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DOES THE INTEGRATION OF ICT IN PHYSICS INSTRUCTION IN SECONDARY SCHOOLS PLAY THE MAGIC CARD?

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Abstract:
Physics is one of the subjects that have suffered low enrolment and performance in secondary schools. This enrolment and performance are pegged to the students' perception that Physics is difficult and uninteresting due to its abstract nature. Research has shown that integration of ICT in Physics instruction has the capability of simplifying the abstract content as well as creating interest in learners and consequently improving the quality of education. However, for this to be possible, Physics requires adequate operational ICT knowledge and resources. This study targeted 40 schools, 40 principals and 121 Physics teachers. The study was based on the Unified Theory of Acceptance and Use of Technology (UTAUT) model. Descriptive survey design was used. Random sampling technique was used to get a sample of 18 schools and 52 Physics teachers whereas purposive sampling was used to get 18 principals. Questionnaires, interview schedules and an observation schedule were used to collect data. Validity and reliability of the study instruments were established through consultation, triangulation and piloting. The data was analyzed using SPSS. The study found that integration of ICT in Physics instruction in secondary schools was still very low. The study recommends that more ICT resources should be provided to secondary schools; and requisite integration skills should be given to all Physics teachers.

Keywords: integration, ICT integration, instruction, classroom instruction, physics instruction, quality of instruction, resources, ICT resources

Background to the Study

Ofodu (2007) refers to Information and Communication Technology (ICT) as 'electronic or computerized devices, assisted by human and interactive materials that can be used for a wide range of teaching and learning as well as for personal use'. Oye, Iahad and Rahim (2011) define ICT as 'Processing and sharing of information using all kinds of electronic devices, an umbrella that includes all technologies for the manipulation and communication of information (p.2)'.This study utilized both definitions.

Information and Communication Technology (ICT) has increasingly become important in almost all sectors of modern life. Education being a powerful agent of change is at the forefront of embracing ICT. According to UNESCO (2007), ICT has the capability of widening education access and subsequently improving learning outcomes especially those of Physics that has been consistently low. Information and Communication Technology (ICT) is especially important to the Kenyan education system and it is hoped that ICT can be the launch pad of the country to achieve the MDGs and Vision 2030 that largely depends on Physics knowledge in terms of infrastructure and ICT.

Researches by Sutton (2006) and Bangert (2008) show that ICT can advance the learners' academic qualities through promoting higher order thinking, improved communication skills, problem-solving and deep understanding of the learning tool and taught concepts and retention. Another common reason for using ICTs in the classroom has been to prepare the current learners for the work environment where ICTs, in particular computers, the internet and related technologies are becoming very necessary (Tinio, 2002). The learners will later on compete in the global market for jobs and for general survival and they will be at a loss if at the end of their education, they are not able to understand and use ICT as well as be able to fit in the technological age. Therefore, for Kenya to be able to fit in the global market, and for her to produce quality graduates, it is mandatory that the education system embraces ICT and especially in Physics, whose principles are key in attainment of Vision 2030.

Apart from improving learners' interest in Physics and making abstract content easy to understand, ICT in form of video clips and animations is a good reinforcement as well as a substitute for laboratory apparatus that some schools may not be able to afford, hence enabling learners to see how they operate. It can also help the teacher bring in the classroom a 'field trip' in a far off country which is relevant to the study content yet would be impossible to go due to the cost that would be incurred. However, this is not possible minus the necessary ICT resources required to use ICT in classroom instruction. It is not yet known, whether ICT resources are available and adequate in

Nairobi County secondary schools to enable effective use of ICT in classroom instruction of Physics, hence the need for this study.

The MOEST has contributed positively towards use of ICT in classroom instruction. In 2010, the MOEST identified five schools in each of the former constituencies in Kenya and supplied them with ICT resources to jump-start the ICT integration project in Kenyan public secondary schools; this was with understanding that ICT is key in the improvement of education. However, it was not clear whether the resources were adequate. The Kenya Institute of Curriculum Development (KICD) has digitized content as a way to have relevant teaching content for schools. This content was designed in such a way that it can be delivered using ordinary computer systems, web-based for online access both locally and globally, mobile phones and other mobile technology devices, therefore significantly transforming the way teaching and learning should be conducted (Omuya, 2012). Strengthening of Mathematics and Science in Secondary Education (SMASSE) programme have adopted to use of ICT in classroom instruction, however, this cannot be possible unless the school has adequate ICT resources to facilitate use of ICT in classroom instruction to promote learner-centered method of learning. Therefore, to succeed in improving the status of Physics, teachers need to change modes of teaching Physics from the traditional teacher-centered to learner-centered by adapting new learning cultures of using ICT in classroom teaching, which is proven to improve quality of education (Nallaya, 2010). However, this is only possible with availability of adequate resources.

