4,000 students. Results indicate that Internet connection frequency features are positively correlated with academic performance, while Internet traffic volume features were negatively associated with the academic performance of the students. The detailed study clearly showed the power of machine learning in predicting the academic performance of students based on their Internet usage. However, the machine learning models in the work limit the expected prediction results to only two possible outcomes. There is still a need to consider other machine learning models that may give a wider prediction for better interpretation, especially using higher school performance metrics.

Another attempt at employing machine learning in predicting the academic performance of Bangladesh high school students based on their Internet usage is seen in the work of [36]. The authors specifically analysed the effects of internet usage on students' academic progress and predicted their performance using distinct machine learning (ML) algorithms such as logistic regression, decision tree, random forest, and Naïve Bayes algorithms. Exploratory data analysis showed that the main purpose of Internet usage as it concerns University students are for studies and social media. On the other hand, college students tend to use the Internet often for social media and entertainment. However, the study is solely based on the input obtained from the students themselves through a survey. Making predictions that include the actual cumulative grade points of the students will present a better picture.

These studies on the effect of the Internet on students are limited, as there was no direct link or quantitative research evidence carried out on their GPAs. In high schools, academic performance is measured using the GPA of students. This is the progressive accumulation of points by a student for the respective courses offered during a period. Unfortunately, little or no research has looked at the relationship between Internet usage and the GPA of the students, which is their real academic performance. In addition, there appears to be little or no information on how new trends in Internet usage (social media, sports, and so on affect the academic performance of students, especially in computer science, where the students are supposed to understand the implications of Internet abuse the most. There is a need to therefore employ a machine learning approach to investigate how the Internet usage time of Computer Science students, in particular, influences their actual academic performance, especially with new trends in Internet usage.

3. METHODOLOGY

In this section, we shall present the conceptual problem and the accompanying solution formulation. We shall also present the materials and the methods employed in the solution formulation.

3.1 Conceptualising the problem

Globally, Internet usage and subscriptions continue to increase as people depend more on digital provisions. Recent technological breakthroughs in artificial intelligence also contribute to the Internet's needs and dependence. According to thje authors in [37] , the rate at which Internet websites are visited is summarised in Table 1.

Table 1: Types of Internet Websites and percentage visitation

Website visited	Percentage visitation
Social Network	96.9
Chat & Message	96.4
Search Engines and Portals	82.6
Shopping	72.9
Music	55.9
Maps, Parking & Location	54.5
Entertainment	47.7
Email	47.5
Games	42.9
Weather	36.0

Social Network websites seem to attract more subscriptions at 96.9 per cent of visitation. In 2024, the number of active social media subscriptions worldwide was estimated to be 5.42 billion users. [38], [39]. The number is much considering that the world population is estimated to be 8.2 billion [40]. The majority of these users are youths in higher schools who are between the ages of 16 and 28. According to [38] Facebook was found to be the leading social network with approximately 3 billion active social media users worldwide, YouTube with 2.5billion, Instagram and WhatsApp with 2 billion, while others recorded below 2 billion respectively.

High school students engage in social media. Hence, taking a cue from Table 1, we categorise students' purpose for using the Internet into three categories as shown in Figure 1.

