# An Investigation of Integrating Information and Communication Technology into Teaching Science and Mathematics in Sudanese Secondary Schools

**By**

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## Abstract

*The purpose of this paper is to explore the extent to which Information and Communication Technology (ICT) is integrated into the teaching and learning of mathematics and science in Sudanese secondary schools. A descriptive survey design was used, with questionnaire and interview as instruments to collect the data. A sample of 50 secondary schools from the Khartoum state was selected using a stratified random sampling technique. The data-collection instruments were issued to 100 science and math teachers from identified schools (50 schools). A total of 84 questionnaires were completed and retained for analysis. According to the findings of the study, secondary school math and science teachers are not yet ready to integrate ICT into their classrooms due to a number of obstacles, including the unavailability of infrastructure, limited time for planning and the lack of support from school administrators. The findings also showed that most teachers have negative attitudes regarding ICT integration in the teaching and learning of math and science subjects.*

**Keywords:** *ICT use, infrastructure, integration, secondary schools.*

## 1. Background to the Study

Technologies such as Information and Communication Technology (ICT) are a powerful force driving, economic, social, and educational reforms. As a developing country, Sudan cannot afford to remain passive in regard to ICT if it is to compete in the global economy. More than ever, the advent of the knowledge economy and global economic competition compel governments to prioritize educational quality, lifelong learning, and the provision of educational opportunities for all. Policymakers widely accept that access to ICT in education can help individuals compete in a global economy by creating a skilled work force and facilitating social mobility (UNESCO, 2014). The use of ICTs in education has become essential for providing opportunities for students to learn. In addition, the use of ICTs in teaching and learning has been shown to aid teachers and students to work efficiently in this information age (Salehi & Salehi, 2012).

Today, many Sudanese secondary schools (particularly the private ones) strive to integrate appropriate ICT tools into their classrooms. Despite the numerous investments in hardware, software, and supporting ICT resources, little is known about integration. Moreover, teacher training appears to be a constraint (Ahmed, 2015). Although the ICT implementation policy in Sudan was launched in 2002 and most schools have computers and Internet connectivity, the majority of teachers and students do not really understand what to do with the computers installed in their labs. This shows that the integration of ICT into schools was not carefully planned, and the implementation was a top-down initiative that did not take into account the involvement of local policies (Ahmed, Howie & Osman, 2013). The integration of ICT in teaching and learning is a new domain in Sudanese schools. The technology keeps changing, and there is very little literature and research regarding the integration of ICT into Sudanese secondary schools.

### Theoretical Perspectives in ICT integration
The integration of ICT in teaching and learning is a complex process. Various competencies must be developed throughout the education system for ICT implementation and integration to be successful. The

research by Law, Pelgrum and Plomp (2008) on ICT integration highlights the need for change within the classroom setting, with a move away from teachers as lecturers and students sitting passively. In classrooms where ICT is successfully integrated, students are actively engaged in "constructivist activities" using ICT to find information, collaborate with others, and share their knowledge with others within and outside the classroom. There is also a growing belief that ICT can play a major role in helping learners acquire the 21st-century skills of creativity, innovation, critical thinking, problem-solving, communication, and collaboration (Bosco, 2009).

The Second Information Technology in Education Study "SITES-M3" by Plomp, Pelgrum and Law (2007) reports that the incorporation of ICT in teaching and learning in schools is influenced by a number of factors external to the school, such as the visions and prescriptions that are reflected in the national curricula and national policies on ICT in education. However, the way in which ICT is integrated into teaching and learning within schools depends on numerous factors, such as (a) vision on education or the teaching/learning process, (b) knowledge and skills of the teachers, (c) availability of content (educational software), and (d) the hardware infrastructure. In addition, Hooper and Rieber (1995) suggest that using educational technology means applying ideas from various sources to create the best possible learning environments for students. They note that educational technologists ask questions such as how a classroom might change or adapt when computer-based learning is integrated into the curriculum. They propose a simple model as a tool to help explain the patterns of adoption by teachers after they are first introduced to educational technology. The model describes five hierarchical stages for technology integration, through which all teachers must progress in order to integrate the technology effectively: familiarization, utilization, integration, reorientation, and evolution.