Objective of the Study

Assess adequacy of ICT resources available to Physics teachers for effective ICT integration in classroom instruction that will translate into sustainable development in the job market.

Review of Related Literature

The word ICT resources in this study refer to ICT tools in the school necessary for Physics teachers to use in integrating ICT in their classroom instruction (Teo, *et al*., 2007). According to Bandele (2006), Bryers (2004), and Ofodu (2007), ICT facilities/ equipment include desktop computers, LANs, laptops, printers, radio, television, overhead projectors, CD-ROM, internet, smart boards, video/ VCD machines, among others. According to Inveneo (2011), computers are the most commonly used form of

ICT in many developing countries and they are still very expensive, hence many schools cannot afford them.

Hennessy, *et al*., (2010), Groves and Zemel (2000) express the fact that the teachers' acceptance and use of ICT is highly dependent on availability of resources. If the resources are not available, the teachers will not be motivated to use ICT in classroom instruction, simply because there are no resources to use or the resources are not adequate for use in relation to student populations. On the other hand, the study by Teo, *et al*., (2007) found that the resources were not very important in influencing the teachers' attitudes towards adopting and using ICT. This could be because even with the availability of resources, the teachers can only use that which they are competent to use. Therefore, in such a case, availability of resources would not influence teachers' use of ICT.

This study therefore, sought to find out whether ICT resources that were supplied to the study schools by the MOEST were adequate and whether or not they had influence on the Physics teachers in Nairobi County to use ICT in classroom instruction and hence lead to sustainable development when the learners join the job market. Kumar, *et al*., (2008) add that the teachers avoid allocating time to ICT–assisted instruction if the quantities of resources are inadequate to meet the needs of their students or are not functioning well. The MOEST supplied ICT resources to five schools in each constituency in Nairobi County in 2010. However, it was not yet fully established if the resources supplied were adequate and whether they were in use by the Physics teachers, hence the need of this research.

According to the World Bank (2011), despite efforts by governments, NGOs, corporate organizations and individuals to donate computers to as many schools as possible, they are still not adequate. Therefore, there are a big number of schools unable to purchase computers for use by their teachers and students. Yet, teachers must have adequate access to functioning computers (and other ICT facilities like laptops, projectors, digital content, internet) and sufficient technical support. The schools that were involved in this study already had resources from the MOEST, a good step from the Kenyan government to kick start ICT in secondary schools. However, it was not clear whether the resources were adequate for use.

Further, a study by Kiptalam and Rodrigues (2010) observed that access to ICT facilities was a major challenge facing most African countries, with a ratio of one computer to 150 students per school against the ratio of 1:5 students per school in the developed countries. The situation is even worse in African Countries considering that not all schools have ICT resources, even in Kenya, not all schools have the resources. The ones that were given resources were only a fraction, five schools in each

constituency. An ideal student computer ratio would be 1:1, but due to the advantage of collaboration, 1:2 would be best whereby learners can share a computer and assist each other in the learning process.

According to Kumar, et.al (2008), to ensure teachers use ICT in the classrooms, the Malaysian Education Ministry gave support and assistance to the Mathematics, Science, and English language (MSE) teachers in the form of providing ICT facilities and financial incentives. Incentives motivate teachers to adopt innovations. The above studies did not focus on Physics teachers specifically. This study aimed at finding out if Physics teachers in Nairobi County had adequate resources and if they were given any incentives as a motivation to integrate ICT in classroom teaching and whether they were utilizing the resources supplied by MOEST.

In a study by Wanjala, Khaemba and Mukwa (2011) in Bungoma County, Kenya teachers reported that the computers were not enough and had no access to software. This made them not to use ICT in classroom instruction; however, a study by Kiptalam and Rodrigues (2010) across Kenya found that a large number of teachers from the sampled schools had access to ICT resources and especially computers and internet both at school and at home. However, just a few had accessed relevant content on the web. Hence still, there was little use of ICT in classroom instruction. Since these studies were not done in Nairobi County, nor were they on Physics teachers, this study sought to find out the situation in Nairobi County's Physics teachers, Kenya.

