

Role of ICT in sustainable development

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Abstract: The Sustainable Development Goals (SDGs) are a set of worldwide aims for economic, social, and environmental development. The United Nations (UN) launched a campaign in 2015 to encourage most member nations to recognise the important role businesses play in accomplishing such goals; among such enterprises are those in the ICT sector. The use of information and communication technologies (ICT) to benefit the environment has encouraged sustainable education, which has helped students become more responsible and aware. To create more sustainable education, management institutions must embrace ethics to ensure long-term development. The goal of this magazine is to examine the various ways in which the ICT sector has contributed to the achievement of these SDGs in education. In addition, the characteristics of ICT in education are discussed, as well as their relationship to sustainable development and education.

Keywords: Sustainable education; computing for SDG; Education; ICT for sustainable Education; Sustainable Development Goals; Education for All.

I. INTRODUCTION

Information and communication technology (ICT) in educational institutions has advanced learning to new heights in recent decades. In both pre-schools and higher education institutions, technology-enhanced learning is used as a supportive education tool to spread learners' knowledge and abilities. Researchers have noted that technology-enhanced learning has facilitated knowledge and skill acquisition in the majority of previous study on the use of technology in education. Critical thinking is one of the key areas where technology has significantly increased understanding, as students are encouraged to approach and utilise chances with daring and potential. Further, Digitization has enabled students to move into an era of digital learning, spearheaded by ICT's adoption as an interconnected environment. ICT has helped institutions make more informed decisions that have led to the adoption of measures responsible for upholding the economy and environment's integrity. Through this, a transformative, comprehensive, and higher quality education system is brought forward. Learning has been made interactive and learner-centered as a result of ICT implementation in schools. By using ICT, students have been able to be agents of change and transformation in society. This research paper will examine the role of ICT in realizing sustainable education by 2030 by using scientific methods. This research will use data to ascertain the research question. This study will start by focusing on prior research carried out on technology and education (literature review. This will be followed by a methodology where data analysis will be conducted. Then research results will be followed by a discussion and finally the conclusion of this research.

II. LITERATURE REVIEW

The internet for Sustainable Education

According to Kent and Facer (2004), the emergence of digital technologies began with the invention of the internet, which

enabled learners and other members of the public to have immediate access to information. ICT has brought about significant improvements in a variety of industries, including energy and industry. As we will see, education is another industry that will be profoundly altered. The IoT (Internet of Things), which connects everything through networks of sensors and tightly integrated AI, will be the next wave after the internet. We will have sustainable education available by 2030 if education is positioned to ride the current and next waves in ICT.

By allowing avenues for protecting the environment, ICT through technology has been key to improving society's development and economy. According to Brush (2008), one of the best means of attaining the SDG goal for education is ICT, as it has portrayed a very high potential. This is because it has led to an interconnection around the globe, hence enhancing people-people interaction. We shall look into how tools developed using ICT have been used to accelerate and promote education in line with the SDGs.

The development has been a highly scrutinized term. It refers to activities that have unfolded to fulfill human needs and demand. These demands have remained basic; however, as societies grow, more complexities arise (Brush, 2008). The scope of the three basic needs, food, shelter, and clothing, have increased and widened over time, and the efforts to accommodate such growth have been referred to as development goals.

III. ICT FOR SUSTAINABLE EDUCATION

Information and Communication Technology (ICT) is defined by Kent and Facer (2004) as the use of the internet, computers, and other electronic delivery mechanisms such as radios and televisions. According to Kent and Facer, the education system has been an important determinant in children's computer exposure since they use computers more actively to participate in a variety of activities (2004). ICT is becoming a more effective tool in the education sector for teaching,

learning, and assessing students; as a result, modifications and reforms are required to ensure that all students receive a quality education.