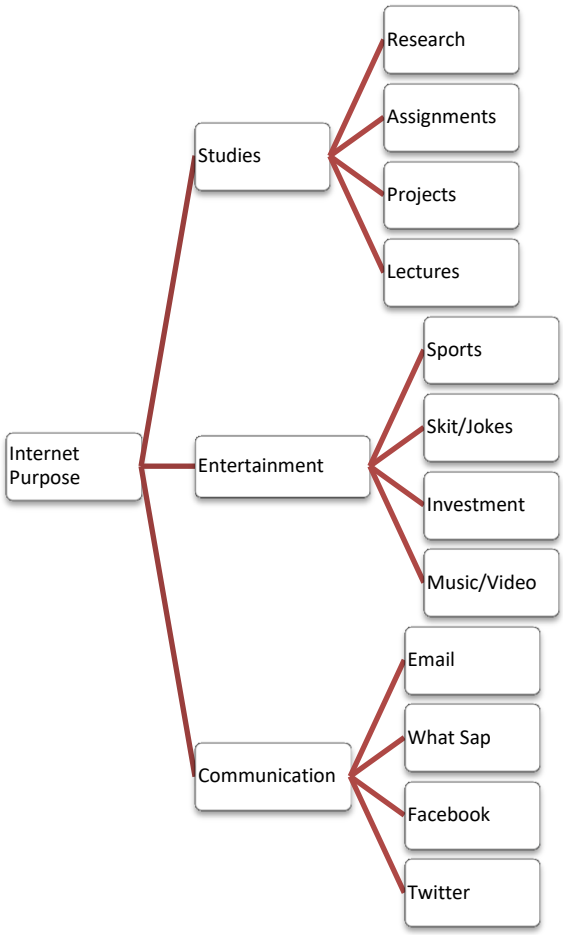

Figure 1: Students' Purpose for Using the Internet

From Figure 1, each of the three Internet purposes was further classified into four examples as follows;

a. Studies:- The Internet's purpose for studies is classified as

i. Research:- Examples of Internet use for research purposes include the quest for further knowledge, the quest for more content, etc

ii. Assignments: Examples of Internet use for assignments include: seeking online solutions or guides to assignments and class work, etc

iii. Projects:- Examples of Internet use for projects include: seeking degree project topics, downloading online books for project writing, surfing for code snippets for project software development, looking for related literature, etc

iv. Lectures:- Examples include: making notes after lecture, getting more content after lecture, browsing for related books after lecture, etc

b. Entertainment:- The Internet's purpose for entertainment is classified as;

i. Sports:- Examples of Internet use for sports include: watching live football matches, watching other live sporting activities, Bet9ja, 1xBet, 22Bet, Betwinner, Betano, Melbet, Betway, etc

ii. Skit/Jokes:- Examples include small video clips for fun, animated images for fun, write-ups, computer games, etc

iii. Investment:-Examples include; Forex trading, Cryptocurrency etc

iv. Music/Video:- Examples of Internet use for playing and watching movies include: YouTube live streaming and downloading. Other examples include entertainment sites which can come in video clips, such as fashion clips, cooking clips, religious clips, etc

c. Communication:- For communication, we focus on email and three major social media platforms as follows;

i. Email:- Examples of internet use for email include Gmail, Yahoo Mail, MSN and others, which are used for sending and receiving mail as well as sharing documents.

ii. Facebook:- The most popular social media platform for communication

iii. What sap:- Another popular social media platform with several subscribers

v. Twitter:- This is also a very popular social media platform that usually attracts attention among high school students.

3.2 Emphasis on Computer Science

i. According to [41], COS101 (Introduction to computing sciences) is a major course offered in the first year in the department of Computer Science. The course introduces the Internet, as well as the associated computer tools required for accessing the Internet. At the end of the course, the students are expected to;
ii. explain basic components of computers and other computing devices;
iii. Describe the various applications of computers.
iv. Explain information processing and its roles in society.
v. Describe the Internet, its various applications and impact.
vi. Explain the different areas of the computing discipline and its specialisations; and
vii. Demonstrate practical skills in using computers and the internet.

Based on the learning outcomes, we map the effect of the course that may trigger obsessive behaviour in the students as shown in Table 2.

Table 2: Mapping COS101 content on obsessive behaviour

S/N	Content Keywords	Tools	Effect (Positive & Negative)
1	Basic components of computers and other computing devices	Laptops, Notebooks, Desktops, Mobile phones	Frenzy to acquire or purchase requisite devices, attachment to digital devices and increased usage time
2	Applications of computers	study software, communication software, entertainment software	Internet time channeled towards cheat codes, Chat GPT and tutorials
3	Information processing and its roles in society	Recorders, Video capturing tools, questionnaires, and Google online forms	Acquisition of videos, audios, cartoons from the society for information, skits, jokes and fun and increased Internet time
4	Internet, its various applications and its impact	Web development tools, blogging applications	Frenzy for the Internet for Web development and blogging for financial gains, pornography, games, fashion, etc
5	Computing discipline and its specialisations	Specialised tools for software engineering, cyber security, information technology, etc	Awakening of computer programming, networking, computer security skills, etc
6	Practical skills in using computers and the internet	Tools for computing societal needs, jobs and industrialisation	Increased pursuit of financial gains using computers and the Internet, decreased interest in theoretical training, Chatbot dependency, and lecture boycott.

