DIGITAL SCHOOL MODEL OF EXCELLENCE IN AFRICA: BASIC STUDY ON ICT INTEGRATION IN TEACHING AND LEARNING STEM IN CÔTE D'IVOIRE SECONDARY SCHOOLS

FINAL REPORT

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SUMMARY

ACRONYMS AND ABREVIATIONS

ADSI	African Digital Schools Intitiative
AFD	French Development Agency
APFC	Antenna of Pedagogy and Continuing Education
AUF	University Agency of Francophony
BAC	Bachelor's degree
C2D	Debt Reduction and Development Contract
CAFOP	Animation and Pedagogical Training Centers
CFIT	Chinese Funds in Deposit (UNESCO-CFIT)
CNMS	National Center of Scientific Equipment
COGES	Management Committee of Schools
CONFEMEN	Conference of Education Ministers of countries using French
CEPE	Elementary Primary Education Certificate
CP	Preparatory Course
CPPP	Preschool and Primary Education Advisor
DDENETP	Departmental Board of National Education, Technical and Vocational Education
DELC	Management of Schools, High Schools and Colleges
DPE	Directorate of Planning and Evaluation
DPFC	Directorate of Pedagogy and Continuing Education
DRENETFP	Regional Directorate of National Education, Technical Education and Vocational Training
DRH	Human Resources Department
DIPES	Directorate of Informatics, Planning, Studies and Statistics
DSPS	Directorate of Strategy, Planning and Statistics
DVSP	Directorate of Monitoring and Program Follow-up
E-Gouv	Electronic Governance
ENEACI	Digital School of African Excellence in Côte d'Ivoire
ENS	Higher Normal School
ENSEA	National School of Statistics and Applied Economics
ETFP	Technical Education and Vocational Training
FAD	Distance Learning
FOAD	Open Distance Learning
GESCI	Global E-Schools and Communities Initiative
IA	Assistant School Teacher
IEPP	Control of preschool and primary education
IFADEM	Francophone Initiative for Distance Learning Teachers
IO	Ordinary School Teacher
LT	Technical High School
MENETFP	Ministry of National Education, Technical Education and Vocational Training
MESRS	Ministry of Higher Learning and Scientific Research
MCENP	Ministry of Communication, Digital Economy and Post
NEPAD	New Partnership for African Development
ODD	Sustainable Development Goal

OMD	Millennium Goal for Sustainable Development
OIF	International Organization of the Francophony
PAMT	Medium Term Action Plan
PAPDES	Support Project for the improvement of learning and management of schools
PASEC	Program of Educational Systems Analysis of CONFEMEN
PSE	Education / Training Sector Plan
PSO	Compulsory Schooling Policy
PTF	Technical and financial partners
RESEN	State Report on the National Education System
SCAC	Service of Cooperation and Cultural Action (France Embassy)
STEM	Science, Technology, English and Mathematics
TBS	Gross enrollment ratio
TIC	Information and Communication Technology
TICE	Information and Communication Technology for Teaching
TNI	Interactive Digital Table
UNESCO	United Nations Organization for Education, Science and Culture
UNICEF	United Nations Children's Fund

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EXECUTIVE SUMMARY

The ICT pedagogical integration is now an inevitable reality in Africa where the use of digital resources for educational purposes are legion.

In order to succeed in these experiments and to ensure optimal exploitation of these resources, it is increasingly necessary to master the operating environment of these facilities in schools, and to strengthen the capacities of main actors and beneficiaries, namely, school heads, teachers and students.

Since September 2012, the Côte d'Ivoire government has initiated an education and training system reform through the use of digital resources. This aims at a deeper transformation and a high efficiency of education and training system.

Since then, various experiences have been undertaken involving different activities and a variety of actors in the national education and training system. It is in this context that the project "Digital School of African Excellence Côte d'Ivoire" (ENEACI) is initiated in Côte d'Ivoire. The ENEACI project is part of the African Digital Schools Initiative (ADSI, 2017-2019) promoted by GESCI (Global E-Schools and Communities Initiative).

This project meets the overall objective of the Government of introducing ICT and leveraging the effectiveness of this tool as leverage qualitative changes in the national education system

This basic study is to achieve an overview of ICT integration in secondary schools in Côte d'Ivoire.

The study is planned to answer the following four sets of research questions and objectives:

Research questions from the ADSI program:

1. Institutionalization: What is the overall situation of African Digital Schools Initiative (ADSI) project in terms of historical, educational, policy and reform factors that can support or limit implementation and expansion of ADSI project in Côte d'Ivoire?

2. Development of digital schools of excellence: what is the level of academic ability for ICT pedagogical integration into teaching and learning STEM in the classroom? Which policies at school level (micro) and out of school (macro) are in place to help make better use of ICT in the classroom? What were the deployment characteristics in terms of objectives, planning, support and resources for ADSI project expansion in schools in Côte d'Ivoire?

3. Development of teachers: what is the level of teachers' preparation for ICT pedagogical integration into teaching and learning STEM in the classroom? To what extent do teachers use ICT in STEM teaching practices in the classroom? What is the level of teachers competence for the professional integration of ICT in the classroom?

4. Learners: What are students' attitudes towards the use of ICT in STEM? To what extent do learners use ICT in STEM classroom activities, assignments and projects? To what extent do learners improve STEM outcomes with the integration of ICT in the classroom?

   The strategic objective of the study is to determine the status and context of ICT use in STEM teaching and learning in ENEA schools in Côte d'Ivoire.

The specific objectives of the study are:

1. Institutionalization: to assess the institutionalization level of national strategies for the pedagogical integration of ICT use in STEM and the teaching of other subjects in relation with the development policy of teachers, programs, student teachers and serving teachers, tutoring and management methods;

2. Development of digital schools: to analyze conditions, needs, resources and priorities of schools in relation to ICT in STEM teaching and learning; to specify the level of digital development of schools;

3. Vocational Development of the Teacher: To analyze teachers' skills and practices for the use of ICT in STEM; to clarify teachers ability in the use of computers;

4. Student learning: assess knowledge of the learner of early twenty-first century in relation with STEM and experiences, as well as attitudes vis-à-vis the ICT utilization in learning STEM both at school and outside the school; to specify student achievement in STEM in national knowledge acquisition tests.

To answer questions and objectives of the study, a survey was carried out among duly identified actors: heads of schools, STEM subject coordinators in these schools, teachers and students in STEM classes. STEM class observations were also organized. The survey and observation were carried out in ten secondary schools of Abidjan and Yamoussoukro districts (7 in Abidjan and 3 in Yamoussoukro) and involved 229 people.

As part of the institutionalization of ICT integration, results show that the ICT integration meets the support of a vast majority of educational actors in secondary schools, thanks to the local leaders involvement on the one hand and the awareness of ICT usefulness on the other.

Although this integration is still at a rudimentary stage because of the inexistence or inadequacy of digital teaching materials within institutions, educational actors are of the opinion that ICT facilitates research, lessons preparation, motivate students and solve learning difficulties.

Moreover, significant changes are noticeable in terms of the digitization of pedagogical and administrative activities and the use of ICT as a course material. Although these practices are limited, they demonstrate the extent to which ICT can increase the services operational readiness and constitute a palliative in the absence of a laboratory in schools.

But these results highlight the lack of actor's awareness and information on the vision of educational decision-makers of the national ICT policy. This would allow the adherence of leaders, teachers and all other actors and the development of ICT implementation in schools within 5 years.

With regard to the development of digital schools, the study highlighted the lack of appropriate infrastructure and facilities for ICT development within institutions. It also revealed institutions and actors needs in digital resources for a quality education of STEM.

Indeed, as revealed by the school heads and STEM materials coordinators, the situation analysis has shown precarious conditions or even lack of resources in digital resources.

Teacher's vocational development results indicate that teachers have a good perception of ICT usefulness in teaching and learning. However, they have real difficulties in integrating them into pedagogy, management and organization of classes. Nevertheless, in terms of ICT use in assessment and curriculum, teachers have a moderate level.

Concerning technological knowledge of the educational content (TPACK), results show differences between groups of science, English and Technology teachers on one hand, and those of mathematics on the other. Teachers in the first three subjects have high average scores while the lowest average score is obtained by mathematics teachers.

Finally, with regard to ICT use in student learning, the majority of respondents reported using at least one computer at home or elsewhere (such as a cybercafé or library). Very few students report ever using a computer at home or in another location.

However, for them, using a computer in class is not a common pedagogical practice in their school. Indeed, most of them say that they have "never" used this tool during classes, regardless of the subject taught.

At school, their computer use mainly aims to "seek information on an unknown subject with a computer" or to "access information using a computer" on the Internet. Students

are not taught to perform tasks related to the organization of information collected from an internet source, nor from the "search of different types of digital information on a given subject".

Despite students' limited knowledge of computers potential in their learning, they are aware of ICT usefulness. For them, working using a computer is of paramount importance for their training and learning. For this, they express a strong interest in technology and a desire to discover the immensity of tasks that can be accomplished through a computer.

In the light of the study results, several recommendations are made, notably concerning the institutionalization of ICT integration in teaching and learning, development of digital schools, strategies for the vocational development of teachers and the use of ICTs in student learning.

INTRODUCTION

For nearly half a century, the entire world has been confronted by a revolutionary invention that has transformed the daily live of citizens: Information and Communication Technologies (ICT) advent and especially the Internet. In all countries of the world, ICT has become a field of study and its application has changed daily habits of individuals and societies (Karsenti, 2005).

The education and training sector has gradually opened up to ICT which is a crucial component of primary schools, secondary schools and higher leaning curriculum. If there are more experiences of ICT integration in the North (in North America and Europe, in particular), they are rapidly becoming established in many southern countries (South America, China or India) while they are more recent in education in Africa (Karsenti, Larose, 2001, 2005).

The generalization of ICT introduction in education systems implies necessarily the strengthening of main actors capabilities such as teachers, school managers and students in order to master and to use effectively this resource.

In order to meet this new requirement that transforms modes of action and thought, African governments have engaged in various initiatives to introduce ICT in education after first computers appeared in schools at the end of the year 1970s.

For example, in Kenya the promotion of ICT use in schools and other educational institutions has been largely articulated in national ICT policy documents, parliamentary texts and programs designed for this purpose.

Since 2012, the government of Côte d'Ivoire has initiated a process of education and training system reform in order to make it more efficient thanks to access to digital technology. This desire led to the adoption of Decree No. 2012-994 of 19 September 2012 which put in place the E-Learning program that integrates a digital technology into the education system. Indeed, education officials became convinced that digital technology could contribute to meeting of current major challenges of the education system, namely: governance, teachers' skills development, improvement of school results and quality of teaching-learning and universal education.

Digital technology seems to be a lever for transforming pedagogy and an opportunity for national school system progress. Today, as in many developing countries like Côte d'Ivoire, ICT is being used increasingly in order to collect enrollment data (through online registration system), students' attendance, and basic information about teachers and schools. Thus, ICT mainly helps administrators and managers to get a better idea of the education system size and to evaluate efficiency indicators for making decisions on basic resource allocations and improving school performance.

The project "Digital School of African Excellence Côte d'Ivoire" (ENEACI) is part of the

African Digital Schools Initiative (ADSI, 2017-2019) promoted by GESCI (Global E-Schools and Communities Initiative).

This project meets the government's overall goal of introducing ICT and harnessing the effectiveness of this tool as leverage qualitative changes in the national education system.

This basic study is to achieve an overview of ICT integration in Côte d'Ivoire secondary schools

This project is a result of series of other digital introduction initiatives in schools, and is a result of resolutions made at major international meetings on the subject.

This report presents the following key points:

1. Background and justification of the study
2. Basic study methodology and research questions
3. Results and discussion
4. Recommendations and Proposals for Policy Strategies

I. BACKGROUND AND JUSTIFICATION OF THE STUDY

I.1. International background

Education is an economic and social development pillar and is at the center of the concerns of almost all states. It constitutes a priority sector where States invest many means both financial, material and human.

At the international level, many agreements put in place to make education as one of essential levers of sustainable human development. Thus, education appears in NEPAD Objectives, Millennium Development Goals (MDGs) and, more recently, in the Sustainable Development Goals (SDGs).

The quality of the educational process and especially the development of core skills to succeed in society, remains a challenge for most sub-Saharan African countries, given the economic, social and cultural constraints that these countries face. These constraints are generally expressed in terms of poverty, lack of classrooms, didactic materials, teachers, initial and continuing training of teachers

In view of this, UNESCO Africa Department has developed an operational strategy for Priority Africa, 2014-2021 (37 C / 4) in its program 2. The aim is to strengthen educational systems for sustainable development in Africa by improving equity, quality and relevance. The overall goal is to improve an internal efficiency of education systems through the implementation of inclusive holistic policies tailored to African countries. To this end, among other actions, Africa Department advocates the capacities strengthening of national training institutions of teachers in order to provide quality education by using mixed strategies based on ICT.

The statement of Qingdao International Conference on ICT and Post-2015 Education in People's Republic of China reaffirms a new educational vision of Incheon's 2030 by emphasizing on mobile learning for effective dissemination of lifelong knowledge and that can not be done without ICT.

In order to achieve this goal, the SDG4 Framework for Action calls in its target 4.C for States to significantly increase the number of qualified teachers and to put in place necessary policies and regulations so that teachers are empowered, properly recruited and remunerated, motivated and professionally qualified teachers to hold classrooms and address the needs of all learners in their diversity. To achieve this, various strategies have been defined, including:

- To review, analyze and improve the quality of initial and in-service training of teachers, and to give to all teachers quality initial training and ongoing vocational development and support.
- To develop a certification and qualification framework for teachers, trainers of teachers, teachers' supervisors and inspectors.

