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Stakeholders' Perceptions of ICT Integration on KCSE Chemistry Performance in Public Secondary Schools in Kisumu County, Kenya

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Abstract:
Information Communication Technology (ICT) integration is embraced in education to improve the quality of learning and performance globally. In 1996, the Ministry of Education in Kenya directed secondary schools to introduce computer studies into their curriculum. In 2006 (with studies having demonstrated a positive correlation between ICT integration and performance), under its national ICT policy, the ministry encouraged ICT integration in education using even basic infrastructure, including mobile phones and the Internet. It jumpstarted the program with grants for ICT equipment to 5 schools in every constituency in the republic. Chemistry is expected to benefit more because the versatile ICT tools concretize concepts and enhance the learning of its abstract content. This study aimed to assess stakeholders' perceptions of ICT integration on Kenya Certificate of Secondary Education (KCSE) Chemistry performance. The study was anchored on the 'stimulus and response' theory involving Teacher Quality, Instructional Quality, and Student Outcome. A descriptive survey and a sequential exploratory design were used. Quantitative analysis of data was done using descriptive statistics that included frequency counts, percentages, means, and standard deviations, while qualitative data was analyzed thematically. Findings indicated that stakeholders had positive perceptions that ICT integration improves performance, but teachers seldom used it in instruction. The study concluded that all schools should have instructional websites and go digital with all their pedagogical activities.

Keywords: *Information Communication Technology, ICT integration, ICT equipment, Technology, Internet, Performance, Perceptions*

1. Introduction

There is a widespread perception that ICT can and will empower teachers and learners, transforming the teaching and learning process from being highly teacher-dominated to student-centered. This transformation will result in the following:

- Increased learning gains for students (InfoDev, 2020; Beaurain, 2016),
- Creating and allowing for opportunities for learners to develop their creativity,
- Problem-solving abilities,
- Informational reasoning skills, and
- Other high-order thinking skills

However, according to InfoDev (2020) report, there are currently very limited unequivocally compelling data to support this. However, it is believed that specific uses of ICT can positively affect student achievement when used appropriately to complement teachers' existing pedagogical philosophies.

Lindfors (2007) investigated the perceptions of a group of European Chemistry teachers on using ICT in teaching. The findings revealed a perception that teaching was the most important thing and ICT as a tool or method was in second place. It recommended a balance between ICT and traditional teaching and concluded that teachers have a perception that the use of ICT has to be combined with traditional classroom-based teaching from the pedagogical point of view. On the contrary, statistical analysis reveals that ICT positively affects students' academic achievement and retention when contrasted with conventional teaching techniques, as Hussain *et al.* (2017) investigated using a pre-test-post-test equivalent group design. Fifty ninth-grade students were randomly selected from Kohsar public school, Latamber, Karak, Pakistan, and grouped based on pre-test scores. Findings indicated that ICT positively affects students' academic achievement and retention. They were more compelling, effective, rewarding, and valuable in teaching chemistry when contrasted with conventional teaching techniques. It may be safe to say that universally teachers face similar challenges and share similar experiences. It would be important to establish if Kenyan teachers in Kisumu County share similar perceptions as European teachers with better training and opportunities.

In Rwanda, Munyengabe, Yiyi, and Hitimana (2017) investigated primary teachers' perception of ICT integration for enhancing teaching and learning by implementing the One Laptop per Child (OLPC) program in primary schools.

Findings indicate that teachers are aware that ICT will help learners do their self-coaching and that teachers have positive feelings towards ICT integration into the teaching and learning process, concluding that the success of the program depends on teachers' perceptions. The conclusion is relevant as the study was on ICT integration, but none has been done in its use in teaching Chemistry.

In Kenya, Mwendwa (2017) investigated the perception of teachers and principals on ICT integration in primary schools in Kitui County, Kenya. The sample was drawn from three hundred and eighty-eight public primary schools in the county. Data were collected using questionnaires for teachers and interview guides for the principals. The results indicated that most teachers had a positive perception towards using ICT hardware and software tools in their instructional process if only the required resources and facilities for ICT integration in the curriculum were present in their schools. The finding is relevant to the current study because, by knowing educational stakeholders' perceptions of ICT integration, there will be an understanding of what they do with technology in relation to their work. Kerenji (2016) investigated integration in teaching English and found that it faced many challenges. No research has been done on other stakeholders' perceptions of ICT integration in Kisumu County. There was a need to carry out such a study to establish their view on the innovative use of technology in teaching and learning.

1.1. Aim of the Study

This study intends to establish the extent that schools embrace the use of ICT in teaching and learning in the light of its enormous benefits in everyday life in and out of school. This study aims to assess stakeholders' perceptions of ICT integration on KCSE Chemistry performance in public secondary schools in Kisumu County, Kenya.

1.2. Research Questions

The following overarching question guided this study:

- What are the Stakeholders' perceptions of ICT integration on KCSE Chemistry performance?

This study further explored the availability of ICT resources for teaching Chemistry and Chemistry teachers' preparedness to integrate ICT in pedagogy and determined the extent of ICT integration in teaching and learning Chemistry in public schools. With this in mind, the study was further guided by the following underlying questions:

- Which resources are available in public secondary schools in Kisumu County for ICT integration?
- What is the level of Chemistry teachers' ICT preparedness to integrate technology in pedagogy?
- What is the extent of ICT integration in the teaching and learning of Chemistry in public secondary schools in Kisumu County?

