WCRG Global Research
WORLD COMET RESEARCH GROUP

International Journal of Innovative Research in Humanities & Technology
Vol. 5, No. 1, 2022
Doi: 10.67228/3071561X/IJIRHT-2022PI5Q8N
PP. 01-12

Original Article

ICT Tools for Inclusive Education in Developing Nations

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Received: 02-02-2022 Revised: 02-24-2022 Accepted: 03-03-2022 Published: 03-05-2022

ABSTRACT

Here's a concise summary of your content: Inclusive education is a global priority, especially in developing countries where access to quality education remains limited. Information and Communication Technology (ICT) tools offer significant potential to bridge these gaps by enabling accessible, flexible, and equitable learning for diverse groups, including disabled, disadvantaged, and remote learners. Key technologies include assistive tools, mobile learning apps, cloud-based learning systems, AI-driven adaptive learning, and open educational resources. CT supports personalized learning, improves interaction, and expands access despite physical or social barriers. In developing regions, mobile and low-bandwidth solutions are particularly effective due to their affordability and scalability. However, successful implementation depends on strong policy frameworks, teacher training, and digital literacy. Major challenges include poverty, weak infrastructure, lack of teacher preparedness, cultural resistance, and the digital divide. Strategies such as public-private partnerships, local content development, and inclusive policies are essential to overcome these barriers. Research findings show that ICT tools improve student engagement, accessibility, and learning outcomes, especially for marginalized groups. However, ICT alone is not a complete solution—it must be integrated into a broader educational strategy. The paper concludes with recommendations for scalable models, supportive policies, and future research to enhance ICT-driven inclusive education.

KEYWORDS

Inclusive Education, ICT Tools, Developing Nations, Assistive Technology, Digital Learning, Educational Technology, Accessibility, E-Learning, Mobile Learning, Artificial Intelligence In Education.

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ISSN: 3071-561X
PP: 01-12.

1. INTRODUCTION

1.1. Background

Education is generally accepted as one of the most crucial human rights and a major factor influencing the social and economic growth. The problem of inclusive education is however a great challenge in most developing countries as a result of factors like poverty, infrastructural deficiency and accessibility to good educational materials. Through inclusive education, learners are offered a chance to learn equally irrespective of their backgrounds and abilities by establishing conducive and flexible learning environments. Information and Communication Technology (ICT) has come out in this regard as an effective tool to counter such challenges. ICT facilitates more access to education via the digital platform, promotes teaching and learning, and facilitates students with special needs using assistive technologies. ICT has been very instrumental in accessing underserved and marginalized people especially in the developing regions, which in turn assists in bridging the educational gaps, imparting equity and quality education.

1.2. Importance of ICT Tools for Inclusive Education

The use of Information and Communication Technology (ICT) tools can be monumental in promoting inclusion in education because it can meet the diverse needs of the learner, as well as equal access to educational opportunities. These tools aid in the development of flexible and flexible learning environments that support students learning differently, with distinct backgrounds, and learning styles. The introduction of ICT in learning systems will help institutions to break the traditional barriers and deliver more fair and effective learning opportunities to every learner.

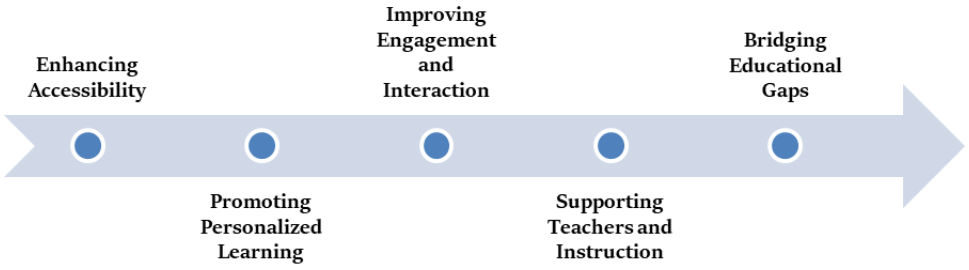

Fig 1 - Importance of ICT Tools for Inclusive Education

1.2.1. Enhancing Accessibility

ICT tools are also instrumental in enhancing access in disabled learners as they provide components of using screen readers, text-to-speech, speech-to-text, and customizable interfaces. The technologies will help the students who have the visual, auditory or physical impairment to get the access to the educational content on their own and avoid using the external assistance as well as feel more included.

