ANALYZING DATA CONSUMPTION RATE AMONG NIGERIAN TEACHERS: USING NASH EQUILIBRIUM SOLUTION ON TEACHING-LEARNING

Ukwah, Christopher Nwambam
Department of Computer Science,
Ebonyi State College of Education,
Ikwo

Abstract

The potential fluctuation in price of internet access has brought educational clients' focus on a good internet service. Clients in educational sector now quest for demand guarantees for the bandwidth promised. Proposed scheme in which educational clients are assured connection and bandwidth and if assured service is not provided, service providers pay penalty to them. The use of multi-SIM handheld devices such as mobiles and tablets has enabled educational clients to make a "choice" between multiple service providers for communication services. With competition, an educational client will prefer connection to that provider who is providing the lowest price with guarantees. Data collected was analyzed using mean and standard deviation for the research questions and analysis of covariance (ANCOVA) for hypotheses. Results showed that showed that students taught using internet resources (data) performed better than those taught using traditional method. In this scenario of potential fluctuation pricing and guarantees, providers have to decide on pricing strategies which will maximize their income. This present a solution among two service providers which achieves a Nash equilibrium with the maximizing of the expected income being the decision criterion.

Key Words: Data consumption rate, Approximate solution, Clients, Nash Equilibrium, bandwidth

Background of the Study

A nation's position in today's highly competitive global knowledge economy is directly dependent on the quality of its human capital – the aggregate of skills and knowledge imparted to its citizens by its education system. Its highly trained workforce must be able to innovate and compete on the world stage. Nigerians have witnessed the development of ICTs in various sectors over the last decade including education. The change from teacher-centered education system to learner-centered education the world over in the past years contributes to the use of ICTs in education. Opted from the word "Knowledge –Driven world" as asserted by (Hawkins, 2004; Inwent, 2004), means that education reform practices should focus on equal access and quality of education which should highlight the

importance of change in the education sector through use of ICTs and equipping new generation with enhanced skills to operate in the 21st century. The use of ICTs in Nigeria and African countries generally is increasing and dramatically growing. However, while there is a great deal of knowledge about how ICTs are being used in developed countries, there is not much information on how ICTs are being introduced into schools in developing countries (Beukes-Amiss and Chiware, 2006). Looking at Nigeria as one of the developing countries according to these authors, there is generally limited access time per month using ICTs resources by the teachers, facilitators and students, use less time spent with reliable internet access because of the economic implication on teachers and facilitators. It should be noted that availability of ICTs vis-à-vis access in term of ratio of teachers, facilitators and students differs significantly. Despite this, the new and emerging technologies challenges the traditional process of teaching and learning, and the way education is managed. While information communication technology is an important area of study in its own right, it is having a major impact across all curriculum areas. Easy worldwide communication provides instant access to vast array of data, challenging assimilation and assessment skills (Fowowe, 2006).

Rapid communication and increased access to information communication technology (ICTs) has potential to revolutionize the way we learn. By providing ubiquitous access to information and learning resources. ICTs can facilitate a culture of lifelong learning. An activity in which the pace of technological change forces constant evaluation of teaching process itself. Some benefits of this paradigm shift include:

i) Flexibility: Learning that can occur anywhere anytime at the learner's pace;

ii) Personalization: ICTs enable tailored learning experiences, catering to individual needs and interests;

iii) Accessibility: People with disabilities, remote, or underprivileged communities can access learning resources;

iv) Collaboration: Global connections facilitate knowledge-sharing, peer-to-peer learning and international collaboration; and

v) Up-to-date information: ICTs provide instant access to current events, research, and industry developments.

To fully harness the potential of ICTs and its resources (internet data) for lifelong learning, its essential to ensure learner have the necessary skill to navigate and utilize digital resources effectively - development of digital literacy; provision of reliable, highspeed internet access and suitable device for learning – investment in infrastructure; creating inclusive learning environment – designing learning spaces that accommodates device needs and abilities; and foster a culture of continuous learning – that

is encouraging adoption growth mindset, embracing lifelong learning as a norm. By leveraging on ICT resources and promoting a culture of lifelong learning, we can empower individuals to stay adaptable, responsive and competitive in an ever-evolving global landscape.