The effect of COS101 may vary among students; however, the effect could be mapped to establish a relationship with obsession with the use of the Internet for communication and entertainment rather than for studies.

3.3 Rachman's Cognitive Theory of Obsession

The author in [42] posits that obsessions arise from catastrophic misinterpretations of one's intrusive thoughts, images, or impulses. These misinterpretations lead individuals to perceive their thoughts as highly significant and threatening, causing persistent distress. The obsessions are said to continue as long as these misinterpretations are maintained and diminish when they are weakened. The first-year students of the department are young, naïve and vulnerable. COS101 is usually taught in the first semester of the new session and is also the first computing course. Being their first time in the University and having been duly informed of the nature of the course as pure computing, the students are worried and highly excited about what to expect. When they are introduced to COS101 course content, the impact varies in them, but most are affected by what they have learnt and the emphasis on success. If the effect of the teaching is not properly managed, some of the students may derail and become obsessed as they devote so much time to social media and entertainment. Hence, we map the components of Rachman's cognitive theory of obsessions with COS101 course content using the following 5 steps;

a. Intrusive thought

A student who is enrolled to study Computer Science is troubled by the following;

i. Computing is difficult,

ii. Computing is trending. Can I study it?

iii. Computing requires the Internet a lot.

iv. You need sound knowledge of the Internet to study computing

v. You need a computer and a good smartphone for good Internet services

b. Cognitive interpretation

The students catastrophically misinterpret the COS101 content teaching as emphasis is laid on the Internet, Digital devices as requisite tools for studying Computing.

c. Emotional response

This misinterpretation creates intense anxiety in the students and fear of career failure.

d. Compulsive behaviour

To neutralise the threat and allay their fears, they engage in compulsions, frantically trying to acquire and learn the Internet overnight. They resort to Internet usage for Social media and Entertainment to prove that they cannot fail in their career because they do not have in-depth knowledge of Internet usage.

e. Reinforcement cycle:

Surfing the Internet reassures them that they can do it. However, at this point their thought may have corroded to believe that it is by spending long hours on the Internet that success in a Computing career is achieved. This eventually leads to obsession and abuse of Internet usage among them.

The effect of the Cos101 course content may trigger obsession and Internet time abuse among the students, as so much time may be allotted to Internet for communication and Entertainment rather than to meaningful studies. This eventually may negatively impact on their academic performance. There is need to moderate how these students use the Internet by proposing an Internet usage plan based on the academic strength of the individual students.

Based on the discussions, we present a summary of the problem as shown in Figure 2

Figure 2: Conceptual problem and solution approach

3.5 Research Procedure

This paper adopts a survey research method. A sample of 1,500 first year students of Computer Science whose first semester GPAs were digitally available was used for the survey. The survey was carried out using academic data for 2023/2025 session from two universities in Nigeria. The University of Nigeria Nsukka (South East) and Prince Abubakkar Audu University, Anyigba, Kogi state (North central). It was done during the second semester when the first semester results were available. A sample of 520 students was selected from one University while 980 were selected from the second one. The results were obtained from the departmental Examinations unit with the approval of the departmental examination board, and for research purposes only. A computational template was developed for the purpose to ease the data collection. The scores of each student per course were obtained, the total credit unit based on registered courses was also obtained and the GPA for the semester was subsequently computed for each student. The selected students were then asked to fill an online Google form to ascertain the average daily time they spend on Internet for studies, entertainment and communication. However, only 1,377 of them filled the form for the two sessions. They filled the form without prior knowledge of their GPA. The responses were matched with their respective GPAs to obtain training data for the research. The GPA of the students was further classified under the linguistic variables shown in Table 3.

