



The Role of Information and Communication Technology in Enhancing Teaching–Learning Processes in School Education

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Abstract

Information and Communication Technology (ICT) plays a vital role in strengthening teaching–learning processes in school education by transforming traditional instructional practices into more interactive, flexible, and learner-centered approaches. The integration of ICT in classrooms enhances access to diverse learning resources, supports innovative pedagogical strategies, and facilitates effective communication between teachers and students. Digital content, collaborative platforms and data-driven assessment tools contribute significantly to improving student engagement, motivation, and learning outcomes. From a constructivist and socio-constructivist perspective, ICT encourages active learning, critical thinking, and collaboration while enabling differentiated instruction and inclusive educational practices that address varied learner needs. At the same time, effective use of ICT depends on several enabling conditions, including adequate infrastructure, reliable access to digital resources, curriculum alignment, and teachers' professional competence. Persistent challenges such as limited technological facilities, insufficient training opportunities, and disparities in access continue to restrict the full realization of ICT's educational potential, particularly in public school systems. When supported by appropriate policies, continuous professional development, and sound pedagogical frameworks, ICT becomes a strategic tool for enhancing instructional quality and enriching students' overall learning experiences. Thus, meaningful and systematic integration of ICT is essential for achieving sustainable improvement in school-level teaching and learning.

Keywords: Information and Communication Technology, Teaching–Learning Process, School Education, Student Engagement, Pedagogical Innovation, Curriculum Alignment, Digital Assessment.

1. Introduction

The information and communication technology (ICT) is changing and transforming classroom teaching and learning processes over the past few decades worldwide. Teaching and learning are evolving rapidly with the use of ICT in classrooms, which applies various technologies to advance teaching processes, disseminate knowledge, and facilitate learning. ICT has become an essential part of the school educational system globally, spanning content delivery, continuous assessment, and learning evaluation. Having access to ICT in school can lead to significant improvement in teaching and learning processes (Abdullahi, 2013).

In Ghana, an assessment of the role of ICT in secondary schools demonstrates that ICT has become a medium of teaching and learning and provides opportunities for both teachers and learners to engage in the information and technology age. It fits into the 21st-century classroom and furthers

the school's educational objectives. The implementation of ICT in Ghanaian secondary school education has improved the teaching and learning experience and demands new teaching method and approaches, however, challenges persist regarding the adoption and integration of ICT. Difficulties arise from information communication technology illiteracy among teachers and inadequate ICT facilities and resources in schools. Such challenges thwart all efforts of effective teaching and learning activities (Johnson Dei, 2018).

Thus, this research aims to investigate the ICT role in teaching-learning processes in government schools in Ghana. The study selects three public schools in Accra as case studies to undertake a qualitative research design with a focus on two questions: "What roles do ICT resources play in the teaching-learning process in selected public schools in Accra" and "What challenges do teachers face in the use of ICT in teaching-learning processes in selected public schools in Accra?" The overall justified inquiry reflects upon the application of ICT tools in basic public school education to determine impacts on student engagement instruction dynamics.

2. Conceptual Framework

Integrating information and communication technology (ICT) in education is a catalyst affecting education delivery. Multiple objectives are achievable using ICT, particularly pedagogical transformation, educational accessibility, and enhanced learning outcomes. Empirical studies indicate a favorable shift in ideas on using ICT in schools. UNESCO insists on equipping learners with education spanning knowledge, skills, and attitudes to navigate contemporary challenges. Schools must adopt a new curricular design and pedagogical methods emphasizing twenty-first-century skill development, worldwide issues, social participation, and the use of digital technology. The previously cited ICT objectives correspond with the Ministry of Education and Culture's (MOEC's) desire to enrich students' lives in Indonesia by integrating twenty-first-century skills and implementing profound educational change, including curriculum and industrial reengineering policies. Curriculum design incorporates important aspects of an education system, making it crucial in the teaching-learning process. ICT exerts a prominent influence on curriculum and pedagogy. The rapid advancement of ICT facilitates convenient information and communication development, motivating approaches to pedagogy, curriculum, and assessment (Corazon Saturnina A Castro, 2019). Curriculum and pedagogy transformations enabled by ICT correlate and contain many educational units adaptively formed through the use of ICT. One form of exposure to ICT tools concerns the sharing of training, experience, and capacity building.