The current issue is the use of ICTs in the classroom by the teachers. This includes specifically the use of computers, internet, telephone, digital camera, data projector, etc. Teachers need to continue incorporating these new technologies into their teaching, as the world continues to revolve around technology. Studies have been conducted on uses of ICTs by teachers particularly on the issue of their professional development.

The research wishes to compare the data consumption rate among Nigerian teachers using different ISP companies' performance in teaching using internet resources. This researcher wants to compare this performance of students using this research work titled, "analyzing data consumption rate among Nigerian teachers: using Nash equilibrium solution on isp choice in teaching-learning**"**'. Believing that that the result of this study if turn positive will be a turning point to the teaching and learning of computer in the south eastern part of Nigeria.

Internet Data Consumption Rate Among Teachers

Internet data consumption rate in education vary in education widely depending on factors like location, type of school, and teacher training. Teachers' ability to effectively use digital tools and resources greatly impacts on internet data consumption. A study found that 42% of teachers don't see digital devices as strategic tools for educational development, highlighting the need for improved teacher training, that is, teacher training and digital divide. Teachers' perception of digital teaching materials (DTMs) influence internet data usage. Some teachers prefer traditional methods, while others leverage on DTMs to promote computational thinking and artificial intelligence. The reliable internet access and speed significantly impact data consumption. Schools with solid connectivity and sufficient ICT tools tend to have higher internet data usage. However, data driven decision making schools leverage on "dark data", that is, anonymized data from various sources, including online learning habit to inform instructional decisions and improved educational outcomes.

To better understand internet data consumption rates in education, its essential to consider these factors and other specifics to your context. Internet data consumption rates in education by teachers vary depending on several factors, including the type of educational institution, location and the specific digital tools being used.

Statement of the Problem

ICT resources as one of the tools necessary for subject delivery in educational research, teaching, learning and evaluation in our colleges of education today unavoidably compulsory in its applications in all fields of study. This has been undergoing crisis in teacher's usage of ICT resource tools. Reasons for this range from inadequate/low level of ICT infrastructure, poor (ISP) Internet Service Provider network coverage, inadequate training of teachers on ICT and its usage, high cost of internet surfing to teachers, inadequate teacher qualification as well as possession of below standard pedagogical delivery/content knowledge (Semela, 2010). Government uncanny approach to teacher educational technology application to colleges. Many teachers consider use of online teaching, learning and reference work as difficult, abstract compared to real life in teaching and learning. The subject is devoid of applications in day-to-day life. Many students find it boring in programming development and enjoyable in problem solving (Hirschfeld, 2012). Interest in colleges of education is increasing and decreasing in abstract and logical thinking, learning motivation is declining, and the examination results are getting worse (Garwin and Ramsier, 2003; Manogue and Krane, 2003).

The improvement on the teachers' performance in any subject in school is influenced by the teachers' interest towards the subject accessed. Teachers appear to believe that the most problematic subject to study is subject/topic that online usage is involved, though not because of its difficulty but as a result of poor perception, negative attitude towards the subject and government low improvement to educational technology usage. Accordingly, (Eze, 2006) and (Adedoyin 2008), observed that students generally shy away from the core applied science due to perceived difficulty and wrong attitudes. A lot of problems have been associated with the study of computer science and applied sciences at colleges of education and secondary schools levelin the country as identified by (Adeniran, 2002), (Onah and Ugwu, 2010) and (Gonteng, 1998). These include:

That teacher's performance in colleges of education research, teaching and leaners evaluation over the years has not dynamically changed rather still embracing traditional methods.

There are shortages of academic and professional ICT oriented teachers in colleges, as well as shortages of resource materials for carrying out laboratory and new innovations in colleges of educations. Colleges of education requires a lot of mathematics, programming, hardware and internet applications tutorials which most teachers lack the basics to flow in use of in online teaching and learning background.