The foregoing underlying questions assisted the researcher in getting a better understanding of stakeholders' perceptions about the pedagogical integration of ICT on Chemistry performance.

1.3. Significance of the Study

The findings of this study could influence the development of appropriate and relevant guidelines by the curriculum developers on the usage and uptake of ICT by teachers, starting from teacher training to practicing teachers in schools, by involving all stakeholders in the program. The study could further be significant to the ministry of education in Kenya to enable informed decisions on the enhancement of ICT use in education, especially on the emphasis on e-learning school work at home during lockdown when schools closed for a long period due to the COVID-19 pandemic.

2. Literature Review

There is substantial literature on the integration of ICT in classrooms. In a global context, both developed and developing countries recognize the value of integrating ICT tools for their economic development. However, according to a report by Thayer (2020), there are currently very limited unequivocally compelling data to support this. This is an indication that the entire aforementioned is available in literature but not yet experimentally confirmed. In his study in Europe, Earle (2002) holds a view that specific uses of ICT can have positive effects on student achievement when used appropriately to complement teachers' existing pedagogical philosophies. Educational systems are also adopting new technologies:

- To integrate ICT into the teaching and learning process,
- To prepare students with the knowledge and skills they need in their subject matter (Hussain *et al.,* 2017)

In this way, the teaching profession is evolving from teacher-centered to student-centered learning.

In France, Cardellini (2012) investigated the aspect common in every culture: the decreasing number of students studying Chemistry and the barriers preventing students from studying the subject. The researcher states that for many students, Chemistry is seen as a difficult, complex, and abstract subject that requires special intellectual talents and too much effort to be understood. Nonetheless, the researcher points out that more than other sciences, understanding Chemistry relies on making sense of the invisible and untouchable, noting that the source of students' difficulties can have at least three origins:

- The nature of science itself makes Chemistry inaccessible,
- The methods by which teachers have traditionally taught Chemistry raise the problem,
- The methods by which students learn are in conflict either with the nature of science and teaching methods or with both (Cardellini, 2012)

The researcher avers that ICT integration into teaching the subject can ease the complex content. In Kenya, a similar problem is envisaged as Chemistry is a compulsory science at the secondary school level, and mass failures in the

subject are experienced all over the republic. Despite this, there is void information on any attempt to improve the performance of learners in the subject. In addition to the foregoing, nationally and specifically in Kisumu County, Chemistry performance is poor, with mean grades bordering D. With such grades, learners graduating from high schools cannot pursue science-related courses, especially at tertiary institutions and universities. Given this discrepancy, there is a need to integrate Chemistry pedagogy with ICT to make its abstract concepts easier to understand and improve performance. Dori *et al.* (2013) researched and presented a perception of using and incorporating ICT into teaching and learning Chemistry. Investigation of students' ICT skills in Chemistry, in particular, and sciences, in general, established that ICT-based learning environments play a significant role in education. Another research study by Barnea *et al.* (2010) on developing and implementing inquiry-based laboratories to reform high school Chemistry in Israel has exemplified visualizations in science laboratories such as molecular modeling, data collection, and presentations. On the other hand, Bell *et al.* (2010) in their study focused on ICT use via World Wide Web (WWW) and virtual reality, as well as the role of ICT in developing higher-order thinking skills such as inquiry, graphing, and modeling. Other examples included different assignments for teaching Chemistry using ICT. In the case of Kenya, Internet connectivity and affordability are a challenge in most public schools to enable access to the Web and virtual reality, majorly caused by high costs.

Muhammad *et al.* (2019) investigated the impact of ICT on students' academic performance in Chemistry by applying association rule, mining, and structured equation modeling. The study established that ICT plays a significant role in students' academic performance. From a statistical and mining perspective, overall results of descriptive statistics, reliability analysis, confirmatory factor analysis, OLS regressions, structured equation modeling, and data mining algorithms such as association rule, mining, and éclat have been employed to evaluate the comparative importance of the factors in identifying the academic performance of students. Overall results indicate that there is a significant relationship between ICT use and students' academic performance. The proposition suggests a significant relationship between ICT integration and learner performance. However, they ignore the distinct effects of ICT use, especially Internet use and the effects of social media that raise questions about the effectiveness of educational policies that guide ICT use in education. Avinash and Shailja (2013) established that the ICT program is more compelling and effective than the conventional teaching approach regarding students' achievement scores in Chemistry. This view is shared by Oginni and Popoola (2013), who established that by using ICT, students' retention scores were better when contrasted with those who were instructed via conventional methods, affirming the results of former researchers that students learn and retain better when they are taught through ICT. This finding is relevant and links to the current ICT integration research in chemistry teaching and performance. Moreover, when it comes to learners understanding the subject, ICT assists in explaining complex concepts and processes through interactive media, animations, and photographs. This ensures the quality of learning and performance. One observation that this review would like to make is that the integration of ICT in teaching and learning is recommended because it has worked elsewhere, such as in Europe, India, Pakistan, and Israel. Research has not proved its workability in a developing country like Kenya, though it appears quite obvious. The question is, though it exists in research findings and in paper, whether teachers have implemented their use has not been ascertained.