The application of contemporary technology and ICT in the curriculum emphasizes competencies in higher-order thinking, creativity, and critical thinking. Pedagogy comprises complex activities that enable students to learn and develop. Pedagogy applies different methods and styles to assist students in the teaching-learning process. Technology fosters innovative pedagogical development to aid students through shared software, application, teaching aid preparation models, and training for materials and digital assessments. They motivate teachers to apply instructional methods facilitated by ICT tools for curriculum improvement, mutual sharing capacity enhancement, digital assessment tools and materials preparation, content development capacity maintenance, and curriculum modification. The new curricular approach complements and constitutes an essential part of pedagogy demanding similar modifications in ICT application and choice. Pedagogy corruptly handles the development model and conditions for successful ICT integration, such as school readiness for all ICT aspects affecting educational means. Frameworks specifying conditions and available pedagogies accommodating recent curricular concepts are valuable (Agalo & Oluoch, 2014). Major undertakings in combined case studies across contexts examine ICT application in each adapted pedagogical model as extensive support and awareness of the choice taken. Cases clarify pedagogical intentions in ICT selection and engagement depth with curriculum dictates or guidelines. Adaptable and ready-to-use contributing pedagogies for curriculum practice depict extensive openness in ICT application, outreach limited to particular topics, and widespread subject engagement in curriculum enactment.

Effective ICT use among students has similar issues. Understanding ICT utilization by students attending education programs at the Faculty of Education remains essential. Education

establishments frequently face difficulties in program development and improvement and in determining students' major course-selection tendencies. Students exhibit various preferences toward ICT tools or services enabling studies. Students respond to instructional methods, receiving and consulting materials, gathering information via curriculum organization, and acquiring educational support through guidance, advice, and agendas supported by other decision respondents (Ahmad Khan et al., 2011). Pedagogically, the definitions of ICT-related concepts furnish clarity on maintained ICT components. The expression educational refers to functions purposefully delivered or accomplished by ICT. Well-prepared engagements for each respondent support better uptake by enabling wider channel reach and targeted content aimed at additional beneficiaries inside or outside the curriculum track.

3. ICT Tools and Pedagogical Models

Schools deploy varied tools to mediate teaching–learning processes such as content, management, feedback, assessment, and collaboration, prompting the development and adaptation of pedagogical models (Atuahene, 2019). These tools can be grouped into digital content and resources, interactive and collaborative learning environments, and data-driven instruction and assessment, each connected to different pedagogical models.

The first category includes types of digital or digitized educational materials such as curriculums, textbooks, videos, images, simulations, tools for producing content, discovery environments, open educational resources, and educational games. Quality, relevance, and accessibility are key criteria for choosing digital content, along with aspects such as copyright and licensing. Standards, whether formal or informal, help educational settings select freely available resources. Adopting content aligned with curriculum standards offers predictable opportunities for integration, especially in schools with clearly defined programmes.

Interactive and collaborative learning environments facilitate content and class management by distributing materials, timing activities, collecting submissions, organizing dialogue, and enacting unique instructional designs. The growing range of platforms supports diverse collaboration workflows and therefore different pedagogical models. Content management systems, learning management systems, and networks also create space for resources and interaction, simplifying resource sharing among educators.

3.1. Digital Content and Resources

To facilitate teaching–learning, school ICT may provide teachers and students with digital content and resources. These resources help convey subject matter, clarify concepts, stimulate discussion, and incorporate current knowledge and professional practice into the curriculum (Sharma et al., 2011). Various types of content are available: teaching and learning plans, texts, images, animations, simulations, interactive exercises, and assessments. Resources differ in quality, and well-established criteria exist for assessing their suitability for educational use (Corazon Saturnina A Castro, 2019). Such assessments should address alignment with academic standards, accessibility for learners with special educational needs, and compliance with legal regulations (including intellectual property, copyright, and open licensing). They should also evaluate the inherent value of resources, including their pedagogical appropriateness, engagement potential, and potential to promote meaningful discussion and extend active learning beyond the primary learning environment.