Purpose of the Study

The purpose of this study is to analyze the internet data consumption rate of teachers at the five (5) Ibo states of southeast. Specifically:

i) to understand internet bundle pattern among Nigerian teachers;
ii) to determine the ideal data bundle size usage (daily, weekly, and monthly);
iii) to identify data bundle allocation to teachers for optimal engagement, skills and capacity development;
iv) to identify the socioeconomic factors affecting quality and effective access of internet in colleges of education in Nigeria and to identify challenges in accessing digital learning content.

Significance of the Study

The findings of this study will be of much benefit to students, teachers and government and society in general. The findings of the study will` be beneficial to teachers in the sense that the teachers will no longer have difficulty in usage of internet resources in delivery of their lessons.

Students on their own part will be at ease to assimilate well packaged delivery. This if turns positive will facilitate quicker and easy understanding of lessons delivered. The findings of the study will be beneficial to parents because their ward will now be performing better in computer examinations. Government and society will experience development brought about by the improvement in the study if improves on stabilizing the dynamism of internet pricing and bandwidth enlargement by isp companies.

Scope of the Study

This study focused on analyzing data consumption rate among Nigerian teachers: using Nash equilibrium solution on isp choice in teaching-learning. It is aimed at approximating solution using Nash Equilibrium modeling. Due time and financial constrains the study will cover five colleges of education in the five South Eastern states of Nigeria. The research made use of 222 selected personnel. States used have 5 colleges of education with selected 150 lecturers and 72 teachers from 5 Government/Public Senior Secondary Schools in each state in 5 South Eastern states in the study with Anambra and Imo state selection of 6 personnel each as the states the new ones were created from.

Research Questions

The following research questions will guide the study:

1. What is the impact of using internet resources (data) over the use traditional method in teaching and learning?

2. What is the mean performance of teachers and students taught using internet resources (data) over the use of traditional method in teaching and learning?
3. What is the interaction effect of using internet resources (data) over the use of traditional method in teaching and learning?

Hypotheses:

$H0_1$: There is no significant difference in the mean performance of students taught using internet resources (data) over those taught with traditional method.

$H0_2$: There is no significant difference in the mean performance of teachers and students taught and learning using internet resources (data) over those taught and learn with traditional method.

Method

This study adopted the quasi-experimental design. Ali, (1996) defined quasi-experimental design as research methodology that is similar to experimental design but lacks the element of random assignment of participants to group instead, the participants are assigned to groups based on natural characteristics or pre-existing conditions. It is the type of design often used when random assignment is not possible or ethical (Nweke and Nwachukwu, 2023). In particular the samples will be collected in one college of education and one secondary school in each of five states of the Igbo language speaking south eastern states of Nigeria.

This summed up to 150 lecturers selected from 5 colleges of education from the South East and 72 teachers from five secondary schools, five from each three states with 6 each from the remaining two states. Instrument for data collection was called Survey Response Achievement Test (SRAT). The Survey Response Achievement Test (SRAT) will consist of 20 multiply choice questions with option A -D constructed from the content of senior secondary school computer topic. Each question has only one correct option. Each correct answer attracts ½ mark while each wrong answer attracts zero mark. The instrument received face validation from the experts in Computer Education Department of 'the Ebonyi State College of Education, Ikwo and one in the Measurement and Evaluation Department of Ebonyi State University, Abakaliki. The reliability of SRAT was established using Kuder-Richardson formula 20. Descriptive statistics of which mean and standard deviation was used to answer the research questions, while the analysis of covariance (ANCOVA) was employed to test the hypotheses. All hypotheses will be tested at an alpha level of 0.05 significance.

Results

This presents the results of the study in accordance with the research questions and hypotheses that guided the study.

Research Questions 1

What is the impact of using internet resources (data) over the use of traditional method in teaching and learning?

To answer this research questions, reference was made to the information on table 1, The data was obtained using the Survey Response Achievement Test (CAT) administered to both the lecturers and teachers involved in the study. The pretest and posttest scores were adjusted simultaneously during the analysis. The summary of the result is shown on table 1.

Table 1: Mean and Standard Deviation of achievement scores of using internet resources (data) over the use of traditional method in teaching and learning.