Table 3: GPA Linguistic Classification

GPA Range	Standard Class	Linguistic Class
GPA >= 4.5	First Class	Excellent (1)
3.5 >= GPA < 4.5	Second Class Upper	Very Good (2)
2.4 >= GPA < 3.5	Second Class Lower	Good (3)
1.5 >= GPA < 2.4	Third Class	Fair (4)
GPA < 1.5	Pass	Poor (5)

The modelling employed an unsupervised approach to develop an Internet usage plan using clustering machine learning models such as K-means, Affinity Propagation, and Agglomerative models to model the data. Unsupervised models tend toanalyse and model data without labelled responses or predefined categories [43]. K-means:-The K-Means machine learning model is a known clustering model that aims to group data by assigning the different observations to clusters based on their proximity to the cluster centre [44].

Agglomerative clustering:-Agglomerative clustering is a bottom-up approach to hierarchical clustering where each data point starts as its own cluster, and then pairs of clusters are successively merged based on similarity until all data points are in a single cluster [45].

The affinity propagation clustering algorithm identifies clusters by having data points pass messages to each other to determine which points are "exemplars" (cluster centres) and to which exemplar each point belongs. The Affinity propagation algorithm does not require the number of clusters to be specified beforehand; rather, the number is determined based on the data.

The three unsupervised models were compared for the best performance based on their silhouette score, Davies-Bouldin Index score and Calinski-Harabasz Index score. A moderation strategy for Internet usage was therefore developed using the best-performing model. The modeling was done in PyCharm 2024 edition using Python 3.10.8 software.A control experiment was further carried out to test the impact of the moderation plan on 30 selected newly admitted students of computer science.

3.6 Ethical Considerations

This study was conducted in compliance with institutional ethical standards. Participation was voluntary, and informed consent was obtained from all respondents prior to data collection. To ensure confidentiality and anonymity, no personally identifiable information was recorded, and academic performance data were accessed only with institutional permission and were analysed in aggregated form. Participants were informed of their right to withdraw from the study at any stage without penalty.

3.7 Limitations of the Study

Despite the robustness of the dataset and experimental design, this study has certain limitations. First, the sample was drawn from two Nigerian universities, which may limit generalizing the findings to other institutional and cultural contexts. Second, Internet usage behaviours were partly self-reported and may be subject to response bias. Third, the experimental intervention was conducted over a relatively short duration; therefore, long-term behavioural sustainability could not be fully assessed. Future studies could employ longitudinal designs and multi-country datasets to enhance external validity.

4. DATA ANALYSIS AND INTERPRETATION

The correlation between the variables was computed to ascertain the relationship among them. The results are shown in Table 4

Table 4: Correlation plot of the Variables

Variable	Study	Entertainment	Communication	Performance
Study	1.000	-0.772	-0.888	-0.468
Entertainment	-0.772	1.000	0.825	0.292
Communication	-0.888	0.825	1.000	0.529
Performance	-0.468	0.292	0.529	1.000

Study Internet time is negatively correlated with entertainment Internet time (-0.77) and communication Internet time (-0.89). Communication and entertainment time have a strong positive correlation (0.82). Performance, on the other hand, correlates negatively with study (-0.47), positively with communication (0.53) and weakly positively with entertainment (0.29).

The clustering models were then applied to the dataset, and their performance metrics were recorded in Table 5 as follows;

Table 5: Best-performing clustering Model result

S/N	Number of clusters	Silhouette Score	Davies-Bouldin Index	Calinski-Harabasz Index
Kmeans	**3**	**0.592**	**0.602**	**622.34**
Affinity Propagation	3	0.592	0.602	622.34
Agglomerative	28	0.204	1.404	89.77

The Calinski–HarabaszIndex evaluates how well the clusters are separated. The silhouette score tells us how well each of the data points is suited to its cluster. It ranges from -1 to 1. A high score near +1 means a point is well-matched to its own cluster and far from other clusters, while a score near 0 indicates it is on the border between two clusters. On the other hand, the Davies-Bouldin Index (DBI) indicates the quality of the clustering. It measures the average similarity of each cluster with its most similar cluster. A lower DBI score signifies better clustering, meaning the clusters are more compact and farther apart from each other. In our case, K-means and Agglomerative clustering achieved the same score across the three tests, showing that the clusters are well separated. Kmeans is known to handle large datasets efficiently as it is known to utilise more memory than agglomerative hierarchical clustering [46]. A K-Means clustering approach was thus employed to ascertain a feasible Internet usage plan. The number of clusters (*k*) was determined by plotting an elbow plot, silhouette plot and Calinski-Harabasz Index score against each k as recommended [47], [48], [49]. The plot is shown in Figure 3.