According to Fu (2013), appropriate use of ICT would efficiently raise a said people's educational quality. Education does not have to be carried out in an enclosed space or a classroom as it is the norm. Still, it is a continuous process that is lifelong in which the learner will continue seeking knowledge through various sources. This means that ICT skills are increasingly being indispensable to them. ICT has been seen as a critical factor that expands access to education because, with it, education can occur at any time and anywhere. Most education material is available online at any time. Technologies such as teleconferencing allow students and instructors to interact simultaneously, efficiently, and conveniently. There is a myriad of resources on a particular subject matter available on the internet today; these resources are of various materials: videos, audio podcasts, 3d visual representation, and etcetera. The main task in achieving sustainable education for all by 2030 has been converting the education environment into more learner-centered (Sánchez et al., 2011). This will enable them to be more decisive planners and thinkers (Lu, 2010).

According to Brush (2008), ICT for education sustainability has helped students and learners across the world access educational material more effectively and efficiently. ICT has been a tool that has enabled them to discover new areas of interest, solve problems, and discover new perspectives.

According to Chai et al. (2010), through ICT, students' understanding and knowledge in several areas have been increased, thus creating an environment where creative learning has been taught. This is mainly through applications that have been designed purposefully to meet a variety of needs. There are some main characteristics that we will have to look into: creativity, capability, and autonomy (Lowther, 2008). Autonomy dictates that students take control of their learning. They tend to become used to working by themselves and in conjunction with others without necessarily having a teacher's input. Through this, students can then develop confidence in specific disciplines hence nurturing their capabilities.

Special requirements, anxiety related to the use of electronic devices, and students' capacity to travel from one area to the next are among the challenges facing the implementation of ICT standards and protocols to meet sustainable education for all by 2030, as identified by Frederick et al (2006). To achieve this goal, governments have been required to prioritise curriculum creation, infrastructure, capacity building, policy stipulation, and assistance.

According to a United Nations report (2010) from the Department for Economic and Social Affairs, the European region population has increased by 800 million people in 18 years between 2000 and 2018. An estimated 400 million will be added to this number to bring the total population to 4.9 billion people by 2030. Paying attention to this, the school-age population contributes to 20.9% of the total population on

average, that is, the ages of 5-17. With most of these countries having a high fertility rate, the number of children is continually increasing, putting pressure on the public system to provide efficient and effective services that touch on essential factors like health and education. Of the allocated budgets, an increase is expected from year to year because the number of students enrolling in schools for education keeps on increasing.

According to Shaikh (2011), most of these countries will be forced to inject tremendous resources into the educational sector to achieve sustainable education for all. There have been notable changes in improving educational standards, and ICT is one of them. With this, most countries aim to deliver lifelong learning efforts to tuck on the various educational areas ranging from technical to vocational education and training. ICT has been deemed ineffective in achieving this goal due to the following factors: it spreads quickly, as evidenced by the current number of mobile phones in this region. ICT significantly reduces expenses, which is a significant benefit for the education industry. Students may get an education no matter where they are thanks to low-cost internet platforms.

IV. ICT FOR SUSTAINABLE EDUCATION IN ITALY

According to Fleming and Hynes (2014), the majority of Italy's higher education institutions have undergone significant changes as a result of long-term technological and social tendencies toward digitization. This has resulted in the creation of a linked ecosystem that has allowed for the cultivation of student digital learning. Learners were in a position where they could make timely, well-informed decisions and take appropriate actions. Countries like Italy, for example, confront significant educational hurdles and may be unable to meet the 2030 target. The incorporation of ICT in schools, in particular. Class sizes are constantly rising as a result of rising populations, but funding these classrooms has remained a difficulty. There is an initiative to have one-teacher-per-student, but this has been a matter of contention, so the consequence that follows has been a decrease in the available comity of teaching facilities and resources. Having more students also led to overcrowding, thus decreasing the value of education.

Information technology equipment and tools must be made available to achieve the 2030 vision education goals. Italy has started enhancing and readying its education system to use ICT for learning and teaching; this is being done through building an education system that can integrate ICT within its system. This entails the appointment of dedicated experts to effectively plan, manage, support, and monitor the evaluation and deployment of ICT infrastructure in schools. After this is done, a lot of work and effort will build teachers and school administration's confidence in using ICT in education; this will provide each teacher with a computer for personal use and preparation for lessons. They should then be trained and given basic training in the use of ICT equipment. Once the teachers and the administration have the mentioned, ICT

presence in the schools must be established. This is done by providing both hardware and software that will help in administration and ensure that there are networking facilities catered for. The provided content is safe and curated for use in the education system. The content to be used must be evaluated and be reviewed periodically to ensure that it still meets the said and required quality. These institutions will then have to be connected and linked into an education network monitored and safe for use. Because ICT equipment is prone to failure if not used correctly, a support facility must be set up to assist schools and teachers.