- To enable teachers acquire technological skills needed to use ICT and social networks, as well as media analysis and source critique skills, and to and provide them with training tailored to challenges of teaching students who require special education.

More generally, the literature on pedagogical uses of ICT in education is recent but rich, as is the object itself which offers opportunities for innovation in administration, management, teaching and learning.

The context analysis will be organized around the four main themes of the study: Institutionalization, Digital Schools of Distinction, Development of Teachers and Learning of Learners.

1. Institutionalization: This is about studying the institutionalization level of national strategies for the pedagogical integration of ICT use in STEM and other subjects related to teacher development policy, curricula, pre and in-service, academic support and management practices.

Institutionalization refers to the process by which a coherent and concerted effort is made and maintained in the use of ICT in education. According to Hamdy (2007), this involves a multi-dimensional strategy based on ICT infrastructure modernization, teacher training and professional development to strengthen the capacity to implement ICT at all stages of the teaching-learning process. . It also involves creating some form of commitment to making ICT a permanent part of teaching. Different models and frameworks have been developed and adopted to explain how ICT integration should work. However, all models are aware that in order to achieve the positive effects of ICT, a deliberate effort is needed to create national ICT policies, provide sufficient ICT infrastructure, ensure the development of teachers, and introduce organizational change (Pelgrum , 2003).

The institutionalization of ICT integration in education imposes guiding policies that set comparable standards for all schools, teachers and appropriate implementation strategies.

The introduction of information and communication technologies (ICT) in schools brings major transformations in education systems. In fact, findings of many studies show that the appropriate use of these technologies in teaching can bring multiple benefits (Balanskat, Blamire and Kefala, 2006, Kulik, 1994, Machin, McNally and Silva, 2006).

While in the North ICT has largely reached many school, Africa still lags behind. For many years, African education systems have been facing a lot of difficulties and several countries have undertaken reforms that, for the most part, attach little importance to ICTs.

ADEA (2002) emphasized that ICT is a learning channel that can greatly improve the quality of education at the basic education level. (Karsenti, 2005)

However, several conditions are required for the success of any ICT integration project in education. Thus, according to Karsenti and Larose (2005), the conclusions of a study by the OECD (2004) establishing "... how the organization of teaching hours, the organization of the class ... and the weak techno-pedagogical competence of the teachers compromise the true integration of ICT in school classes in some of 15 industrialized countries "(p2).

While the availability of ICT materials and equipment, in sufficient quantity and quality, is a prerequisite for successful integration of ICTs into education, another very important factor is that of the professional development of ICTs of educational actors and their ability to use ICT effectively in their teaching practice. In other words, the effective integration of ICT in education requires that these actors acquire new technological and pedagogical skills related to the new roles and new learning practices. In particular, the acquisition of skills or lack of skills among teachers is the most important factor which influences the success of any ICT integration project (Alwani and Soomro, 2010, Pelgrum and Law, 2004).

The goals for access to education for all are not yet met in many developing countries, especially in sub-Saharan African countries. At the same time, information and communication technologies seem today essential in international exchanges. They represent spaces for exchange, discovery, cultural appropriation and community development. Today they affect all sectors of activity and education is not left behind.

However, an examination of the current situation of African education systems suggests that ICTs do not yet have their place in the school environment. Because school policies consider that the needs to be met are so enormous that other choices should be privileged. Therefore, priority would not be given to computer equipment, let alone the pedagogical integration of ICT. As a result, the need for ICT use by students and teachers is often overlooked (Karsenti, 2005). Many point out that it is utopian to talk about technologies in education in a continent where many schools do not have electricity, running water, or walls, when there are schools.

According to Howell and Lundall (2000), the main factors preventing schools from using microcomputers as teaching and learning tools are inadequate financial resources.Insufficient number of computers, lack of qualified computer teachers, inability of teachers to integrate computers in different areas of education, and lack of appropriate curricula for the teaching of microcomputers (Karsenti, 2002).

According to all the studies consulted, equipment is still the first major constraint to fair use of innovative technologies. The lack of structures and equipment costs would greatly complicate the ratio of computer use per a student group.

However, all 54 African countries are already connected to the Internet (Jensen, 2002).

But reaching a ratio of one computer per 10 students to 100 per cent connection rates in primary, secondary or higher schools is a headache and difficult ideals for most schools in Africa. For example, a figure of 139 students is given for 1 computer as part of the World (2000) project.

According to Farrell (2007), the main features of an effective education policy include the integration of ICT in education, availability of digital equipment, connectivity and network infrastructure, access and equity, technical support and maintenance, exploitation of emerging technologies, training (capacity building and professional development) as well as research and development.

2. Digital Schools of Excellence: It's about establishing the enabling conditions, needs, resources and priorities of schools with regard to ICT in teaching and learning STEM and to clarify the electronic preparations at school.

According to the ENEA model, in deciding which schools fall under digital schools of distinction, the focus is on five key areas, namely: i) ICT, Leadership & Vision that expresses the policy direction of ICT at school level and that defines a vision and strategy and a positive attitude towards the use of ICT. ; ii) the place of ICT in the curriculum: schools will show the integration of ICTs through the learning and teaching programs. Staff will clearly demonstrate how ICT can be used in the program to enhance student learning. Iii) The technological culture of the school: here, the schools will demonstrate the awareness that ICTs have an impact on the quality of learning and teaching, on the attitudes and behaviors of students and on the school community in it all together. Iv) ICT professional development will include a demonstration of the commitment to ICT-related continuing professional development, with a mechanism in place to inform teachers of professional development courses, as well as support and encouragement for professional development at a school level. And finally, v) ICT resource and infrastructure criteria will imply that schools have appropriate ICT resources, including hardware, software and infrastructure for support.

The above criteria imply a need for capacity building to improve and refine teachers' existing skills to help them integrate ICT. It also requires equipping schools with adequate ICT infrastructure and training teachers in the use of ICTs in STEM areas.In its ICT Competency Framework for Teachers, UNESCO (2011) helps education policy makers and program designers to identify the ICT skills that teachers need to integrate ICT into education. UNESCO further recommends that the identification of ICT skills for teachers be based on a clear understanding of the country's overall approach to the use of ICTs in education. There are few studies on ICT integration strategies in education in Africa. Amuche and Lyekekpolor (2014) undertook a study in Nigeria to assess the ICT competence of college teachers. The study revealed that the level of competence of teachers is low and that the majority of teachers can not use ICT to teach their subjects Majority of teachers of personal computers / laptops had little or no skill in using ICT in the classroom for lack of proper training. In addition, the study highlighted the main challenges of ICT use by teachers, namely the financing of ICT training, the availability of

ICT equipment and a heavy workload. Given the rigor of the criteria for the aforementioned digital schools of distinction, it seems clear that these institutions can not be classified in this category.

The studies also show that teachers preparation for the use of ICTs in training schools remains largely inadequate. Thus, in a study conducted in Benin, Danner and Pessu (2013) demonstrated that this is due to the lack or institutional provision of ICT infrastructure, lack of access to the Internet and poor Internet connectivity within the university. The same situation can be observed in Ghana (Boakye and Banini, 2008) or in Kenya (Gravenir and Mse (2012)), where the lack of preparation of learning institutions in terms of ICT integration in learning explains the low penetration of ICT in the university space and among the teachers. In general, the problems that prevent African schools from acquiring computers are: lack of electricity, lack of funds, insufficient capacity, lack of qualified personnel and insecurity. Moreover, there is very little equipment devoted to the use of ICT. In sub-Saharan Africa, the low density of telephone networks and the high costs of installation and maintenance of lines remain a major obstacle as well. (Karsenti, 2005)

In most African states, there is no infrastructure potential to accommodate the connection, provide national coverage, and support the costs of the facilities. According to the Young African magazine, in late 2017, the continent had nearly 281 million Internet users for an average access rate of just 23%, according to the latest figures from the Internet Live Stats, member of the Real Time Statistic project[1].

Mastafi (2015) shows through the results of a research conducted in 2011, among thirty-three heads of primary and secondary schools of the Doukkal-Abda Regional Academy that despite the availability of ICT equipment in all participating institutions, the use of ICTs in teachers' practices remains very limited, if not lacking. In fact, the analysis of these results allowed for the identification of five categories of barriers to know: the obstacles related to ICT infrastructure at the school level, the obstacles to ICT professional development, the structural problems in the Moroccan education system itself, obstacles to the policy and strategy for implementing ICT in schools, and problems related to cultural issues, language and negative attitudes.

The policies or even ICT projects, developed without strong involvement and leadership of education stakeholders, focus primarily on investment in technology and ultimately produce misinformed implementation strategies resulting in a lag between technological deployment and the capacity of education and training systems to assimilate technology-based innovation and to update pedagogical practices.

[1] http://www.jeuneafrique.com/398696/economie/acces-a-internet-continent-africain-entre-progres-inegalites/

Mian (2010) states that Côte d'Ivoire, like most African countries aspiring growth, is putting a lot of effort into ensuring the quality of education and training for children and young people. Despite these efforts, it is clear that the quality of education system seems to be well below expectations. The Ivorian education system, organized in three cycles, faces major challenges such as the high demand for education of an increasingly young population. In order to alleviate this situation, the Ivorian Government is committed to using ICTs to improve the quality of its education system.

In Côte d'Ivoire, the integration of ICT into the classroom began with the broadcast of schools in 1960 leading to multimedia (1990) for teaching and learning (Duboux, 1996). Indeed, school radio and television has been the source of great hopes in the context of mass training. This pilot project was a failure both in France and in French-speaking countries. As for computers and the Internet; they became increasingly successful in pedagogy because of the multiplicity of possibilities. These new media were interactive, fun and gave access to databases. The history of the pedagogical integration of ICTs is punctuated by failures and successes. The integration of ICTs remains a major challenge in teaching and learning as the school has to foster a deep, daily and regular integration of ICTs to take advantage of the new, innovative, promising and diversified possibilities of ICTs.ICT in Education (Karsenti, 2002).

The adoption of Decree No. 2012-894 of 19 September 2012 establishing the ICT discipline in pre-school, primary and secondary education marks a decisive turning point in the government's commitment to the use of ICTs in education. This decree advocates the integration of ICT in education / training, both as tools to improve teaching / learning and as a discipline. For the implementation of the decree, the Ministry of National Education, Technical Education and Vocational Training (MENETFP) has, through the Direction of Pedagogy and Continuing Education (DFPC), developed programs and ICT Implementation Guides for Preschool Classes from Middle Section, Primary and Secondary Cycle One (6th to 3rd). Each of the three documents begins with a presentation of expected competencies and pedagogical regimes for ICT education. Then it approches the TICE program itself and finishes on the program guide.

Ndiku (2003) also highlighted the problems encountered in implementing educational ICT projects and found that an insufficient number of computers, lack of teachers' knowledge and inadequate technical assistance were factors impeding successful integration of ICTs. All of these studies highlight the urgent need for clear ICT policies in schools, staff training, the integration of ICT into curricula and the provision of adequate ICT equipment.

The above results are a very convincing argument in favor of the ENEA model which aims to strengthen the institutionalization of ICT. This will facilitate the professional development of teachers in the use of ICT. If teachers are to integrate ICTs into STEM teaching and learning, they need the skills to prepare learning materials and activities

and to develop a critical awareness of ICT applications and their social implications among their students (UNESCO, 2011).

3. Professional development of teachers: The main question is what is the teacher's level of preparation for the pedagogical integration of ICT in teaching and learning STEM in class?

It is important to know the extent to which teachers use ICTs in STEM classroom teaching practices. Similarly, what is the competence level of teachers for the professional integration of ICT in the classroom?

Since the end of the 1990s, the pedagogical integration of ICT has had a strong impact on educational discourse. The goal is for teachers to develop their skills and teach the various disciplines using information and communication technologies, and for students to be able to learn more, and more easily with these same technologies. According to Charlier and Peraya (2003), Savoie-Zajc and Larose (2001), the integration of ICT involves changes in teachers' practices and deeply affects their presentations of learning, their methods of collaboration and evaluation, and their relationship to knowledge. This integration can thus play a catalytic role insofar as, as Develay (2002) points out, it upsets the teaching-learning modes as well as the workplace (Peraya, 1997, Viens and Rioux, 2002). For Karsenti, (2005), information and communication technologies are a transversal skill in education for both students and teachers.

Teaching with ICT requires an innovative pedagogy based on the exploitation of the collaboration between the learners and limits the transmitting role of the teacher. The literature review on the impact of ICTs in European schools (Balanskat et al., 2006) emphasizes that the use of ICT must be done in an educational approach that takes into account differentiation and supports the project-based approach to improve learning. (Mastafi, 2015)

Ossama (2001) argues that the integration of information technologies in the whole educational process must become an imperative, a fundamental requirement for nations around the world. The school must prepare new generations for the complexity of the emerging information society, especially as computers gain power and become capable of being used in intellectual activities.

4. Learner learning: The study aims to assess students' report on the use of ICT in STEM. The aim is to assess the skills of 21st century learners in relation to STEM as well as their experiences, as well as their attitudes towards the use of ICTs in STEM learning both at school and outside the school setting. Finally, it is necessary to specify the performance of STEM students in national knowledge acquisition tests.

I.2. National context

I.2.1. Performance of the education system

Côte d'Ivoire's education and training system was severely affected by the succession of socio-political and military crises that the country experienced during the 2000-2011 decade.

