

Teachers' Use and Integration of ICT in the Teaching of Life Science: A Case of Two Urban High Schools in Namibia

***Wilhelmina Etuna Simon¹ and Elizabeth Ndeukumwa Ngololo²**

Office of the Dean of Students¹, University of Namibia

Continuing Professional Development Unit², University of Namibia

**Corresponding author: esimon@unam.na*

ABSTRACT

Many developing countries recognised the importance of Information and Communication Technology (ICT) in education for teaching and learning. In Namibia, ICT use and integration in the classrooms remains limited. This study has sought to investigate how Life Science teachers with access to technologies use and integrate ICT into their classroom through collaborative and creative teaching. The study was designed as a qualitative research using a multiple case study approach. The study was guided by activity theory as a theoretical framework. Two Life Science teachers were observed and semi-structured interview were conducted. The findings of the study revealed that Life Science teachers demonstrated use of ICT in their classrooms through smart boards connected to e-Learning Management Systems and collaborated with each other by sharing notes but did not co-teach nor developed their own teaching materials. The study recommends that teachers be provided with the necessary tools and be trained to develop teaching materials, and to co-teach for purposes of enhancing collaborative teaching.

Key words: *Life Science teachers, ICT use and integration, professional development, creative teaching*

1. INTRODUCTION AND PURPOSE

Many developing countries (e.g., South Africa, Kenya, Ghana, and Nigeria) have adopted ICT in the belief that it adds value to both teaching and learning science in the classrooms (Draper, 2010; Hennessy, Harrison & Wamakote, 2010). Studies related to application of ICTs in the teaching and learning process in high schools have been conducted in urban areas in some developing countries (Adomi & Kpangban, 2010; Ndawi, Thomas & Nyaruwata, 2013). These studies indicated that science teachers intergrated ICT in their lessons (Draper, 2010; Agyei & Voogt, 2011). This implies that some urban schools in developing countries are equipped with ICT resources.

The teaching of science with ICT in Namibia has been a challenge (MoE, 2005a). The MoE has made enormous investments in enhancing ICT practices through the Education and Training Sector Improvement Programme (ETSIP), aiming at improving the quality of

education in Namibia (MoE, 2005b). The ICT for Education Implementation Plan is a component of ETSIP aimed at improving teachers ICT skills and use in classrooms (MoE, 2006). Teachers were trained in both ICT skills and integration between the years 2007-2011 (MoE, 2012). lipinge (2010) found that lecturers at the Teacher Training Colleges are not trained in ICT and therefore lacked the necessary expertise to train the teacher trainees. Upon graduation teachers were absorbed in schools without the necessary relevant skills to use and integrate ICT in teaching. To aggravate the situation, Ngololo, Howie and Plomp (2012) found that each secondary school with electricity was supplied with 20 computers and other necessary ICT equipment. However, ICT use in rural-based science classrooms was rudimentary. A few teachers were found to implement ICT in their science classrooms without having undergone professional training and having advanced and or necessary equipment. The study also found that rural schools had more serious needs like lack of water and toilet facilities and therefore regarded ICT as secondary (Ngololo, 2010). Nevertheless, the few teachers had basic ICT tools for teaching basic concepts in science, assessment and administrative purposes. Like in South Africa, teachers were found to use ICT in the science classrooms for simulation, data logging and in the use of understanding the science concepts (Draper, 2010).

In Namibia, little is known about how teachers use ICT to teach subject content, especially Life Science. In this regard, teachers are expected to enhance teaching instead of using ICT as a literacy course. However, it was reported that teachers in other regions were not integrating ICT into their teaching (Katulo, 2009; Ngololo, 2010; Matengu, 2011). This study seeks to investigate Life Science teachers' use of ICT in the teaching of Life Science in urban high schools in Namibia. The study therefore asks the following question: *1) How do Life Science teachers use and integrate ICT in their classrooms through collaborative and creative teaching?*

2. LITERATURE REVIEW

The literature review focuses on the use and integration of ICT in science classroom and on collaborative and creative teaching. ICT use is necessary to achieve ICT integration. It should be noted that 'ICT integration' was used in the ICT Policy for Education in Namibia to mean 'ICT use' and therefore in this paper 'ICT use' will be used interchangeably with 'ICT integration' (Draper, 2010; Ertmer, et al., 2012) ICT integration is achieved by positioning ICT at the centre of the unit making it the context rather than the content for learning, "combine components, parts or elements into a complex but harmonious whole" (Lloyd, 2005, p. 6).