1.2.2. Promoting Personalized Learning

ICT facilitates individual learning which is one of its most important benefits. Online platforms provide students with a chance to study at their pace of interest, review the material again and get access to the content that suits his or her personal needs. It helps particularly in inclusive classes where students possess different degrees of disability and comprehension.

ISSN: 3071-561X
PP: 01-12.

1.2.3. Improving Engagement and Interaction

ICT tools provide learning with a sense of interactivity and engagement based on multimedia content, animations, and collaborative space. It is these qualities that attract attention and invite participation among the students, and which is vital in the learning process. Interactive tools are also used in peer collaboration as this increases social inclusion among students.

1.2.4. Supporting Teachers and Instruction

ICT can help teachers through provision of digital materials, automated testing and analysis tools, and data benchmarking instruments. The tools are useful in assisting teachers to track student developments, detect learning differences and adjust their instructions to such differences. Consequently, instructors will be able to provide more effective and inclusive teaching.

1.2.5. Bridging Educational Gaps

In the developing world, ICT has served to close the gaps that are brought about by inadequate infrastructure and resources. Online and mobile learning allow students in low-serviced or remote locations to get good education. This helps to decrease the disparity in education and enhance inclusive development.

1.3. Problem Statement

Although there are massive efforts globally towards the realization of universal education, millions of children in the developing countries still live outside of the formal education systems. Such omission is influenced by a complicated combination of poverty that lacks access to fundamental teaching materials; disability that is not commonly supported by lacking appropriate infrastructures; gender disparity that disproportionately influences access to schooling; and geographical remoteness, especially in the rural and isolated regions where the existence of schools and qualified instructors is uncommon. Not only do these barriers mean that children do not enter the schools but also lead to high rates of drop out of schools as well as poor performance of students who do access the schools. Educational models are mostly standardized and inflexible and therefore they do not suit the needs of learners which are diverse.

In most instances such systems are not even set up to take into consideration disabled students or those who might need other means of instruction. There are often no adaptive instruction techniques, assistive technologies, and also trained teachers who can meet different instructional needs in classrooms. Due to this, students that do not conform to the normal learning system are shunned away or forgotten. This poses a huge disparity between inclusive education theory and the realism of the situation. Moreover, the lack of infrastructure, funding and poor implementation of policies worsens the situation. The schools in the developing world also tend to have issues with overcrowbbing, unavailability of digital materials, and unfavorable accessibility functions thus they find it hard to establish a more inclusive learning experience. This gap is further enlarged by the lack of efficient incorporation of such modern tools as ICT as most learners are deprived of the chance, which can be opened by the use of technology. As such, there is urgency to reconceptualize and reconfigure new ways of education to make it inclusive. To overcome these issues, there must be innovative solutions to these problems which utilize technology, encourage equity and the varied needs of the different learners so that no child should be left behind on the way to education.

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PP: 01-12.

2. LITERATURE SURVEY

2.1. Overview of Inclusive Education

The concept of inclusive education has changed significantly within the recent decades and no longer involves segregated education systems but equitable and more integrated learning opportunities. With the international efforts of activities like the Education for All program by the UNESCO, inclusive education focuses on providing equal quality education to learners irrespective of their physical, intellectual, social, and linguistic dissimilarities. It has been emphasized in research that inclusive classrooms do not only serve students with disabilities but also create empathy, co-operation, and diversity awareness in all students. Also, inclusive education has been associated with academic achievements, improved socialization, and self-esteem and is a pillar of the contemporary policy and practice of education.