Group	**Mean Score**	**SD**	**N**
Treatment	7.90	2.70	150
Control	7.32	3.05	150
Difference	0.58	0.65	00

The result on table 1 above showed that students taught using internet resources (data) had a mean achievement score of 7.90 and standard deviation score of 2.70 while those taught over the use of traditional method had a mean achievement score of 7.32 and standard deviation score of 3.05. The mean difference in favour of students taught using internet resources (data) is 0.58. This result shows a slight increase in the achievement of students taught using internet resources (data) .

Research Questions 2

What is the mean performance of male and female students taught using internet resources (data) over the use of traditional method?

Data collected from male and female students' group were used to answer this research question.

Summary of result is presented in Table 2:

Table 2: Mean and standard deviation of achievement scores of male and female students taught using internet resources (data) over the use of traditional method.

Group	**Experimental Group**		**Control Group**		N
	Mean Score	**SD**	**Mean Score**	**SD**	
Male	8.08	3.12	7.38	2.88	150
Female	7.72	2.83	7.26	3.21	150

Difference	0.36	0.19	0.12	0.67	00

The result on table 2 above showed that male students taught using internet resources (data) had a mean achievement score of 8.08 and standard deviation score of 3.12 while those taught the use of traditional method had a mean achievement score of 7.38 and standard deviation score of 2.88 while female side those taught using internet resources (data) had a mean achievement score of 7.72 and standard deviation score of 2.83 while those taught the use of traditional method had a mean achievement score of 7.26 and standard deviation score of 3.21.

Research Question 3

What is the interaction effect of using internet resources (data) over the use of traditional method?

Data collected for male and female students in both the treatment and control groups were used to answer this research questions. Summary is presented in Table 3.

Table 3: Interaction effect of using internet resources (data) over the use of traditional method?

	Experimental Group		**Control Group**		**Mean**	
Group	**Mean Score**	**SD**	**Mean Score**	**SD**	**Difference**	**N**
Male	8.08	3.12	7.38	2.88	0.60	150
Female	7.72	2.83	7.26	3.21	0.46	150
Mean Difference	0.36	0.19	0.12	0.67	0.14	00

The result on table 3 above showed that male students taught using internet resources (data) had a mean achievement score of 8.08 and standard deviation score of 3.12 while those taught the use of traditional method had a mean achievement score of 7.38 and standard deviation score of 2.88. The mean difference in favour of male students taught using internet(data) is 0.60. This is a slight increase in the achievement of male students taught using internet resources (data). On the female side those taught using internet resources (data) had a mean achievement score of 7.72 and standard deviation score of 2.83 while those taught the use of traditional method had a mean achievement score of 7.26 and standard deviation score of 3.21. The mean difference in favour of female students taught using internet resources (data) is 0.46. This is also a slight increase in the achievement of female students taught the use of traditional method.

Down the table show that male students achieved higher than female students, in both experimental and control groups. These results is an indication that using internet resources (data) in teaching and learning will favour better understanding of the lesson especially on male students.

Hypotheses

$H0_1$: There is no significant difference in the mean performance of students taught using internet resources (data) over those taught using internet resources (data).

Table 4: Analysis of co variance for students the mean performance of students taught using internet resources (data) over those taught using internet resources (data).

Source of variation	Type III Sum of squares	Df	Mean square	F. Value	F. probability	Decision
Corrected model	7.884	4	2.086	11.850	0.000	
Intercept	26.758	1	25.958	158.296	0.000	
Pretest	0.089	1	0.089	0.543	0.436	Rejected
Posttest	1.005	1	1.005	5.282	0.015	
Error	12.534	73	0.152			
Total	1062.000	78				
Corrected Total	19.834	77				

Result on table 4 showed that for hypothesis 1, the alpha level (0,05) is greater than the significance of F-value (.000). The decision rule is to reject the null hypothesis when the alpha level is greater than the significance of F-value. Based on the decision rule, the researcher rejects the null hypothesis and concludes that there is a significant difference in the mean performance of students taught using internet resources (data) over those taught the use of traditional method.