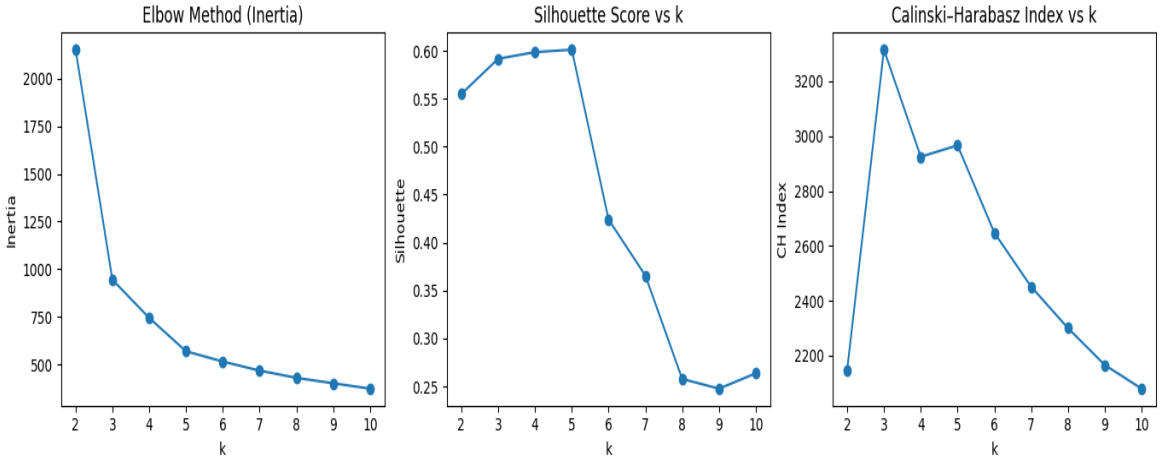

Figure 3: Silhouette and Elbow Plot of the data

The Elbow plot, Silhouette plot and Calinski-Harabasz Index in Figure 3 all showed that k=3 was a good choice for the dataset. Hence, using k = 3 clusters, the K-Means clustering model was employed on the data, with the result shown in Figure 4.

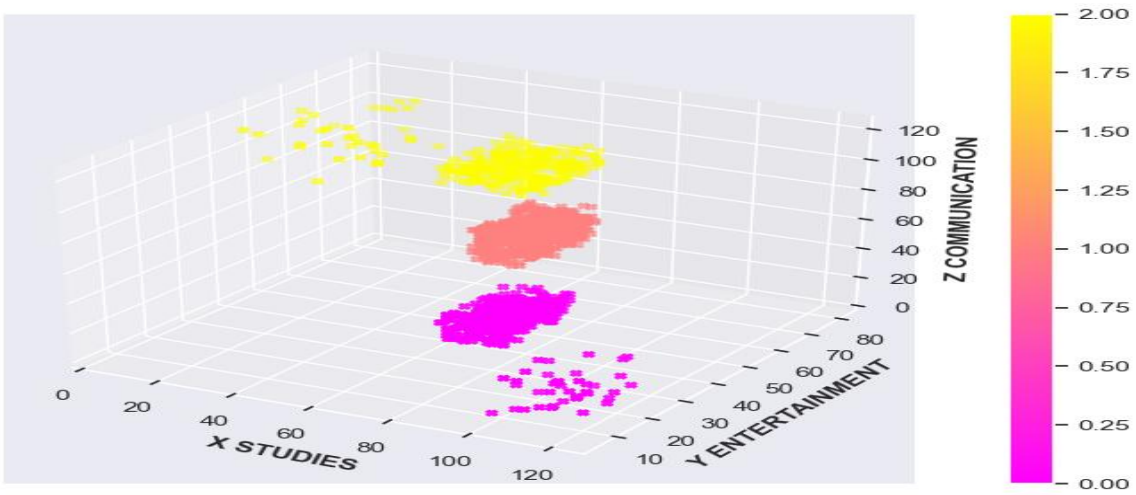

Figure 4: K-Means clustering of the data

The different colours indicate the distinct clusters. The results of the different clusters and their associated linguistic classification are presented in Table 6.