In 2011, with the support of Technical and Financial Partners (TFP), a medium-term Action Plan (ALMP) for the education / training sector for the period 2012-2014 was developed based on the diagnostic analysis of the RESEN[2] and an Education Policy Letter (2010) presenting a sustainable development scenario for the sector by the year 2020.The implementation of the ALMP, which has been successfully implemented until 2016, has led to encouraging results, particularly in terms of access to education at the different levels, completion of the various cycles of teaching and passing exams (MENETFP, MESRS, 2017).

Despite of these successes, significant deficiencies and challenges remain to be addressed at different levels: access to education for girls and disadvantaged populations, quality and internal efficiency (poor performance in writing and numeracy, repetition rates and high drop-out rates), external efficiency (difficulties of integration into the labor market by graduates), governance, a large share of private education, recurrent strikes by teachers, pupils and students), etc.

For example, the analysis of school exclusion reveals that about 42% of children of primary school age and 58% of children of secondary school age are not there, while 43% of children of 11 years and 40% of 12-16 year olds enrolled respectively in primary and secondary education are at risk of dropping out (UNICEF, ENSEA, 2015). With completion rates of 64% in primary, 36% in lower secondary and 20% in upper secondary, the Ivorian education system has a low level of internal efficiency which necessarily reflects a low quality system as a whole. Indeed, more than 2 million children leave the education system without any qualification in the proportions of 6 out of 10 in the primary, 4 out of 10 in the first cycle of secondary and 2 out of 10 in the second cycle (DIPES / MEN, 2015).

Numerous national and international assessments corroborate that this tendency of the Ivorian education system displays a low level of quality almost permanently.

In 2012 and 2014, PASEC[3] ranks Côte d'Ivoire eighth for children's education and the poorest in girl's education in 10 candidate countries.

In addition, a national assessment of students' achievement published by the Directorate of Monitoring and Program Monitoring (DVSP) in the Ministry of National Education (MEN) shows that 88.3% of children do not know how to read at the end of CP1. According to the PASEC report aforementioned, 70% to 80% of students at the end of

[2] RESEN: State Report of the National Educational System, 2009

[3] Programme d'Analyse des Systèmes Educatifs de la CONFEMEN

primary education do not meet the "sufficient" language skills threshold; although half meet this threshold in mathematics.

Finally, according to the 2015 RESEN, 2,039,788 students are in a situation of dropping out of school, that is, they stop studying before obtaining a certificate. Thus, according to this study, out of 10 students entering primary school, only 6 come out with the CEPE certificate. In high school, first cycle, they are 4 out of 10 who get the BEPC and in the second cycle there is only 2 out of 10 who get the BAC certificate.

The factors that may explain this weakness of the education system are diverse and varied. They are at times social and cultural, economic, political or socio-educational. Certain factors relate to the teacher, such as the methods of his recruitment, his entrance profile, his initial and in service training, methods and means of teaching or the learning context can influence the internal efficiency of the system. .

In this context, educational reforms are needed in the entire education sector (access, internal and external efficiency, initial and in-service training of teachers, investment in educational inputs (books, teaching materials, ICT, etc.).

Faced with these observations, what are the policies and strategies developed by the public authorities in terms of ICT policy, particularly as a factor to improve the quality of education.

I.2.2. ICT policy in education

Having identified the causes of the internal inefficiency of the system, in particular, the obsolescence and insufficiency of training materials and school equipment, the maladjustment and the non-mastery by teachers of teaching methods geared towards the learner, the Sectoral Plan for Education (PSE) 2016-2025 undertakes a number of measures aimed at correcting these dysfunctions. Thus, several strategic actions have been defined to achieve the expected results, including the use of digital in educational activities to improve learning. "The strategy will consist of (i) training of trainers in the production of digital pedagogical resources and their use, (ii) the development of Open and Distance Learning (ODL), (iii) the acquisition of 2050 educational tablets for 30 primary schools on experimental basis, (iv) support for the administrative and pedagogical management of schools, particularly in monitoring attendance and learning outcomes ".

Côte d'Ivoire has committed itself to the sustainable development goal N ° 4 (SDG 4), that is to say, to promote an inclusive and fair education of quality and lifelong learning for all, it has decided to use innovative training methods, facilitating the use of Information and Communication Technologies (ICT) for easier access to education and training, including distance learning (FAD).

The use of digital technology, in particular distance learning (ADF) in general and Mobile Learning in particular, is today high on the government’s agenda on new strategies.

Like other African countries, the development of ICT in Côte d'Ivoire affects all spheres of society. However, Côte d'Ivoire is lagging behind in the development of ICTs. Indeed, in 2013, the country was ranked 137th out of 157 countries with an ICT development index of 1.70 ITU (2013).

As of 31/12/2017, TRAC (Telecommunications Regulatory Agency in Côte d'Ivoire) indicates that the total number of mobile subscribers was 31,747,233 for a national penetration rate of 127.73%. Regarding Internet subscribers (fixed or mobile), the agency also indicated that their number was 17 million as at 31/12/2017, a penetration rate of 72%[4].

However, it is important to note that the interest of the training-of-trainers institutions for ICT in education is quite recent. Indeed, in a recent study, Bih and Aka (2017) show that digital education in schools is still limited to the introduction to basic software such as Word, Excel, and PowerPoint. . This is mainly due to “lack of computer rooms and the small number of teachers trained in ICT in the initial training". According to the authors, "the initial teacher training programs give very little space to ICT: among the teachers surveyed, only 11.5% say they have received ICT training compared to 85.6% who never received this type of training.

We therefore understand the low level of introduction of communication and information technologies into school training programs. If the training-of-trainers schools that should be a model in this area are devoid of training materials and logistical equipment and access to the internet, it is not surprising that the teachers themselves are ignorant of the opportunities and the conveniences which this technology can offer.

Despite the lack of some infrastructure, the data shows that the Government, through the implementation of e-Governance (e-Gov), wants to make ICT a tool for development. It recognizes the universal role of ICT integration in education as a bridge to a knowledge-based economy. The very strong penetration of the mobile phone in the Ivorian society seems to have an effect on the social and communication practices.

The Ivorian experience with ICTs being intensified recently, beginning in 2013, in an effort to generalize these tools in education with the aim of preparing young people for digital literacy, modernizing teaching methods and promoting pedagogical innovation in initial and in-service training.

Thus, the legal and regulatory framework for the digital pedagogical integration was set up by Decree No. 2012-994 of 19 September 2012 integrating ICT into the educational system was to make acquisition of computers a full disciplinary (the 14th) in the secondary school learning.

[4] http://www.artci.ci/index.php/Telephonie-mobile/abonnes-service-mobile.html

The Government has set up a master plan (2012-2017) for e-Governance (E-Gouv) spearheaded by the Ministry of Communication, Digital Economy and Post (MCENP). The Government's e-Gouv vision is to make Côte d'Ivoire an emerging country through ICT, modernize the administration to better serve users and improve the quality of life of citizens through ICT. This project is based on two fronts:

- The e-Administration front, which aims at improving the working conditions of the administration through the use of ICTs by setting up a government intranet.
- The e-Service front, which aims at improving public services provided by the administration to the citizens and businesses through the use of ICT. This front focuses on various sectoral projects including e-Education which aims at the usage of ICT in the Ivorian education system.

In total, over the last decade, ICT has grown considerably in Africa. The enthusiasm of African countries for these technologies is real. The growth of cell phone users and connections to the Internet is impressive.

If Africa's mission is to better prepare its citizens for the challenges of the third millennium, it must also promote an in-depth integration of information and communication technologies, a pedagogical integration of daily and regular ICT in education to take advantage of their new, promising and diverse opportunities.

What is the point of the ICT projects initiated within the Ivorian education system?

I.2.3. An overview of initiatives for the integration of ICT in education in Côte d'Ivoire

With the support of development partners, various projects implemented to adapt the education system to the digital era. Almost all of these projects are offered as part of continuing education for teachers and educational supervisors. These include the following projects: IFADEM, UNESCO-CFIT, SANKORE, Digital Education, Mobile Learning and GESCI (ENEACI).

The table below presents an overview of these different projects. These are characterized by their limited scope of intervention with the exception of the IFADEM and UNESCO-CFIT projects. They almost never involve the initial training of trainers' structures. They have a limited life in time.

It should be noted that through the implementation of the ENEACI project, the government aims to exploit the potential of digital technology to increase the number of students in Science, Technology, English and Mathematics (STEM) in high schools and colleges.

This project is supported by GESCI in partnership with the MasterCard Foundation and the Ministry of National Education, Technical Education and Vocational Training in Côte d'Ivoire, has embarked on a digital school of excellence in Africa (ENEACI). It is a vast program for the implementation of an efficient, sustainable and reproducible model of the development of the digital school in its entirety at the secondary education level, which will encourage the development of the 21st century student, learning outcomes and preparation for the knowledge economy in the workplace.
It is important to point out that the Digital Generation project of the MTN Côte d'Ivoire Foundation, which aims to provide schools (secondary and tertiary) with a multimedia room for students and the use of resources. Numbers from Orange Foundation in Côte d'Ivoire do not appear on this table. Only projects dedicated to the training of teachers in the use of digital resources are mentioned here.

PROJECT	objectives	activities	targets	duration	State of progress	Funding
1/ Francophone Initiative for Distance Learning (IFADEM) Support Project for Improving Learning and School Leadership (PAPDES)	1Train 10,000 Teachers Strengthen the capacity of 15,000 Principals 3/ build the capacity of 1,373 colleges to help improve the quality of management and teaching in these institutions.	Strengthening national capacities for pedagogical supervision and the development of adapted infrastructures	-10,000 Teachers -15,000 School Directors -2000 college Principals -Drums of the HRD, the DRENETP, pedagogical supervisors of primary and CAFOP -IEPP -CPPP - Managers of the digital spaces of CAFOP, DRENETP, IEPP, APFC	September 2014 to May 2015: experimental phase from February 2017 to June 2019 (PAPDES)	10 and 11/05/2016: seminar restitution of the evaluation of the experimentation Planning / training: February 2017- February 2019	AUF OIF AFD (C2D)
2/ UNESCO-CFIT Ivory Coast	1/ to facilitate the access of the continuing training for more supervisors and college teachers using ICTs; 2/ to install skills in design engineering / production and tutorial engineering in pedagogical and continuing training centers; 3/ To popularize the use of ICTs in education.	Strengthening teacher training (CAFOP and APFC); Capacity building of pedagogical supervisors at the primary and secondary levels in educational production engineering and tutorial engineering. Experimentation of in-service training in mobility with tablets and smartphones Initiation of teachers to the use of ICT tools (smartphones, tablets, computers, etc.) in distance-learning courses ("bring your own device").	Initial and continuing training institutions under the responsibility of the MENETP: 16 CAFOPs, 36 pedagogical units; pedagogical units by locality 33,200 primary school teachers and 10,100 junior high school teachers	Phase I of the project: January 2014 to December 2015. Phase II: March 2017 to December 2018	a national center for digital teaching resources in Abidjan and nine (09) equipped regional centers. **Distance Education** a video conference room at the CNRE training rooms by distance learning on satellite sites (11) **Online education** An equipped room (secure and air-conditioned) for the production of content and digital media Supervision and follow-up of teachers placed in formation	UNESCO Rep. People's Republic of China - CFIT (Chinese Fds in deposit)

PROJECT	objectives	activities	targets	duration	State of progress	Funding
3/ Mobile Learning	Facilitate access to continuing education for a large number of teachers through the tablet Reduce the educational deficit in highly disadvantaged regions Produce digital learning resources adapted to Mobile Learning Make available to beneficiaries the tools of Mobile Learning	Capacity building of 1000 teachers with tablets as a training tool capacity building of project team members in the pedagogical engineering of Mobile Learning organization of regional campaigns of information and sensitization of the actors and partners on the project design of resources for teacher training by module writers	1000 teachers including 540 ordinary teachers and 460 college teachers50 pedagogical supervisors (30 Sector Pedagogical Advisers and 20 secondary school counselors) trained in tutoring		Acquisition of 1100 tablets13 modules, including 07 for the primary and 06 for the college were developed, pre-validated by the Scientific Committee and scriptedTransfer of 13 scripted modules on 1100 tabletsTutoring TrainingImpregnation phaseOfficial launch ceremony with delivery of tablets to DRENETP	AFD , AUF
4/ Digital School of African Excellence (IN ACI) / GESCI	Promote digital integration to improve the quality of governance of the education system and teaching / learning Train in the installation of 21st century skills through digital	20 Digital Schools of Excellence in pilot phase. ICT training of 200 STEM teachers with an extension to 400 of other disciplines (ICT, Professional Development and Leadership) Professional development of 20 school heads, 600 teachers and the educational community STEM skills development and other disciplines of 30,000 students at term	DRENET-FP Abidjan and Yamoussoukro secondary schools.) Heads of establishment STEM teachers and other disciplines Students in STEM and other disciplines Educational Community (COGES)	2 years	7 June 2016, signature of the partnership agreement between MENETFP and GESCI Basic study in progress	GESCI
5/ SANKORE	Create and share free digital educational resources Use Interactive White Boards or Interactive Digital Boards	Program of equipping African schools with digital classes; ecosystem for creating and sharing free digital educational resources; training of new masters by digital	Students professors	2013—2014	Donation of six hundred (600) SANKORE digital classes (CNMS) on May 13, 2013	French Embassy (SCAC)
6/ Digital School	Improve the reading, writing and numeracy skills of C.P.	Establishment of digital classes by the use of the Interactive Digital Table (TNI)	Students			Orange Foundation

I.3. Rationale of the study

It is increasingly evident today that adequate teacher training is an essential requirement for effective ICT integration and use in schools. Despite the existence of political directives and education / training sectoral plans, few concrete actions are implemented to improve student achievement, mainly because of the low mastery of those responsible for information management tools.

