ENHANCING AND SUPPORTING SCIENCE EDUCATION WITH ICT

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ABSTRACT
Information and Communication Technology (ICT) has in recent years played vital roles in our society, by greatly improving the way things are done. In education, ICT has improved the quality of education as it has increased access to educational resources and enabled the provision of varied teaching methods and strategies. Online and distant learning is now possible as well as extended through ICT. Tools for sharing of resources and platforms for collaboration are some of the benefits of ICT in education. ICT provides the needed motivation, interactivity and student-centered environment, helping students to learn better. Using ICT enables feedback when assessments are given; there is also possibility of re-use and authentication of assessments. ICT has many benefits for the teacher, the student and assessment when incorporated into the educational system. The aim of this paper is to review available evidences on the use of ICT in education particularly, science education. The paper presents possible areas ICT is used in science education as well as the benefits derived from such usage. At the end, suggestions that will help in effectively using ICT in science education are made.

Keywords: Information, communication, technology, science, education, assessment

Introduction

The effect of technology is gradually being felt by almost every facet of the society as was predicted by many scholars in the past. Kumar and Kar (1995) observed the way in which Information Technology (IT) had extensively penetrated the lives of people and predicted that every individual in the world will be affected by it. In line with the above observation, several scholars suggested that Information and Communication Technology (ICT) will be an important part of education for the next generation (Bransford, Brown, & Cocking, 2000; Grimus, 2000; Yelland, 2001).The 21st century is now generally referred to as information age. In the age, globalization has become possible through Information and Communication Technology (Osuji, 2002).

Globalization refers to processes that increase world-wide exchanges of national and cultural resources. Scholars like Ossai-Ugbah (2011), Ukodie (2004); Brakel and Chisenga (2003) rightly maintain that ICT will be the driver of development in the 21st century and beyond. Since we are living at a time ICT is improving the way things used to be done, our schools can also tap from the benefits of the age and improve on the teaching and learning process.

The evolution and expansion of technological tools have become one of the more promising aspects of the changes and advances experienced by today's society, influencing very rapid changes in people's daily lives, particularly in those of younger generations (Colas-Bravo, Pablos-Pons & Ballesta Pagan, 2018). ICT refers to technologies that provide access to information through telecommunication (Ratheeswari, 2018). It is similar to Information Technology (IT) but focuses primarily on communication technologies. To Aluko (2004), Information and Communication Technology are enabling technologies which include both hardware and software necessary for delivering of voice, audio, data (low speed and high

speed), videos, text and internet services from one point to another. ICT devices or tools include radio, television, cell-phones, computer and network, hardware and software, satellite system, etc.

ICT has become so indispensable that it is almost part of people's daily living in our modern society. There is daily use of ICT in our society today in online reading of newspapers, paying bills, keeping in touch with friends and relatives as well as searching for information for private and professional purposes. ICT has revolutionised the work in almost all fields of human endeavour in many ways due to its speed, versatility and complexity in handling varied problems. It is now possible to handle larger amounts of scientific data, and test more complex models and simulations. The communications within the educational sector of the community are speeded up as access to research results in online journals becomes easier. It is also easier to collaborate with fellow educationists across geographical boundaries with the help of ICT.

The traditional methods used in teaching and learning in our educational system are fraught with a lot of challenges and limitations. The learning is usually teacher-centred as there is no much variety of teaching strategies. There is also no variation of teaching formats leading to lack of innovation, interactivity and engaging of students in the learning process. Teaching resources are not readily available and even the available ones are no longer current. There is no extended teaching as everything has to be done in the four walls of a class room. Integrating ICT into the educational process enables a variety of teaching strategies such as learner-centered, collaborative, project-based teaching and flipped classrooms. There will be improving access to resources as well as sharing of resources. ICT provides a variety of resource formats enabling the creation of innovative, interactive and engaging types of learning. ICT enhances and extends learning environments through the use of technologies in the classroom, through an online environment and through to a mobile environment with the use of mobile technologies. ICT will also cater for individual difference of learners which is not given much attention in the traditional method. The new educational practices seek equality and respect for differences between people. This would be impossible without the inclusion of technologies inthe educational system that promote the development of new methods and forms of learning that reduce inequalities and make it more inclusive (Ibujes-Villacis & Franco-Crespo, 2019). Apart from helping to improve the teaching learning process, ICT will enable students develop the skills required for success in the 21st century. Ibe-Bassey (2011) supports this assertion by stating that "ICT is a critical tool for preparing and educating students with the required skills for the global work place".