Italy has then moved forward and ensured that ICT had been integrated into school management and education curricula (Polizzi, 2011). This is done by ensuring that half of all teachers are proficiently trained and have access to technical support training. Eight out of every ten schools must have school administrators integrate ICT in administration and management efforts. The presence of ICT in these institutions is then established by ensuring that they have their labs networked. There are a seamless integration and communication framework set to aid in planning, management, and communication.

Hepp and Laval (2000) pointed out that the Italian government has taken a lot from the Chilean government ICT for education initiative, better known as Enlaces, a crucial component in the countries' reform. It has aimed at integrating ICT in all public schools. There was a pilot project in 1992 to integrate ICT into the Chilean education system. Because of such success, more than 90% of the student population have access to ICT, and 80% of the teachers deployed have been trained on using ICT equipment. With the Enlaces program's success, it is clear that merely supplying ICT equipment to schools that may seem very important at first is not enough. Supporting factors such as teachers, student training, technical support training, and others must be carried out to achieve the 2030 goal of sustainable education for all. The government has helped the schools design their customized education projects, which have further catapulted these ICT projects' success. The Chilean government program has been aiming to reduce the 28 students per computer mark since 2006 (Blignaut, 2010).

Buabeng-Andoh (2012) points out that many computers have been deployed in schools and colleges in Italy. It has been witnessed that most of the students have expressed some eagerness to approach and use the computer for the first time to develop new skills that have enabled them to discover knowledge as they improve their prospects in life. The government's focus should be on ICT and better education, delivered through integrating ICT into their educational system (Buabeng-Andoh, 2012). ICT has enhanced the traditional teaching of various subjects as various teaching materials like multimedia presentations have been introduced. These implementations and integrations have focused solely on equipping the students and their teachers with necessary IT skills. This has been vital since they also prepare the individuals to access further employment opportunities as

most countries like Italy focus on attaining the sustainable education goal. Through research on human learning, it has been noted that learning is a natural process that requires collaboration with other students and teachers (McCombs, 2000). Learning is also an active process that will rewire knowledge production rather than describing already pre-existing knowledge, which ICT helps effectively attain.

According to Henderson (2011), the usage and relevance of ICT in any country's development initiatives, whether economic, social, or economic, cannot be overstated. ICT in education has made both teachers and pupils more sustainable, conserving energy and other resources while also adding value. This value is derived from the fact that less physical input is required; thus, life quality improves. STEM has had a significant impact on the growth of any country. With ICT comes long-term development, which leads to a fully realised society based on social values. Studies from time immemorial have documented that the role of ICT on sustainable education is crucial and has significant leverage to reduce the carbon footprint in other industries. In Nigeria, ICT has even been used to enhance the quality assurance procedures in Nigerian universities. If put into fair use, these tend to enhance and ensure that they align with the prescribed MAS - Minimum Academic standards (Kazeem & Ige, 2010).

Current State of ICT for Sustainable Education in Italy

Aristovnik et al. (2012) point out that most Italian schools have relatively low ICT penetration into their schools. This means that Italy is not well-positioned compared to other countries within the same region as far as IT equipment in schools is concerned. During the years 2011-2012, the average number of computers available for 100 students was 6. This is compared to an average of about 15 computers in the EU region for grade 4 students. As students' age progresses, it is expected that the number of available computers increases, but on the ground, this is not the case. There are roughly eight computers for every 100 students in grade 8. This ranks Italy at the bottom of countries concerning ICT penetration and preparedness. Another factor that ails the plan of using ICT for sustainable education for all in this particular country is that most schools have only the necessary IT infrastructure. They have very slow or no internet connection at all. Compared with other countries within the EU, Italy has an ICT infrastructure implementation percentage of roughly 6% against the average 37% (Gil-Flores, 2017). Given these issues at hand, a program launched by the government titled the National Plan for Digital Schools was regarded as a very crucial step in mainstreaming the use of ICT in the classrooms as a catalyst for achieving sustainable education for all. The program aims to target institutions and learners eager to use ICT in their curricula and stress on using technology other than just placing them randomly in any institution and expecting them to be used effectively. This is a targeted approach that ensures the best results by triggering a wide-scale change, beginning at the smallest level. The government will then need to raise the required funding to carry out the program effectively. This