It is established that even when schools have access to ICTs, new technologies are hardly used as a medium of instruction. What is in question is often the lack of training because many teachers do not have ICT skills; therefore, they are not comfortable using digital resources in their classrooms.ICTs therefore have no real impact, whether in terms of teaching, research or administration. In addition, there are few concrete examples of educational models based on science, technology and mathematics (STEM) teaching. Teachers tend to prefer traditional approaches, i.e. face-to-face active teaching.

In addition, none of the digital introduction projects in education in progress specifically concern STEM subjects, with the exception of the IFADEM project which integrates science and mathematics education in primary education. However, we know that the teaching of Science, Technology and Mathematics is an important challenge for African countries, especially Côte d'Ivoire, which suffers dramatically from the lack of teachers in STEM subjects.

With the advent of computer technology in school systems, changes are gradually appearing in school administration and management habits, teaching strategies, work organization within the school, and the way students learn. These changes include approaches to the use of ICTs by these individuals in their activities in the school system.

This study is part of change in logic within the school institution. It postulates that the introduction of digital resources at school brings with it power of qualitative transformation in the management, administration, organization of the pupil's work by the teacher and in the strategies of the teacher knowledge and skills development among students. It is particularly concerned with the teaching of STEM subjects in which students generally have poor performances.

Information and Communication Technologies (ICTs) are not yet fully used in the perspective of improving teaching and learning, it has proposed a paradigm shift and, with it, a model of science teaching in particular, to improve standards, develop teachers' skills and students performance.

II. THE METHODOLOGY STUDY

II.1. Objectives of the study

II.1.1. Strategic objective

The strategic objective of the research is to determine the reference status and context of the use of ICTs in STEM teaching and learning in ENEA project schools in Côte d'Ivoire.

II.1.2. Specific objectives of the study

1. Institutionalization: to assess the institutionalization level of national strategies for the pedagogical integration of the use of ICT in STEM and the teaching of other subjects in relation to the development policy of teachers, programs, student teachers and serving teachers, tutoring and management methods;

2. Development of digital schools: analyze the conditions, needs, resources and priorities of schools in relation to ICT in STEM teaching and learning; specify the level of digital development of schools;

3. Teacher development: analyze teachers' skills and practices for the use of ICT in STEM; to clarify the ability of teachers to use computers;

4. Students' learning: evaluate the learner's knowledge of the early 21st century versus STEM and the experiences and attitudes towards the use of ICT in STEM learning at school and outside the school setting, specify the performance in STEM and student's acquisition of knowledge in nationlal tests.

II.2. The Scope of the work of the research team

This preliminary study focuses on three main objectives:

- Present a start-up report with a proposal for performing the data analysis including:

  a. A review of the literature and documentation on the concept notes of ENEA.

  b. A review of data collected in Côte d'Ivoire project schools

  c. A proposal for a mixed methodological approach for the analysis of the quantitative (survey) and qualitative data sets

- Perform data analysis such as:

  a. Cleaning of preliminary data
  b. Preliminary data analysis

- The report includes

  a. A draft summary of the preliminary report
  b. A final study report that incorporates revisions based on the technical balance sheet.

II.3. Research questions from the basic study

The research questions and the specific objectives of the ADSE program are defined in relation to the four fields of intervention of the study announced in the objectives, namely: the institutionalization, the development of the digital schools, the development of the teacher and student learning.

1. Institutionalization: What is the overall status of the African Digital Schools of Excellence (ADSE) project in terms of historical factors, education, policy and reform that can support or limit the implementation and the expansion of the ADSE project in Ivory Coast?

2. Development of digital schools: What is the level of academic ability for the pedagogical integration of ICT in teaching and learning STEM in the classroom?

- What policies are in place at school (micro) and out of school (macro) to help make better use of ICT in the classroom?

- What were the deployment characteristics in terms of objectives, planning, support and resources for the expansion of the ADSE project in schools in Côte d'Ivoire?

3. Teacher development: what is the level of teacher's preparation for the pedagogical integration of ICT in teaching and learning STEM in the classroom?

- To what extent do teachers use ICTs in STEM teaching practices in the classroom?

- What is the level of competence of teachers for the professional integration of ICT in the classroom?

5. Learners: What are students' attitudes towards the use of ICT in STEM?

- To what extent do learners use ICTs in STEM classroom activities, assignments and projects?

- To what extent do learners improve STEM outcomes with the integration of ICT in the classroom?

The preliminary study will focus on the first questions in each domain related to the context and level of use of ICT in ADSE schools prior to the deployment of the intervention.

II.4. Methodology Survey

The study combines qualitative and quantitative approaches to achieve its objectives. These approaches include the use of desk analysis and the use of different types of data collection tools.

II.4.1. Documentary analysis

It consists of collecting and using different types of administrative documents (laws or decrees) or scientific documents (books, communications, etc.) available on the subject.

An analysis grid is applied to reports and documents available on policies, strategies and actions relating to the introduction of digital technology in schools and the results obtained.

The literature review makes it possible to identify the orientations of the issues related to the introduction of ICT in education as well as the prospects that emerge from it.

II.4.2. Data collection tools

In the data collection process, personal interview, questionnaire and class observation were used.

The data collection was carried out through individual interviews with Principals and STEM subject coordinators in the school.

An interview guide is designed according to the objectives of the study. It is organized around the four main themes of the study, namely: 1) institutionalization of ICT and school of excellence; 2) Development of the digital establishment of excellence of the study; 3) ICT teacher skills development and 3) Improved 21st century STEM skills and learning outcomes.

II.4.2.1. Survey

From a quantitative perspective, it will be administered to different groups of subjects (students and teachers of STEM disciplines) a questionnaire designed specifically to identify the state of play of the introduction of ICT in the selected institution.

II.4.2.2. Class observation

A class observation will be organized in each school of the study during a course conducted by a STEM teacher. An observation grid specifically designed for this purpose makes it possible to identify and analyze the different aspects of use by the ICT teacher.

II.5. Target population and Field of Study

The target population of the survey consists mainly of secondary school leaders who are willing to participate in the study, STEM subject teachers and students from these institutions; they are selected in two districts of Côte d'Ivoire (Abidjan and Yamoussoukro).

These are students who are regularly enrolled during the 2017-2018 academic year. Eligible institutions are public institutions approved by the Ministry of National Education, Technical Education and Vocational Training (MENETFP) and fulfilling the criteria to participate in the ENEACI project.

A total of 10 institutions were visited, 7 selected institutions in the District of Abidjan and 3 in the Yamoussoukro Autonomous District. This sample structure is representative of the distribution of STEM teachers' population of schools in these two districts.

Table 3: List of institutions in the sample

Number	DISTRICT	EDUCATIONAL INSTITUTIONS
1	**Abidjan**	Saint Mary High School(Cocody), Modern High School Adjamé Harris, Technical High School of Abidjan (Cocody), Modern Boys High School GNALEGA Mémé Jérémie (Bingerville), Modern High School Port -Bouët, Modern Highway College (Treichville), Municipal High School Simone Ehivet GBAGBO (Yopougon).
2	**Yamoussoukro**	Mamie Adjoua High School Yamoussoukro; Modern High School of Toumodi, Yamoussoukro Scientific High School.

The pre-test of the tools was carried out at the Modern High School of Cocody, an establishment that does not belong to the selected sample.

II.6. Sampling

Ten (10) teachers and ten (10) students are selected from each school selected for the

uestionnaire, ten (10) teacher coordinators of STEM subjects at the rate of one teacher per institution for the interview. The principals of the ten (10) institutions in the sample were interviewed. Similarly, the course of one (01) STEM discipline teacher was observed per institution, making a total of ten teachers.

Teachers and students are chosen throuhgf a draw for the equi-representativeness of the subjects (STEM) in the final sample.

The total sample size includes 229 subjects whose distribution by target and by data collection tool is provided in Table 4 below.

Table 4: Distribution of the sample study according to tools and targets

Collection Tools	Targets	Total Workforce
Questionnaires	Teachers STEM 1	93
	Students	106
Interviews	STEM Coordinators	10
	Principals	10
Class Observation	Teachers STEM 2	10
GENERAL TOTAL		**229**

The distribution of the sample by district is provided in Table 5 below:

Table 5: Sample Distribution by District

District	Principals	STEM Coordinators	Teachers	Teachers 2	Students	TOTAL
Abidjan	7	7	66	7	76	163
Yamoussoukro	3	3	27	3	30	66
TOTAL	**10**	**10**	**93**	**10**	**106**	**229**

II.7. Data Processing Procedure

In order to have reliable and relevant indicators, it is important to have quality data. This objective requires the realization of a set of important operations to guarantee a better quality to the data collected.

This will require the digitization of data collection and capture operations. For this purpose, the collection tools will be deployed on the SurveyMonkey platform. They will also be tested through a pilot survey. Following their validation, they will be installed on the computers of each interviewer. A clearance and quality control program is developed to automatically correct inconsistency issues that appear in the data.

II.8. Data Analysis

The analyses are done by the stata software for quantitative analysis, and the nvivo software for qualitative data. Three statistical tools will be applied to the analyses. Flat-based sorting using graphs and frequency tables will help break down the main trends in the use and integration of ICT in education. The cross-tabulations and statistical tests will serve as a framework for identifying the factors that may impact the use and integration of ICTs in education. Finally, the factor analysis performed on the sample of teachers will reveal the potential factors that may encourage teachers to use ICTs in teaching more.

11.9 Difficulties Encountered

The research team faced some constraints and difficulties in the field while collecting data.

Indeed, the duration of the field survey was extended due to the absence of some STEM teachers initially selected in the sample. A second visit to the schools was necessary to organize the last interviews.

The small size of the sample was a major obstacle in the statistical processing of the data collected. In fact, instead of 20 institutions initially selected for the basic study, only 10 secondary schools participated in the study. The small number of subjects in certain response modes made some statistical calculations impossible.

Finally, the absence in almost all the institutions of statistical information in archives on the overall results of the establishment and annual average in the STEM subjects made it impossible to produce the basic situation. Similarly, when the results are available, they are unreliable because the averaging method was different from one institution to another.

However, despite these difficulties inherent in any research process, we believe that this did not significantly affect the overall quality of the product delivered.

III. RESULTS AND DISCUSSION

The results of the study are presented according to the order of presentation of the research questions: 1 / institutionalization, 2 / digital schools of development, 3 / professional development of ICT teachers and 4 / attitudes of students vis-à-vis ICT in STEM subjects.

Before presenting the results of the study, it is important to give some characteristics of the institutions and the study sample.

III.1. Facility and sample characteristics

III.1.1. Gender of respondents

Table 6: Distribution of respondents by sex

Region	Teachers STEM 1	Teachers STEM 2	Students	Coordinators STEM	Principals
Man	10 *(100%)*	86 *(92,5%)*	48 *(45,3%)*	8 (100%)	2 *(25%)*
Woman	0 (0%)	7 *(7,5%)*	58 *(54,7%)*	0 (0%)	6 *(75%)*
Total	**10** ***(100%)***	**93** ***(100%)***	**106** ***(100%)***	**8** ***(100%)***	**8** ***(100%)***

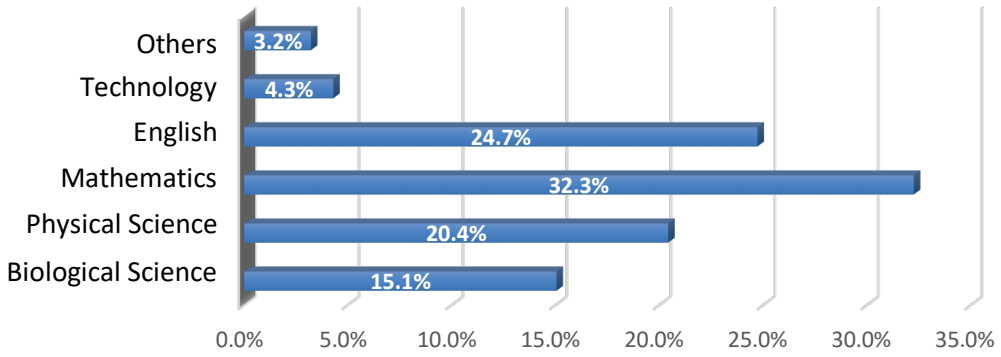
Table 6 shows that there are no female teachers and STEM coordinators. The respondents in these two sub-groups are men only. Women are also few (7.5%) of the teachers surveyed in general. Male teachers account for 92.5% of the sample of teachers.

Among students, women are strongly represented with 54.7% compared to 45.3% for men. The proportion of women is also important among school leaders. They represent 75% of this subgroup against 25% by men.