2.1 ICT use and integration in Science classroom

Draper, (2010), found that South African science teachers were able to use ICT effectively to add value to teaching and learning. South African teachers were reported to using ICT in their classrooms in many different ways namely, 1) for simulations, 2) data loggers



during practical work, 3) for conceptual understanding of science and 4) for student motivation in science. Teachers were observed utilising ICT tools such as Interactive whiteboard with presentation software for lesson presentation. Simulation software used during practical investigation for understanding science concepts such as chemical reactions and friction. In her findings, Draper (2010) suggested for ICT to be gradually introduced into schools and into teaching and learning activities.

In another study, Hennessy, et al., (2010) noted that when conceptualised as a tool in the teachers' classroom practices ICT supports a real change in the pedagogical approach. Hennessy et al., (2010) conducted a synthesis of the research literature on teachers' use of ICT in secondary schools in the sub-Saharan Africa, with a particular emphasis on improving the quality of subject teaching and learning. They added that, the change can impact on assessment tasks, with new learning environments moving away from summative methods of assessment. The findings from the reviewed literature indicated several successful programmes for teacher education in ICT use. Further, they suggested that the teachers can be encouraged to share resources with others, locate good practices on the web and adapt these to their local circumstances (Hennessy et al., 2010, p. 45). They concluded that, there is a need for teachers to integrate ICT into subject teaching and learning using contemporary pedagogical approaches. They further recommend for teachers assistance to work collaboratively over time with peers, and to learn from one another's innovations and experiences (Hennessy et al., 2010, p. 49).

Furthermore, a study by Ndawi et al., (2013) in Harare based secondary schools revealed that ICT integration in education was still a new pedagogy and that schools were at different stages of the adoption. The results indicated that on the one hand, government schools had shortage of infrastructures required for ICT use in the classroom. On the other hand, private schools were ahead in using ICT because they had adequate support and encouragement from their respective management. Also, teachers had a clear sense of direction on how to use ICT to enhance the learning of students (Ndawi et al., 2013). Further, the results show a general appreciation of the benefits associated with ICT use although the majority of teachers lacked the necessary skills. A number of tools such as databases and curriculum management software had not been used and no Professional Development courses were conducted to train teachers on the available resources.

In recent years, a number of studies pertaining to ICT use and integration by teachers have been conducted in different contexts in Namibia. Isaacs (2007) noted that Namibian secondary schools were equipped with computers and internet connection. Computers were utilised by teachers for lesson preparation and presentation. The internet was used as a tool for searching content information related to teaching and learning (Isaacs, 2007). However, ICT use in schools is low and thus the integration. Matengu (2006) stressed on teachers integration of ICT in the subjects they teach. The results on ICT integration at schools indicated that teachers lacked training on how to use and integrate ICT (Matengu, 2006) in the classroom. This information will be useful to establish if the teachers are integrating ICT in the Life Science classroom.

2.2 Collaborative and Creative teaching

Recent international studies have shown the importance of collaborative teaching practices in improving classroom instruction (e.g., Davies, Jindal-Snape, Collier, Digby, Hay & Howe, 2013; Chu, Tse & Chow, 2011; Pinheiro & Simões, 2012; Reilly, Lilly, Bramwell & Kronish, 2011). These studies have documented that teachers can enhance their teaching practices through creative teaching (Chu et al., 2011) to promote student learning (Davies et al., 2013). The implementation of active and collaborative practices in ICT classrooms promotes deeper learning and reasoning skills at a higher level (Pinheiro and Simões, 2012).

Pinheiro and Simões (2012) conducted a study in Portugal on Constructing Knowledge: An Experience of Active and Collaborative Learning in ICT Classrooms. The study described specific environment that makes use of collaborative tools such as wikis and forums within an e-learning platforms. The results collected through a simple questionnaire via the University's e-learning platform, indicated that online discussion forums are an increasingly common use of new ICT in education. The findings also suggested that teachers should incorporate ICT in teaching and learning to promote active and collaborative practices.