$H0_2$: There is no significant difference in the mean performance of male and female students taught using internet resources (data) over the use of traditional method.

Table 5: Analysis of co variance for students the mean performance of male and female students taught using internet resources (data) over the use of traditional method.

Source of variation	Type III Sum of squares	Df	Mean square	F. Value	F. probability	Decision

Corrected model	7.284	2	3.186	13.840	0.000	
Intercept	24.753	1	24.753	178.322	0.000	
Pretest	0.089	1	0.089	0.563	0.436	Rejected
Posttest	1.005	1	1.005	2.278	0.015	
Error	13.574	83	0.487			
Total	983.000	88				
Corrected Total	18.671	87				

Result on table 5 showed that for hypothesis 2, the alpha level (0,05) is greater than the sig. of F-value (.000). The decision rule is to reject the null hypothesis when the alpha level is greater than the significance of F Probability. Based on the decision rule, the researchers reject the null hypothesis and concludes that there is a significant difference in the mean performance of male and female students taught using internet resources (data) over those taught the use of traditional method.

Summary of Finding

This study recorded the following findings:

1. The study showed that students taught using internet resources (data) had a mean achievement score of 7.90 and standard deviation score of 2.70 while those taught the use of traditional method had a mean achievement score of 7.32 and standard deviation score of 3.05. The mean difference in favour of students taught using traditional method is 0.58. This result shows a slight increase in the achievement of students taught using internet resources (data).
2. It also exposed that male students taught using internet resources (data) had a mean achievement score of 8.08 and standard deviation score of 3.12 while those taught using traditional method had a mean achievement score of 7.38 and standard deviation score of 2.88 while female side those taught using internet resources (data) had a mean achievement score of 7.72 and standard deviation score of 2.83 while those taught using traditional method had a mean achievement score of 7.26 and standard deviation score of 3.21.
3. The study went further to show that male students achieved higher than female students, in both experimental and control groups. These results is an indication that use of using internet resources (data) in teaching and learning computer will favour better understanding of the lesson especially on male students.
4. The study rejected the null hypothesis and states that there is no significant difference in the mean performance of students taught using internet resources (data) over those taught using traditional

method had and concluded that there is a significant difference in the mean performance of students taught using internet resources (data) over using traditional method had.

5. The study rejected the null hypothesis and states that there is no significant difference in the mean performance of male and female students taught computer using local language (Igbo language) over those taught using traditional method had and concluded that there is a significant difference in the mean performance of male and female students taught using internet resources (data) over those taught using traditional method had.

APPROXIMATE SOLUTION

Assumption that there are two internet service providers and each client can connect to either of the two ISPs. Each client requires exactly one unit of bandwidth (this is to reduce the size of the solution space). When a client tries to connect, each of this service providers signal low bandwidth service with synchronization with the effective price relation from a finite set of possible prices. The client connects to the ISP offering the lower price, randomly choosing one if the prices are the same. If an ISP decides to reject a request, it offers the highest possible price. This is done to avoid paying a penalty (rejection of client in subsequent usage) without a client deciding to connect to it. So, if ISP 1 wants to reject and ISP 2 is offering the (high bandwidth services) highest price, the client will see both offering the highest price and it is only with a 50% probability that ISP 1 will have to pay a penalty as the client may connect to ISP 2 and get accepted. So only after an ISP is chosen, will the ISP accept or reject the connection. In the latter case, the ISP will pay a penalty (rejected usage) to the client. The client will then connect to the second ISP. Here again there may be an acceptance or a rejection.

The process of finding the Nash Equilibrium using the *figure 1* below analysis requires high memory space and computation time. Therefore, the researcher presents an approximate solution which has low space and time complexity. This approximate solution is compared with the accurate solution by running the two solutions for small values of m_{max} and comparing the expected incomes. In the approximate solution, the state of a service provider is represented by a single integer m, the number of clients connected to the service provider. I do not keep track of the number of clients that are in session or waiting for a session (n in the accurate solution). Instead, we estimate the number of clients that are in session. The method to find the approximate Nash equilibrium is similar to the method used in the accurate solution. There are three differences: the first difference is that the number of solution matrices to be consider are reduced because the state is represented by a single integer, the second difference is

that the equations of *Pr()* are different and the third difference is that the *Waiting ()* function's value is different.