III.1.2. Teachers distribution by discipline and seniority

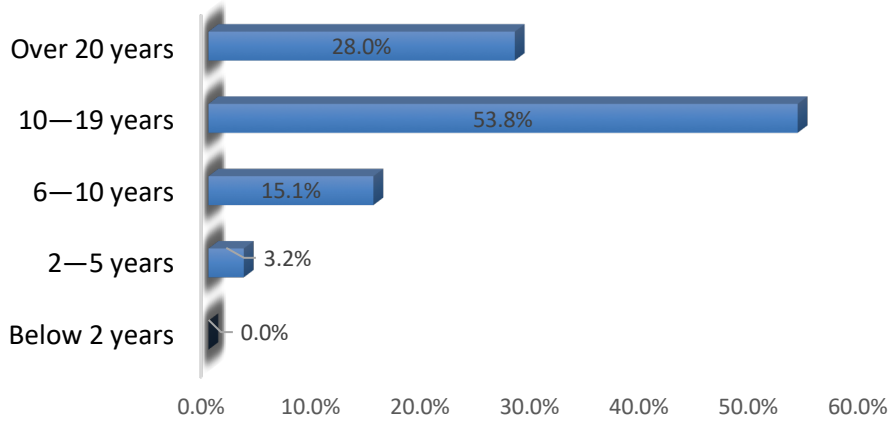
The distribution of the sample of teachers by discipline taught shows mathematics teachers are the most numerous (32.3%). They are followed by English teachers (24.7%) and those of Physical Science (20.4%).Technology teachers represent (4.3%) of the sample. Figure 1 shows the distribution of teachers by subject taught.

Figure 1: Distribution of teachers surveyed by discipline



The distribution of teachers in the sample by seniority reveals that more than 80% of them have a professional experience of more than 10 years. The figure below shows the distribution of teachers by professional experience.

Figure 2: Distribution of Teachers by Seniority



The sample institutions do not all have information on both annual average performance and annual average per subject. Since this type of information is not included in the annual report template to be produced by the institutions, this data is not calculated within the institutions.

Out of the ten (10) institutions in the sample, only five (5) were able to provide these results at the request of the research team. They must be taken with great reserve because the researchers can not guarantee the uniformity of the method of calculating these average scores.

Summarised average scores from institutions in STEM subjects between 2013-2015 periods are presented in Table 7 below.

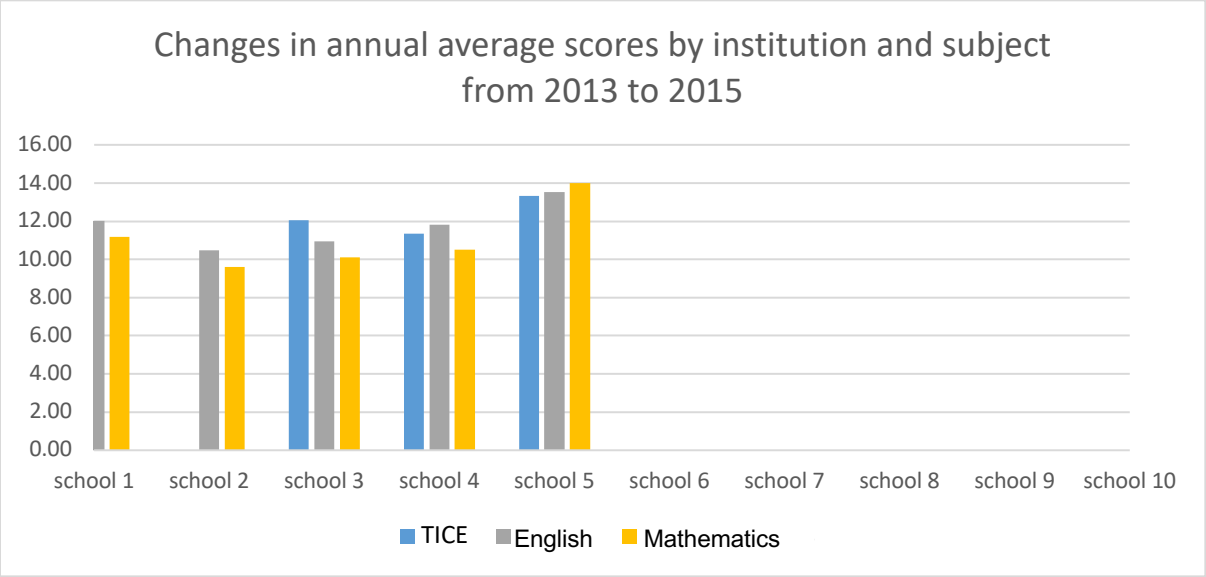
Table 7: Growth of annual averages of institutions by STEM subject from 2013 to 2018

Institution→ Subject STEM↓	school 1	school 2	school 3	school 4	school 5	school 6	school 7	school 8	school 9	school 10
Biology, physics, Chemistry	11,98	0,00						12,05	11,35	13,32
TICE										
English	12,02	10,49						10,95	11,82	13,51
Mathematics	11,18	9,60						10,09	10,51	13,99

One can note that the scores vary from one institution to another. The institutions of excellence (St Mary's High School, School 1 and Scientific High School of Yamoussoukro (School 10) have the highest averages, even if more or less well equipped ,computer rooms exist in these institutions, in the daily reality. Technology is not yet actually taught in institutions.

The growth of these performances is presented in Figure 3 below.

Figure 3: Average growth performance of schools by STEM subjects and by year from 2013 to 2015



III.2. Results 1: Institutionalization of ICTs and Digital School Development Policy

To better understand the level of institutionalization of ICTs and mastery of digital development policies in schools in Côte d'Ivoire by the main actors, heads of schools and coordinators of STEM subjects were interviewed in the schools. Topics covered in the interview include: i) ICT in school vision and planning, ii) ICT and curriculum, pedagogy, organization and management of the school, iii) ICT adherence and results achieved. The results obtained are presented in the following points.

III.2.1. School Vision, Leadership and Planning

The study highlights the interest of heads of schools and STEM coordinators for digital education. However, despite the existence of legal and regulatory provisions in the field of ICT at school (decision taken since 2012, institution of a TICE material in training programs), these major players in the school system at the base seem to be unaware of these provisions. Indeed, they deplore the lack of a national ICT policy in schools, which should define its objectives, content and means.

But when asked about their own vision of the integration of ICTs into teaching within their school, there is no clearly articulated vision or planning based on goals and activities within a defined time frame.

However, they believe that if this policy is defined at national level, they would be able to implement ICT in their institutions in a period ranging from 3 to 5 years.
The vast majority of school principals and STEM coordinators agree that the ENEACI project should improve the quality of teaching and hence the performance of students and institutions if ICTs are indeed taught as a separate subject and integrated into the curriculum.

Some respondents claim to have participated in more or less similar projects (Africa code week project, MTN project, SANKORE project, Orange Ivory Coast). Some of these projects (SANKORE project, Orange Côte d'Ivoire) are among those currently underway in the national education system.

Overall, the study shows that school leaders and STEM coordinators are aware of the usefulness of ICTs. As a result, many have developed outreach strategies for this tool within their institution. For example, there is awareness among parents of students, teachers and students in some institutions.

Finally, the study shows a difficulty systematically noted by the speakers: lack of learning materials within the institutions and lack of training to efficiently conduct an introduction program of digital resources.

Also, different needs for materials and equipment and training are identified and formulated. These include:

Technical materials needs

- Computers
- Internet connection
- Overhead Projector
- Projectors
- Risographs Photocopiers
- Printers
- Scanner
- Stabilizers
- Whiteboard
- Chalkboard markers.
- Etc.

Training needs

- Training in the handle of informative tools

- Training in the mastery of teaching methods

- Training in computer skills and internet tools

III.2.2. Pedagogical integration of ICTs as a solution

The study also showed that ICT mainstreaming is at a rudimentary stage and provides insights into the challenges to be met if ICTs are to contribute to improving the performance of the school in general, students and teachers in particular. The use of ICT by teachers is often limited only to the entry of homework and the recording of student grades and averages.

However, officials and teachers are aware that the TICS would be a mitigating factor in the the absence of laboratories if they are integrated into the methodology and course of lessons. This would facilitate the research and preparation of courses, motivate students through observation of the phenomena studied and make it easier to solve learning difficulties. Nevertheless, one should be vigilant in the choice of content on the net because some content have no educational value.

In the end, the integration of ICT meets the support of teachers even if the extra work involved in this activity has caused some reluctance at the beginning. School leaders and STEM coordinators are aware of the benefits of ICTs in the education process. They reduce the cost of laboratory equipment and course preparation time. This is why they consider this reform necessary, which meets the vision of the school authorities and they want teachers to be encouraged.

The usefulness of ICT is evoked by a coordinator of a school in the city of Yamoussoukro in these terms: "ICTs capture the students' minds and make teaching effective" and "they allow the student to be better trained and develop his knowledge »

III.2.3. Planning and Integration of ICT in Schools

The study reveals that apart from the ENEACI project as it is implemented in its pilot phase, no specific planning is deployed by school heads. In other words, school leaders encourage STEM teachers to use ICT in their educational activities without any planning being given to them. It is up to these teachers and students to demonstrate personal will. In the absence of materials and training, the will of the actors seems insufficient. This is why; the interviewed stakeholders are unanimous to make the following propositions:

- each school should have a computer room with an internet connection,

- each teacher should have his own laptop,

- each student and teacher should be trained in the use of the computer,

- all written records should be digitized

The materials to be mobilized for the implementation of the reform are the same as those mentioned above.

III.2.4. Communication: Purpose and expected results

The interviews made it possible to identify various means that have been used within the institutions to raise awareness, inform students' parents, students and teachers. These are:

- SMS;
- E-mails;
- Meetings;
- Seminars and;
- Training

The information and awareness of teachers, including those that will not be taken into account in the pilot phase, as well as those of students' parents and students, are mainly through these channels.

III.2.5. Contribution of ICTs to the development of curricula, methodologies and pedagogical management

The study shows that there have been some positive changes in the attitudes of educational actors since the introduction of ICT including:

- Digitization of letters and newsletters;

- The systematic seizure, in some establishments, of interrogations and duties;

- The use of ICT as a course medium by some teachers especially in physics / chemistry, and Natural sciences.

However, these changes are very limited in scope. This is why some educational actors recommend that material conditions be brought together for an effective integration of ICT in curricula as a specific subject to increase its interest among students. Some principals estimate that 10 to 30% of student learning time should be allocated to ICT and that IT should be included in national exams.

In addition, observation of STEM courses has shown that very few teachers use ICTs mainly because of the lack of materials. To this end, it should be noted that courses without digital support rarely integrate TPACK and do not appeal to the skills of learners of the 21st century. Communication is mostly vertical. Peer collaboration and critical thinking are almost non-existent.

However, teachers recognize that ICT can very well be integrated into the various stages of the course, either as motivation support or as a demonstration medium. Some cases of using technology in learning have been noted with mixed results. For this purpose, here is the demonstration provided by a teacher:

"From a video uploaded to YouTube showing the experience of water electrolysis, we will study the products of the decomposition and recomposition of water."

Unfortunately the video was projected on the screen of a laptop in the absence of a video projector. This has significantly reduced its educational impact.

The use of audio media in language classes (English) is a motivating factor in that the student talks to a virtual speaker whose pronunciation and accent may be different from that of the teacher. Here is what a teacher says about this:

"The audio supports allow students to become familiar with British and American accents."

These experiences show that the first obstacle to the integration of ICT in the pedagogical approach remains the lack of equipment.

Finally, the study shows that the use of ICTs would make it possible to present lively and lively situations for learning within the framework of continuing vocational training (CVT) and to reduce the negative impact of excessive numbers on the pedagogical management through to the use of projectors

III.2.6. ICT adherence, use and results

The study shows that there was no particular resistance to ICT integration. Early reluctance was reduced through awareness. This is what school heads have to say about this:

"There can be resistance, but you have to inform, educate, supervise and train".

Insufficient or no material appears to be the main factor limiting the enrolment of the majority. This is why school heads want schools to be equipped with materials.

For school principals, the use of ICT in teaching and learning is a source of increasing motivation and more active participation of students in the course. They also hope that ICTs will solve the problems of lack of laboratory in most cases. Finally, they hope that the use of ICTs will become a reflex for teachers and students for research at school and beyond. All this implies that the teacher controls the operation and use of the digital tools at his disposal.

Finally, the study shows some expected results:

- equipment of schools in digital materials including internet connection;
- the endowment of each teacher with a laptop in his own care;
- the digitization of all administrative and educational acts;
- mastery of digital technology by teachers in the conduct of courses;

In order to to measure its progress, here is what school heads say:

"When we see in 3 years time from now, 3/4 of teachers teaching in ICT in equipped classes and diligent, interested and successful students, we shall appreciate the integration of ICT."

In order to do this, the school heads are faced by some challenges including the following.

- sensitize teachers to each have a laptop;
- look for external partners in the sustainability phase of the project;
- teachers' training for the purpose of tool maintenance;
- mobilize financial resources to cover the costs

We can conclude on the following remarks of a head teacher and a STEM teacher from two institutions in Abidjan:

"This project is noble, important and necessary. It will allow teachers to increase their performance and students to have better results. "But" what is the motivation of STEM teachers in this project? What do STEM teachers earn?
This shows that the interest of the project was well perceived by the educational actors and the conditions of its implementation in terms of awareness and equipment were described but for
the sustainability of the project, it is necessary to clarify the issues touching on teachers' salaries from the start to avoid any misunderstanding.

III.3. Results 2: Digital Development Schools

III.3.1. Limited digital resources with restricted access

What is the state of play regarding the mobilization of actors and human, material and technical resources for an effective start-up of digital schools of development excellence in Côte d'Ivoire ?

This major questioning is answered through interviews with headmasters and coordinators, as well as, in the responses to the answers to questionnaires from teachers and students.

With regard to the development of digital schools, the study highlighted the lack of appropriate infrastructures and equipment for genuine integration and full development of ICTs within schools.