A study by Kirimi (2012) in Kangema Murang'a County found that majority of schools had some ICT resources like computers, however, they had less than five computers, most of which were used for other purposes like clerical work other than classroom teaching. Only a few teachers were able to access the ICT resources on a daily basis. This shows that the majority of the ICT resources were used for managerial purposes other than the required purpose of classroom instruction to improve quality and student performance. Majority of the teachers reported that inadequate number of computers hindered them from using ICT in classroom teaching. Similarly, in Mwingirwa's (2012) study in Tigania East, majority of the schools had computers, but some were for general use.

Theoretical Framework

The study was guided by Unified Theory of Acceptance and Use of Technology (UTAUT) model. The model explains user acceptance (behavioral intention) i.e. an attitude leading to the teacher wanting to use technology. It also explains usage of technology (usage behavior) i.e. actual usage. The two are dependent on four factors,

namely: performance expectancy, effort expectancy, social influence, and facilitating conditions (Khan and Iyer, 2009; Wade and Schneberger, 2005; Anderson and Schwager, 2004; Igor, 2005). It was from these four independent variables that the researcher modified and came up with the variable of adequacy of ICT resources falling under the facilitating conditions variable for this study. From the UTAUT model, adequacy of ICT resources influence use of ICT by the teachers.

Research Design

Descriptive survey design was used for this study because the study required original data from Physics teachers and principals as regards adequacy of ICT resources supplied to the schools by the MOEST and those that may have been acquired through other means. The information gathered from Physics teachers and principals, was used to describe, analyze and interpret adequacy of ICT resources, hence descriptive survey design was appropriate.

According to Creswell, (2009) descriptive survey design provides quantitative description of the state of the parameters of study, in this case, it provided quantitative description of the state of ICT integration in classroom instruction by Physics teachers in Nairobi County as it is, by studying a sample of Physics teachers. This design was also affordable to the researcher since it enabled the researcher to collect data within a short period of two weeks as per the researchers' schedule.

The study was done in Nairobi County. The study targeted 40 schools, 40 principals and 121 teachers of physics. Random sampling technique was used to get a sample of 18 schools and 52 Physics teachers whereas purposive sampling was used to get 18 principals. Questionnaires, interview schedules and an observation schedule were used to collect data. Validity and reliability of the study instruments were established through consultation, triangulation and piloting. The quantitative data was analyzed using descriptive statistics generated from SPSS version 21. The interpreted data was discussed, inferences were made and the report written.

Findings

Reponses by Physics teachers as regards availability and adequacy of resources for ICT classroom integration are as shown in Figure 4.14.