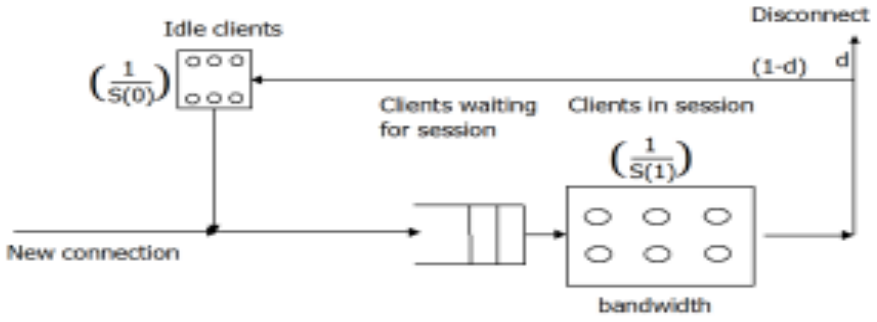

Figure 1. Connected clients

The arrival of clients is modelled as a Poisson process as stated by I. J. B. F. Adan and J. A. C. Resing (2001). λ is the mean arrival rate of clients. After connection, a client sometimes remains idle and sometimes consumes bandwidth and these durations are both exponentially distributed. When a client consumes bandwidth, it is termed as being in session. When a client requests for bandwidth but he has to wait, it is termed as waiting for session. When a connected client is neither in session nor waiting for session, he is in an idle state. A client moves out of idle state when he needs to enter the session state. He may have to wait to get into the session state. If so, he gets a penalty from the ISP for the duration he has to wait. He is then waiting for a session. Figure 1 illustrates the scheme. After a session ends, with probability d the client exits the system. Otherwise, he goes into the idle state. Consider a situation in which two service providers have the knowledge of the parameters (bandwidth, prices, etc.) of each other. Assume service provider 1 chooses strategy *st1* and service provider 2 chooses *st2*. If the best strategy of service provider 1 is *st1* given that the strategy of service provider 2 is *st2* and the best strategy of service provider 2 is *st2* given that the strategy of service provider 1 is *st1*, then this situation is said to be in Nash Equilibrium. If the two service providers are in Nash equilibrium, they are likely to be doing their best. Our problem is to find a Nash Equilibrium between two service providers.

Conceive a situation in which two service providers have the knowledge of the parameters (bandwidth, prices, etc.) of each other. Assume service provider 1 chooses strategy *st1* and service provider 2 chooses *st2*. If the best strategy of service provider 1 is *st1* given that the strategy of service provider 2 is *st2* and the best strategy of service provider 2 is *st2* given that the strategy of service provider 1 is *st1*, then this situation is said to be in Nash Equilibrium. If the two service providers are in Nash

equilibrium, they are likely to be doing their best. The problem is to find a Nash Equilibrium between two service providers.

Discussion of Findings

Effect of using local languages (Igbo language) in teaching computer

The main discovery of this study is that students taught computer using local language (Igbo language) performed better than those taught using foreign language (English language). The result is with Ghasemi et al, 2011 that computer as a medium for language learning has been acknowledged by many educators in the past years. Using computers for language learning has proved not only interesting but also positive and stimulating for many language teachers and learners. While Garba et al (2019), states that Language is an important tool that every human uses as a specific and common means of expression, communication and conveyance of different thought. It is also important as the way of impacting knowledge, instruction, and teaching at in our outside classroom.

In this presented a Nash Equilibrium solution between two internet service providers which maximizes the income of each of the service providers. But the solution has high complexity and so I have also proposed an approximate solution of lower complexity. Results show that the approximate method gives results very close to the accurate method. The approximate method can be applied to multiple service providers also. In future work intendency to explore the range of solutions that will get when the number of providers is more than two, and when the bandwidths of providers are different. Intent to examine if it can show the existence of a Nash Equilibrium in all cases, and whether such an equilibrium is unique.