It should be noted, however, that some digital resources are available in all institutions as shown in the table below:

Table 8: Distribution of digital equipment within intitutions

Institutions	Number of computer rooms	Number of computers	Number of functioning computers	Number of computers in classroom	Number of computers in the staffroom	Number of computers in the principal's office	Internet connection
St Mary HighSchool Cocody	2	10	10	0	3	2	yes
Modern High School Harris	1	8	8	0	2	1	yes
Technical High School Abidjan	4	52	27	0	indefinate	indefinate	yes
Boys High School Bingerville	1	22	22	0	indefinate	indefinate	yes
Modern High School Port Bouet	1	10	10	0	indefinate	indefinate	yes
Modern Highway College	1	10	10	0	indefinate	indefinate	yes
Ehivet Gbagbo yopougon High School	1	4	4	0	indefinate	indefinate	yes
Modern High School Toumodi	2	indefinate	indefinate	0	5	1	yes
Mamie High School Adjoua yakro	1	25	indefinate	0	3	1	yes
Yamoussoukro Scientific High School	1	10	indefinate	2 (sankoré)	indefinate	indefinate	yes
TOTAL	15	151	91	2	13	5	10

Indeed, each institution has at least one computer room more or less well equipped with functional computers. On the other hand, no classroom is equipped with computers.

However, interviews with principals and coordinators generally reveal the overall state of deprivation in which the project schools are located. As shown in the table above, institutions have computer rooms, some materials provided by ongoing projects (SANKORE, Mobile Learning) but access to these resources is very limited and regulated both for teachers and for the students. For example, no school has computers in the classrooms, with the exception of the Yamoussoukro Scientific High School, two of which have benefited from the equipment of the SANKORE project. If all the institutions claim to have a wifi connection whose connectivity level is often low, none of them has a website.

Instead, the study revealed the existence of significant ICT needs

III.3.2. Infrastructures and resources needs

The study identified the materials and infrastructure that school principals need to implement ICT in schools. These are :

- Computers
- Internet connection
- Overhead Projector
- Projectors
- Risographs Photocopiers
- Printers
- Scanner
- Stabilizers
- Whiteboard
- Chalkboard markers.
- Etc.

Training needs

- Training in the handle of informative tools

- Training in the mastery of teaching methods

- Training in computer skills and internet tools

III.4. Results 3: Professional Development of Teachers: State of Play of the Pedagogical Integration of ICT in Teaching and Learning STEM

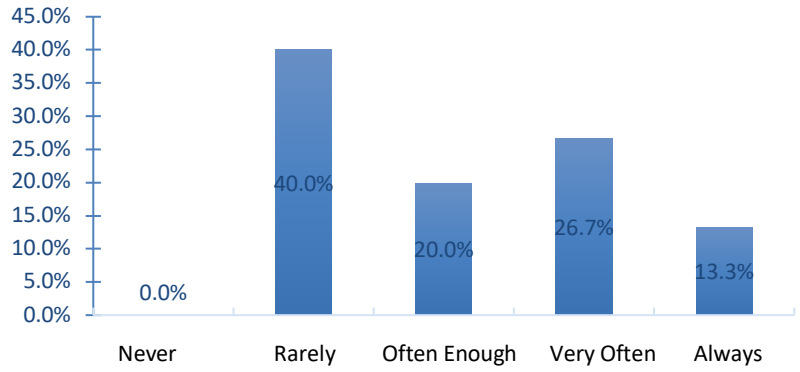
III.4.1. The Use of ICT

III.4.1.1. The Use of computers at school

The use of computers by teachers in their schools is not yet effective. In fact, 81.5% of teachers answered that they did not have access to computers within their school. Only 18.5% of teachers, one in five teachers, responded positively to the use of computers at school.

However, when computers are available in the school, a total of 60% of teachers have access to them, either "quite often" (20%), "very often" (26.7%), or "always" (13). , 3%). However, 40% of teachers say they rarely use computers in their school. The breakdown of computer usage frequency is summarized in the figure below.

Figure 4: Distribution of frequency use of computers by teachers in their school

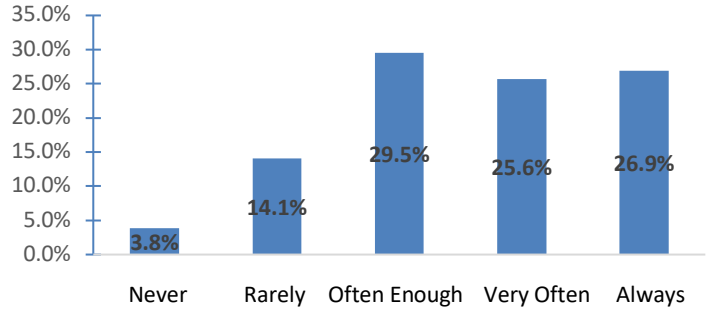


III.4.1.2. The Use of computers and internet at home

The study reveals that over 91.3% of teachers, or nine out of ten teachers have access to computers at home, fairy tales of 8.7% who answered not to own computers. Of those teachers who reported using computers at home, 75% indicated that they had access to the Internet through their home computer.

The frequency of internet use on teachers' personal computers is very high. At least 82% of teachers have "often enough" access to the Internet (Cumul terms "Quite often", "Very often" and "Always"). The figure below gives the distribution of the frequency of access to the internet on personal computers.

Figure 5: Frequency distribution of Internet access at home



III.4.1.3. Perception of teachers about the usefulness of ICT

The study aimed to evaluate teachers 'perceptions of the usefulness of ICT in learning and improving students' knowledge. Also, they were invited across a Likert scale (Strongly Agree = 5, Agree = 4, Neutral = 3, Disagree = 2 and Strongly Disagree = 1) to assign a score to the items defined in this end.

Table 9:Perceptions of the usefulness of ICTs in learning by teachers.

Items	Average Score	Average standard deviation
Students' use of ICTs can enhance their learning	4.78	0.439
ICTs provide valuable resources and tools to support student learning.	4.8	0.431
ICT can be mainly used for clear presentations	4.58	0.745
ICTs have limited capacity to be beneficial in the classroom	3.13	1.335
General perceptions	**4.3**	**1.07**

The analysis of the responses shows that the overall perception of teachers of the usefulness of ICT in education is high (mean score 4.32, SD = 1.07). This utility is all the more important as the average score of the item "ICTs provide useful resources and tools to support student learning. Is 4.80 with a standard deviation of 0.431 on the one hand and teachers reject the assertion "ICTs have limited capacity to be beneficial in the classroom" whose average score is 3.13 indicates neutrality.

III.4.2. Assessment of teachers' skills in ICT

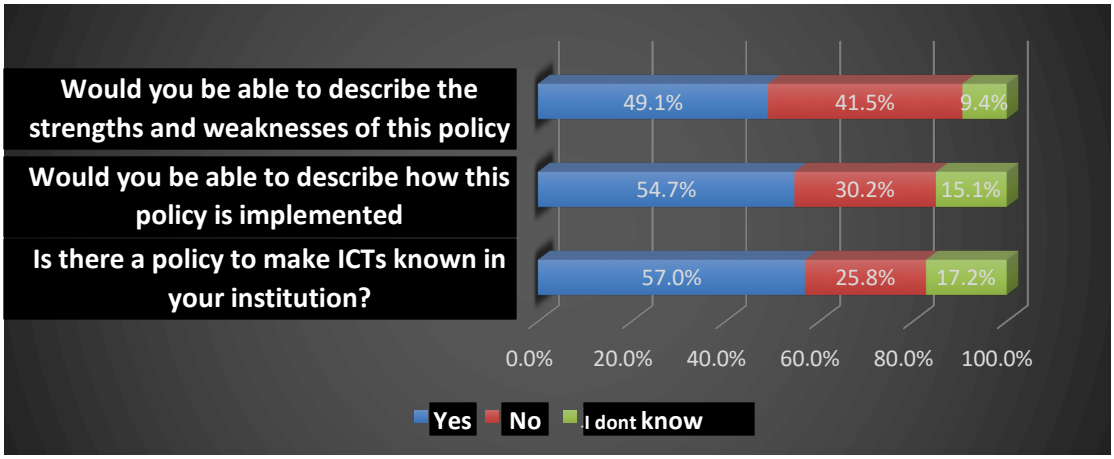
III.4.2.1. Awareness of ICT policy

The study focused on educating teachers about the existence of policies that integrate ICT into education at local or national level. Out of the 93 teachers surveyed, over half (57%) indicated that they were aware of policies for the introduction of ICT in education while 25.8% of teachers indicated that they did not know of the existence of ICT policy in the education system.

Among teachers who know about the existence of ICT policies in the education system, almost half (54.7%) are able to describe their implementation and to identify their strengths and weaknesses.

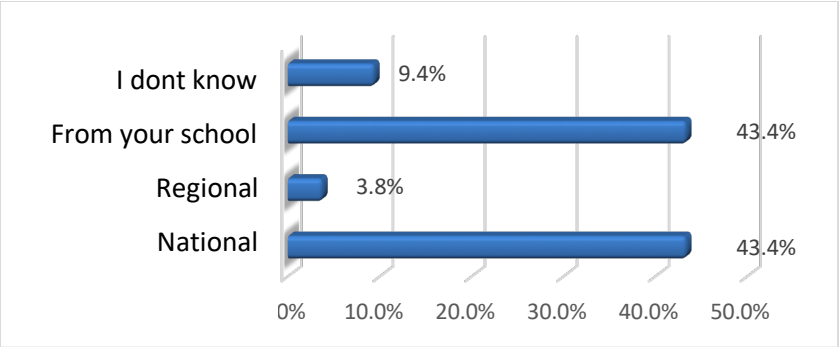
However, nearly one third of teachers (30.2%) are unable to describe the strategies for implementing these policies, on the one hand, and to determine the strengths and weaknesses of the other. The figure below shows the distribution of teachers' responses to questions related to raising awareness about ICT policies in schools.

Figure 6: Teachers' views on the existence and implementation of ICT introduction policy in the education system



In addition, teachers who are aware of the existence of ICT integration policies were invited to define the framework for their implementation. They were divided between implementation at the national level and at the level of their institution. Indeed, an equal proportion of teachers, 43.4%, believe that ICT policies are implemented both at national level and in their institution. (See Figure 6)

Figure 7: Opinions of teachers on the level of implementation of ICT policy

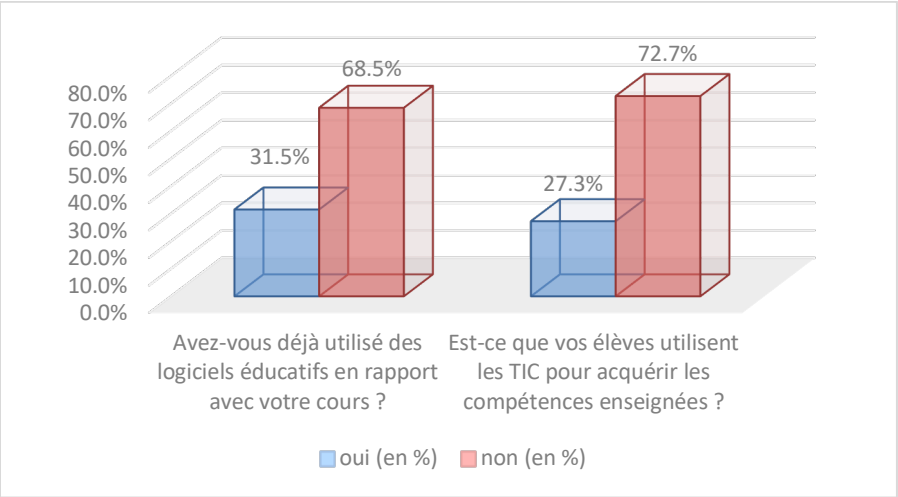


III.4.2.2. Curriculum and evaluation of learning

This section aims to assess the use of ICT in curricula and student learning. Thus, the majority of teachers (68.5%) said they did not use educational software related to the courses taught.

Most (72.7%) think that students do not use ICT to deepen their understanding of the courses they receive. However, a small proportion of teachers (27.3%) think that students use ICTs to learn the subjects taught.

Figure 8: Teachers' perception of ICT use in STEM fields.



In general, teachers believe that ICTs are not yet used in teaching and in student assessment as evidenced by the average scores of items in Table 8. Indeed, the average score of ICT use in the curriculum and student assessment is 1.55 with a standard deviation of 1.02.

Table 10: ICT use in teaching and assessment by teachers

Item	average score	Average standard deviation
To what extent do you use ICTs with your students as a teaching subject?	1.54	1.038
To what extent do you use educational software related to the course with your students?	1.48	0.89
To what extent do you use digital artifacts from student homework as proof of student achievement?	1.26	0.632
To what extent do you use ICTs to monitor, evaluate and report student results?	1.90	1.316
General use of ICT in curriculum and assessment	1.55	1.020

III.4.2.3. Use of ICT in education

For ICT to be used wisely, the teacher must view it as an integral part of the educational design of his teaching. Respondents were asked to describe how they integrate software presentation and digital resources during their classes.

The analysis of the responses of the items in the table below shows that the eduacational use of ICT in teaching is very limited or even absent for the majority of teachers. Indeed, the average score of general ICT use in education is 1.79 with a standard deviation of 1.071 (see Table 9).