Incorporating ICT facilities into our educational system will enhance the quality of our education. Quality education is a human right and is the main tool for eradicating poverty, guaranteeing inclusive education and creating learning opportunities, as established in the objectives for sustainable development (UNESCO, 2017). This paper aims at reviewing the evidences on the use of ICTs in supporting and enhancing education particularly, science education.

Science Education and ICT

The advent of ICT, and its more widespread access in schools, potentially has an important part to play in re-shaping the curriculum and pedagogy of science (Osborne & Hennessy, 2003). Science education is the field of science that is concerned with sharing of scientific content. Science education encompasses learning by doing, problem solving, information seeking and analysis and critical thinking skills and qualities. Teaching/learning of these skills is better handled using ICT which reduces the abstract nature of the traditional methods. Science education may also involve large amount of data, complex models and simulations which ICT can handle. The work of scientists has in many ways been revolutionized by ICT. It is now possible to handle larger amounts of data, and more complex

models and simulation. The communication processes within the scientific community are speeded up because of easier access to research results in online scientific journals, and with access to the Internet, it is easier to collaborate with fellow researches across geographical boundaries.

These changes in the work of scientists should to a certain degree be reflected in science education. ICT has the potential to play an important role in making school science more relevant, interesting and motivating for students, and it offers opportunities to dissolve the boundaries between school and society. According to Linn (2003) students today need to learn how to search databases, interpret models, and critique electronic resources to succeed in school and in the workplace.

How ICT is used in Education

ICT helps in keeping pace with the latest developments in education. Different technologies can be used to do this. These include: www which stands for World Wide Web, it is one of the most important and widely accepted services of the Internet which has a very rich and colourful content. A web is a series of interconnected documents stored on computer sites or websites.

E-learning – E-learning is also known as online learning. E-learning is a learning programme that makes use of an information network such as the internet, an intranet (a kind of local area network) or extranet (a kind of wide area network) whether wholly or in part, for course delivery, interaction and/or facilitation. Web-based learning is a subset of e-learning and refers to learning using an internet browser such as the model, blackboard or internet explorer (Tinio, 2002). E-learning encompasses learning at all levels both formal and non-formal that uses an information network like the Internet, intranet or extranet. The components include e-portfolios, cyber infrastructures, digital libraries and online learning object repositories.

Open and Distance Learning (ODL) is any learning activities within formal, informal, and nom-formal domains that are facilitated by information and communication technologies. ODL plays a great role in teacher education. It removes the barrier of distance, allowing higher participation and greater interaction. It also improves the quality of education by facilitating learning by doing, directed instruction, self-learning, problem solving, information seeking and analysis and critical thinking as well as the ability to communicate, collaborate and learn.

Technology is becoming increasingly present in different areas of society, impacting daily on the lives of people. The transformations in the field of education are a reflection of this. These advances have facilitated the development of new educational practices that improve the teaching-learning processes of students (Carranza, 2007). There are two main-categories of ICT use by teachers; these are supportive ICT use and classroom ICT use (Tondeur, van Braak, & Valcke, 2007). The first category, supportive ICT use, refers to the use of ICT for pro-active and administrative teaching tasks, such as preparing worksheets, developing evaluation activities, keeping track of pupils' learning progress, etc. The second, classroom ICT use aims to support and enhance the actual teaching and learning process, such as the use of computers for demonstration purposes, drill and practice activities, modeling, representation of complex knowledge elements, discussions, collaboration, teleconferencing, project work, etc. (Sang, Valcke, van Braak, Tondeur, & Zhu, 2010). The paper focuses on the second category of use of ICT by teachers.