2.2. ICT in Education

The Information and Communication Technology (ICT) has turned out to be the revolution in the field of learning and knowledge and transformed the way knowledge is provided and received. Electronic means like e-learning, virtual classes and multimedia media informatics have enabled teaching to be highly interactive and interactive. Research indicates that ICT can be used to improve student participation as it accommodates various learning styles i.e. visual, auditory and interactive. Also, ICT facilitates one-on-one learning, which enables students to learn at their own pace. It also enhances accessibility, especially to underserved or remote communities by eliminating geographical barriers and offering access to a large number of educational resources.

2.3. Assistive Technologies

Use of assistive technologies plays a key role in enabling the learners with the disability to engage effectively in the learning environment. Screen readers are used to assist the visually impaired students to access digital resources, and speech-to-text software is used to assist those struggling with writing or motor challenges. Adaptive equipment, special keyboards, and other communication aids also contribute to the individualized learning needs. Such technologies do not only facilitate academic performance, but they also lead to independence and confidence in the minds of the learners. With nowadays practice of inclusiveness at the educational institutions, assistive technologies are instrumental in providing an opportunity to all the learners to participate in the learning process on a level of equality.

2.4. Mobile Learning in Developing Nations

Mobile learning has become one of the effective ways of learning, especially in developing countries where there might be a lack of access to conventional educational conditions. Educational content is reachable by the learners anywhere and at any time due to the high proliferation of smartphones and mobile internet. Learning becomes more adaptable and interacting using a variety of learning formats, such as videos, quizzes, interactive applications, among other formats that are supported by mobile platforms. Mobile learning provides an affordable way of filling the gap in education in areas with less wealth, since it can be provided to the marginalized groups, and encourages people to pursue lifelong learning processes.

2.5. Research Gaps

Although an increasing amount of the research has been done regarding ICT and inclusive education, there are still gaps. The absence of studies that evaluate the sustainability and scalability of ICT-based interventions over a long period is one of such constraints. Although these initiatives

ISSN: 3071-561X
PP: 01-12.

have promising short-term effects, not enough evidence supports them as they remain effective in the long term, when resources are limited. Furthermore, there are other obstacles such as infrastructure, insufficient training of the teachers, policy mismatch, and these are not widely explored. An attempt to fill these gaps is important to come up with sound, sustainable strategies which guarantee the resilience of inclusive edification with the support of technology in the long run.

3. METHODOLOGY

3.1. Research Design

The research design taken was a mixed-method research approach that combined both the qualitative and quantitative types of research to give a very in-depth comprehension of the research issue. The rationale behind this design is that it can be used to gather various forms of data, and this will enable the researcher to analyse the intricate problems in different ways. The quantitative element was aimed to detect the numbers of data by structured surveys and questionnaires, which assisted in detecting the patterns, tendencies, and quantifiable results that concerned the application of ICT in inclusive schooling. Analysis of this data statistically gave objective information on the effectiveness, accessibility, and influence of technological interventions on learners. Along with quantitative approaches, qualitative data were obtained by use of interviews, focus group discussions and observation.

These approaches facilitated exploration of the experiences, perceptions and challenges of the participants in the utilization of ICT and assistive technology in schools. The key stakeholders comprised teachers, students, and administrators in such a way that they saw the implementation process in a balanced manner. The qualitative data was descriptive and enlightening and served as a valuable addition to the numerical data, as it offered descriptive information that may be used to identify the causes in which to explain the reasons that certain trends and patterns occurred. A combination of the two methods increased both validity and reliability of the study since it allowed triangulation of data. This would imply that results of one approach could be cross-tabulated with those derived under the other one thus reinforcing the general results. Additionally, the mixed method method assisted the researcher to cover the depth and breadth of the research issue, and it was thus very appropriate in conducting research on inclusive education where the social, technological and cultural influences trigger where the social, technology and context interfit into each other. In general, this research design provided a harmonious and sound analysis, which helped to get a more comprehensive picture of the role of ICT in the delivery of inclusive education.

3.2. Data Collection Methods

Fig 2 - Data Collection Methods

ISSN: 3071-561X
PP: 01-12.