3.2. Interactive and Collaborative Learning Environments

Information and communication technologies (ICTs) have changed how teaching and learning take place, providing new ways to create interactive and collaborative learning environments. Digital environments provide several possibilities for both synchronous and asynchronous collaboration, enabling learners to work together, to share and critique each other's work, and to provide feedback (M. Slattery & Cleary, 2018). Collaborative workflows such as peer assessment, project-based learning, and co-editing, supported by networked technologies, allow collaborative work on a larger scale (Mangino, 2018). ICT-supported interactions have important benefits, such as promoting deep

learning, increasing student motivation, and helping develop essential communication and collaborative skills. However, collaborative teaching and learning models also present challenges. Students' limited experience with collaboration may inhibit large-scale adoption; learning activities can become fragmented without oversight of design principles; and rigor is sometimes sacrificed when teachers aggregate students' input without synthesis, editing, or reformulation.

Education increasingly relies on the use of digital interactive and collaborative learning environments supported by networked ICTs. These extend beyond the traditional approach of simple teacher-student interactions to incorporate student-student (among peers), student-content (engagement with course materials), and student-external-expert connections, utilizing a wider network of educational resources. Adopting a socio-constructivist or connectivist perspective places greater emphasis on sustained connections and more generous definitions of participation. Educational practices that privacy and security concerns allow should foster student-student, student-content, and student-external-expert connections and reflection on the influences of these networks on learning.

3.3. Data-Driven Instruction and Assessment

Data-driven instruction and assessment utilize various sources of data, such as students' backgrounds, academic progress, and performance, to make informed decisions about teaching and learning. Data sources include summative assessments (standardized tests administered periodically, e.g., state assessments), formative assessments (in-class tests, quizzes, observation, online learning systems), and basic usage statistics (classroom interaction, homework completion) (Sharma et al., 2011). These sources can point teachers toward the students most in need of help or pedagogy adjustments, do not intervene too early in the learning process, provide insight into the effectiveness of a new resource, and give actionable feedback before the next school year or when introducing new content on an established topic (Corazon Saturnina A Castro, 2019). In these scenarios, data flowing from students to teachers and/or from teachers to content providers creates a simple feedback loop.

More advanced data-analysis strategies include clustering tools and expert systems that provide task-specific recommendations for instructional decision-making, track student growth toward standards, adjust instruction based on students' next-recommended learning modes, examine links and process models that predict which teaching and learning activities most influence each student's knowledge, and verify whether chosen activities are effectively used by learners.

4. Impacts on Teaching and Learning

The rapid advancement of information and communication technology (ICT) has engendered substantial transformation in many spheres of human activity, with education standing out as an area where ICT integration promises significant improvement. ICT facilitates teaching and learning through enhanced access to information, improved communication among teachers and learners, and timely, flexible feedback that adjusts instruction to students' evolving needs. Socio-constructivist theorists support these views, positing that the proliferation of diverse communication platforms and media has redefined how knowledge and understanding are formulated, exchanged, and evaluated (Abdullahi, 2013), and that technology-aided environments invigorate student engagement and motivation by enabling exploration, collaboration, and feedback (Atuahene, 2019).

Teaching and learning practices in schools constrain the comprehensive integration of ICT into pedagogical settings. Various countries and educational authorities have conducted analyses of the impact of ICT on teaching and learning. Many studies consistently confirm that ICT and relevant pedagogical models exert a significant influence on both teaching and learning. Above all, ICT has been shown to enhance student engagement and motivation through better access to meaningful content, diversified instructional stimulus, and increased opportunities for interaction during the learning process (Sharma et al., 2011).

4.1. Student Engagement and Motivation

The impact of ICT tools on pedagogy, student engagement and motivation is examined through variable analysis of student engagement metrics undertaken on educational and social platforms. There are numerous indications that the education sector has not adapted adequately to the rapid evolution of social media and microblogging trends. Deficient ICT training and unpreparedness to integrate social media platforms into the education mechanism are further observed. Student participation and enthusiasm for assignment completion were positively affected by the introduction of ICT-based tools designed for collaborative learning and adapted to multimedia-oriented learning styles. A significant increase in student motivation levels was reported when ICT tools promoted social interactions, fostered student-student engagement, and stimulated instant, recurrent interaction with instructors (Farooq Hashmi et al., 2019).