Davies et al. (2013) conducted a systematic review of 210 pieces of educational research, policy and professional literature relating to creative environment for learning in schools, commissioned by Learning and Teaching Scotland. Of the reviewed papers were 34 case studies involving the collection of qualitative data such as interviews, classroom observations and teachers' reflective journals. The systematic review found evidence in the literature to identify:

- key characteristics of the environment and conditions that are most effective in promoting creative skills
- impact of creative school learning environments on the educational development
- specific roles of teachers which promote creative skills development
- ways in which teachers can best be supported to develop the skills and confidence to facilitate creative learning environments (Davies et al., 2013, p. 84)

The results of the systematic review indicated that there is evidence that suggests an impact of creative learning environments on learners' academic achievement; increased confidence and resilience; enhanced motivation and engagement; development of social, emotional and thinking skills (Davies et al., 2013). The evidence also suggested that teacher skills and attitudes; willingness to work as role model; awareness of learners needs; flexible approaches to curriculum and lesson structure; particular types of classroom engagement with pupils, together with the use of ICT and assessment, are important components for teaching with creativity. Furthermore, the evidence also highlights the importance of supporting creative practice of teachers to develop their own creativity and the importance of undertaking action research and reflection on their own practice (Davies et al., 2013, p. 88). The review by Davies et al. (2013) recommends Continuing Professional Development for teachers that elicits their preconceptions of



creativity; stimulates dialogue around models of creativity in teaching and learning; provides opportunities to develop their own creativity; and engages them in reflective professional enquiry into their own pedagogy.

Teachers' collaboration with colleagues in the same or different schools encourages resource sharing, co-teaching and creative lessons (Reilly, et al., 2011). It is vital for this study to adopt a theoretical framework that encompasses all the major issues raised in the literature review above. This paper presents the Activity theory adopted as a lens to interpret the use and integration of ICT in the Life Science classrooms.

3. THEORETICAL FRAMEWORK

The study adopted the activity theory as a lens to explore human activity in their natural environment (Murphy & Rodriguez-Manzanares, 2008), in this case Life Science teachers' use and integration of ICT, where their collaboration with other teachers might result in the transformation of activity (Karasavvidis, 2009). The theory addresses systems of activity at a collective level by presenting artifacts and people as embedded in dynamic activity systems (Engeström, 1993). In addition, applying activity theory to the educational practice can promote technological creativity and collaboration among teachers (Engeström, 1993). The activity system model has seven components: subject, object, tools, division of labour, community, rules, and outcome (Law & Sun, 2012, p. 480).

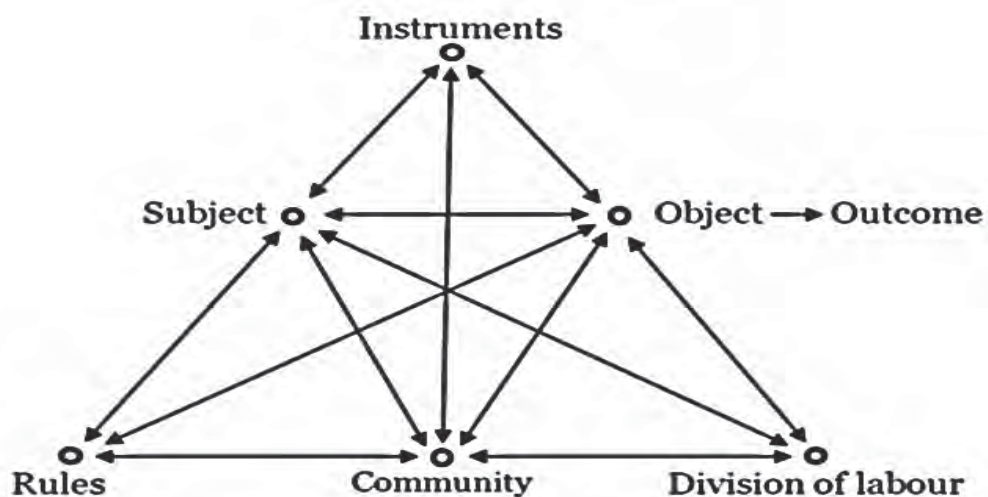


Figure 1. Shows the structure of a human activity system adopted from Engeström (1987)

Collaborative teaching refers to teachers working together on their planning and co-teaching using ICT (Chu, et al., 2011, p. 134). In this paper, the concept is understood as

teachers' engagement with colleagues to co-teach, develop interesting lessons and sharing teaching resources.

Creative teaching refers to teachers' engagement in everyday creativity with lesson planned and improvised to meet the varied needs and interests of learners through the use of various ICT tools (Reilly, et al., 2011, p. 533). In this paper, the concept is understood as teachers using existing and or developing interactive teaching materials to enhance ICT use.

Subject refers to the two Life Science teachers who participated in the study.

Object refers to an objective Life Science teachers had as a motive to use ICT in their lesson.