Table 6: K-Means Cluster details

Cluster	Study	Entertainment	Communication	GPA	Linguistic Classification			GPA
0*	**89.66**	**24.21**	**39.7**	**4.06**	**VH**	**L**	**L**	**VH**
1	72.51	49.83	64.88	2.94	H	H	H	H
2	48.79	68.28	85.48	1.85	VH	VH	VH	L

**Key: VH - Very high, H - High, L - Low

Table 6 shows the mean time associated with each cluster and for each feature. The mean scores are ranked for each feature to obtain the linguistic classification. For example, the mean scores for the study for the three clusters are 89.66, 72.51 and 48.79. The rank produces VH, H andLas shown in the linguistics classification column. Based on the obtained results, clusters 0 produced the best academic performance for the students (VH) followed by cluster 1 (H). Cluster 0 academic average performance was low (L). On the same note, cluster 0 average time spent on study was equally VH followed by cluster 1 and 2 with H and L respectively. The average time spent on entertainment was L for study H on cluster 1 and VH for cluster 2. Similarly, the average time spent on communication Internet activities was L for cluster 0, H for cluster 1 and VH for cluster 2.

5. APPLICATION OF FINDINGS IN MODELLING STUDENTS' INTERNET USAGE AND STUDY TIME

Based on the clustering results obtained, we propose an Internet usage moderation plan that allows the students to control the time they use the Internet for their studies, entertainment and communication services. The proposed plan is expected to provide an obsession-free and balanced Internet usage plan that will not affect their academic performance adversely and at the same time improve their cognitive development. Hence, we represent the time spent on study as S_t, time spent on Entertainment as E_t, and time spent on Communication as C_t. The respective means for the Internet services are MS, ME and MC, which are already computed in Table 5. Hence, we can compute the associated percentage of Internet time given to study for category (a) as;

$$\%S_a(of\ Internet\ time\ spent\ on\ study) = \frac{MS}{MS+ME+MC} \times \frac{100}{1} = 42\% \quad (4)$$

$$\%E_a(of\ Internet\ time\ spent\ on\ entertainment) = \frac{ME}{ME+MS+MC} \times \frac{100}{1} = 23\% \quad (5)$$

$$\%C_a(of\ Internet\ time\ spent\ on\ entertainment) = \frac{MC}{MC+MS+ME} \times \frac{100}{1} = 35\% \quad (6)$$

$\%S_b$,$\%E_b$, and $\%C_b$ were also computed respectively and shown in Table 7.

Table 7: Internet Usage moderation plan

Category	Study Time (Hrs/Mins)	Entertainment Time (Hrs/Mins)	Communication Time (Hrs/Mins)	GPA	Classification
a	1hr 30mins	24mins	40mins	4.06	1st Class and 2nd Class Upper
b	1hr 13mins	50mins	1hr 5mins	2.94	2nd Class lower,
C	49mins	1hr 8mins	1hr 26mins	1.85	Third Class and Pass

The plan proposes an average study time of 1hr30mins, entertainment time of 24mins and communication time of 40minsfor students who wish to be classified under 1st class or Second class upperdivision.It proposes an average study time of 1 hour 13 minutes, entertainment time of 50 minutes, and communication time of 1hr 5 minutes for students that wish to be classified

under Second class lower division. It also proposes an average study time of 49 minutes entertainment time of 1hr 8 minutes and communication time of 1 hour 26 minutes for students that wish to be classified as third class and pass division.