In a parallel study in Kenya, Wasike (2018) investigated the perceptions of teachers, learners, and school principals on the integration of ICT in teaching and learning secondary school Agriculture in Bungoma County, Kenya. The purpose of the study was to establish the teachers' perceptions of using ICT in teaching and learning Agriculture in Bungoma County. The objective of the study was to ascertain the teachers' perceived usefulness of ICT, ease of use and adoption of ICT, and their preparedness to use ICT as a pedagogical tool in secondary schools in Bungoma County. The study also gathered perceptions of learners and school principals on the use of ICT in teaching and learning Agriculture. Even though the focus of the study was Agriculture, there is a need to carry out a similar study on the integration of ICT in teaching Chemistry. Moreover, without physical Lesson Observation of ICT-integrated lessons, it is difficult to tell if a few teachers mentioned in the former study integrated ICT in teaching Agriculture. This study was, therefore, designed to fill the gap by establishing whether stakeholders' perceptions relate to what teachers do in relation to their work.

3. Methodology

This section explains in detail the research methodology. It addresses research design, study area, study population, sampling techniques, sample size, sampling procedure, instruments and instrumentation, data collection procedures, piloting, reliability and validity, methods of data analysis, and presentations. The steps involved were elaborated in detail and carried out systematically to achieve a high degree of reliability and validity.

3.1. Research Design

This study used a combination of descriptive surveys and sequential exploratory designs. These were used to allow the researcher to gather information about the current state of ICT integration in schools and then make follow-ups and draw valid general conclusions from the facts discovered. According to Gall, Borg, and Gall (2007), and Orodho (2005), descriptive survey research describes the state of affairs as it currently exists. The design provided an opportunity for the researcher to probe deeply and obtain precise and concise information about the study population, and gather information about the present and existing condition of the phenomena under study.

According to Ivankova (2011) and Ivankova, Vicky, and Clerk (2005), sequential exploratory mixed methods design implies collecting and analyzing quantitative and qualitative data in two consecutive phases within one study. This design is characterized by an initial quantitative phase of data collection and analysis, followed by a phase of qualitative data collection and analysis, with a final phase of linking data from the two separate strands of data. This design was used in this study by enabling the researcher to validate quantitative results with qualitative findings. Using a Lesson

Observation Guide, the researcher attended ICT-integrated lessons of teachers who had indicated a tendency to integrate ICT in their Chemistry pedagogy. During this time, the researcher visited selected study schools and did Lesson Observation in ICT-integrated Chemistry lessons. The results were related to the outcomes from the first quantitative data gathered through questionnaires to the respondents and analyzed to give the state of ICT integration in the study schools.

3.2. Research Sample

The sampling unit was the personnel: principals, teachers, and students in the schools and the SCQASOs who were respondents. Thayer (2020) defines a sampling unit as a singular value within a sample database. In this study, the individual respondents were regarded as the sampling unit. The study population from which the sample was drawn was 55 schools with 55 school principals and 125 Chemistry teachers. From these, 31% was drawn to make a sample of 17 schools. Thereafter, a sample of 17 school principals, representing 31% of the population, were purposively sampled, and 39 Chemistry teachers, representing 31% of the study population, were purposively sampled, respectively.

According to Mugenda and Mugenda (2008), a sample of 30% to 40% of the study population is enough for a descriptive survey. A saturated sampling technique was used to select 6 SCQASOs for the study. Krejcie and Morgan (1970) Sample Size Estimation Table for a large population was used to determine the representative sample size of 340 Form Four students taking Chemistry from the 17 study schools sampled, randomized as per the number of schools to ensure equity.

3.3. Reliability of the Study Constructs

The reliability of the structured instruments (questionnaires for students, Chemistry teachers, school principals, quality assurance officers, the observation checklist, and the Lesson Observation Guide) was established through piloting (Mugenda & Mugenda, 2008) by the Test-retest method. The pilot study done in 10% of the population not involved in the final study was a means of ascertaining the reliability of the tools. Piloting was done in six secondary schools that had computers. Consequently, six school principals, twelve Chemistry teachers, and twenty-four Form Four students were selected for the exercise. The questionnaire for SCQASO was piloted at one sub-county and involved one SCQASO who did not also form part of the final study. After two weeks, the instruments were re-tested on the same group of students, teachers, school administrators, and SCQASO to enhance reliability. Their responses were then analyzed manually by comparing their first and second set of responses to establish if the instruments attained a threshold reliability index. The final version of all the instruments was designed around the themes identified for the research.

The reliability threshold index was realized at $\alpha = .70$ for the Questionnaires for the principals, $\alpha = .72$ for Questionnaire for Chemistry teachers, $\alpha = .71$ for Questionnaire for Chemistry students, and $\alpha=.73$ for Questionnaire for SCQASO (see appendices A, B, C, and D) using Cronbach's coefficient alpha, which were considered reliable according to Gall *et al.* (2007). Findings were used to adjust the instruments to remove deficiencies and ambiguities.

3.4. Ethical Considerations

Preceding the data collection process, respondents or study participants were recruited through a recruitment process that culminated in counseling sessions in line with Belmont principles (Ryan, 1979) that guide research using human participants. The issues of confidentiality, anonymity, informed consent, and plagiarism, including consent for persons who are minors, were addressed. A detailed consent form was developed for respondents to read and consent before signing (see Appendix K). Learners signed the consent forms and then took part in the study. According to the Belmont principles (Bethesda, 1978), justice and respect for a person demand that subjects enter the research voluntarily and with adequate information. Voluntary response and honesty were clearly stated to the respondents. According to the Belmont principles, confidentiality and anonymity urge the professional to keep secrets because harm will almost certainly follow if the information is revealed (Ryan, 1979). This study endeavored to maintain high standards of confidentiality and anonymity as professionally recommended.