Tools refer to instruments such as ICT that Life Science teachers use in class and for lesson preparation.

Rules are instructions of engagement with ICT as set by Life Science teachers to manage the use of ICT in the classroom.

Community refers to Life Science classrooms at the respective schools, Schools A and B, where Life Science teachers share skills and experiences.

Division of labour refers to how tasks are divided among Life Science teachers in the school.

Outcome refers to Life Science teachers' seamless integration and use of ICT into the curriculum and classrooms.

The diagram illustrates that in the classroom, teachers (subject) have a motive (object) to use ICT mediating tools (instruments) with a common objective to achieve a desired learning outcome. Life Science Teachers interact with one another in a community of practice in order to enhance teaching and learning. Wenger, McDermott and Snyder (2002) offer an insight on communities of practice and their value to organizations. Within community of practice, Wenger et al., (2002:4) pointed to a need for teachers to collaborate on an on-going basis to typically share information, insights and advice. Life Science teachers and learners in the classroom have different responsibilities (Division of labour) and are guided by classroom rules to promote collaborative and creative teaching as an outcome.

4. METHODOLOGY

The researcher employed a qualitative research design. This paper was part of a larger study for Master of Education degree. In this study a multiple case study approach was used in order to explore how Life Science teachers use and integrate ICT in their classrooms. According to Yin (2009) a case study method can be used to understand a real-life phenomenon in depth in the Life Science classrooms. The purposive sampling procedure was informed by the list provided by the MoE of teachers who have been trained on ICT use and integration during the years 2007-2011. The researcher visited five secondary schools selected randomly from the list provided by the MoE and compiled a list of teachers observed using ICT in their classrooms. The identified teachers were



confirmed by the school principals. The researcher selected one Life Science teacher from three identified schools within the close proximity of the location of the researchers. A total of three Life Science teachers participated in this study. Of these three, two teachers participated in the main study.

Furthermore, the case study engaged two schools located in Windhoek. Both schools were technologically rich, that is, equipped with ICT, and had comparably similar characteristics in terms of their school management (guided by rules), curriculum, student background, and teacher qualifications. In School A, the class size was 15 learners. There were two computer laboratories with 26 computers in total, connected to the wireless internet and one was equipped with data projector, projector screen, smart board, printer, scanner and digital video camera. Additionally, an on-site technologist (computer technician) was available to resolve technical problems. The technician, who is also the IT manager, is the administrator of the school's network and is responsible for installing software and organising CPD for teachers. Some teachers at this school were trained and certified in ICT integration.

In addition, the Life Science teacher had a laptop in the classroom that was connected to the smart board and to a three-in-one printer/scanner/photocopier positioned in the administration block. The smart board in the Life Science classroom was used to display various biological diagrams, notes, class activities and question papers.

School B had a class size of 13 learners. It had a computer laboratory with 29 thin clients computers connected to the wireless internet and was equipped with data projector, projector screen, smart board, printer, scanner and digital video camera. The computer teacher who is the System Administrator was also available to connect teachers and learners' iPad to the wireless internet with an Active antivirus and firewall. The System Administrator was responsible for software installation on all the devices available in school for teachers and learners. EDU 2.0 e-Learning system was customized by the school's Administrator from <http://www.edu2.0.org>. Teachers were trained on ICT integration but no certificate awarded. The Life Science teacher used an iPad and a projector to display Biological drawings, notes, class activities on the whiteboard. With the wireless internet available in the classroom, the teacher post learners home work, projects and question papers on the school's website.

Data collection occurred during the second term of the 2013 school year (May to July). For this study, ten (10) Life Science ICT-mediated lessons were observed per teacher totalling twenty (20) lessons. Observations were documented in descriptive and reflective field notes. In addition, semi-structured interviews with Life Science teachers were conducted. Finally, thematic analysis was used to analyse the data. The ideas or concepts from the field notes and interviews were grouped into themes. In addition, referencing units of text were sorted, coded and labelled according to meanings and patterns. Also, emerging themes were recorded as expected themes.

5. LIMITATIONS OF THE STUDY

The study was limited to two selected Life Science teachers from schools in the Khomas region. Given that this small number is not statistically representative of all Namibian teachers, the results of the study cannot be generalized to the larger population of all secondary schools in Namibia. However, findings are limited to schools with teachers that use ICT for teaching and learning.