Conclusion

In conclusion this study compares performance of college students and secondary school students when taught using internet resources (data) and when taught using traditional method. The study showed that students taught using internet resources (data) performed better than those taught using traditional method.

The study also showed that both male female students taught using internet resources (data) performed better than both male and female taught using traditional method. The study went further to show that male students achieved higher than female students, in both experimental and control groups. This result is an indication that using internet resources (data) in teaching and learning computer will favour better understanding of the lesson especially on male students.

The use of dynamic pricing and imposition penalties as a way of providing guarantees. The model shows real situations fairly accurately. This has presented a Nash Equilibrium solution between two internet service providers which maximizes the income of each of the service providers. But the solution has high complexity and this has also proposed an approximate solution of lower complexity. Results show that the approximate method gives results very close to the accurate method.

Recommendations Based on the results of this study, the researcher made the following recommendations:

1. That teachers in higher institutions and secondary schools should inculcate the use of using internet resources (data) in teaching the subject as it will improving the understanding of what is taught to the students.
2. That government with school's administrators should create enabling structures, environment, provide the necessary teaching material and assistance for teachers to teach using internet resources (data).
3. Experts or professionals in computer studies should help create or develop local names for some of the computer terminologies that have not been given to facilitate the full use of internet resources.
4. Workshops and seminars should be organized for teachers on how, why and way to use internet resources in teaching especially ICT unknowledgeable staff.
5. Government formulating policies to control ISP companies to price manipulations of its resources for practical use in teaching and learning of the computer.

REFERENCE

Aidoo, B.; Macdonald, M.A.; Vesterinen, V.; Pétursdóttir, S.; Gísladóttir, B. (2021). Transforming Teaching with ICT Using the Flipped Classroom Approach: Dealing with COVID-19 Pandemic. Educ. Sci., 12, 421. [CrossRef].

Bredin J, Kotz D, Rus D, Maheswaran RT, Imer C, Basar T. "Computational markets to regulate mobile agent systems," Autonomous Agents and Multi-Agent Systems", vol. 6, p. 235–263, 2003.

C. A. Gizelis and D. D. Vergados (2011). A survey of pricing schemes in wireless networks. IEEE Communications Surveys and Tutorials, 13(1):126–145.

CEO Forum on Education Technology (2001). School technology and readiness report:

Key building blocks for student achievement in the 21st century: integrating digital

content. Washington, DC: Author. Available a http://www.ceoforum.org/downloads/report4.pdf. Accessed {12th December, 2024}.

Cowie, B.; Jones, A. (2023). Teaching and Learning in the Ict Environment. International Handbook of Research on Teachers and Teaching; Springer: NewYork, NY, USA; pp. 791–801. [CrossRef].

Fowowe, S.S. (2006). Information technology: A veritable tools for sustaining the Universal Basic Education Programme in Africa. Paper presented at the African conference on Achieving Universal Basic/Primary Education in Africa in 2015. University of Botswana. 16- 19 October.

H. Pervaiz and J. Bigham (2009). Game theoretical formulation of network selection in competing wireless networks: An analytic hierarchy process model. In Next Generation Mobile Applications, Services and Technologies, 2009. NGMAST '09. Third International Conference on, pages 292–297.

Lei, J. & Zhao (2006). Technology uses and student achievement: A longitudinal study. Computers and Education. http://www.sciencedirect.com {Accessed on 12 September, 2024}.

R. S. Randhawa R. Garg. Asla (2002). Framework for qos provisioning and dynamic capacity allocation. In 10th International Workshop on Quality of Service (IWQoS 2002), pages 129–137.

Vuorikari, R.; Punie, Y.; Carretero, S.; Van Den Brande, G. (2016). DigComp 2.0: The Digital Competence Framework for Citizens. Update Phase 1: The Conceptual Reference Model; Publications Office of the European Union: Luxembourg.

Urbina, S.; Pérez-Garcías, A.; Ramírez-Mera, U.N.(2021). The digital competence of university teaching staff in teacher training. Virtual Campus, 11, 49–62.