Although the integration of ICTs contributes to a number of benefits in the teaching of science and mathematics, teachers will not be able to use ICT effectively if there are factors that hinder their pedagogical practices. Yan, Xiao and Wang (2012) summarize the barriers that hinder the effective integration of ICTs into teaching and learning by teachers, including inadequate access to the technologies, lack of funding, lack of digital resources and infrastructure, and inadequate training and staff support. Consequently, knowledge of the extent to which these barriers affect teachers in integrating ICT into teaching and learning will help in making decisions about how to deal with these barriers.

*Purpose of the Study*
This study explores the extent of the integration of ICT into the teaching and learning of mathematics and science in Sudanese secondary schools and examines the obstacles to using ICT in math and science teaching at the secondary school level.

*Research Questions*
The study was guided by the following research questions:
1. To what extent have mathematics and science secondary schools teachers integrated ICT into their classrooms?
2. What are the obstacles that prevent the integration of ICT into teaching process in Sudanese secondary schools?

## 2. Methodology

The study was conducted using a quantitative approach. In addition, this study used a survey approach to investigate the extent of ICT integration into the teaching and learning of mathematics and science in Sudanese secondary schools. The study used a questionnaire to collect the data from the schoolteachers.

*Research Sample*
A stratified sample of 50 schools was drawn from secondary schools in Khartoum state. The sample targeted for this study was comprised of science and math teachers from secondary schools. A total of 84 science and math teachers participated in this study.

*Research Instrument*

This study used a survey approach to collect the data. Altogether, there were 13 questions in the questionnaire. The first 4 questions were used to elicit personal information about the respondents, such as age, gender, highest level of education, and years of experience. Questions 5, 6, and 7 were used to learn how often teachers used the scheduled learning time of the class for learning activities, how often they conducted learning activities, and whether they used ICT for those activities. In Questions 8 and 9, the respondents were asked to indicate which types of assessment methods were used for assessing learner performance and to determine whether the respondents used ICT to carry out the assessments. Questions 10, 11, and 13 were used to learn more about obstacles to using ICT in teaching.

## 3. Results

*Teacher practices*

The respondents were asked whether they had used scheduled learning time for the activities as well as whether they used ICT when these activities took place.

**Table 1: Mean Scores for the ICT Activities in the Scheduled Learning Time in the Schools**

| Learning activities | Learning activities | | | ICT use | |
|---|---|---|---|---|---|
| | N | Mean | Std. Error | Mean | Std. Error |
| Extensive courses | 84 | 1.89 | 0.102 | 1.23 | 0.046 |
| Producing creative works | 84 | 1.62 | 0.081 | 1.14 | 0.038 |
| Self-accessed courses / learning activities | 84 | 2.14 | 0.103 | 1.17 | 0.041 |
| Scientific research | 84 | 2.02 | 0.066 | 1.32 | 0.051 |
| Teachers' lectures | 84 | 2.13 | 0.111 | 1.19 | 0.043 |
| Exercises to practice skills and lesson procedures | 84 | 3.11 | 0.110 | 1.14 | 0.038 |
| Discovering mathematics principles and concepts | 84 | 2.76 | 0.109 | 1.18 | 0.042 |
| Studying natural phenomena through simulation | 84 | 1.88 | 0.092 | 1.14 | 0.038 |

Table 1 shows that the primary ICT activities used in the scheduled learning time were the exercises to practice skills and lesson procedures (mean= 3.11) and discovering mathematics principles and concepts (mean= 2.76). The table also shows that producing creative work was the weakest activity in scheduled learning time regarding ICT use in mathematics and science subject. Overall, however, the use of ICT in all these activities was very limited.

The respondents were asked whether they used ICT in their assessment processes during the school year. The majority of the respondents did not use ICT in their assessment processes. This section presents the mean scores of the use of ICT in various assessment methods used by teachers in the school sample.