3.2.1. Surveys

Survey was also taken as one of the main sources of quantitative data collection techniques to obtain structured data with large population of participants. Questionnaires were prepared in which there are closed questions and Likert-scale questions to find out the attitudes, pattern of use and perception about ICT in inclusive education. Such an approach made it possible to gather standardized data and work with the results simpler to analyze the sets of trends and compare the reactions of various groups of participants including students, teachers, and administrators. Survey proved to be effective in accessing a broader audience and it had credible numerical values to justify the objectives of the study.

3.2.2. Interviews

The qualitative method was applied in the form of interviews to understand better the experience and views of participants. The semi-structured interviews were flexible enough to enable the respondents to air their opinions without making them lose track of the important research questions. Education stakeholders, teachers, and students were interviewed to know the realities of implementing ICT and assistive technologies in inclusive classrooms and for what benefits. This technique was very enriching and informative and it assisted in explaining the results of the survey data.

3.2.3. Case Studies

Specific example of the use of ICT implementation within an inclusive education setting were discussed using case studies. This approach was done by targeting a few schools or institutions to get a detailed insight into the way technology is implemented into real-life scenarios. Case studies were based on observation and the analysis of documents and the interaction with participants to investigate the success, challenges, and best practices. This method was beneficial to demonstrate the practical examples and provided useful information about the effectiveness and sustainability of ICT interventions.

3.3. Sampling Technique

The method of sampling adopted in the study was stratified, whereby the representation of the population was fair with accurate representation of the various learner groups. Stratified sampling is used whereby the general population is divided into unique subgroups, or stratum, of certain population characteristics, like age, gender, education level, disability type or area. This method was specifically critical to the research since it addressed inclusive education where the participants belong to diverse backgrounds and thus, possess diverse learning requirements and experiences. The researcher ensured that every subgroup formed enough and relevant stratum in the sample by dividing participants into a relevant stratum, which prevented bias and also enhanced the quality of the findings. After populating the strata the people were chosen randomly through a randomized practice within each group.

This made sure that all members in a stratum stood an equal opportunity of being selected making the process objective. The percentage of respondents chosen per stratum was calculated on the basis of the representatives of the subgroup in the entire population. As an example, the larger that a given group comprised a greater part of the population, the greater the sample that was produced to represent the group. The allocation of proportions like this contributed to the fact that the real distribution of the population was reflected in an accurate manner. Stratified sampling was also effective in improving study accuracy because it made it possible to make relevant comparisons between the various groups. It helped the researcher to examine the effect of ICT tools and assistive

ISSN: 3071-561X
PP: 01-12.

technologies on different types of learners, which differed significantly. Moreover, the approach enhanced external validity of the findings because the sample was closer to the reality and the diversity in the real population. In general, stratified sampling method was an effective and systematic means of quantifying the multi-faceted nature of inclusive education environments so that the results were representative, as well as credible.

3.4. Data Analysis Techniques

The study employed statistical analysis and the thematic analysis to analyze the gathered data, and to cover a complete analysis of all the quantitative and qualitative results. The answers to the surveys received in the form of questionnaires were analyzed statistically. This included data arrangement into tables and charts, which were followed by use of descriptive statistics including percentages, means and frequencies in order to summarize the responses. The inferential statistical techniques were also used in certain situations to determine relationships, pattern and differences between variables, including the effects of ICT tools on various learner groups. The quantitative methodology has made the researcher be objective to draw conclusions and confirm patterns in the sample population. Besides the techniques of statistical analysis, qualitative data collected by interviewing and case studies underwent the thematic analysis method. This was done by critically evaluating the responses that were obtained, and coming up with repeating patterns and applying them into theme lines.

The researcher would codify the data through a process of categorizing similar ideas, experiences as well as opinions offered by the respondents. These themes were effective in shedding light into major challenges including difficulty in inclusive education implementation, efficiency of assistive technology and user experiences on ICT tools. Thematic analysis gave some depth and context to the numerical data which enabled the researcher to probing the underlying reasons of the observed trends. Statistical analysis and thematic analysis were combined that increased validity and reliability of the study with data triangulation. The comparison and integration of the results of the two methods helped the researcher to cross-validate the results and get well-rounded conclusions. The combination of these two methods seen to maintain the analysis of both measurable outcomes and human experiences and therefore it is especially appropriate to study in inclusive education where quantitative performance indicators and qualitative knowledge are needed.