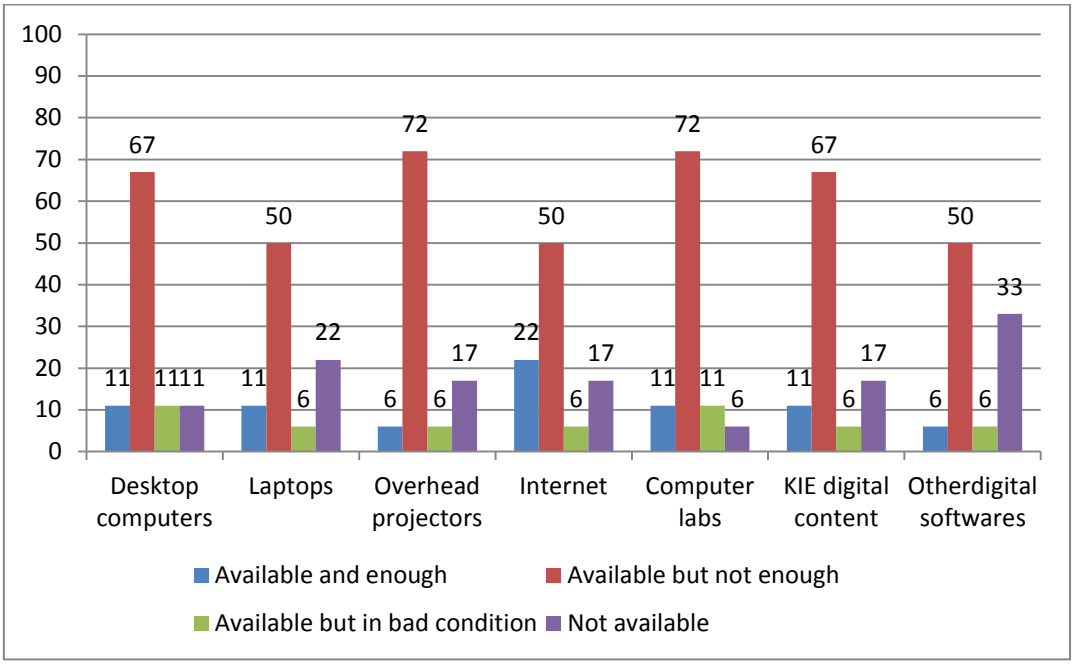

Figure 4.14: Availability and adequacy of ICT resources for ICT integration

From Figure 4.14, it is notable that ICT resources were available (since the sampled schools had been supplied ICT resources by MOEST). However, it is also noted that these resources were not enough as reported by the teachers and from observation. This is in regard to the ratio of teachers and students in the schools. Regarding desktop computers, 67% of Physics teachers indicated that they were available but not enough, 11% were available but in bad condition, 11% others indicated that they did not have any desktop computers. Only 11% of Physics teachers indicated that they had enough desktops for their use. When resources are inadequate, the likelihood of teachers using ICT in instruction is very minimal.

On average, most schools had 10 desktop computers, in an average class of 55 learners, it means 5 learners per computer which is a crowd hence, there may not be effective learning. The space per desktop computer was also small such that it could not accommodate 5 chairs for the 5 learners at ago, hence making it difficult for teachers to use the desktop computers in classroom instruction. This scenario means that for a one streamed school 220 learners and 440 learners for a double-streamed school will be scrambling for the same resources at a ratio of 1:22 and 1: 44 respectively as a result the rate of wear and tear becomes high. This also means for students to access the computer laboratory a specific timetable has to be followed, meaning no one subject can use the resources consistently.

Observation confirmed that scenario as shown in photograph 4.1.

Photograph 4.1: A Photograph showing a computer lab

In most schools, since the computer labs could not handle large groups of learners, due to limited number of computers, only the students who were taking Computer Studies as an optional subject were allowed into the computer labs to do their projects. These results are in tandem with those of a study by Kirimi (2012) in Kangema and Migwi's (2009) who found that majority of schools had computers but they were inadequate for efficient teaching by the teachers. The desktop computers would be instrumental in simulations, which are activity based, where the learners do activities and see the results but if the learners cannot access the desktops, then it is difficult to use such simulations, which are key in student-centered approach, simplifying abstract content and at the same time creating interest in the learners of Physics.

On the other hand, on observation, some computer labs in some schools had been vandalized as shown in Photograph 4.2.

Photograph 4.2: A photograph showing a vandalized computer lab

All the other ICT resources (desktop computers, internet connection, projectors, laptops and digital content) had been stolen. In such schools (11%), there was totally no use of ICT. Vandalism had adversely affected the concerned schools since they would be required to start the programme afresh meaning extra cost. This is because they would be required to replace the resources, most probably using funds in the schools which might be a big challenge. With such a trend, it becomes unlikely for the teachers to use ICT in instruction because the number of desktops is not enough for the big class sizes in public secondary schools as a result of free day secondary education.

The desktop computers require relevant digital content, as indicated in Figure 4.14, majority (67%) of Physics teachers did not have adequate digital content, 17% others did not have digital content at all, and only 6% of the teachers indicated that they had enough of the digital content. This shows that even if the schools had enough desktop computers, they would still face the challenge of digital content. The digital content can be obtained from KICD, private suppliers or by downloading from the internet, which would require a teacher to be competent to know how to get the right content as well as have extra time to search for the content on the internet. However, 50% of the teachers indicated that they did not have reliable internet access (bundles), 22% indicated that they had good access to internet, 17% did not have internet access at all while 6% had access though in bad condition, meaning unusable. This makes it more difficult for the teachers to source for the digital content on the internet as well as collaborate with other teachers through emails.

As indicated on Figure 4.14, 72% of the teachers did not have enough overhead projectors, 17% did not have any projector at all. However, 6% of Physics teachers had enough overhead projectors. On the other hand, 50% did not have adequate laptops, 22% did not have laptops at all, only 11% had enough laptops while 6% had laptops but in bad condition. When a school has just one projector and one laptop as was the case of many schools (67%), or has but broken down as reported by 11% or worse vandalized as reported by another 11% , then it means no teacher can use ICT consistently. This is because all the teachers in the school have equal rights to that limited resource. In the case of Physics where the teacher requires to use animations, videos and simulations frequently to explain the abstract concepts, to make them simpler as well as create interest in the learners, it becomes impossible.