6. CONTROL EXPERIMENT FOR TESTING THE INTERNET USAGE PLAN

The proposed model was deployed in the 2024/2025 session on 100 level students of Computer Science department. A sample of 40 students was used for the test. The selection was spread across the admission list. However, the interest was to ensure that the four linguistics classes of academic performance (1st class, 2nd

class upper, 2nd class lower, 3rd class) were dully represented in the sampling. Hence, the stratified sampling approach was employed across the admission list to carefully select the students. The selection comprises 10 students who topped the primary admission list, another 10 who perfumed very well, another 10 who are on the average and the last 10 that performed fairly well. The aim of the control experiment was to find out the effect of the moderation plan on the performance of the 40 selected students after the first semester examinations. The students who topped the primary admission list are expected to maintain their excellent status; the others are expected to improve based on the moderation plan.

6.1 Experimental procedure

At the beginning of the semester, before commencement of COS101 lecture, the students were given the daily Internet usage plan to follow. The average Internet study time, entertainment time and communication time were clearly explained to them with strict instructions to follow them. The plan was implemented between 12pm to 2pm and 4 to 5pm when they usually have a lecture free time. Within those times, they were asked to use the Internet for their study for 1hr 30mins, use it for entertainment for 24mins and for communication 40mins. This was repeated for 60 days before their 1st semester examinations. However, the design could not guarantee the usage of the Internet beyond the control period. In addition, 2 students from the fair admission score category dropped from the experiment; hence only 38 completed the task

At the beginning of the 2nd semester, the first semester results of the 40 students were collated and their GPA computed for the purpose of comparison. The data were analysed using percentage gain and drop respectively. A summary of the computation result distribution is shown in Table 8.

Table 8: Experimental Result Comparison

Class division	Final Total	No that dropped in Performance	No that gained in Performance	No that were unaffected in Performance	% GPA drop	% GPA gain	% GPA unaffected
1st class & 2nd class upper	20	4	9	7	20	45	35
2nd class lower	10	3	5	2	30	50	20
3rd class & pass	8	1	6	1	12.5	75	12.5

The result of the experiment shows that there was a consistent increase in GPA across the class divisions with the 3rd class division recording the highest increase in GPA.

7. DISCUSSION ON FINDINGS

The mapping of COS101 curriculum content to Rachman's cognitive obsession constructs (Table 2) demonstrates that the course contains salient intrusive-thought attributes capable of stimulating compulsive Internet engagement among Computer Science undergraduates. These attributes can predispose students to excessive use of the Internet for entertainment and social communication, thereby diverting attention from academic activities.

Comparative evaluation of the clustering algorithms indicates that the K-means model outperformed Agglomerative and Affinity Propagation clustering based on multiple internal validation indices. Specifically, K-means achieved the highest Silhouette score (0.592), the lowest Davies–Bouldin Index (0.602), and the highest Calinski–Harabasz Index (622.34), confirming its superior cluster separation and compactness. Consequently, K-means was adopted for subsequent behavioural profiling.

Correlation analysis revealed a strong inverse relationship between study-related Internet usage and entertainment ($r = -0.77$) as well as communication ($r = -0.89$), indicating that increased academic Internet engagement significantly reduces time allocated to non-academic online activities. Conversely, communication and entertainment exhibited a strong positive correlation ($r = 0.82$), suggesting that students who frequently communicate online also tend to engage more in entertainment-oriented Internet usage.

Academic performance demonstrated a moderate negative correlation with study time ($r = -0.47$), implying that excessive academic Internet usage without behavioural balance may not necessarily translate to improved outcomes. In contrast, performance showed a positive correlation with communication-related Internet use ($r = 0.53$), reflecting the beneficial role of digital communication platforms (e.g., WhatsApp, email, and academic social networks) in facilitating collaborative learning, assignment discussions, and academic support.

Based on the identified behavioural clusters, an Internet-usage moderation framework was derived to guide optimal time allocation. The model recommends an average study Internet usage of approximately 90 minutes and entertainment usage of 24 minutes for students aiming to attain an average GPA of 4.06 (First Class/Second Class Upper Division). Students with moderate academic outcomes (average GPA $\approx$ 2.94, Second Class Lower Division) were associated with average study and entertainment Internet usage times of 73 minutes and 65 minutes, respectively. Conversely, students with comparatively lower academic outcomes (Third Class/Pass Division) were characterised by average study, entertainment, and communication Internet usage times of 49 minutes, 68 minutes, and 85 minutes, respectively.