ICT can be used in education to support and enhance teaching, learning and assessment. It consists of computers and devices, networks including the Internet, applications/tools, and digital content. ICT can support different learning styles such as auditory, visual and kinaesthetic learning styles by enabling the creation of resources in a variety of formats such-as text, images, audio, video, animation and interactive formats. According to ICDL (2017) there are many learning style theories and models, which classify learning styles or preferences in many different ways. The teacher has to determine which learning style model, if any, is appropriate

for him/her in his/her teaching context. Teachers can support different learning styles by selecting resource formats for teaching, learning and assessment activities that suit individual learning styles. In terms of teaching a whole class, a teacher can incorporate a range of formats into their lesson in order to suit the range of learning styles in the class. Some examples are outlined below:

- Auditory - Teachers can use audio-enabled digital content to support auditory learners, such as audio books, video, television, radio, and audio-enabled e-learning courses.
- Visual - Teachers can use image and video formats to support visual learners, such as video and graphic rich e-learning, presentations, and online demonstrations, video calls with outside experts or other classes and modelling software. Teachers can also incorporate the use of visual formats to support visual learners when designing learning activities.
- Kinaesthetic - Teachers can use interactive formats to support kinaesthetic (knowledge of the position and movement of parts of your body, which comes from sense organs in the muscles and joints) learners, such as simulations, interactive games and quizzes. Teachers can also incorporate the use of interactive formats to support kinaesthetic learners when designing learning activities. For example, a teacher might design a learning activity where students use internet search tools to complete a search for information on a particular topic.

Benefits of ICT in Education

Like in other fields of human endeavor, ICT has a lot of benefits for the education sector of the society. The idea that using ICT enhances student motivation is becoming clearer in recent years (Campbell, 1984; Rieber, 1991; Schofield, 1995). Schofield (1995) gives a range of potential reasons such as novelty value, variety from teachers' lecturing, usefulness of ICT skills later in life, students are in control and can work at their own pace, and finally, some ICT tools provide rapid feedback. Dawes (2001) stated that new technologies have the potential to upkeep education across the curriculum and deliver opportunities for efficient student-teacher communication in ways not possible before. The advent of ICT, and its more widespread access in schools, potentially has an important part to play in re-shaping the curriculum and pedagogy of science (Osbome &Hennessy, 2003). ICT offers easy access to a varied array of Internet resources and other new tools and resources that facilitate and extend opportunities for empirical inquiry both inside and outside the classroom. ICT provides up-to-date resources. Apart from being a source for massive and most of the times up-to-date resources, ICT may also serve as a tool facilitating collaborative learning and discourse among peers. According to Bell and Avis (2006), the following benefits can be derived from incorporating ICT in the educational processes:

i. Global access to knowledge - Instant sharing of experience and best practice self-paced and self-based learning.
ii. Learning becomes interactive and joyful through multimedia tools,
iii. Stimulations of experiential learning – Opening windows for new thinking, an atmosphere of innovation.
iv. Bringing excitement and motivation, creating a feeling, of in a way, being well ahead of time.

From the forgoing, ICT makes teaching/learning of science more efficient. It encourages, interactivity, sharing of resources and provides motivation needed for science education. Also, access to scientific knowledge is widened and abstractness of scientific facts is reduced when ICT is used.

Benefits for Teachers

A teacher has a lot to gain from using ICT to aid in the teaching process. Below are some of the benefits:

1. Support for a variety of teaching strategies. ICT can support a variety of traditional and new teaching strategies in many engaging and innovative ways. Strategies like Learner-centred, Inquiry-based learning, Project and Flipped classrooms where the traditional teaching model is flipped.
2. Improving access to resources. ICT improves access to teaching resources by enabling teachers to find and share resources more easily. For example, they can access and share resources quickly and easily from wherever they are, whenever they want, using an Internet connection. For example, when teaching a topic like isotopes in chemistry, a teacher can easily browse to get up-to-date information.
3. Enhancing and extending learning environments – ICT can enhance traditional learning environments through the use of technologies in the classroom, such as display technologies. ICT can also extend the learning environment to an online environment through the use of Internet connections. ICT can also extend the learning environment to a mobile environment through the use of mobile technologies.
4. Providing a variety of resource formats.ICT can provide teachers with a variety of resource formats such as text, images, audio, video, animation and interactive formats. This enables the creation of innovative, interactive and engaging resources.
5. Supporting continuous professional development -*A* teacher can also use collaboration and communication technologies to engage with global and regional online communities.