This is because the Physics teacher will be required to book the laptop and/or projector because another teacher of another subject may also require it at the same time, this inconsistency in accessing the resources when required, may discourage the teacher from using ICT often. This trend of inadequate resources was prevalent despite the fact that the sampled schools were among the schools that were supplied with

resources by MOEST under the ESP programme. This shows that the resources supplied by MOEST were not adequate.

Sixty nine percent (69%) of the principals interviewed indicated that their schools were well equipped with ICT resources. This was despite the fact that on observation, the resources were few compared to number of the learners at an average computer to student ratio of 1:5, per class, 1:22 in a one-streamed school and 1:44 in a double-streamed school. However, 31% of the principals agreed that the resources were not enough for classroom instruction. The schools were beneficiaries of the ESP programme, yet it was so evident that the resources were not adequate for effective integration for just one subject (Physics) meaning the other subjects were equally affected. It shows that the programme was not yet successful and hence more needed to be done for effective integration of ICT in classroom instruction.

The 11% of the teachers, who indicated that they had enough resources, were from schools that had received some resources from other sources like support from BOM, NGOs and other well-wishers. However, it still seemed not sufficient since out of 56% principals that had received resources from elsewhere, only 11% of their teachers were satisfied with the available resources and still the average computer to student ratio was 1:4 per class session, 1:15 in a single streamed school and 1:29 in a double-streamed school. This was so because the highest number of computers in the computer lab was 15 computers, some of the computers were being used for other purposes in the offices.

This is a clear indication that there still exists a deficiency in ICT resources and that there was disparity in terms of management of ICT resources because all the schools were funded equally, yet disparity was noted in terms of the resources available. However, this finding was an improvement of a study by Kiptalam and Rodrigues (2010) who observed that access to ICT facilities was a major challenge facing most African countries, with a computer to student ratio of 1:150 per school. This was against a ration of 1:15 per school in the developed countries, which has improved with time to 1:5 per school.

According to the World Bank (2011), despite efforts by corporate organizations, governments, NGOs and individuals to offer computers to as many schools as possible, they were still not adequate. This is despite the fact that teachers must have access to adequate functioning computers (and other ICT facilities) and sufficient technical support to be able to implement ICT integration in classroom instruction. Farrell (2007) argues that despite the ICT policy in Kenya, few schools have satisfactory ICT resources.

Figure 4.16 shows the teachers' responses on the frequency of use of the available ICT resources in classroom instruction of Physics.