will be achieved by the government, raising the budget allocated for the education sector during every financial year until the numbers of computers per 100 students have increased effectively across the board. However, a rise in the budget is not feasible, considering the current economic climate affected by the Covid-19 pandemic. The best approach to this is selecting some schools that will act as testbeds for the plan, using them to test and adopt new practices, new organization styles, and educational tools that use ICT, all in the hope of making ICT sustainable for all (Kubler, 2016). Identifying test schools and then studying them to see the effectiveness will make it possible and much easier to consider issues that might not be addressed effectively on a broader scale. This is a bottom-up approach to the plan.

V. CHALLENGES TO ICT FOR SUSTAINABLE EDUCATION

The difficulties in implementing sustainable ICT in Italy were highlighted by Fu et al. (2013). In response to the administrative and ICT infrastructure problems identified by, most educational administrators will place a greater emphasis on the quantity of educational content offered rather than the use of ICT. This is mostly due to the educational institutions' lack of administrative support from the proper authority to ensure successful utilisation. Even if ICT infrastructure is already in place, school administrations tend to focus on educational outcomes rather than utilisation and implementation for long-term sustainability. So far, a lack of proper and appropriate software, hardware, and materials has posed a significant problem.

Solutions to ICT for Sustainable Education

Fu et al. (2013) pointed out some of the measures that can be taken to address these challenges regarding schools and higher learning institutions, mainly by providing the appropriate access to technology. In addition to this, the Italian schools will then need to formulate and implement policies that involve educators in the decision and planning process regarding ICT use in schools. The only way to establish a well-managed ICT driven education system is that ICT tools must be readily available, procedures and policies effectively established, and efficient division of tasks after being well understood between learners and their instructors (Remenyi, 2017). By emphasizing these, learners will be engaged and capable of high-order thinking.

According to Ether and Ottenbreit-Leftwich (2010), research on existing literature elements enabled instructors and teachers in the current educational system to use ICT as a tool to attain sustainability in education for all. They listed a recommendation that showcased it was vital to provide teachers with evidence that the impact of ICT on education has positive implications; this is done by providing models and examples of existing real-life scenarios for use in the class exercises. Once the teachers and instructors have understood the ultimate goal of ICT in education is for sustainability, then the entire process will be efficiently implemented.

VI. METHODOLOGY

This journal's research methodology summarizes this study's purpose and the research methods employed in data collection and analysis. Further, it outlines the research's design, data, and sources. The validity and appropriateness of the used methods to analyze data are also discussed.

This journal aims to examine and establish the contribution that ICT has fostered for Italy's Sustainable Development Goals in education for 2030. According to the Italian Ministry of education, all schools in Italy, both private and public, should have access to ICT services in schools. The students can work with computers freely and carry out their research (Aristovnik, 2012). In this research, we have used quantitative data to examine and analyze whether ICT has reflected any impact on learning.

VII. PROCEDURE

To do so, we conducted a study of eleven schools. Schools were chosen at random from a list of 110 institutions which included both public and private schools. We chose seven sixth-grade pupils from each school. The technique of selecting pupils to be included in the study sample in each school was also done at random. We combined seven KitKat chocolate with Dairy milk chocolate to guarantee, there were no biases in selecting the seven kids from the 10 schools chosen at random. Students were handed these chocolates. Each school's research sample size includes the pupils who got KitKat chocolate; only seven students were chosen. The information about the pupils' schooling that was collected from seven students who were chosen at random. Previous computer study outcomes and overall performance were among the education details recorded from the seven randomly selected pupils in each school (the total points for all subjects). It was believed that computer studies achievement would be associated with students' overall performance in order for ICT to have an impact on the educational system.