4.2. Learning Outcomes and Achievement

The process of teaching and learning is central to the educational system. The effectiveness of the process determines the learning outcomes of students, which can be assessed in terms of academic achievement. Teaching refers to the method used by the teacher to facilitate the learning process, while learning is the second eye of the learning process, which refers to the actual activities carried out by students in order to achieve the expected learning outcomes (Sharma et al., 2011). The rapid advancement of information and communication technology (ICT) and its implementation in various sectors have inspired many educational institutions, including colleges and universities, to incorporate ICT tools into the teaching–learning process (Atuahene, 2019). This innovative approach in education not only aims to increase performance in academic subjects, but also seeks to enhance the engagement and motivation of students during the teaching–learning process. Both aspects deserve attention from practitioners in the education sector.

4.3. Differentiation and Inclusive Education

Teaching and learning strategies have changed over time to respond to social demands such as globalisation, the emergence of the knowledge society, cultural diversity, and citizenship education. Educational institutions are required to prepare students to participate actively in a diverse, interconnected, complex, and rapidly changing world, and to take an active role in giving meaning and value to their own lives.

In this regard, inclusive education and the 21st-century approach seem to share similar principles and objectives; being the hypothesis that the former represents a starting point (something rather new for many countries) and the latter a natural evolution of the former (a follow-up already under discussion in several countries). These two topics can be considered as a continuum in the education debate in certain countries. Together with the increasing diversity of students within classrooms and societal calls for greater equity, the demand for accommodating students' learning needs is reflected in teaching and learning policies. Accordingly, it is hypothesised that there is an explicit link between efforts made toward achieving inclusive education and efforts made toward accommodating students' learning preferences.

Educational institutions are required to prepare students to participate actively in a diverse, interconnected, complex, and rapidly changing world, and to take an active role in giving meaning and value to their own lives. Teaching–learning processes may illustrate common principles at system, institutional, and classroom levels and how these processes need to evolve to respond to both educational issues, features of the learner-determined instructional design and pedagogical delivery process, and challenges—certainly in the educational field, but also in—associated with inclusive education, differentiation, and accessibility in the knowledge society, learning economy, and digital economy (Corazon Saturnina A Castro, 2019).

The systemic approach remains a pertinently structured methodology applied to educationally significant topics, leading to readily applicable models such as the educational system as an access-modulated area. Educational systems are to be designed, established, and sustained as systems with no lack of pertinence, though with varying degrees of autonomy towards higher-level systems. Under

access-modulated area modelling, quality and equity become critical at system level; the two attributes are strongly interrelated (Montenegro Rueda & Fernandez Cerero, 2019).

5. Implementation Considerations in School Settings

Public and private education systems around the globe recognize that enhanced teaching–learning processes involving school-based children can contribute significantly to the achievement of specific national objectives. Consequently, various policies, plans of action, projects, and initiatives to promote the implementation of information and communication technology (ICT) in school education are actively undertaken.

In developing countries, physical access to ICT infrastructure and the continuous supply of energy are often problems. Rural schools are particularly disadvantaged. Few governments provide funds for the continuous maintenance of the equipment. During school holidays, hardware and software are inevitably subject to deterioration, and even breakage. Fewer services are readily available to keep the equipment operational again. In urban settings, the workplace ICT installed cannot be used freely. Schools and universities as workplaces are governed strictly by common regulations.

Local electricity systems are often relatively cheap and accessible to the community. A combination of institutional arrangements involving monthly payment or free access, and a mix of fee schedule awareness-raising, could enhance the pace of entrepreneurship education and other creative activities. By using the non-school period call-to-join-message in campus-wide communication systems, academic advertisements could enhance the outreach effect, especially the arrangements of interactive or enjoyable learning processes. Many creative activities focus on promoting certain content, requiring central communication within each kind of group (Atuahene, 2019).