Plagiarism is defined as presenting another person's work as one's own work. Presentation includes copying or reproducing it without acknowledging the source (Narhe, 2005). This study respects and values other people's work, and as such, references were appropriately cited and acknowledged.

4. Findings and Discussion

This study investigated the impact of ICT integration on chemistry performance in secondary schools in Kisumu County, Kenya. For the systematic presentation and data analysis, this section has been organized based on the research objective: Establishing stakeholders' perceptions of ICT integration on KCSE Chemistry performance. To achieve this objective, school principals and Chemistry teachers in the study schools were asked to respond to several statements intended to describe their perceptions of ICT integration on KCSE Chemistry performance. The Chemistry KCSE performance of the study schools was retrieved from the observation checklist as extracted from school archives. In response to this objective, data from principals, Chemistry teachers, Chemistry students, SCQASO, and Lesson Observation Guide were analyzed by looking at the following:

- Performance trends in KCSE Chemistry mean grades for the study schools.
- Chemistry means and deviation from the mean per school according to Chemistry teachers and school principals.
- Chemistry teachers' perceptions on the frequency of integration of software in teaching and learning and performance in the subject
- Chemistry teachers' perceptions on mean usage of ICT and performance

Data on this objective was analyzed under the research question 'what are the stakeholders' perceptions of ICT integration on KCSE Chemistry performance?' Data analysis and interpretation of responses from stakeholders revealed positive perceptions of ICT integration on performance, but teachers seldom perform ICT tasks in pedagogy.

4.1. Performance Trends in Study Schools from 2011 to 2017 in KCSE Chemistry

It was important to establish teachers' perceptions of ICT integration with regards to their students' performance at KCSE examinations, and hence their perceptions of learning theories of ICT as a stimulus in instructional environments and performance as the response. To confirm if stakeholders' perceptions were real and reflected school data in terms of performance, Performance Trends between 2011 and 2017 in Chemistry as examined in KCSE examinations were investigated in the study schools and obtained through data collected using the observation checklist. This was the period when all the study schools were categorized as 'schools with computers'. It was necessary to obtain the performance trends of the schools in the examination to establish if the trends could have been dependent on, but not limited to ICT integration, category (type) of the schools, traditions established by schools, or any other attributes in the population not considered in the study. For this reason, trend analysis was used to gauge the performance of individual schools but not to rank the study schools. The results are presented in table 1.

Type of School	2011	2012	2013	2014	2015	2016	2017	Mean
1. County girls	3.493	3.524	4.157	4.761	4.363	4.045	5.104	4.207
2. Special	3.375	3.500	3.110	3.419	2.838	2.980	3.720	3.277
3. Extra-county boys	8.721	6.261	6.618	7.066	8.209	7.782	7.645	7.422
4. County boys	5.210	4.661	5.300	5.860	6.520	5.290	5.283	5.446
5. National girls	7.218	6.278	6.946	7.605	8.209	7.463	8.585	7.472
6. Sub-county mixed					5.255	4.197	4.016	4.489
7. National boys	9.397	9.266	8.375	8.680	10.247	9.819	9.899	9.383
8. County boys	2.770	3.670	4.086	3.240	3.420	4.330	5.744	3.894
9. Extra-county boys	5.534	4.619	5.403	5.615	6.391	6.391	6.379	5.762
10. Sub-county mixed	3.490		3.410	3.360	4.010	3.720	3.920	3.652
11. Extra-county boys	6.424	6.425	6.416	5.484	6.662	5.775	5.802	6.141
12. County girls	3.481	3.375	3.187	3.659	5.000	3.821	6.500	4.146
13. Extra-county girls	3.310	4.190	4.320	4.458	4.893	4.160	4.500	4.262
14. Sub-county mixed	2.835	2.625	2.500	2.470	4.137	2.592	3.304	2.923
15. Sub-county mixed	2.558	2.800	3.255	4.706	4.501	2.649	2.813	3.326
16. Sub-county mixed	3.430	3.130	3.383	4.155	4.798	3.961	4.365	3.889
17. Sub-county mixed	2.770	2.670	4.086	3.240	3.420	4.330	5.744	3.751
County Mean	4.354	3.940	4.385	4.575	5.463	4.90	5.489	4.845

Table 1: Performance Trends in Study Schools from 2011 to 2017 in Chemistry at KCSE (X/12)

The data in this table were generated from the Observation Checklist section that captured performance records for each school's Chemistry KCSE results from 2011 to 2017. Table 1 gives the trends of performance in the study schools from 2011 to 2017 and finally gives an overall mean for each school for the seven-year period. Also, the county mean for each year and for the seven-year period is given. Table 1 shows that the trend in some of the schools lacked consistency as the mean grades in Chemistry tended to fluctuate from as low as less than 3.5/12 for more than 10 sub-county schools in the year 2011. The trend indicated for some of the schools was fluctuating improvement shown up to a maximum in 2015 (except for school number two, a special school) but dropped in 2016 and 2017 to give a mean grade of below 4.5/12 in sub-county schools. This is an exception for the national school for boys, with a mean of 9.383/12, and the national school for girls, with a mean of 7.472/12. Other schools that did not show much change in their Chemistry mean grade is extra-county schools for boys, with a mean of 5.762/12, and 7.472/12, respectively. Others include one county school for boys with a mean of 6.141/12 and one county mixed-day school with a mean of 5.446/12. These are the schools whose mean grades remained more or less constant from 2011 to 2017. The trends indicated by the study schools do not show variation in teacher quality or instructional quality that would have warranted a response of improved performance among learners. The trends show ordinary performance in evaluation. The performance could have been influenced by school type more than any other stimuli.