**Table 2: The Use of ICT in Assessment**

| essment methods | Present assessment | | | ICT use | |
|---|---|---|---|---|---|
| | N | Mean | d. Error | Mean | Std. Error |
| Written test/examination | 84 | 2.00 | 0.000 | 1.20 | 0.044 |
| Written task/exercise | 84 | 2.00 | 0.000 | 1.10 | 0.032 |
| Individual oral presentation | 84 | 1.87 | 0.037 | 1.07 | 0.028 |
| Group presentation (oral/written) | 84 | 1.85 | 0.040 | 1.08 | 0.030 |
| Project report and/or (multimedia) product | 84 | 1.21 | 0.045 | 1.10 | 0.032 |

Table 2 shows that the most common assessments used in the school sample were written test or examination (mean= two) and written task or exercise (mean= two). The table also shows that few teachers used project report and/or (multimedia) product assessment (mean= 1.12). However, the table shows that only a few teachers used ICT in these assessments.

The respondents were asked about the learning resources they used in the learning activities or assessments.

The teachers were asked to indicate whether they used ICT tools in their teaching and learning. Table 3 presents the teachers' responses.

**Table 3: Learning Resources Used by the Teachers in Teaching and Learning**

|  | essment methods using ICT | | |
|---|---|---|---|
| rning resources | N | Mean | Std. Error |
| Tutorial/exercises software | 84 | 1.54 | 0.071 |
| General office suite | 84 | 2.00 | 0.000 |
| Multimedia production tools | 84 | 1.21 | 0.059 |
| Simulations/modeling software/digital learning games | 84 | 1.19 | 0.049 |
| Digital resources | 84 | 1.20 | 0.063 |
| Mobile devices | 84 | 1.17 | 0.044 |
| Smart board/interactive whiteboard | 84 | 1.11 | 0.045 |

Table 3 shows that general office suite had the highest mean score among the ICT learning resources used by the teachers (mean= 2.00). The lowest mean score among the learning resources used by the teachers was for smart board and/or interactive whiteboard (mean= 1.11).

*Learners' practice*
The teachers were asked to indicate to what extent their learners engaged in class activities and whether their learners used ICT for these activities. The results are shown in Table 4 below.

**Table 4: Learner Practice**

|  |  | Present | | ICT use | |
|---|---|---|---|---|---|
| ner practice | N | Mean | Std. Error | Mean | Std. Error |
| Learners learning during lessons at their own pace | 84 | 2.51 | 0.106 | 1.83 | 0.041 |
| Complete worksheets, exercises | 84 | 2.90 | 0.094 | 1.08 | 0.030 |
| Give presentations | 84 | 1.79 | 0.094 | 1.05 | 0.023 |
| Determine content goals for learning | 84 | 2.02 | 0.090 | 1.13 | 0.037 |
| Explain and discuss ideas with teacher and peers | 84 | 2.64 | 0.091 | 1.12 | 0.036 |
| Answer test or respond to evaluations | 84 | 3.19 | 0.090 | 1.08 | 0.030 |
| Self and/or peer evaluation | 84 | 2.46 | 0.113 | 1.06 | 0.026 |
| Communicate with outside parties | 84 | 1.62 | 0.081 | 1.10 | 0.032 |

As shown in Table 4, the most frequently employed learner practices used in class activities were answer test or respond to evaluations (mean= 3.19) and complete worksheets, exercises (mean= 2.90). The table also shows that communicate with outside parties had the lowest mean score among the learners' practice activities. However, the use of ICT in all learners' practices in class activities was very limited. The interview showed that the majority of the respondents complained that they had inadequate skills and insufficient ICT facilities to consider ICT integration. They asserted that it was too difficult for them to

integrate ICT tools into teaching and learning activities. Example of their negative attitudes: "I think it is a dream to integrate ICT in teaching...I do not care." "I am too old for ICT integration."

## 4. Discussion of Results

The purpose of this study is to investigate the extent of the integration of ICT into the teaching and learning of mathematics and science in Sudanese secondary schools. This will enable Sudanese secondary school policymakers to make judgments on the current situation regarding the use of ICT and to reflect upon possible improvements that could be effected in the near future. This study has found that the activities primarily used during scheduled learning time were the exercises to practice skills and lesson procedures. In contrast, producing creative work was the least used activity. However, most mathematics and science teachers are not familiar with and do not use ICT in these activities. The utilization and integration of ICT tools can assist teachers and their students in acquiring mathematics and science competency as well as enhance the quality of their learning experience. The integration of ICT tools into the teaching and learning of mathematics and science has been found to bring other benefits as well. By motivating learners and increasing self-esteem and confidence, ICT can enhance learner interaction, verbalization, and involvement in collaborative learning.

