

An Overview of ICT and Educational Change: Development, Impacts, and Factors

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Abstract: This paper focuses on the development of information and communication technology (ICT) in education, its impact on teaching and learning, as well as the factors that sustain change in education. Since the rise of e-learning in the 1990s, ICT has evolved rapidly in the field of education. Furthermore, ICT is seen as a catalyst for change in education, and its impact on both, students and teachers should not be understated. In addition, the sustenance of these positive changes brought about by ICT should also garner attention. This paper consequently focuses on an overview of the evolution of ICT in the field of education in the last decade or so, its impact on the changes in teaching and learning, as well as the factors that sustain the changes. Through a study of prior literature and reports, the results found that ICT has had a different focus and predicted direction each year from 2009 to the present, as well as significant effects on the content, approach, time, and place of teaching, administration, research process, and roles of teachers and students. Additional factors that influence educational change include funding, equipment software, and personnel expertise. Therefore, this article provides referenceable evidence for further ICT applications in education.

Keywords: ICT; Educational change; ICT development history

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1. Introduction

Whether education is seen as preparation for work from a utilitarian perspective or as the development of full human potential, education must change in response to ubiquitous societal change ^[1].

Moreover, the impact of information and communication technology (ICT) is evident in the changes in the way people live and work, changing the most common practices in the work environment ^[2]. ICT has been described as a technology that allows users to gain direct access to a large amount of information ^[3]. It is closely associated with educational change. Research has also proven that technology can be a catalyst for educational change ^[4]. Therefore, in recent years, the effective use of ICT has been embedded in the larger process of education reform ^[5]. In this process, ICT has led to fundamental changes in educational approaches, with a focus on using ICT to improve teaching and learning ^[6]. In addition, it has brought about changes in classroom practices, with classrooms gradually shifting from teacher-centered to student-centered ^[7].

This article summarizes and discusses the impact of ICT on educational reform, its factors, and the development of ICT in the field of education.

2. Development and evolution of ICT in education

In 2002, the UNESCO and its partner countries launched the “ICT in Education in Asia and the Pacific”

program to prepare countries for the full integration of ICT in education. About a decade ago, the NMC released the 2009 Horizon Report 2009^[8,9], which stated that ICT is changing the way students learn and predicted that collaborative environments and online communication would become mainstream teaching and learning practices. This era of ICT has already begun developing rapidly the field of education.

According to the 2012 Horizon Report, the core trends of educational change include a paradigm shift towards online, blended, and collaborative learning, with more learning opportunities available to learners through online resources^[10]. At the same time, learners may use their smartphones in the classroom, making it easier for schools to manage financially and increase the learning efficiency; people can work anywhere and anytime, and learning has become an enjoyable process, with discovery learning and active learning becoming the focus of classroom learning. However, the lack of technology, the school system, and the gap between theory and practice are the new challenges that have surfaced. In addition, the report predicted that tablets and other mobile devices will be widely used in the classroom.

By 2013, a major transformation had taken place. At this time, open materials and learning resources became widely available, and MOOCs (massive open online courses) began to develop^[11]. The transparency of data and information began to influence new values, the reduced cost of technology and more scientific attendance policies allowed for greater use of mobile devices in the classroom, and students gained more knowledge through the web, which began to redefine the role of learners. Challenges during this period include inadequate professional development of teachers, the lack of encouragement and attention to technology practices in education, the competition between educational institutions and a variety of for-profit and charter schools due to the emergence of MOOCs, as well as the underdevelopment of existing technology levels. The report also predicted that technologies such as cloud computing, mobile learning, and virtual and remote labs will be developed and retained in the future.

The 2014 Horizon Report indicated that education had begun to demand a reshaping of the role of teachers, so flipped classroom began to emerge as a new trend^[12]. At the same time, education demanded the pursuit of deep learning, the reinvention of school mechanisms, and a larger emphasis on open resources. It was then faced with the challenge of competing with new teaching models, personalized learning, managing formal education institutions, and developing students' thinking skills. Among the future trends, the report also pointed to the development of "bringing your own device," cloud computing, learning analytics, gamification, and the internet of things. Within five years, from 2009 to 2014, schools have begun to shift from traditional classrooms to technology-driven learning centers. Blended learning and authentic learning experiences are the next technologies that are expected to be widely used in schools.