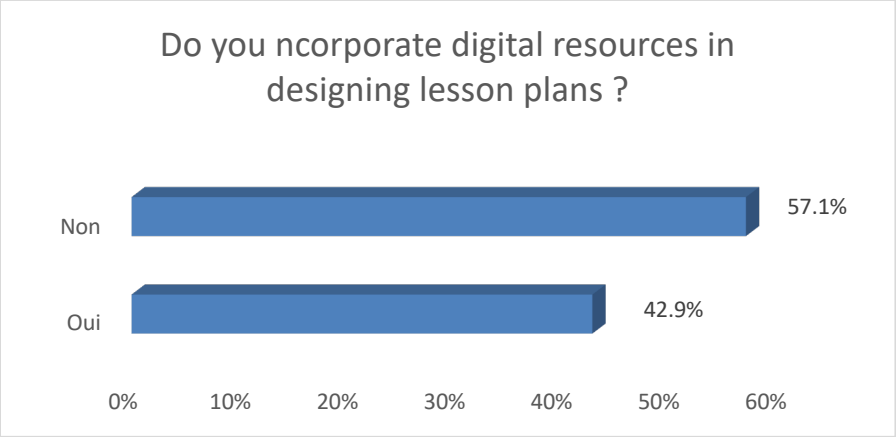
Table 11: Use of ICT in education

Items	Average score	Standard deviation
How much do you use presentation software during your classes?	1.26	0.737
How much do you use digital resources during your classes?	1.84	1.16
How much do you share your experience of using ICTs with other teachers?	2.21	1.092
General use of ICT in pedagogy	1.79	1.071

(Rating scale: 1 = No measurement; 2 = lesser extent; 3 = certain measure; 4 = good measure; 5 = great extent)

Learning with ICTs, where multimedia means are used to improve teaching or replace other media without changing teaching and learning methods, is not yet complete because more than half of the respondents among teachers (57.1%) indicated that they do not develop lesson plans incorporating digital resources (See Figure 8).

Figure 9: Teachers' perceptions of ICT use in their subjects taught



III.4.2.4. Use of ICT in general

The use of ICT in the school context in a professional and sustainable way requires teachers to master these tools. The study was therefore interested in verifying the level of use of the tools mentioned by the teachers:

- word processing and presentation software,
- web browsers and search engines
- e-mail addresses and open educational resources.

The average score for the overall use of these tools is 3.14 with a standard deviation of 1.527. In other words, the use of ICT tools is moderate.

However, word processing software (SM = 4.02, SD = 1.109) and the use of email addresses (SM = 3.70, SD = 1.309) are regularly used by teachers. In regard to software presentation, their use is rare (SM = 1.65, SD = 1.063).

Table 12: Use of ICT tools by teachers

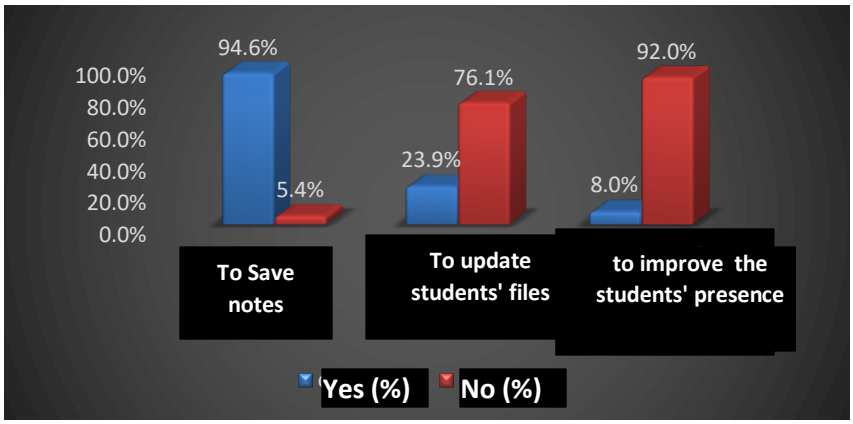
Item	Average score	Standard deviation
How much do you use a word processor?	4.02	1.109
How much do you use presentation software?	1.65	1.063
How much do you use a web browser?	3.19	1.491
How much do you use a search engine?	3.43	1.477
How much do you use an email address?	3.70	1.309
How much do you use open educational resources?	2.82	1.452
Use of ICT tools in general	3.14	1527

(Rating scale: 1 = No measurement; 2 = lesser extent; 3 = certain measure; 4 = good measure; 5 = great extent)

Majority of teachers (94.6%) primarily use computers to record students' grades. Only 8% of them use computers in order to track students' attendance.

However, nearly one-quarter of teachers (23.9%) use computers to track students' records.

Figure 10: Teachers' Perceptions on Computer Use



III.4.3. Organization and Management

The study looked at the degree to which teachers integrate digital resources into the organization and management of their classrooms. Thus, they were asked to indicate the extent to which they integrate ICT into classroom teaching activities. The results are instructive and show that the use of ICT by teachers to facilitate classroom teaching is very low (Mean: 1.45, SD: 0.914).

Table 13: Teachers' Responses to Classroom Management and Organization

Item	Average score	Normal standard deviation
To what extent do you integrate the use of a computer lab in educational activities?	1.32	0.901
How much do you use ICT in the classroom?	1.63	1.019
How much do you use ICT with your students for presentations without changing the classroom configuration?	1.33	0.838
How much do you use ICT in the classroom for individual learning?	1.47	0.880
How much do you use ICT in the classroom for small group activities?	1.38	0.837
Global	1.45	0.914

(Rating scale: 1 = No measurement; 2 = lesser extent; 3 = certain measure; 4 = good measure; 5 = great extent)

The low level of integration of ICTs in the management and organization of classes raises questions about the explanatory factors for this situation. Is it lack of ICT skills or training for teachers or lack of infrastructure that hinders the use of ICTs in teaching?

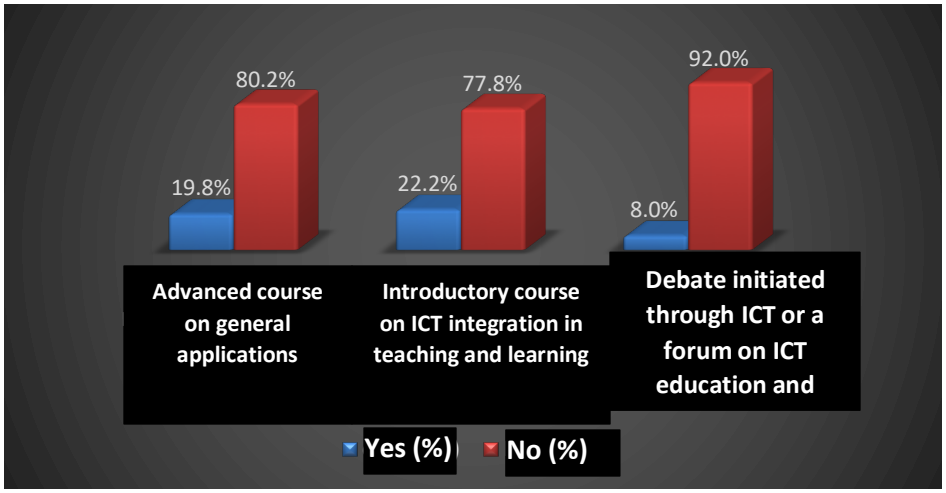
III.4.4. Professional Development of the Teacher

Teachers must possess the technological skills and skills necessary to acquire new pedagogical knowledge to enhance their professional development. To this end, the study sought to find out whether teachers have benefited from advanced courses on the use of applications in general or introductory courses on the integration of ICT in teaching / learning.

The results show that the majority of teachers (80.2%) did not benefit from refresher courses in the last two years. A significant proportion of teachers surveyed (77.8%) say they have not benefited from introductory courses on ICT integration in teaching and learning

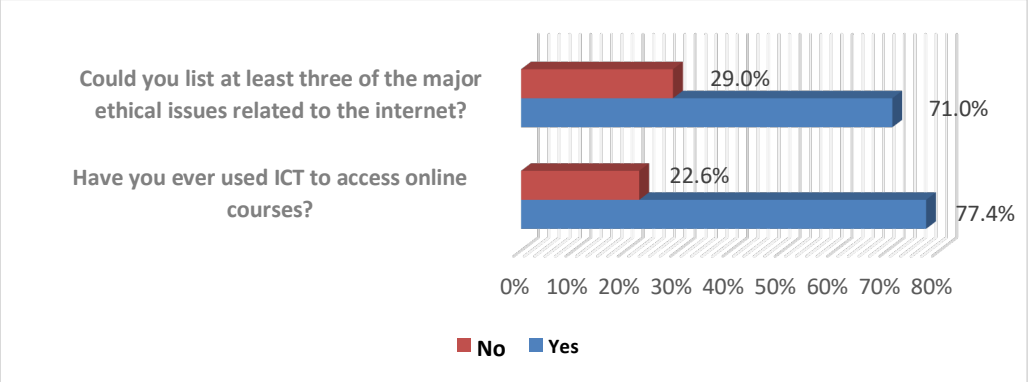
They are even more numerous (92%), the proportion of teachers who have not yet participated in ICT exchange forums or in a forum on ICT teaching and learning.

Figure 11: Teachers' responses on refresher and introductory courses on ICT integration



Despite the lack of an institutional framework for teacher development, they are personally engaged in a process of professional self-learning through the use of ICTs to access various online resources to build their individual capacities. For example, 77.4% of teachers said they had access to online educational resources.

Figure 12: Teachers' perceptions on professional learning



In addition, teachers were asked to list at least three of the major ethical issues related to the Internet. More than two-thirds of teachers (71%) indicated that they were able to list ethical issues related to the Internet, while 29% of teachers indicated that they were unable. (See Figure 11)

Teachers also expressed their skill levels on the use of ICTs in professional learning. The results indicate that levels of ICT use in teacher professional learning are moderate (mean: 3.40 and standard deviation: 1.352). Table 6 shows the teacher's point of view on their degree of use of different ICTs in professional learning.

Table 14: Teachers' point of view on their professional learning

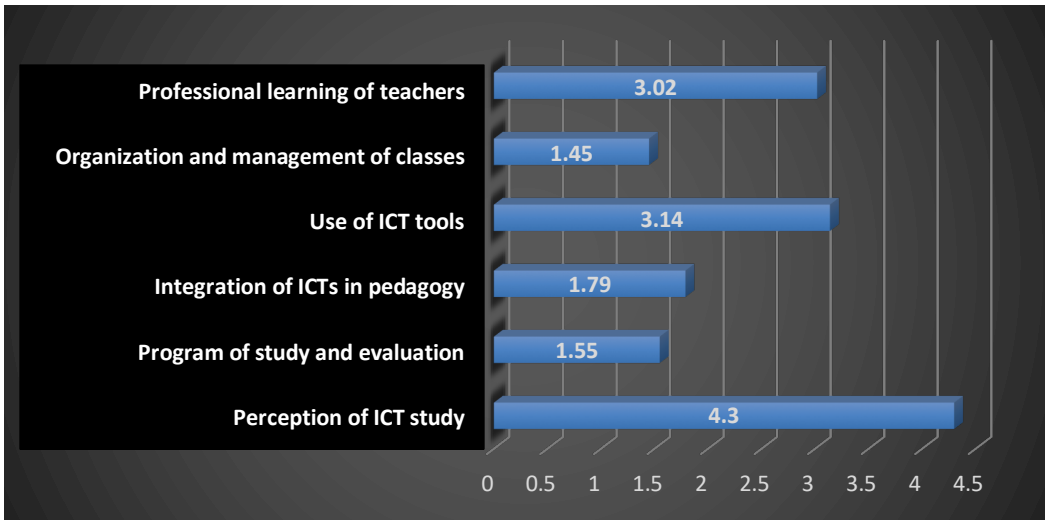
	Average score	Standard deviation
How much do you use digital resources to improve the productivity of your school?	2.64	1.25
How much do you use digital resources to learn more about your discipline?	3.40	1.352
Overall Average Score	3.02	1.36

Benchmarks: large area=5, Good range = 4; certain extent=3, lesser measure = 2; No measures = 1)

In conclusion, we will compare the assessment of teachers' skills on the use of ICT in schools and classroom practices using the six dimensions of the ICT-CFIT framework as reported by teachers. Figure 12 gives a synthetic view of the average scores of the different dimensions.

It appears that teachers have a good perception of the usefulness of ICT in education (MS: 4.3). However, they have real difficulties in integrating them into pedagogy (SM: 1.79) and into the management and organization of classes (SM: 1.45). Nevertheless, in terms of ICT use, teachers have a moderate level (MS: 3.14).

Figure 13: Summarized view of average scores of ICT-CFIT framework dimensions



III.4.5. ICT Skills Assessment 2 (TPACK)

The teacher survey also focused on their self-assessment of the use of technology, pedagogy and content knowledge (TPACK) in science and technology teaching and learning subjects, English and mathematics.

Koehler and Mishra (20005) presented the TPACK -Technological Knowledge and Content Model as a model for promoting and understanding the integration of technology in educational settings, primarily in schools and pre-service teacher training programs.

This model gives a representation of the integration of technologies in the classroom. It describes how the teacher's technological knowledge is articulated with his pedagogical and didactic knowledge for a successful integration of technologies into teaching.

The TPACK model describes three areas of teacher knowledge: knowledge of content to teach, knowledge of pedagogy and technology. Content knowledge (CK) refers to the knowledge of the subject taught; it depends on the discipline and the academic degree. Pedagogical Knowledge (PK) is a thorough knowledge of teaching and learning processes, practices and methods. Technological knowledge (TK) refers in this model not only to digital literacy but also to the mastery and in-depth understanding of information technologies from the point of view of information processing, communication and problem solving.

In this study, we draw on this model for a self-assessment of teachers' abilities to effectively integrate technologies into teaching.