6. RESULTS

The results were obtained through two case studies, School A and School B respectively. Both the non-participatory observation of Life Science ICT mediated lessons and interviews with the respective teachers are presented below in line with the seven constructs in the Activity theory:

6.1 Subject and object

Teachers were asked to state the lesson objectives with respect to ICT use and integration. Teachers indicated the objectives for specific ICT mediated lessons as follows: *You want the learners to understand the syllabus; you want them to understand the work that they need to write the exams on. The objectives of using ICT in the classroom, is to make the work clear to the learners.* (Teacher A, 24 July 2013)

In the classroom, we make use of the internet and other devices in order to make the work understandable to the learners. (Teacher B, 29 July 2013)

This is interpreted to mean that, teachers understand the objectives for using ICT as a way to make their learners understand the syllabus. Also, different ICTs are used to illustrate examples of the different concepts and for assessment.

Teacher A further indicated that:

The objectives of using ICT teaching strategies could afford learners the opportunity to manage their own learning (Teacher A, 24 July 2013).

In addition, teacher B indicated:

Using a variety of assessment strategies that could also motivate learners to set their own goals and evaluate their own work. (Teacher B, 29 July 2013).

This means that using a variety of teaching strategies will expose the learners to different kinds of information resources and thereby possibly choose the one they are comfortable with and that which they can manage in terms of content. Also, learners are exposed to a variety of assessments including self-assessment modes that will give results instantly. This can help the learners identify the weak areas that they must improve.



6.2 Tools and Rules

Asked to identify tools used in the Life science classroom, the teachers indicated that they use hardware such as iPad, projector, scanner, smart board amongst others and Cyber room captive portal, e-Books, e-learning (EDU 2.0) amongst others as software.

Teacher B emphasised that:

The ICT tools have become the mediating tools in the classroom (Teacher B, 29 July 2013).

As observed, all teachers were provided and equipped with the necessary ICT tools such as iPads, laptops, and Smart Boards bought by the schools. In our opinion, the tools are regarded as mediating tools in the classroom because they serve as medium for interaction between the teacher, learners and the learning objectives. We observed that the teachers frequently used the smart board in every lesson observed.

Teacher B also testified to this by saying:

Because everything we do today runs through the different devices...I cannot imagine teaching without using the smart board. (Teacher B, 29 July 2013)

This is interpreted to mean that, teachers were comfortable using the tools in their lessons daily. Meaning that, they were motivated to use the tools and therefore used them in all the lessons observed.

When asked if the teachers have established rules with regard to ICT use in the classroom.

Teacher A indicated that:

The uses of earphones are strictly prohibited in the school (Teacher A, 24 July 2013).

Teacher B added that:

All submissions by the learners should be done online and closes at 00h00 midnights (Teacher B, 29 July 2013).

This is interpreted to mean that the teachers in this study had set classroom rules with regard to ICT use. Meaning that, with regard to the management of the tools as used in those schools, the researcher observed that there are clear classroom rules with regard to ICT use.

6.3 Community and Division of labour

When asked if the teachers have established a community of practice. Life Science teachers indicated belonging to a community of practice and they collaborate with each other. Teacher B stated that:

We share electronic question papers, assessment activities and lesson plans (Teacher B, 29 July 2013).

At the school level Teacher A indicated that:

Life Science teachers meet regularly during departmental meetings to outline the scheme of work based on the division of the syllabus; identify appropriate teaching and learning tools, exchange teaching strategies and latest software with regard to ICT; share notes, videos, worksheets, tests and question papers to ensure quality teaching of Life Science across the curriculum. (Teacher A, 24 July 2013)

According to Teacher B:

At the community level teachers from different schools come together to review question papers with regard to setting up and weighting of questions. [Teachers also] share and exchange lesson preparation files, resource files and teaching aids... in addition, the teachers also shared these online. (Teacher B, 29 July 2013)

This is interpreted to mean that educational resources were shared during teachers meeting indicating collaboration with colleagues regardless whether they are located in the same or different schools and abroad. However, there seems not to be clear evidence that teachers develop tools that may result in creative teaching. It appears as if teachers opt to share the ready-made tools which they have downloaded from the internet.

6.4 Outcome

It should be noted that the direct outcome of the Activity theory is collaborative and creative teaching. CPD in the participating schools has enhanced the process of achieving the outcome. In this light, CPD will be discussed in relation to the outcome.