This finding is in contrast with the study by Wastiau *et al.* (2017) on the use of ICT in education during a survey of secondary schools in Europe that established that students who were taught with ICT had a better academic performance with ICT instructional package, recommending the use of ICT for teaching and learning in secondary schools. This implies that in the current study, the presence of ICT equipment in the study schools did not impact learner performance because they were not integrated with teaching and learning.

4.2. Chemistry Mean Grades and Deviation from the Mean per School According to Chemistry Teachers and School Principals

The Chemistry teachers were asked to state their perceptions of ICT integration and the extent it affected Chemistry mean grades by estimating deviations from previous means (ranging from negative to positive deviation up to +3) in their schools for seven years of ICT integration. Their responses were compared to the school Chemistry mean grade and frequency of use of ICT as indicated by the same teachers per school. The summary is presented in table 2.

School	Chemistry KCSE Mean	Deviation from Previous School Mean	Teachers' Mean Frequency of ICT Usage	SD
1	4.207	3	2	1.20
2	3.277	3	1	0.45
3	7.472	3	2	1.54
4	5.446	4	4	0.69
5	7.472	4	3	0.90
6	4.489	3	2	1.59
7	9.383	5	4	0.98
8	3.894	2	2	1.72
9	5.762	4	5	0.92
10	3.652	3	3	1.58
11	6.141	3	3	1.39
12	4.146	4	5	1.01
13	4.262	3	2	0.99
14	2.923	5	2	0.63
15	3.326	5	1	0.23
16	3.889	3	1	0.54
17	3.751	2	2	1.31

Table 2: KCSE Chemistry Mean Grade per School, Perceived Deviation from Previous Mean and Teachers' Frequency (N=17)
**Key: Deviation from Previous School KCSE Chemistry Mean Grade: 1=Negative, 2= Not At All, 3= +1, 4= +2, and 5= +3.*
**Key: Frequency Of ICT Usage: 5-Daily, 4-Weekly, 3-Monthly, 2-Termly, 1-Not At All*

The instruments used in collecting data in this table were the teachers' and principals' questionnaires on the sections dealing with how ICT has affected syllabus coverage, Chemistry mean grade, KCSE mean grades, and teachers' average frequency of ICT use. Table 2 presents the summary of individual schools' KCSE Chemistry mean scores, deviation from the previous school mean as projected by Chemistry teachers. This was compared with the teachers' mean frequency of ICT integration. The findings show that teachers in schools number 8 and 17 projected 'No deviation' from the previous mean, as their KCSE Chemistry grades stood at 3.894 and 3.751, respectively. The teachers in both schools posted a mean frequency of ICT usage of 2, meaning the teachers at least integrated ICT on a termly basis in pedagogy, and a standard deviation of 1.72 and 1.31, respectively, indicating an almost perfect agreement. Similarly, teachers in schools number 1,2,3,6,10,11,13, and 16 had projected a positive mean deviation of +1 from the previous mean for their schools' Chemistry KCSE mean grade, while from their performance, their mean grades for the years of analysis were 4.207, 3.277, 7.472, 4.489, 3.652, 6.141, 4.262, and 3.889, respectively. All the teachers in these specific schools had a mean frequency of ICT integration ranging from 1 to 3, meaning the teachers did 'Not at all' integrate ICT in pedagogy, nor did it on a termly or monthly basis with Standard Deviations ranging from 0.45 to 1.59, respectively. This finding shows that when teachers integrate ICT in pedagogy less frequently, they have low expectations.

On the same note, it is interesting to report that principals of schools' numbers 10 and 16 expected no deviation at all in syllabus coverage, general KCSE mean grade, and Chemistry mean grade due to ICT integration. This could mean that the administrators probably know that their teachers are not integrating the technology in pedagogy and hence did not expect anything from it. Incidentally, the principal of school number one did not respond to this question, leaving a gap in his/her perception. On the same note, principals of school numbers 2, 3, and 11 projected a mean deviation of +2 in Chemistry performances and +1 in syllabus coverage and general KCSE mean grade, indicating some hope in technology.

Table 2 also shows that teachers in school numbers 4, 5, 9, and 12 projected a mean deviation of +2 from the previous mean. The Chemistry mean grades for the study period were 5.446, 7.472, 5.762, and 4.146, respectively, while their mean frequency of ICT usage ranged from weekly to termly. The findings indicate that when teachers consider integrating ICT more frequently in pedagogy, they develop high expectations for their learners. Incidentally, the principal of school number 12 agreed with his/her teacher on the projection of +2 for syllabus coverage, KCSE mean grade, and Chemistry mean grade. On the other hand, the principal of school number 4 differed from his/her teacher as he/she projected a mean deviation of +3 in syllabus coverage, general KCSE mean grade, and Chemistry mean grade. While the principal for school number 5 projected a mean deviation of +1 for KCSE, the Chemistry mean grade yet projected a deviation of +2 for syllabus coverage. Similarly, the principal of school number 6 projected a deviation of +1 for general KCSE and Chemistry mean grades but a deviation of +3 for syllabus coverage.