The 2015 Horizon Report identified the main developments in ICT as strategies for deep learning, enhanced collaborative and blended learning, and the transitioning of students from consumers to creators^[13]. However, there are still many challenges, such as the lack of integration of ICT into education, the issue with the effectiveness of the diffusion of pedagogical innovations, and the difficulty in achieving composite thinking in teaching. The report predicted that makerspace, 3D printing, adaptive learning technologies, wearable learning technologies, and other technologies will penetrate the education field in the future.

In 2016, the significant trends in school ICT applications included students becoming creators and schools developing students' programming literacy and redesigning learning spaces^[14]. The challenges faced included the inequitable digital development and large achievement gaps, in addition to the existing challenges. The Horizon Report of that year recognized artificial intelligence, wearable technology, makerspace, robotics, and virtual reality as new advances to look forward to in the next five years.

The 2017 Horizon Report showed a significant increase in ICT implementation, with "coding, STEAM, and innovation" as the main trend and "makerspace, robotics, virtual reality, and artificial intelligence"

expected to dominate by 2022 ^[15]. In terms of challenges, the realization of live, experiential learning, the reconfiguration of the role of teachers, the narrowing of student achievement gap, and the innovation in leadership will all be the new challenges.

From 2018 to 2020, adaptive learning, artificial intelligence, and open educational resources have emerged as key trends in educational transformation and improved instructional design and curriculum development technologies ^[16,17].

In the context of COVID-19, information privacy and security in the teaching and learning process would be of concern from 2021 onwards as distance learning is rapidly evolving.

What is discovered is that with the development of ICT applications in the field of education and also with the unique contexts of society, educational change continues to adapt to the needs of society, learners, and educators, contributing constantly to the rapid development of school quality. Although challenges are always present, they are constantly being overcome, and new expectations and trends are being proposed to facilitate the direction and preparation for future educational change.

3. ICT and educational change

3.1. ICT and educational change

The heart of educational change is the changes in teaching and learning activities ^[18]. ICT has been guiding educational change, and effective ICT should be implemented as part of the educational change process rather than being examined in isolation ^[19].

A researcher stated that ICT is a lever in education that leads to changes in teaching and learning. Under the influence of leadership and school climate, ICT directly contributes to changes in teaching and learning ^[20].

Figure 1 provides a comprehensive overview of the role that ICT implementation plays in educational change and the function of ICT in the school, beginning with leadership change, which is an essential component of educational change. The change in leadership is a crucial component in education reform. As leadership changes and leaves an impact, schools develop new school climates or cultures. For example, traditional student-teacher relationships are replaced by open, two-way relationships, and traditional leader-staff relationships are replaced by two-way communication, where leaders empower staff and teachers or create a technology-enabled school climate. The new school climate will facilitate the implementation and integration of ICT, and in turn, this implementation will directly affect teaching and learning through shifts in students' learning patterns or classroom instruction. Aspects such as the improvement of learning devices or the influence of technological advances on student roles will also affect learning in addition to the impact of instruction on learners.

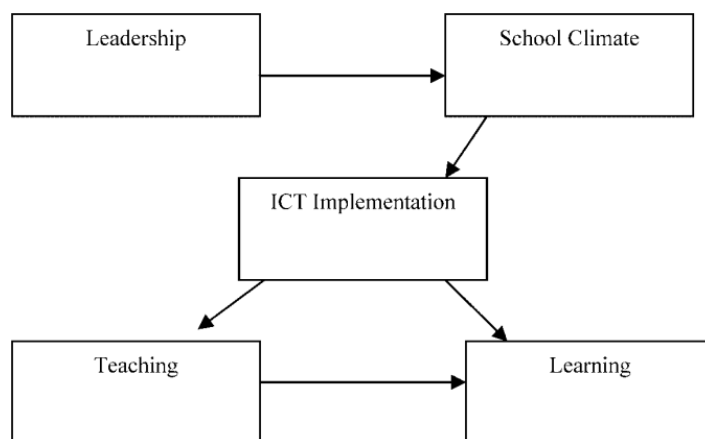


Figure 1. ICT and educational change

3.2. Changes in learning caused by ICT

First of all, the implementation of ICT will cause changes in learning, mainly in terms of the content, methods, time, and place.