To validate the moderation framework, a controlled experimental intervention was conducted. Post-intervention results revealed a measurable improvement in academic performance across all class divisions. Notably, students within the ThirdClass category exhibited the highest relative GPA improvement (approximately 75% increase), indicating that the moderation strategy is particularly beneficial for academically weak student groups.

These findings confirm the efficacy of curriculum-based Internet usage moderation in promoting balanced digital engagement and improving academic performance among undergraduate Computer Science students.

8. IMPLICATION OF FINDINGS ON CURRICULUM CONTENT

The proposed Internet-usage moderation framework provides actionable guidance for universities seeking to enhance students' academic productivity in digitally intensive learning environments. Institutions can integrate the moderation model into first-year orientation programmes, academic advising systems, and digital literacy curricula to promote balanced Internet engagement. The model can further inform the development of institutional digital-wellness policies aimed at mitigating Internet overuse while maintaining students' access to essential online academic resources.
The use of the Internet is diversifying and presents extra pressure on students. Course contents with Internet as well as digital devices topics should also incorporate a moderation strategy.In the case of COS101, the studentsare introduced to several application areas of Internet in their first year of study thereby emphasizing the need for digital devices and Internet usage proficiency which are required to study Computer Science. The pressure arising from fear of failure may lead to a psychological break downunder the pressure of Rachman's Intrusive thoughts and the students may become obsessed with Internet usage for entertainment and communication, while they completely ignore its use in academic research and studies. A moderation plan that guides them on how much time to allocate on the Internet without causing so much harm to their academic performance is therefore pertinent. Contrary to expectations that Social media is a major distraction and negatively impacts students' performance [50], using the Internet for communication was found to be highly correlated with the students' GPA. Entertainment was also found to be of importance to the students' mental and cognitive development, while also having a weak correlation with GPA. The research therefore shows that academic performance does not just depend on the length of time spent studying. Social and entertainment life also plays some important role. The moderation plan recorded a negligible impact on the performance of the students based on the experimental test carried out. Factors such as small sample size, experimental environment and control measures could have contributed to the insignificant result. However, the psychological impact of obsession moderation cannot be ignored. The moderation plan informed the students on the need to have a scheduled time for using the Internet

for studies, entertainment and communication, respectively. Part of the COS101 curriculum content therefore should include a moderation plan for the use of the Internet.

9. SUMMARY AND CONCLUSION

This study demonstrates that first-year Computer Science students are particularly susceptible to obsessive Internet usage behaviours, largely influenced by the curriculum content of the COS101 course, which intensively exposes them to digital technologies and Internet-based learning environments. By integrating survey responses with official academic performance records, this study employed correlation analysis and clustering-based machine learning techniques to examine patterns of Internet usage and their relationship with students' academic outcomes.

Findings indicate that students who allocate a greater proportion of their Internet time to academic study tend to achieve higher grade point averages (GPAs) than those who prioritise entertainment and non-academic communication. Nevertheless, moderate engagement in online communication and entertainment was found to exert a complementary positive influence on academic performance, highlighting the importance of behavioural balance rather than total restriction.

Furthermore, results from the controlled experimental intervention confirm that the implementation of a structured Internet-usage moderation framework leads to significant improvements in students' academic performance across all class divisions. The moderation strategy was particularly beneficial to academically weak students, demonstrating its potential as an effective academic support mechanism.

This study therefore advocates the adoption of curriculum-based Internet usage moderation policies within higher education institutions to promote balanced digital engagement, mitigate Internet-related obsession, and enhance academic productivity. Future work may extend this framework through longitudinal and multi-institutional studies to strengthen its generalisability and long-term effectiveness.

10. FUTURE CONTRIBUTION

The research is limited to the data obtained from the students in the two Universities. It may not reflect the holistic behaviour of Computer Science students in other Universities. There is still need to try out the moderation plan with more data.

Statements and Declarations

Competing Interests: The authors declare that there are no computing interests.

Data Availability Statement: Research data is available on request

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