On the other hand, teachers in schools number 7, 14, and 15 had projected a mean deviation of +3 from the previous mean at the onset of ICT in their schools, whose mean grades stood at 9.383, 2.923, and 3.326, respectively. The school teachers had a mean frequency of ICT usage of 4 - weekly, 2 - termly use, and 1 - not at all, with a standard deviation of less than 1.59, indicating an almost perfect agreement. The findings indicate that some teachers could have projected their expectations without any input in their frequency of ICT usage. The high mean grades in certain schools reflect the frequency that such teachers indicated to integrate ICT in pedagogy. On the other hand, the projections on the mean grades did not reflect the performance in the majority of the schools. Incidentally, the principal of school number 14 projected a deviation of +1 on syllabus coverage, general KCSE, and Chemistry mean grade. While the principal of school number 7 projected a mean deviation of +3 on syllabus coverage and +2 on general KCSE mean grade and Chemistry mean grade, respectively. However, the principal of school number 15 projected a deviation of +2 on syllabus coverage and +3 on general schools and Chemistry mean grades. As can be seen from the above projections by Chemistry teachers and the school principals, there was no consistency in the responses of both educators, indicating that the projections were actually just their perceptions without any past record being referred to objectively.

With this in mind, the researcher adopted a sequential exploratory design and revisited the study schools to actually observe teachers integrate ICT in Chemistry lessons. Only 30% (five schools out of seventeen) organized hypothetical ICT-integrated lessons for the researcher to observe, while Lesson Observation failed to take off in 70% of the study schools. This means that the lessons were organized hypothetically, but real ICT integration in teaching and learning Chemistry does not take place in public secondary schools in Kisumu County. The findings from the Lesson Observation indicate that ICT integration to teach Chemistry in secondary schools in Kisumu County is just a perception but does not take place and hence has no effect on the performance of such schools.

4.3. Chemistry Teachers' Perceptions of Frequency of Use of Software in Teaching and Learning on Learner Performance in the Subject

To explore possible implications of the observed Chemistry mean grades regarding teachers' perceptions of ICT integration, an analysis was performed to determine the frequency teachers of Chemistry in the study schools claim to integrate ICT software in teaching and learning. The status of frequency of use was rated as used on a five-point scale and then compared against the performance of their students. The summary of teachers' responses on the extent of use of specific software in teaching and learning Chemistry was presented in table 3.

	Frequency of Use						
Software	5	4	3	2	1	Mean	SD
Internet	19	3	0	1	16	3.21	1.94
E-library	9	0	0	1	29	1.05	1.70
Video shows	8	8	2	10	11	2.79	1.56
Content-rich software	12	3	6	4	14	2.87	1.70
Content-free software	15	6	2	2	14	3.15	1.80
CD-ROM topical revision	15	3	2	4	15	2.97	1.83
Websites	12	4	2	4	17	2.74	1.79
CD-ROM Encyclopedia	12	0	2	4	21	2.44	1.80
Microsoft Excel	20	5	0	7	7	3.62	1.66
Microsoft Office	21	8	0	4	5	3.95	1.49
Learning systems	11	6	2	3	17	2.74	1.77
Training software	12	3	1	2	21	2.56	1.85
Audio-shows	11	0	9	4	15	2.69	1.66
Simulated videos	8	6	8	4	13	2.79	1.56
Animated videos	9	5	7	4	13	2.82	1.61
Topical videos	9	4	6	5	13	2.76	1.62
Computer skills	11	5	9	7	7	3.15	1.48
Interactive learning software	10	4	5	4	16	2.69	1.69
General revision	12	8	3	4	12	3.10	1.68

Table 3: Chemistry Teachers' Perceptions on Frequency of Use of Software in Teaching and Learning Chemistry (N=39)
**Key: 5-Daily Use, 4-Weekly Use, 3- Monthly Use, 2-Termly Use, 1-Never*

The instrument used in collecting data for this table was the teachers' questionnaire section dealing with the frequency of use of the software. Table 3 illustrates the frequency that Chemistry teachers indicated integrating a variety of ICT software in their classrooms during teaching and learning. At a glance, it was possible to state that the teachers' frequency of use of a variety of ICT was generally low because the teachers who responded to integrate ICT on a daily and weekly basis were less than 50% on the majority of the items presented to them. Examining the individual items for integration, Internet, E-library, and websites as a resource from the Internet was never integrated by 41.03%, 74.35%, and 43.58% or an average of 52.99% of the teachers, respectively. The means for frequency of use of these software were 3.21,

1.05, and 2.74, respectively, or an average of 2.33 with a standard deviation of less than 2, indicating average use of the Internet for integration was on a termly basis or not at all.

Video shows, content-rich software, content-free software, CD-ROM topical revision, general revision, and CD-ROM encyclopedia were never integrated by 28.2%, 35.9%, 35.9%, 38.5%, 30.8%, and 53.9% of the teachers respectively or an average of 37.2. The average mean for frequency of use of these software was 2.88 with a standard deviation of less than 2, indicating an almost perfect agreement on average use on a monthly basis. The findings indicate that general revision software was the most popular revision software among teachers in the study schools.

Microsoft Excel and Microsoft Office were the most frequently utilized software for integration by 51.28% and 53.81% of teachers on a daily basis. The mean frequency of use of these software was 3.62 and 3.95, respectively, indicating an average use on a weekly basis. Learning systems and training software enable learners to perform peer teaching. However, they were never at all utilized for integration by 43.59% and 53.85% of teachers in the study schools, respectively. The mean frequency of use of these software was 2.74 and 2.56, respectively, with a standard deviation of less than 2, indicating a perfect agreement on average monthly use.