In terms of learning content, on the one hand, the curriculum shifts from a traditional curriculum that is based on textbooks to competency- and performance-based curriculum. These courses focus on information acquisition and problem-centered inquiry learning ^[21]. While traditional courses primarily focused on informing students directly from books, new courses require students to be inquiry-based and to discover for themselves the results of their inquiry and the central ideas of their questions, so that they can exercise their thinking skills and level of inquiry ^[22]. On the other hand, general education courses need to consider students' information literacy. With the development of information technology, society demands a high level of information literacy from all walks of life, so students need to be prepared to meet the societal demands. In order to ascertain that students can adapt to the societal requirements, schools are expanding information technology courses.

In terms of learning methods, the teacher-centered approach has become a student-centered approach ^[21]. ICT has become a tool for independent learning, and many students are using ICT as a source of information and a cognitive tool, rather than solely depending on teachers' explanations. With the advancement of information technology, the sources of information and knowledge have expanded to the point where active learning has more opportunities and better conditions and the teacher-dominated curriculum is unable to meet the requirements of learners. As a result, the teacher-centered traditional classroom has started to draw criticism, and the classroom has gradually shifted in such a way that students are now in dominion. This enhances students' capacity for critical thinking and self-direction as well as fosters two-way communication between students and teachers, enabling students to be more flexible and to gain more knowledge in the classroom ^[23].

In terms of time and place of learning, on the one hand, students can learn anywhere ^[21]. The educational venue has become more flexible rather than just being limited to the classroom. It also provides learners with the opportunity to enroll in courses that are offered elsewhere. In a traditional classroom setting, students can only come together in the classroom to learn, with the teacher distributing learning materials or books. However, with the use of ICT, it is possible to overcome situations where students are unable to gain access to classrooms, as in the case of the new coronary pneumonia in 2020. Without online teaching, classes will be forced to stop, and students' progress and learning outcomes cannot be guaranteed. It is because of technology that students and teachers can participate or hold classes through various online platforms, ensuring that students are allowed to learn even when they are not in the classroom. On the other hand, ICT helps learners with special needs to overcome time constraints. Learning cannot take place at a fixed time through videos or the internet. With video recordings, learners do not have to participate in the course at a fixed time ^[24]. Although communication between teachers and students is essential, ICT can deal with specific situations, such as issues with time zones, allowing students to participate in the course at any time using the software on various online platforms. This makes the acquisition of knowledge easier and more convenient ^[25].

3.3. Changes in teaching caused by ICT

Another area of change is in teaching.

The traditional chalk and lecture teaching has changed to more innovative teaching methods, such as using slide presentations and animations, as well as offering different online courses from foreign universities ^[26]. Traditional classroom teachers use chalk to teach, which is inefficient and monotonous, and the lesson presentation is not conducive to the engagement and interest of students. Many schools are now using slides or electronic devices to teach, which not only display vivid images, but also save teachers

a ton of time from writing, thus improving classroom efficiency and garnering students' interest.

The traditional approach of the teaching practice has been changed to the constructivist approach. Contemporary learning theory assumes that learning is an active process of constructing knowledge rather than acquiring it, while teaching is a process that supports this knowledge construction rather than just the transfer of knowledge ^[21]. Constructivism places a strong emphasis on student initiative, and it holds that education should not be about endowing students with the right answers; rather, it should be a process of gradually curtailing external control while expanding students' self-control by continuous rewriting and sublimation as students' understanding grows ^[22].