VIII. DATA ANALYSIS

Our key aim for this research was to examine the impact of ICT on education and whether the implementation of ICT impacts students' performance. To analyze our data, we started by cleaning our data to ensure no outliers (Aristovnik, 2012). We then proceeded to plot a scatter plot to examine whether our data sets (student computer performance versus general performance in all subjects) could be analyzed using linear statistical methods. Further, we plotted the student's general performance and computer performance results to understand the two data sets' trends.

We then analyzed our data using analysis of variance (ANOVA) to examine any relationship between students' performance in ICT and all subjects'. We examined whether there is any relationship between students' performance in ICT and the student's general performance in all the exams.

IX. EVALUATION RESULTS

The two data sets (ICT performance and general performance) showed linear correlation as shown by the best line of fit in the scatter plot from the scatter plot. This shows that the two data sets (students' computer performance and general

performance) can be analyzed using linear statistical methods to establish their correlation. Further, the correlation coefficient between computer performance and general performance was $r = 0.921$. This indicates that there is a strong correlation between the two data sets.

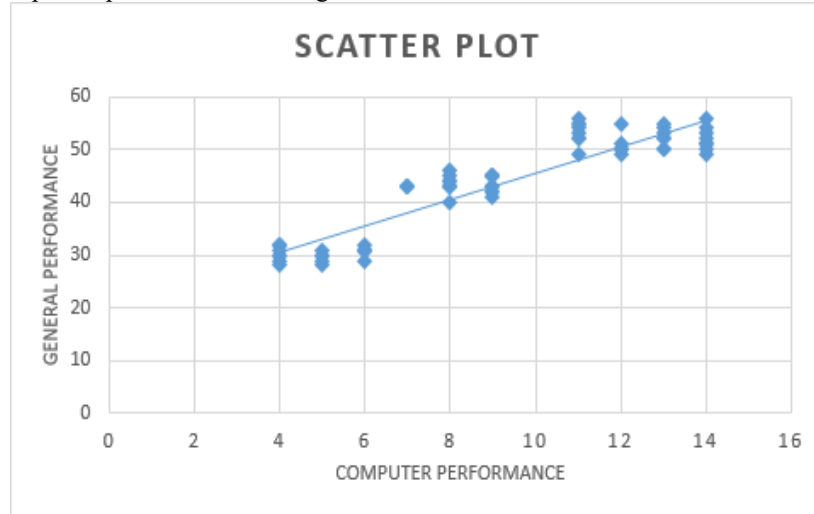


Figure 1

Correlation coefficient between computer performance and general performance was $r = 0.921$. A graph of ICT performance and that of general performance showed that, as the ICT performance goes up, general

performance goes up and vice versa, as shown in the following graph.

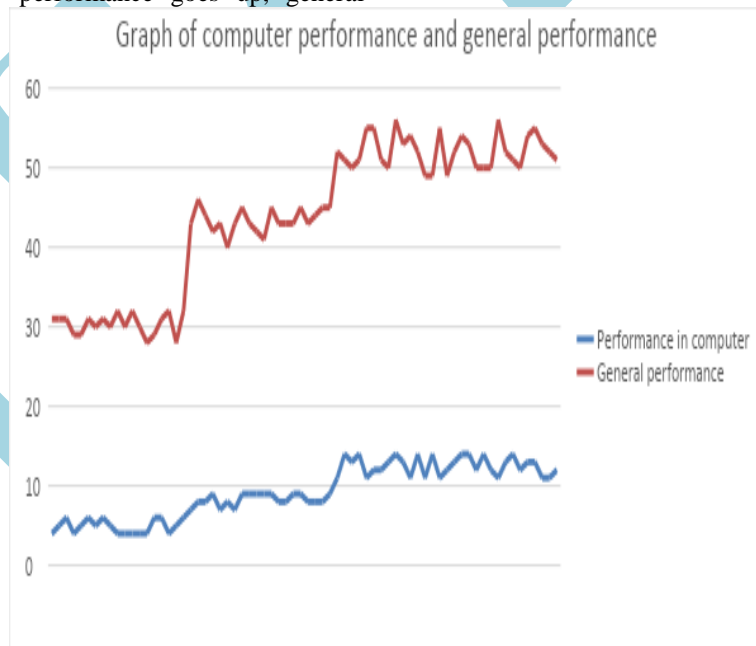


Figure 2

As the ICT performance goes up, general performance goes up and vice versa

We then proceed to carry our regression from the scatter plot; our research data could be analyzed using linear statistical methods. Further, we carried out ANOVA analysis to

establish whether the linear relationship between computer performance and general performance was significant.