Audio shows, simulated and animated videos, and topical video revision software were never utilized for integration by 38.46%, 33.33%, and 33.33% of teachers, respectively. The mean frequencies of integration of these software, as claimed by Chemistry teachers, were 2.69, 2.82, and 2.76, respectively, with a standard deviation of less than 2, indicating an agreement on average use on a monthly basis.

Software that teaches computer skills was never utilized for integration by 17.95% of teachers in the study schools. The mean frequency of use of this software was 3.15, indicating that averagely this software was integrated on a monthly basis, with a Standard Deviation of 1.48. It appears to have been the most used software to varying extents by teachers, most probably used to practice computer skills. Interactive learning software was never integrated on a daily basis by 41.03% of the teachers in their Chemistry lessons. The mean frequency of use of this software was 2.69, indicating an average monthly use with a Standard Deviation of 1.48. This finding was deduced to indicate that ICT integration was still minimal, despite having revision materials on subject content in storage devices available in the public schools. This finding was deduced to indicate that ICT integration was still minimal, despite having revision materials on subject content in storage devices available in Kenyan public schools. The lack of uptake of ICT by Kenyan teachers in Kisumu County could be pegged to their lack of exposure to the global digital age. Research on the use of data logging, for example, in Physics and Chemistry (Mishra & Koehler, 2011), established the effectiveness of the theory and practice of data logging to enhance practical work in Chemistry.

4.4. Chemistry Teachers' Perceptions on Mean Integration of ICT Software and Performance

In order to have an index on the mean extent of pedagogical integration of ICT software by Chemistry teachers per school, the teachers' responses on the extent of use of ICT in each school were averaged and were compared with performance. It was essential to determine whether or not teachers' perceptions reflected their learners' performance. The mean usage of ICT for integration by teachers was computed from their responses on the extent of the use of ICT. Their responses were then analyzed for teachers in each school, ranked from the least use = 1 to the highest use = 5, and compared with specific school Chemistry mean grades. The results of this investigation are presented in table 4.

School	School Chemistry Mean Score	Teachers' Average ICT Usage
1	4.207	0.74
2	3.227	2.24
3	7.427	1.16
4	5.446	3.03
5	7.472	1.61
6	4.489	1.18
7	9.383	3.26
8	3.894	1.21
9	5.762	3.09
10	3.652	1.53
11	6.141	2.40
12	4.146	3.25
13	4.262	3.65
14	2.923	1.21
15	3.326	0.5
16	3.889	2.00
17	3.751	0.53
Average	4.845	2.00

Table 4: Teachers' Perceived Usage of ICT in Pedagogy per School and Chemistry Performance (N=17)
**Key: 5-Daily Use, 4-Weekly Use, 3-Monthly Use, 2-Termly Use, 1-Never*

The instrument used in collecting data for this table was the teachers' questionnaire section dealing with teachers' frequency of use of the software. Table 4 summarizes the relationship between teachers' mean proficiency in pedagogical ICT integration and performance in Chemistry per school. The teachers' mean ICT usage was calculated from the average

of Chemistry teachers' frequency of use of ICT per school. The schools' mean score in Chemistry was calculated from the performance per school as obtained from the observation checklist. Table 4 shows that teachers whose mean pedagogical integration of ICT is ranked below 0.5, rated as Never use ICT came from school number 15, whose mean grade was 3.326, while teachers whose mean pedagogical integration of ICT was between 0.53 to 1.21 also rated as Never used ICT came from schools number 17,1,3,6 and 14 whose scores were 3.751, 4.207, 7.472, 4.489 and 3.894 respectively. This implies that the frequency of use of ICT and performance does not reflect any relationship.

Teachers whose mean usage of pedagogical integration of ICT was between 1.53 and 2.40 rated as used ICT termly came from schools numbered 10, 5, 16, 2, and 11, whose mean grades were 3.652, 7.472, 3.889, 3.277, and 6.141, respectively. Teachers whose mean ICT integration was between 3.03 and 3.26 rated as used ICT monthly came from schools numbered 4, 9, 12, and 7, whose mean scores were 5.446, 5.762, 4.146, and 9.383, respectively. Teachers whose mean integration was 3.65 rated as used ICT Daily came from a school whose mean score was 4.262. The average ICT proficiency for the teachers in the study was 2.00, which indicated that, on average, the teachers in the study tended to integrate ICT in pedagogy on a termly basis.

The implication of this to the current study is that Kenyan teachers in Kisumu County are not interested in developing the communication skills of their learners. Therefore, there is no doubt that teachers should be at the center of success, if any, of the integration of ICT. The present researcher considers a teacher in the light of Mishra *et al.* (2006) in their framework for teacher knowledge and learning as an imparter of knowledge, designer and counselor, coordinator, participant, explicator, and assessor. As facilitators in learning, teachers' perceptions may affect the use of ICT directly and affect students' performance in science indirectly. Therefore, teachers must have positive perceptions of ICT proficiency and usage. The quality assurance officers' (SQASO) perceptions were sought on this. The SCQASO were, therefore, asked to give their perceptions on the extent ICT integration has influenced syllabus coverage, KCSE mean grade, and KCSE Chemistry mean grade in schools with computers.