The role of a teacher has changed from a content expert to a coach or mentor. Teachers should be helpers and guides in the construction of knowledge, and they should pay attention to keeping students in the "nearest developmental zone," as suggested by Vygotsky, as well as provide students with coaching rather than unidirectional transfer of knowledge ^[25]. The role of a traditional teacher is more of a content expert, where the teacher dominates the content and outcomes of learning.

3.4. Changes in administration and research processes

The implementation of ICT has also caused changes in other aspects of education, mainly in school management and research processes. The changes in school management are mainly changes in the traditional paper-based office, simplifying much diverse management and administrative tasks through the use of electronic offices and increasing the efficiency of managing staff and students ^[24]. The management of students and teachers involves the use of electronic records and other forms, as well as novel technologies, such as face recognition to manage attendance, while advanced methods such as electronic marking can also be used to reduce unnecessary time and resource costs in addition to improving the quality of school management ^[25].

On the other hand, changes in research primarily benefit researchers by saving them money, time, and effort, while also raising the caliber of their work ^[27]. Researchers can collect large amounts of data through various software, contact research subjects by email, and also analyze and organize the collected data through different software, all of which will speed up the process of scientific research and promote the progress of research in teaching and learning.

4. Factors that influence and sustain educational change

The first is sustained financial investment. Sufficient funding is the guarantee to sustaining the effect of educational change. The government needs to allocate a reasonable amount of financial investment and a proportion of funds for educational change as well as the development of ICT ^[28]. Since education reform should be long-lasting and sustainable, sufficient and continuous financial input is the necessary material basis ^[29].

The second is the continuous development of ICT-related personnel. Professionalism is a prerequisite, and all educational personnel must have the necessary ICT skills through professional training and familiarize themselves with the latest educational technologies, so as to provide sufficient technical and personnel support for educational change. ICT personnel should update, supplement, expand, and improve their knowledge of professional technology. The main task is to enable professional and technical personnel to continuously learn new knowledge, new technology, new information, and improve their knowledge structure in conjunction with their work theory. The purpose is to improve their independent innovation ability and promote the construction of a high-quality innovative ICT talent team ^[1].

The third is provision of software suitable for the school curriculum ^[30]. In education, there are several types of software. One of it is the resource library type software, which enables teachers to combine the necessary multimedia resources for their teaching design. Another type of software is the academic affairs

type software. Grade analysis, student evaluation, course evaluation, teacher management, scheduling, file management, and other academic management software are all closely integrated with the school, and the development of this type of software requires thorough analysis and research of the school's academic management. In particular, the software should be based on the campus network platform, and there should be a smooth data flow between the management modules, so as to truly realize the automation of academic affairs management. Another type of software is the question bank type software, and schools have a great demand for this type of software. However, teachers can only refer to questions from books, and some of the questions in the question bank are obsolete or updated slowly, thus teachers are reluctant to use it. With revisions to the curriculum, the pertinent software can be updated online at any time for free, which is still valuable and convenient for teachers ^[31]. In conclusion, the rise of online teaching has led to a new application environment brimming with multimedia data processing tools and web design tools, in addition to virtual labs, teaching aids, and other software used in schools ^[29].

5. Conclusion

The implementation of ICT has facilitated various aspects of teaching-centered educational change. As technology evolves, new applications and trends emerge. Although ICT implementation is seen as an integral part of the change, it should not be seen as a determinant of educational change. The management and behavior of human participants in the change are critical. The implementation of ICT primarily affects learning and teaching, but management and research are also largely affected. Several factors are essential in sustaining the outcomes of educational change, including the availability of funding, staff support, resource allocation, and the availability of school software. In the education sector, ICT is an impetus for educational reform. It is not simply a subject that needs to be learned, nor is it just a supplement to traditional education; it is also an essential factor that propels change across the whole education system. The goals, forms, and methods of school operation have all undergone significant changes as a result of the present trend in education toward the integration of ICT and education.

Disclosure statement

The author declares no conflict of interest.

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