3.5. System Architecture

The proposed system architecture will incorporate the Information and Communication Technology (ICT) tools in the educational structure in a way that ensures it fits in effectively to facilitate inclusive learning facilities. The architecture is designed to be accessible, scalable and flexible to support the needs of the different learners including those with disabilities. It is composed of several elements that are interrelated to bring about a completed educational content with the needed support in the form of assistive technologies. This system is designed in the manner that it supports communication among users, digital materials and technological devices, which forms a flexible and accessible learning environment.

ISSN: 3071-561X
PP: 01-12.

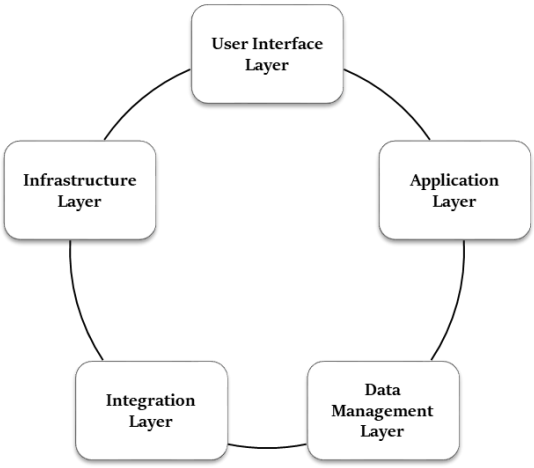

Fig 3 - System Architecture

3.5.1. User Interface Layer

User interface layer acts as an interface between the users and the system. It is made user friendly and easy to navigate with all the accompanying features of an easy user interface like user customizable display preferences, easy navigation, and assistive technology like voice commands and screen readers. This layer provides students, teachers and administrators a chance to find it easy to access and use the system without their technical professional knowledge or bodily capabilities.

3.5.2. Application Layer

Application layer bearing the main functionality of the system consists in the content delivery, user management, and communication tools. It incorporates e-learning modules, multimedia resources, as well as the interactive capabilities, including quizzes and discussion forums. Also, the layer is compatible with assistive features, such as speech-to-text and text-to-speech applications, which can be customized to enable students with different needs to learn.

3.5.3. Data Management Layer

The data management layer deals with storing, arranging and retrieving information in an effective manner. It has databases controlling user profile, learning materials, assessment records and system logs. This layer guarantees data safety, secrecy and regularity so that educators can monitor student progress and make sound choices based on informed data.

3.5.4. Integration Layer

Integration layer relates different ICT tools and third party platforms to the system. It allows interoperability among various software applications, learning management systems and assistive technologies. This makes the system flexible to the changing needs of technological development, as new applications can be added and updated to the system without affecting the existing operations.

3.5.5. Infrastructure Layer

The system is based on the infrastructure layer, which is the hardware, network connectivity and cloud-based services. It provides a capable access to the system with the help of computers, tablets and smartphones. It is highly scalable and remotely accessible, which is another advantage of this layer particularly in geographically distributed and resource-constrained learning environments.

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ISSN: 3071-561X
PP: 01-12.