The result from the variance analysis (ANOVA) for regression and regression statistics are as follows.

SUMMARY OUTPUT								
<i>Regression Statistics</i>								
Multiple R	0.9214							
R Square	0.8490							
Adjusted R Square	0.8468							
Standard Error	3.5909							
Observations	69.0000							
<i>ANOVA</i>								
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>			
Regression	1	4858.5047	4858.5047	376.7895	0.0000			
Residual	67	863.9301	12.8945					
Total	68	5722.4348						
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	20.51135087	1.2660	16.2017	0.0000	17.9844	23.0383	17.9844	23.0383
X Variable 1	2.50584401	0.1291	19.4111	0.0000	2.2482	2.7635	2.2482	2.7635

Figure 3

The above result $r = 0.921$, as seen in the scatter plot, confirms that the data sets (computer performance and general performance) have a strong correlation. Further, the regression from the variance analysis is significant as F computed value is more extensive than its significant F value, as shown in the above table.

X. DISCUSSION

This publication intends to investigate and establish the role of ICT in achieving Sustainable Development Goals in education. To do so, we looked at the influence of ICT on education and whether or not the country's implementation had an impact on students' performance. This was accomplished by examining the relationship between computer proficiency and overall performance in grade VI students from ten schools. The study's ten schools were chosen at random from a pool of 110 schools (private and public schools). In addition, seven students from each institution were chosen to provide sample data for the analysis. The correlation between computer performance and overall performance is 0.921, according to the regression analysis result presented in the regression statistic table. This equals 92.1 percent when presented in percentage form. This suggests a substantial link between computer performance and overall student achievement. The significance of regression results was tested using the analysis of variance (ANOVA). According to the ANOVA, there is a substantial link between computer performance and overall student

achievement. The following is the general equation regarding the relationship between computer performance and a student's overall success :

$$\text{General Performance} = 20.5 + 2.5 \text{ computer performance (ICT)}$$

This implies that every single increase in computer unit score results in 2.5 unit scores for general performance. This is an indication that the implementation of ICT in institutions has improved students' performance. One of the factors that have resulted in much improvement in performance is the increase in efficiency and effectiveness in learning due to ICT implementation in education institutions. For instance, students can carry out further research using the internet to improve their knowledge.

XI. CONCLUSION

Our key focus on this journal was to examine and establish the contribution that ICT has fostered for achievement of Sustainable Development Goals in education for 2030. To achieve this, we examined the impact of ICT on education and whether implementation impacts students' performance. From our literature review, we have established that according to McCombs et al. (2010), most of the higher education institutions have experienced essential changes that have been derived from sustainable, technological, and social trends towards Digitization. On the other hand, from our data analysis, we have established a significant correlation between computer performance and general performance (in

all subjects) from the ANOVA results. Further, from the linear model between general performance and computer performance, we have established that in every single increase in computer unit score, 2.5 unit scores for general performance. This is an indication that the implementation of ICT in institutions has improved students' performance generally. This indicates that there is a general improvement in performance in education system. Hence, it is evident that the contribution of ICT fosters the achievement of Sustainable Development Goals in education for 2030 based on its performance in improving students' academic performance. The main goal of this publication was to investigate and establish how ICT has aided achievement of the 2030 Sustainable Development Goals in education. To do so, we looked at the impact of ICT on education and whether or not the country's implementation has an impact on students' performance. Our literature study revealed that, according to McCombs et al. (2010), the majority of higher education institutions have undergone significant changes as a result of long-term technological and social trends toward digitization. The ANOVA results, on the other hand, revealed a substantial association between computer performance and general performance (in all subjects) based on our data analysis. Furthermore, we have derived a linear model between general performance and computer performance using the linear model.

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