5.1. Infrastructure and Access

The influence of information and communication technology (ICT) on the teaching–learning processes of learners in formal schooling has been investigated at different levels of formal education, including in pre-primary, primary, and secondary schools. However, there has been limited research examining the teaching–learning processes of learners in specific schooling levels and wider school education systems beyond the primary schooling level. A critical review of existing literature and reports reveals the range of ICT tools available, widely endorsed pedagogical models accessing ICT digital solutions, and the various educational opportunities ICT facilities have permitted. Emerging empirical evidence suggests that educational investments in ICT facilities have a relatively high positive impact on the teaching–learning processes of learners within the schooling trajectory. By applying insights into how ICT drives educational reform to curriculum documents and professional support within a school system, it is possible to provide directed guidance for the successful implementation of national ICT strategies at the school level.

The role of ICT in enhancing the school-education teaching–learning process has been investigated from multiple theoretical perspectives, namely, constructivism, social learning. These perspectives have been elaborated to define key constructs for underpinning the analysis, including the nature of ICT, the relevance of access, and anticipated learning and educational outcomes (e.g., attainment, engagement, motivation). The theoretical coverage has been developed into a preliminary framework defining key propositions to guide further research.

Numerous studies have examined the impact of ICT in educational settings, revealing numerous benefits and advantages. Nevertheless, implementation continues to face various challenges, especially within formal schooling systems. Critical prerequisites for effective integration include a broadened understanding of the diverse types and categories of technologies encompassed by ICT, augmented models of professional development and teacher preparation, access to high-quality content and continuous support from professional communities, and the underlying pedagogical models embraced and adopted. (N. Mbatia, 2011) (Josephine Kirimi, 2014) (Corazon Saturnina A Castro, 2019)

5.2. Teacher Preparation and Professional Development

Improved Information and Communication Technology (ICT) integration in school education, through digital content, learning resources, and methods enhances teaching and expands access to learning opportunities. Teachers, as facilitators of student progress, are critical to the effective implementation of ICT (I. Mwangi & Khatete, 2017). Evidence from several contexts suggests that, to fully realize the potential of ICT, teachers must develop a professional understanding of the use of digital tools and open educational resources within pedagogical frameworks such as the Technological Pedagogical Content Knowledge (TPACK) model and its evolutionary adaptations. Teacher preparation and training models must therefore help educators link information, communication, and subject content to learning processes. Continued institutional support, a collaborative culture, and professional-learning communities remain vital in this respect.

5.3. Curriculum Alignment and Standards

In recognition of the potential benefits of integrating ICT into learning and teaching, it is essential to align that integration with curriculum design processes such as those indicated in the Australian Curriculum: Technologies. For many school systems, undertaking such a strategy requires the curriculum to be aligned to externally mandated content standards and/or performance standards. These frameworks reflect high-level learning outcomes that learners are expected to collectively achieve at designated stages of their schooling. The frameworks provide guidance to educators and policy-makers by clarifying the knowledge, skills and understandings that are considered important. In Australia, each state or territory has its own curriculum specifications that collectively present around 80% of the required alignment to the national curriculum (Corazon Saturnina A Castro, 2019). The alignment of ICT integration with the states' curriculum specifications is therefore appropriate. The Australian Curriculum: Technologies provides a basis for engaging with the discipline of Technology, specifically how students may create ideas and solutions and be assisted in devising, designing, developing, evaluating and implementing them. The continued acceleration in the integration of ICT provides opportunities for schools to devise, design and develop solutions in ways commensurate with the times, and therefore remains an appropriate focus.

5.4. Assessment Practices and Feedback

Assessment is crucial in education for evaluating the effectiveness of teaching practices, developing curriculum programs, supporting instructional and curricular practices, and enhancing student learning (Kerry Earl Rinehart & (Bill) Grant Ussher, 2012). In school settings, ICT facilitates both formative and summative assessment methods as well as the provision of feedback. Assessment without feedback, whether it be formative or summative, has limited potential to assist student learning (Ekara Helfaya & O'Neill, 2018). Feedback supports student learning by narrowing the gap between current and desired performance. Computer-based assessment and feedback, while not a substitute for effective teaching, can enrich the educational experience (Helfaya, 2019). The mode of assessment—summative or formative—does not restrict the use of ICT as a complement.