The success of ICT integration into teaching and learning activities is largely dependent on the support given by the school principal (Pelgrum & Anderson, 2001). The majority of the respondents noted negative experiences in relation to a lack of support from the principals. One teacher commented, "… my principal is more concerned about the examination results rather than ICT integration." Another commented, "…my headmaster all the time talks about better grades for the Sudanese Secondary Certificate. He is not interested in using computer in teaching and he doesn't repair computers which are out-of-order." Assessment is an important driver in education and, if not well managed, can become an obstacle to innovation. As ICTs are embedded in learning and teaching reform processes, they can be effectively used in conjunction with other methods in assessments. The present study shows that the most common assessments used in the school sample are written test or examination and written task or exercise. Very few teachers use project report and/or (multimedia) product assessment. However, schools have few teachers who use ICT in these assessments.

Many authors report that ICT has been used as an instructional aid (i.e., computer-assisted instruction) to help learners learn other subjects and to help teachers in their administrative works (Pelgrum & Anderson, 2001; Pelgrum & Law, 2005). In some countries, ICT is now at the center of education reform efforts that involve its use in assessment, coordination with changes in curricula, teacher training, and pedagogy [25]. The findings show that although there are a number of assessments used by teachers in schools, such as written tests/examinations, written tasks/exercises, group presentations (oral/written), assessment of group performances on collaborative tasks, and multimedia products, very few teachers use ICT in these assessments. In addition, the study found that general office suite was the ICT learning resources used most commonly by the teachers. However, many teachers did not use other ICT learning resources tools in their teaching and learning. The resource least used by the teachers was smart board and/or interactive whiteboard. Concerning the link between ICT integration and ICT infrastructure, Lim and Ping (2007) suggest that the availability of ICT tools in schools creates a conducive learning environment for the effective integration of ICT in schools. The study also found that the most frequently used learner practices in class activities were answer test or respond to evaluations and complete worksheets, exercises. However, the use of ICT in all learners' practices in the class activities was very limited. If we compare these results with the integration of ICT into the educational systems in South African and Slovenian secondary schools, Khartoum schools have far to go. In addition, it was found that the most frequent problem was the insufficient number of computers. This finding is similar to the findings of the study conducted by Pelgrum (2001), who points out that most countries have not yet succeeded in realizing sufficient facilities to keep teachers up to date with new technologies to promote their integration into teaching and learning. The study also shows other non-material obstacles that most teachers have found

challenging to integrating ICT into instruction: scheduling enough computer time for students, insufficient teacher time, and the lack of supervisory and technical staff. The teachers' attitude toward using computers was an important factor and a key to the success of implementing and integrating ICT into instructional practices (Pelgrum & Plomp, 1991). This study showed that most teachers had a negative attitude toward using computers. The respondent teachers asserted that it was too difficult for them to integrate ICT tools into teaching and learning activities.

## 5. Conclusions and Recommendations

Two main limitations of the study were encountered: sampling and research. First, the 84 respondents were not intended to be a representative sample of the teachers in Sudanese secondary schools because of the lack of financial support and the political instability in Sudan. Rather, they were chosen as remarkable examples of ICT use in teaching and learning. This sample is obviously insufficient if the objective is to yield significant statistical conclusions. Second, while there were some studies conducted in a few African and Arab countries, there were few studies conducted in developing countries for comparison of ICT integration into teaching and learning.

The following recommendations were raised:
1. Develop a strategic plan to provide all secondary schools with good infrastructure facilities for successful ICT integration.
2. Improve the quality and functionality of the ICT equipment in schools (e.g., multimedia facilities: CD-ROM, CD-WRITER, sound card, video card, modem, USB driver, etc.) and provide Internet access to students and teachers for instructional purposes.
3. Encourage and support the development and design of educational software for all subjects.
4. Develop and promote a better understanding of pedagogical paradigm practice changes and evaluate existing strategies and initiatives in the context of achieving such changes.
5. Provide professional development support to school leadership teams, including principals, teachers, and computer coordinators, for strategic planning in managing change and to offer opportunities for staff development.
6. Encourage and strengthen the study of ICT in education colleges to enable teachers to use and integrate ICT into their teaching and learning effectively.
7. Support teachers' ongoing training in ICT skills and ICT pedagogical knowledge.

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