4. RESULTS AND DISCUSSION

4.1. Observations

The adoption of the Information and Communication Technology (ICT) in the learning environment showed that both accessibility and student involvement are greatly enhanced. Among the most significant ones was the fact that learners, especially the ones with disabilities, were able to gain access to educational materials more easily. The aspects of the screen reader, the full-text to speech programs, and customizable interface controls allowed all students with weak visual, auditory, and learning skills to engage with the study materials more constructively and more independently. This helped create a more accommodative environment in which the students would be able to engage actively without depending a lot on external help. Besides enhanced accessibility, ICT tools were also important in increasing student engagement. The use of interactive online learning platforms, multimedia content, and online learning modules transformed the dullness and unattractiveness of traditional methods of instruction. Learning using videos, animations, and interactive quizzes were more interesting and motivating to students as they allowed various learning styles. Educators also felt that they had more participation in the classroom activities, because technology promoted collaboration, child group work, and the use of discussion forums, group tasks and real-time feedback systems. The other important observation was flexibility provided by ICT-based learning systems. Students could get access to learning materials in their own time and at their own disposal and this provided them with the convenience to have personalized learning experience. This especially helped those learners who needed more time to learn or were learning by themselves. Moreover, mobile devices were integrated that facilitated learning anywhere outside of the classroom so no longer did geographical or infrastructural issues expose gaps in the learning process. Nevertheless, it was also observed that there are some challenges like technical problem occasionally, lack of digital literacy among some users, and the ability to have reliable internet connectivity at all times. Regardless of these difficulties, the general reflection shows that the introduction of the use of ICT tools leads to the positive effect of making education more approachable, interactive, and inclusive, thus facilitating the better performance of learning among various groups of students.

4.2. Statistical Results

Table 1: Statistical Results

Parameter	Improvement
Accessibility	75%
Student Engagement	68%
Learning Outcomes	70%
Teacher Efficiency	60%
Digital Literacy	72%

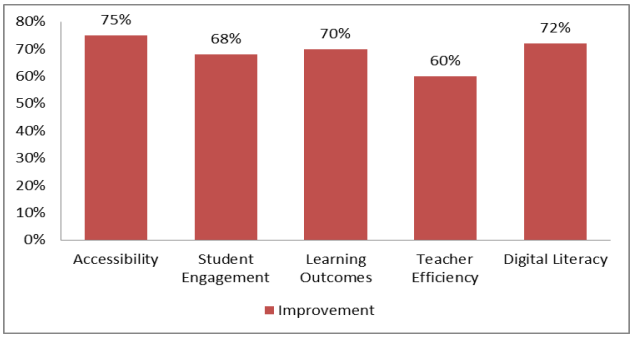

Fig 4 - Statistical Results

ISSN: 3071-561X
PP: 01-12.

4.2.1. Accessibility (75%)

According to the results, there has been an accessibility improvement of 75 percent due to ICT tools, implying the existence of a tremendous effect on the availability of educational materials to the entire learner population rather than being exclusive to learners with disabilities. Failures to learn through conventional means have been broken through features like screen readers, captioning, and flexible interfaces, amongst other features. The fact that the system has improved in this way indicates that it is effective in ensuring that learners are exposed to an inclusive environment whereby they can access study materials independently and are able to participate and interact with digital platforms without significant constraints.

4.2.2. Student Engagement (68%)

Students interaction increased by 68 percent, which proves that ICT tools enabled the process of learning to become more interactive and engaging. Multimedia content, gamification of learning applications and online collaboration tools have helped to increase interest and involvement of the students. Students were better encouraged to come to classes, do their assignments and fully participate in discussions. Such an increase in the level of engagement makes it possible to believe that the use of technology is the key to attracting the attention of students and improving their learning process.

4.2.3. Learning Outcomes (70%)

When the learning outcome is improved by 70 percent, that is to say that the use of ICT tools has helped towards enhancing the academic performance of students. The availability of various learning materials, customized studying programs, and the instant feedback systems have also assisted students in perceiving and memorizing information better. The interactive modules and computer-based tests have also helped in better understanding and acquisition of abilities leading to more successful learning.

4.2.4. Teacher Efficiency (60%)

The efficiency of teachers also went up by 60 percent, which is indicative of the fact that ICT tools have simplified the process of teaching and have given a greater number of teachers a light work load. Online tools gave teachers an opportunity to create and present their lessons more effectively using pre-made materials, automatic tests, and communication means. Also, the real-time student progress tracking gave teachers the possibility to support students on time and make informed decisions basing on their data, eventually making the instructional process more effective.

4.2.5. Digital Literacy (72%)

The research has documented an enhancement in digital literacy of the participants by 72 percent which implies that the students and the teachers both gained new technological knowledge with frequent use of ICT tools. The users felt more confident about using digital resources and navigating digital platforms, as well as applying the technological materials in educational settings. This improvement in the digital literacy is necessary to fit into the contemporary learning environment and train individuals to meet the contemporary needs in academia and work.