6. Equity, Ethics, and Digital Citizenship

Equitable access to ICTs, facilities, resources, and content among students, along with the need for ethical behavior in today's digitalized society, constitute key aspects of digital citizenship in contemporary education. Disparities persist in homes and communities, with low-income households in many jurisdictions lacking the equipment, hardware, and web connections necessary for students to engage in digital education, much less to extend their learning beyond classes. Vulnerable students in one jurisdiction were found to be disconnected from their school's digital-digital educational ecosystem. The differences affected both the time available for students to complete educational requirements and the set of inputs—coursework to download or return, and auxiliary material to consult or include in homework—accessible to students. Efforts to close such divides are highly desirable. ICTs can rarely be relied on to deliver instruction on their own; effective educational practices—some of which ICTs can support—are still required to enhance learning and ensure the maximum usage of ICTs (Novella-García & Cloquell-Lozano, 2021).

7. Challenges and Mitigation Strategies

Despite the immense potential for ICT to transform education, its integration remains hindered by numerous obstacles—systemic, individual, and economic—in both developed and developing countries. Teachers at all levels have difficulties applying ICT in the pedagogically sound manner necessary to support individual, collaborative, and active learning and to encourage higher-order thinking skills (Agalo & Oluoch, 2014). Current limits to ICT integration among school teachers in Nairobi include insufficient pedagogical training, resistance to change, lack of exposure to ICT-enhanced teaching practices, too much emphasis on the role of ICT, and neglect of teacher-learner interaction (Amuko et al., 2015).

Underscoring these systemic, institutional, and cultural factors are persistent problems related to infrastructure, digital tools and materials, ICT leadership, access to technical support, salaries, and technical skills. Schools in both urban and rural areas require up-to-date hardware, software, and learning resources to enable effective ICT integration. Increased and sustained investment to create and maintain adequate infrastructure remains essential. Teacher training and ongoing professional development opportunities, ICT literacy, pertinent and workable curricula, curriculum alignment, and good teaching also remain pressing issues.

8. Future Directions

Accelerated digital transformation in the 21st century prompted governments and educational institutions worldwide to implement strategic plans to enhance learning processes through Information and Communication Technology (ICT) in education. As an enabler of new pedagogical practices, ICT holds the potential to revolutionize teaching and learning methods on a large scale (R Mathipa & Mukhari, 2014). However, an evident gap between the national educational strategy and actual implementation remains. The Kenyan constitution of 2010 outlined the right to free and compulsory basic education as an effective response to the demand for quality learning, improving student retention and participation through the introduction of the 2-6-3-3-3 education curriculum (Josephine Kirimi, 2014). Designed to meet global standards and create a national framework, the National Education Sector Plan (NESP) formed an integral aspect of the government's strategy to enhance school infrastructure and improve learning conditions. A model education sector support programme funded through various donor agencies accompanied the NESP project. Yet, the absence of a comprehensive information and communications technology policy to facilitate monitoring and evaluation of capacitation efforts still impedes potential ICT integration, despite a proven positive relation.

9. Conclusion

Information and communication technology (ICT) is an effective enabler to attaining high-quality education and improving teaching and learning methodologies in schools. It is a recognized fact that educational institutions are more successful and of higher quality when the latest ICT tools, systems, and processes are embedded. ICT provides an unprecedented opportunity to complement the traditional teacher-centered approach of content delivery with a more sustainable, participatory, and inclusive learning environment. The integration of digital content and resources, interactive and collaborative environments, and data-driven feedback on instructional design into school education gives learners access to a wealth of information and knowledge. It allows them to remain constantly engaged and motivated, signals shifts in engagement, enables meaningful and effective participation in experiential activities, and ensures active documentary support across a range of subjects and formats. The vast amount of electronic data in the form of student activities and interventions also constitutes a feedback loop capable of generating new knowledge during the pedagogical process and guiding further instructional decisions.

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