The opinion of SCQASO on the influence of ICT on syllabus coverage, KCSE Chemistry, and school KCSE mean score was summarized. Thus, one expert was of the opinion that ICT had influenced syllabus coverage to a great extent as learners interacted with computers to extend learning sessions. He also opined that improvement had been noted in general mean score and Chemistry mean grades at KCSE in many schools. Another expert was of the opinion that ICT had influenced KCSE mean grades to some extent. One expert gave an opinion of average influence on all aspects of ICT. In contrast, another expert was of the opinion that ICT had made syllabus coverage easier and faster, and the mean grades in KCSE and Chemistry had improved positively.

On the other hand, another expert was of the opinion that there was a low embracement of ICT on syllabus coverage. The influence on KCSE mean grades was remarkable, but it was of the opinion that the influence on Chemistry mean grades was not yet as remarkable. Another expert on syllabus coverage believed that ICT enabled learners to cover more content and interact with new ideas online. In contrast, the influence on KCSE mean grades had shown improvement. However, it was of the opinion that there was still a problem with Chemistry in most schools, without clarifying what type of problem was being experienced by the schools.

These mixed reactions by the experts indicate that ICT integration influence was not yet universal in the county as each sub-county expert had their own independent opinion on the influence of ICT on the aspects of syllabus coverage, KCSE and Chemistry mean grade. Perhaps this is an indication of a lack of networking among the county personnel on the process of ICT integration. The introduction of departmental seminars and workshops at the county could serve to reduce the differences.

5. Implications

This finding adds to the literature surrounding teachers' perceptions of traditional versus technology-enhanced learning environments, suggesting that the stakeholders view technology as effective but do not engage in its effective uptake. This finding is in agreement with the views of Lindfores (2007), who investigated perceptions of European teachers on the use of ICT in teaching; and established that teachers have a perception that ICT use has to be combined with traditional classroom-based teaching from the pedagogical point of view, and the impact of ICT in education greatly depends on how it is used. This finding agrees with the views of Sagra and Gonzales (2017), who acknowledge the role of ICT in promoting learner attention and improving perception skills. However, they observed that teachers have not yet discovered or understood the possibilities that ICT offers students as a means of complementing their traditional receiver role with that of message producer-transmitter, a view also held by Cuban *et al.* (2001), Drent and Melisen (2008). The current study agrees with the view that teachers have not embraced ICT integration but only regard it as effective in improving learner performance from their perceptions but not from their practice.

Generally, from the findings, it can be assumed that performance trends in the study schools do not reflect on ICT integration shown by teachers' perceptions of the frequency of use of ICT in teaching and learning Chemistry. Teachers who indicated integrating ICT daily and weekly are less than 50% in almost all aspects of integration in pedagogy that was presented to them. Microsoft word and Microsoft excel are the most frequently used software by over 50% of teachers than any other software available. This can be attributed to teachers using this software for examination evaluation tasks like compiling marks and creating worksheets instead of pedagogy.

Secondly, teachers' frequency of use of ICT software did not reflect their perceptions of performance, meaning that integration of ICT in teaching and learning Chemistry is not practiced in secondary schools in Kisumu County. Hence, it has no effect on performance. Ministry of education, through quality assurance and standards officers (SCQASO), perceived that ICT integration in teaching specific subjects like Chemistry in Kenya was not yet a universal practice. As a resource for

teaching and learning, there is expected to be an improvement in performance. This perception is contrary to what Badeleh and Sheela (2011) inferred that, generally, to study Chemistry, ICT was more useful than the laboratory training model of teaching.

6. Conclusion

This study investigated the impact of pedagogical integration of ICT on Chemistry performance in secondary schools in Kisumu County, Kenya. The conclusion made is based on the findings of the study in an attempt to find answers to the research question.

The findings reveal that ICT integration in teaching and learning Chemistry is not practiced to any significant extent in Kisumu County to have an impact on the performance of the subject. Chemistry teachers should therefore be encouraged to adopt ICT as a modern teaching method in curriculum delivery.

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Appendix

Appendix K: Information for Consent to Participate by Respondents

You are hereby informed of a research titled: ICT Preparedness, Integration in Education and Stakeholders Perspectives on Chemistry Performance among Public Secondary Schools in Kisumu County, Kenya. That is to be conducted at your institution. The purpose of this research is to investigate ICT preparedness, integration in education, and stakeholders' perceptions of student performance in Chemistry. You have been identified as a participant in this important social research program. The information given by you will be used to determine the relevance of the structure of ICT integration. The information may be used by curriculum developers in recommending an appropriate methodology for ICT integration in secondary schools. The following will help you understand the exercise:

- You will be expected to respond to questions in the questionnaires administered to you. Respond as honestly as possible and to the best of your knowledge.
- There are no known risks that will come from your participation. On the other hand, you will benefit by being a source of information for this important exercise.
- The identity of your institution and yours as an individual will remain anonymous, and any information given by you will be confidential.
- You are free to ask any questions on issues you do not understand, and we will respect your decision in case you decline to participate in the research.
- However, your full cooperation is expected once you have consented to participate in this exercise.
- In any case, if you later decide to withdraw from the research, your decision will still be respected. Consequentially, your institution will miss out on the contribution to this important exercise.
- Underage learners (aged below 18 years), otherwise referred to as minors, will be included in the research. However, their consent to participate will be sought from their teachers, who are expected to have their best interests at heart.

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This section should be completed by the respondent.

I have read and understood the contents of this information, and I voluntarily consent to participate in this research as frankly and honestly as possible.

Name_____signature_____Date_____