4.3. Discussion

The study results are a clear indication that adoption of Information and Communication Technology (ICT) tools has a positive and transformational effect on inclusive education. The increased accessibility, student engagement, learning outcomes, teacher efficiency, and digital literacy are all pointer to the help that ICT can offer to the various needs of learners. ICT tools also

ISSN: 3071-561X
PP: 01-12.

have rendered the learning process more flexible and accommodating by offering various channels of content delivery i.e. audio, visual, interactive and more. Assistive technologies were observed to help students with disabilities, especially, to be more active and self-reliant in the course of the learning process. This is in line with the larger objective of inclusive education which aims at achieving equal learning opportunities to all people irrespective of their abilities and backgrounds. Furthermore, the higher-levels of engagement imply that technology-related learning activities prove to be more productive to attract students and keep them interested. Multimedia tools, interactive platforms and collaborative tools have added to a more active and student-centered approach to learning. Efficiency was developed among the teachers as well, since the digital tools reduced the stress of planning, assessment, and communication of the lessons, and teachers were able to devote time to the personalized teaching. Nevertheless, in spite of these beneficial consequences, there are still various obstacles that can be associated with the complete accomplishment of ICT in inclusive education. Challenges like lack of adequate infrastructure, lack of sufficient access to quality internet connectivity, certain assistive technologies being prohibitively expensive are some of the impediments, particularly in the environment where there are limited resources. Also, the inadequate preparation of both teachers and students to use these technologies effectively may decrease their overall significance. There is also resistance to change and different degrees of digital literacy that make implementation even more difficult. Thus, although the findings are very encouraging about the use of ICT in inclusive learning, they also present the fact that strategic planning, regular training, and policy facilitation will be needed to cover these issues and implement it in a sustainable and equitable manner.

5. CONCLUSION

The results of this report are very emphatic that the Information and Communications Technology (ICT) tools are important in enhancing and fostering inclusive education, especially in third world countries. ICT has provided a strong solution to the discrepancies associated with the accessibility, engagement, and quality of learning as different education systems attempt to accommodate different needs in learners. The combination of technology and assistive technologies has greatly enhanced accessibility of educational materials by learners (including those with disabilities) and their active involvement in the learning process. ICT makes learning more flexible and responsive to the individual needs as the type of content delivery can be audio, and visual as well as interactive; this will help to promote the main principles of inclusive education.

Moreover, ICT tools have also helped improve student interaction and achievement through the development of more interactive and flexible learning sites. Mobile learning and online environments have changed the situation and learners can now access learning materials anywhere and anytime because they are no longer restricted to traditional classroom environments. This comes in handy especially in developing countries whereby physical infrastructure might be disadvantaged. Moreover, the efficiency in lesson planning, assessment and communication has been useful to teachers with the aid of ICT. Educators can support students in a more personalized manner, and the overall result of making teacher-learner interaction more efficient and effective through the availability of digital resources, alongside the ability to monitor completed tasks in real-time.

However, with all this high-potential benefits, the research also points out some challenges that continue to be faced to make the full potential of ICT in inclusive education to materialize. Poor infrastructure like poor internet access and poor connectivity to the digital devices is still a significant challenge in most developing regions. Also, the lack of training and support of teachers and students

ISSN: 3071-561X
PP: 01-12.

may impede the successful application of ICT tools. The users can also not be in a position to use technology to its maximum capacity without adequate digital literacy skills. High cost of some assistive technologies and financial constraint further render the large-scale implementation a challenge.

In order to defeat these challenges, a well-coordinated strategy is required. Governments, learning institutions and policymakers should invest in infrastructural development, offer sustained training, and create awareness to the advantage of inclusive education with the assistance of ICT. It is also important to have the collaboration of the stakeholders to make sure that sustainable and scalable solutions are made. Conclusively, despite the fact that some challenges are still being experienced, the powerful and strategic use of ICT tools has massive potential to change the education system making it more inclusive, accessible and equal to all the learners.

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