The researchers observed frequent use of ICT in the classroom as teachers introduce lessons with a video that demonstrate the concept, such as blood circulation. The researchers observed that in the classrooms teachers use ICT to illustrate interactive diagrams. At School B, the teacher showed a video of the structure of the heart and how the blood circulates as well as digestion just to mention but a few. The Smart board has a software Application that enabled teachers to focus on details on specific diagrams. The use of ICT in an interactive lesson makes the work more understandable to the learners. In addition, teachers incorporated ICT in the Life Science classroom for simulation and modelling. For instance, with regard to the structure of the heart as projected on the smart board, learners could hear the heartbeats through the speakers connected to the smart board.

The teachers asked the learners questions on the topic by posting them on the portal and let the learners respond immediately or as homework. For effective use of ICT the teachers mentioned that they have undergone professional development and were trained on how to use and integrate ICT in their classrooms. Specifically, teachers were given training on the operational use of ICT as well as on how to incorporate the software application of hardware such as smart board and laptop in the teaching of Life Science.

Further, the schools have initiated professional development in ICT use as part of Continuing Professional Development (CPD) Programme. As an outcome of CPD, these teachers were able to use ICT in their classrooms to promote collaborative and creative teaching.

Teacher A emphasises:

I was able to give effective presentation and explanation to make my lessons creative (Teacher A, 24 July 2013).



Life Science teachers have demonstrated creative teaching. However, in our opinion the CPD need to focus more on material development in order to have teachers produce their own teaching material. The fact that teachers may not have seen the necessity to link ICT to the curriculum; this may result into disintegrated use of ICT. The introduction or extension of the CPD at school level has shown that teachers are being supported by the school management in the use of ICT to enhance learners' understanding of the different concepts in Life Science. To a certain extent, Life Science teachers feel motivated to use ICT as observed using ICT on a daily basis.

7. DISCUSSION

The teachers in this study were found to be using and integrating ICT in the Life Science lessons. Through observation, it was evident that the e-learning systems supported an online interaction between teachers and learners through educational forums such as debates, discussions, and dialogues on the school's website, indicating that ICT integration is done. Assessment was also done online. This is evidence of teachers work together to promote teaching that supports the use of ICT (Pineiro & Simões, 2012). It is however, noted that teachers make use of already existing material than developing their own content material. This trend was also noticed in Harare secondary schools (Ndawi, et al., 2013).

The Life science teachers in this study could not state the objectives for using ICT in the lessons. This could be due to the fact that they are not aware of the importance of linking ICT to the syllabus. It is important that the activity of the subject is directed towards the object or goal (Kaptelinin & Nardi, 2006). Thus, professional development courses in ICT should sensitise teachers of the importance to develop ICT related objectives that will speak to what they plan to teach using ICT in their lesson plans. This will enhance teachers' confidence and skills using ICTs.

Also, the teachers have set rules in the classrooms. In the activity system, there are on-going and reformulation of rules by the subject (Murphy & Rodriguez-Manzanares, 2008), rather than subject abiding by the fixed rules (Lim & Hang, 2003). Information about classroom rules with regard to ICT use is necessary to determine the tools and the rules developed by the Life Science teachers to achieve lesson objectives.

Life Science teachers belong to a community of practice and they collaborate with each other in the same school as well as abroad. The teachers' practices' within community of practice is in line with what Wenger et al. (2002) prescribe, to offer an insight on communities of practice and their value to organizations. Community of practice is useful in providing guidance towards teachers' collaboration to participate in formal and informal networks of teachers. However, there is no evidence that teachers co-teach within the same or other schools.

As an outcome of Continuing Professional Development, these teachers were able to use and integrate ICT in their classrooms to promote collaborative and creative teaching. The outcome of an activity can help participants to understand the system. In this case, the teachers are being supported to use ICT optimally and collaboratively in their classrooms. However, there is a need for them to state the objectives of using ICT in their lessons. Also, teachers have positioned ICT at the centre of the lessons thereby integrating activities through the different platforms.

8. CONCLUSION

Life Science teachers' demonstrated use of ICT in their classrooms through smart boards connected to e-Learning Management Systems. Teachers collaborated with each other by sharing notes but did not co-teach nor developed their own teaching material.

8.1 Recommendations

Established on the findings of this study, the researcher recommends the following: Teachers must continuously undergo CPD to update themselves with the new and necessary ICT tools and also update their skills. Also, teachers must be encouraged to develop their own tools as well as content materials. Teachers must be encouraged to develop lesson plans that reflect the motive of ICT use and integration. There is a need for Life Science teachers to establish a community of practice within which activities are clearly defined as well as the terms of reference. Teachers must be encouraged to up keep classroom rules and make the necessary changes with new technological development.

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