Benefits for Learners

Many of the benefits that teachers experience from integrating ICT into their teaching practice can also apply to students. According to ICDL (2017), students using ICT to support learning can lead to the following benefits:

1. Active learning, where the students participate in the learning process rather than being passive recipients of information. For example, students might find information and resources online or they might complete learning activities designed by the teacher that use ICT tools to complete experiments and document results.
2. Independent learning where students, who are typically older, take responsibility for their own learning and can set and pursue their own learning goals, with minimum direction. For example, older students might search online for information and resources using search engines or social networks or they might create their own learning resources using multimedia tools or productivity tools
3. Informal learning, where students follow their own learning paths rather than passively receiving information from the teacher, as is usually the case in a more formal or traditional teaching model. For example, students might source and take online courses or they might join groups on social networks to share resources and ideas, as well as subjects covered by the curriculum.
4. Improving access to learning. Students can use Internet and mobile technologies to access learning at any time and from any location. For example, students might use the Internet to find reference materials, take an online tutorial, or communicate with their peers or experts at any time, from any location. This enables choice of pace of learning and accommodates different learning styles.
5. Improving motivation and engagement – ICT improves student motivation and engagement by using a variety of active and engaging electronic resource formats such as videos, games and simulations.
6. Supporting the development of 21st century skills - The 21st century skills which include creativity, critical thinking, problem solving, communication and collaboration

skills, the ability to learn, social and civic responsibility, entrepreneurship and cultural skills, and ICT and information literacy skills. There are skills the students need to acquire in order to live and work in the ever-changing digital world of the 21st century.

Benefits for Handling of Assessment

There are many benefits for teachers and learners from using ICT to support and enhance the assessment process, including:

1. ICT is used in supporting a variety of assessment strategies. Online survey can be used for diagnostic assessment, an electronic portfolio or an onscreen test can be used to demonstrate a student's skill in a summative assessment, an online quiz, simulation or game can be used for practice and self-assessment. Collaborative tools such as blogs can be used to enable peer and collaborative assessment.
2. Providing a variety of formats. ICT provides a variety of formats for assessment. The formats are text, images, audio, animation, and video to make assessment appealing and engaging for students.
3. Providing authenticity – ICT makes assessment more authentic for students by incorporating real-world scenarios. For example, simulations might be used, virtual worlds and social media can be used to create assessment where students can practice or demonstrate their skills in authentic situations
4. Providing enhanced feedback. ICT provides immediate and adaptive feedback to students. For example, an onscreen assessment can be created where students receive immediate feedback tailored to their responses.
5. Enabling re-use – ICT can enable the re-use of assessment by providing formats that can be re-used and shared such as online quizzes and simulations. This can reduce the workload for teachers.

Barriers to Using ICT to Support and Enhance Teaching, Learning and Assessment

Integrating ICT into teaching and learning is a complex process and one that may encounter a number of difficulties. These difficulties are known as "challenges" (Schoepp, 2005). It isn't always possible for teachers to use ICT effectively or appropriately to support and enhance teaching, learning and assessment due to obstacles that are outside their control. Barriers to the effective use of ICT include:

1. Dependency on network infrastructure – This refers to the dependency on having good quality Internet connections such as high speed broadband.
2. Dependency on computers and devices – This refers to the dependency on having sufficient numbers of good quality computers and devices.
3. Availability of appropriate resources – This refers to the availability of age appropriate, subject-specific, localized and culturally relevant resources.
4. Availability of teacher training and support – This refers to the availability of appropriate technical and pedagogical training and support on how to use ICT effectively in teaching, learning and assessment. Absence of appropriate training and support for teachers can affect the level of the teacher's confidence in using ICT, which can become a barrier to using ICT.
5. Lack of awareness of the benefits of ICT – This refers to a lack of awareness among school staff, students and parents about the benefits of using ICT in teaching, learning and assessment, which can result in a lack of motivation to use ICT.

Conclusion

From the review of the available evidence on the use of ICT it is clear that educational processes thrive when supported by ICTs. ICT improves the quality of education as it increases access to educational resources and makes provision for varied teaching methods and strategies. Tools for easy sharing of resources and collaboration as well as provision of

student-centred learning are provided by ICT. There is enhanced feedback, possibility of re-use of assessments and authentication of assessments. Skills and competences needed to make it in the 21st century will be developed by students, if properly and adequately integrated. ICT has many benefits for the teacher and the students. The Covid-19 lock down that greatly affected our schools wouldn't have affected our schools so badly if facilities for online/distance learning were in place.

Suggestions

The review has revealed that ICT is capable of transforming and enhancing our educational process of teaching and learning yet impeded by barriers. The following suggestions are hereby made.

1. ICT education should be made compulsory at all levels of education.
2. Serving teachers should be trained to be ICT-literate.
3. Government should ensure provision of ICT facilities in schools.
4. Government should ensure the provision of electricity to every school.

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