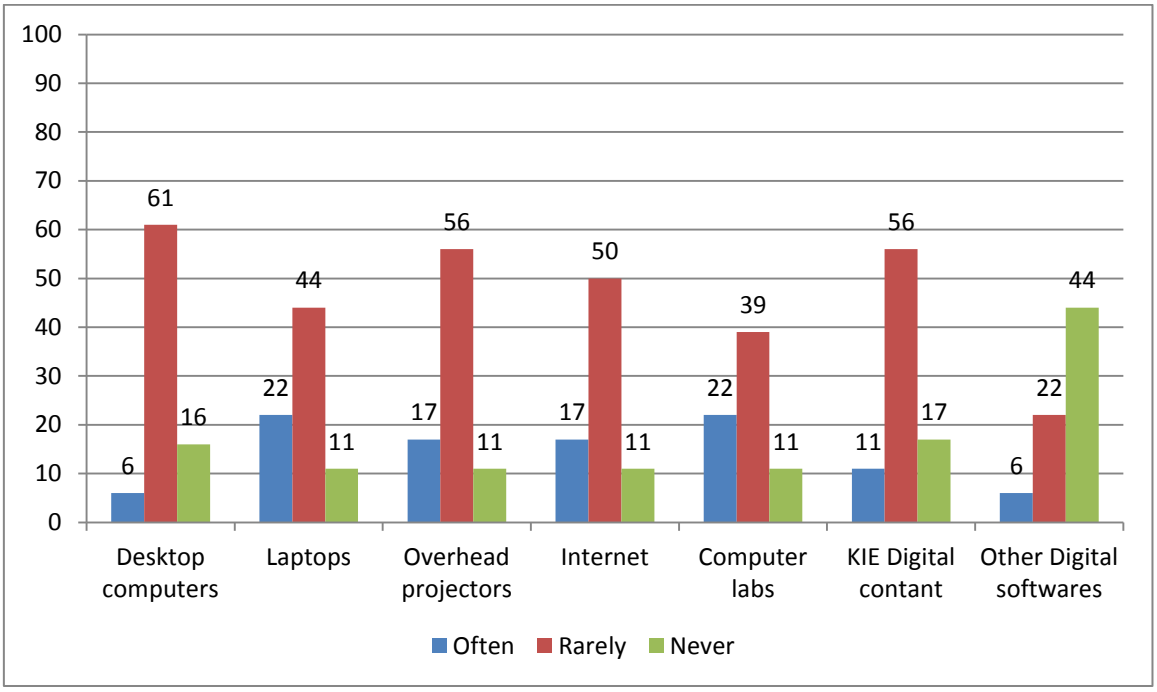

Figure 4.16: Frequency of use of ICT resources by Physics teachers

Most of the resources were rarely used in classroom instruction of Physics. For example, 61% of the teachers rarely used desktop computers, 16% never used them at all and only 6% of the teachers used the desktop computers often. Overhead projectors were rarely used by 56% of the teachers. Only 17% of the teachers used the overhead projectors often while another 11% of them never used the projectors at all. Laptops were rarely used by 44% while 22% of Physics teachers often used them. On the other hand, 11% of the teachers never used laptops at all.

Digital content by KIE was never used by 56% of the teachers of Physics other digital softwares were never used by 56% of the teachers of Physics. Fifty (50%) percent of the teachers rarely used the Internet whereas only 17% of the teachers often used internet to get relevant content for classroom instruction for example video clips and animations. However, 11% of Physics teachers never used internet to get material for classroom teaching. Majority of the teachers never or rarely used radios, TVs and cameras. Generally, from the findings, Physics teachers rarely used ICT resources in classroom instruction.

The findings on frequency of use of ICT in classroom instruction are in agreement with the findings of Migwi (2009), in whose study the use of computers for classroom instruction was as low as 9%. Kirimi (2012) found that only 35% of the teachers were able to access the ICT resources on a daily basis. Majority of the teachers

alleged that inadequate number of computers hindered them from using ICT in classroom teaching. In Mwingirwa's (2012) study, 67% of the schools had computers, but 26% used them for general purposes and not for classroom instruction. Wambeti (2009) found that 25% of the teachers did not use computers at all, 36% did not use Internet and 37% did not use softwares at all.

Most of the teachers used ICT once in a while when they got relevant content from the internet, especially on You Tube. The few teachers (17%) who indicated that they always used the projector, had ICT supported lessons by use of video clips, simulations and animations to explain abstract content, since the desktop computers were few the teachers were using personal laptops and the school projector to project animations and videos on the walls for the learners. It was evident the learners were enthusiastic and liked it when the teacher used ICT than the traditional chalk and board. However, this was only possible because the teachers were using personal laptops and acquired digital content from the internet and from collaborating with other teachers. Despite having own arrangement for laptop and digital content, the teachers faced challenges when other teachers required to use the one projector in the school.

The low use of ICT by the teachers can be explained by the fact that the resources are inadequate as reported by the teachers as well as observed. Kumar, *et al*., (2008) and Hennessy, *et al*., (2010) in their respective studies concluded that teachers falter to use ICT if resources are inadequate to meet the learners' needs or if they are dysfunctional. However, the findings in this study are in contrast with those of studies by Teo, Lee and Chai (2007) and Kiptalam and Rodrigues (2010) who found out that resources were not very important in influencing the teachers' attitudes towards accepting and using ICT. In this study, resources were a great influence because majority of the teachers reported that the resources were limited and when it came to use, about the same percentage of teachers reported they rarely used those resources. On the other hand, the percentage of teachers who reported that ICT resources were enough, correlated with the percentage of teachers who reported that they used the resources often or always.

Conclusion

Most schools had inadequate ICT resources like desktop computers, overhead projectors, digital content and laptops and thus the resources were not sufficient for use by the physics teachers in their classroom instruction. There is a correlation between adequacy of resources and actual usage, since the resources were not adequate; most teachers either rarely used them or never used them at all in classroom instruction and

hence, there was very low use of ICT in classroom instruction. Therefore, ICT integration in classroom instruction is yet to play the Magic Card due to inadequate resources.

Recommendations

1. The school management, with the assistance of the Ministry of Education and other stakeholders should adequately equip schools with ICT resources such as computers, laptops, projectors, digital content and internet. The resources should be adequate in relation to the school population to facilitate effective ICT integration in classroom instruction.
2. The resources should be insured so that in case of vandalism, they can easily be replaced to ensure uninterrupted use of ICT in classroom instruction.

Recommendations for Further Research

1. A similar study should be done on Physics teachers' integration of ICT in other counties in Kenya.
2. A longitudinal research should be conducted on Physics teachers on the use of ICT in Nairobi after a period of five years.

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