III.4.5.1. Knowledge in Technology (TK)

The table below presents teachers' assessment of their technology knowledge expressed through their agreement or disagreement with the proposals made to them.

The average score of Technological Knowledge in general of teachers is moderate (SM: 2.91, SD = 1.189). Teachers expressed the lack of opportunities to work with different technological tools (SM: 2, ET: 1,054). Similarly, they have a limited ability to solve the technical problems they face in ICT (SM: 2.6, ET: 1.265).

However, teachers reported their abilities to easily learn the technology. This item obtains the best average score 3.8 with a standard deviation of 0.632.

Table 15: Descriptive statistics of teachers' responses on KT

Items	Score moyen	Ecart type	Fortement en désaccord	En désaccord	En accord	Entièrement en accord
I know how to solve my own technical problems related to ICT	2.6	1.265	30%	10%	30%	30%
I can easily learn technology	3.8	0.632	0%	10%	0%	90%
I am aware of major technological developments	3.2	1.135	10%	20%	10%	60%
I often use the technology of playful purposes	2.4	1.265	30%	30%	10%	30%
I know several technological tools	3.3	1.059	10%	10%	20%	60%
I have the skills to use technology	3.1	1.101	10%	20%	20%	50%
I had enough opportunities to work with different technological tools	2.0	1.054	40%	30%	20%	10%
Global knowledge in TK	**2.91**	**1 89**	**19%**	**19%**	**16%**	**47%**

III.4.5.2. Technological and Pedagogical Knowledge (TPK)

Teachers were asked to rate their level of knowledge of the pedagogical integration of ICT for their teaching and student learning.

Technological pedagogical knowledge refers to how teaching and learning can change depending on the choice of a technology or how it is used.

Teachers expressed optimism during the survey to be able to teach in the classroom using ICT (see Table 15). Indeed, all teachers fully agreed that they could adapt the use of the technologies they learn to different teaching activities, and that they also thought they would use technology in the classroom. On average, they agree (M = 3.80, SD = 0.67) on their competence in technology pedagogy. Descriptive statistics for items on TPK are shown in the table below:

Table 16: Descriptive statistics of teachers' responses on TPK

Items	Average score	Standard deviation	Strongly disagree	disagree	agree	Fully agree
I can choose techniques that improve teaching methods for a course	3.9	0.316	-	-	10%	90%
I can choose methods that improve student learning for a class	4	0	-	-	-	100%
My teacher's training program made me think about how technology can influence the teaching methods I use in class	3.1	1.287	20%	10%	10%	60%
I seriously think about the use of technology in my class	4	0	-	-	-	100%
I can adapt the use of the methods I learn on different educational activities	4	0	-	-	-	100%
General knowledge in TPK	**3.8**	**0.67**	**4%**	**2%**	**4%**	**90%**

III.4.5.3. Technological Content Knowledge (TCK)

The aim here is to evaluate the level of knowledge of STEM teachers for the appropriate choice of technology suitable for teaching in their subject.

Technological Content Knowledge (TCK) refers to the understanding of how technology and content to be taught influence and constrain each other. The use of a specific technology may, for example, change the type of representations that students construct in a given field. Hence, it is important for teachers to identify the most appropriate technologies to address particular teaching content.

Thus the general self-assessment of teachers on their knowledge of Technology Content is satisfactory (MS: 3.5, SD: 0.972). Teachers in the Technology and English disciplines have expressed a strong potential to combine technology with educational content. (SM: 4, ET: 0).

Math teachers have expressed less ability to integrate technology with course content. (MS: 3.33, 0.57).

Table 17: Descriptive statistics of teachers' responses to the TCK

Items	Average score	Standard deviation	Strongly disagree	disagree	agree	Fully agree
I know the technology I can use to understand and do science	3.25	1.5	25%	-	-	75%
I know the technology I can use to understand and make technology	4		-	-	-	100%
I know the technology I can use to understand and do English	4	0	-	-	-	100%
I know the techniques I can use to understand and do mathematics	3.33	0.57	-	-	67%	33%
General knowledge in TCK	**3.5**	**0.972**	**10%**	**-**	**20%**	**70%**

III.4.5.4. Technological Knowledge of Educational Content (TPCK)

Technology, Pedagogy, and Content Knowledge (TPACK) or the Technological Knowledge of Educational Content is the good knowledge and simultaneous consideration of these three factors (TK, TCK, TPK) in the teaching learning activity. It will enable teachers to effectively integrate technology into teaching. Each teaching and learning situation incorporating digital technologies is in principle the result of a combination of these three factors which are then in a state of dynamic equilibrium (Koehler and Mishra, 2006).

The results reveal differences between the groups of science teachers, English and Technology, on one hand, and mathematics, on the other. Teachers in the first three disciplines have high average scores (SM = 4.40, and = 0) while the lowest average

score is obtained by mathematics teachers (SM = 3.67, SD = 0.577). The overall mean value (SM = 3.9, standard deviation = 0.311) is high and indicates that the respondents appear to have TPACK.

This result is contradictory to the reality when one knows the technology courses are not yet factored in the curriculum of secondary education in Côte d'Ivoire.

Table 18: Descriptive statistics of teachers' responses on TPACK (Sc = 4, T = 1, Eng = 2, Math = 3)

Items	Average score	Standard deviation	Agree	Fully agree
I can give a course that correctly associates science content, techniques, and teaching methods	4.00	0.000	-	100%
I can give a course that correctly associates technology content, techniques, and teaching methods	4	-	-	100%
I can give a course that correctly combines English content, techniques, and teaching methods	4	0	-	100%
I can give a course that correctly combines the content of Mathematics, techniques, and teaching methods	3.67	0.577	33%	67%
General knowledge in TPACK	**3.9**	**0.316**	**0.1**	**99.90%**

The study shows a generally positive self-assessment by teachers of their use of technology, pedagogy and content knowledge in the teaching and learning of science, technology, English and mathematics subjects. This very optimistic result is surprising for teachers, who claim not to have had initial and continuous training in ICT.

III.5. Results 4: The Use of ICT in students learning in STEM classes

The questionnaire submitted to the students had the following main objectives:

- Evaluate the use of computers by students in school
- Evaluate the integration of ICT in STEM subjects in the classroom

In order to achieve these goals, we used items to assess students' abilities to use the computer. Secondly, the students were asked through items to give their appreciation of the use of the computer in various subjects during their classes in class, as well as the computer tasks learned at school.

They had to indicate computer use frequency by choosing one of the following options: (1) Never; (2) In some lessons; (3) In most lessons (4) In almost every lesson and (5) I have not studied this subject / these subjects

III.5.1. Students' ICT skills

More than 70% of the students surveyed said they had used a computer at home or elsewhere (such as a cybercafe or library) at least once. Only 30% of students reported never having used a computer at home or elsewhere.

More than one-quarter (26.7%) of students reported less than one year experience of using a computer. The table below gives the distribution of students by years of computer use.

Table 19: Distribution of students (in %) by years of use of computers.

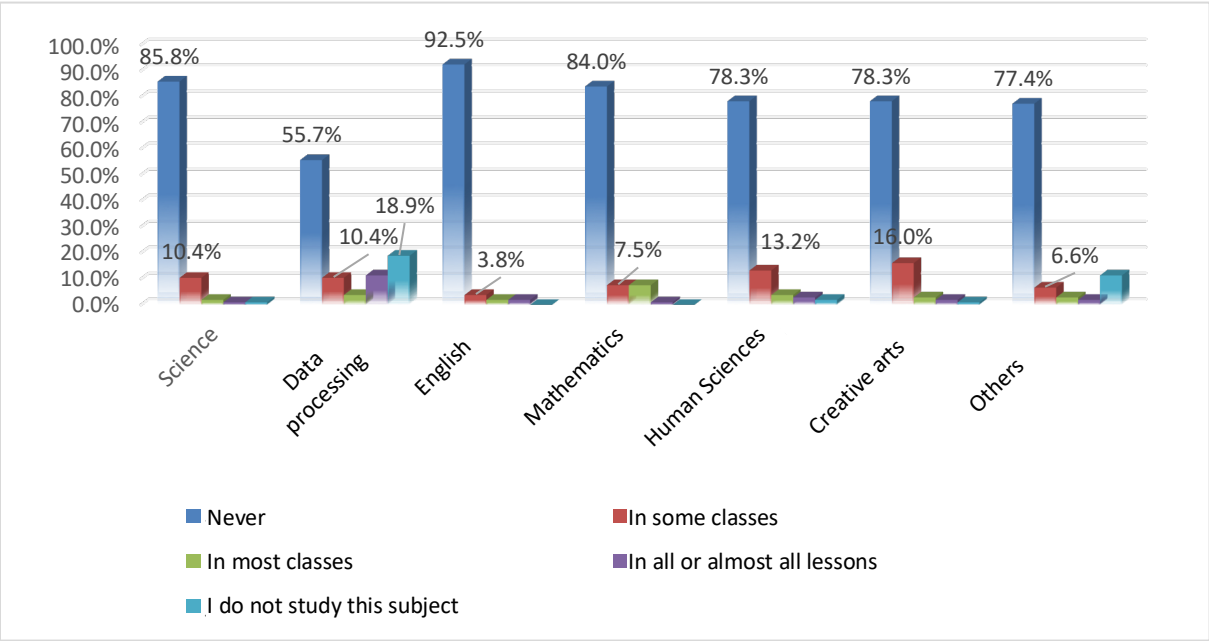
	Proportion	Proportion cumulée
Moins de 1 an	26,70%	26,70%
Entre 1 an et 3 ans	16,20%	42,90%
Entre 3 ans et 5 ans	13,30%	56,20%
Entre 5 ans et 7 ans	17,10%	73,30%
Plus de 7 ans	26,70%	100,00%

III.5.2. ICT use by students in class

The students surveyed said that using the computer in class is not a common educational practice in their school. In fact, most of them (between 77.4% and 92.5%) never use this tool during class, regardless of the subject taught: English (92.5%) Mathematics (84%), Humanities (78.3%), Creative Arts (78.3%) and Other subjects (77.4%).

Regarding computers, 18.6% of students indicated that they did not take courses in this discipline. However, among those who receive computer courses, teaching of this discipline is highly theoretical because 55.7% of students said they had never used a computer during these courses. The figure below gives the graphical representation of students' responses regarding the use of computers in teaching various subjects.

Figure 14: Students' response in regard to computer use during STEM courses



It is important to note that the proportion of computer use is particularly low in science and computer science (10.4%) and in mathematics (7.5).

In total, the computer does not seem to be commonly used tool every day in the students' school environment.

III.5.3. Students' perceptions of ICT integration in pedagogy

The study also sought to identify the specific tasks students have learned to do with computers in their school. The table below shows students' responses to the different tasks they have learned to do with ICT.

The students were instructed mainly to "look for information on an unknown subject with a computer" with a 52.8% affirmative answer.

The second task that students learned in school "Accessing information with a computer" with a score of 42.5%. The task with the lowest score at (18.9%) is "Present computer information" to an audience.

More than 50% of respondents indicated that they did not learn at school to perform various computer tasks such as "Organizing Information from Internet Sources", "Searching for Different Types of Digital Information on a Subject"

Table 20: Students' responses on computer tasks they learned

Tasks	yes (in %)	no (in %)
Identify references to Internet sources	21.0	79.0
Access information with a computer	42.5	57.5
Present information to an audience with a computer	18.9	81.1
Appreciate whether to rely on information from the Internet	36.8	63.2
Decide on the relevance of the information to be included in school work	28.3	71.7
Organize information from Internet sources	21.9	78.1
Decide where to look for information on an unknown topic	52.8	47.2
Search different types of digital information about a topic	41.0	59.0

III.5.4. Students' perceptions on the usefulness of computer

Despite students' limited knowledge of the potential of computers for learning, students are aware of the usefulness of ICTs. As the results in the table below shows, students have a strong perception of the usefulness of using the internet for the retrieval of information (SM: 3.59, ET: 0.766).

They feel that working with a computer is of paramount importance for their training and learning (SM: 3.48, ET: 0.784).

The students express a strong interest in technology and a willingness to discover the immensity of the tasks that can be accomplished through the computer.

Table 21: Students' perceptions on the usefulness of computer

	M	ET	Strongly disagree (in%)	disagree (in%)	agree (in%)	Perfectly agree (in%)
It is very important for me to work with a computer	3.48	0.784	2.8	9.4	24.5	63.2
Learning how to use a new computer program is very easy for me	2.95	0.866	1.0	31.4	36.2	31.4
I think that the use of a computer is nice	3.42	0.742	1.9	9.4	34.0	54.7
I have always been good at working with computers	2.66	0.925	8.5	39.6	29.2	22.6
It's more fun to do my job using a computer than without a computer	3.06	0.954	6.6	22.6	29.2	41.5

I use a computer because I am very interested in technology	3.26	0.919	5.7	15.1	26.4	52.8
I know more about computers than most people of my age	2.39	1.001	20.8	36.8	25.5	17.0
I like learning how to do new things using a computer	3.47	0.707	3.8	0.9	39.6	55.7
I can advise others when they have problems with computers	2.76	0.981	13.2	22.6	38.7	25.5
I often search for things using a computer	3.13	0.806	4.7	12.3	48.1	34.9
I like to use the Internet for research	3.59	0.766	4.7	2.8	20.8	71.7

IV. RECOMMENDATIONS ON STRATEGIES FOR INTEGRATING ICT INTO TEACHING AND LEARNING

IV.1. Recommendations concerning the institutionalization of ICTs

Recommendations to the public authorities (government, MENETFP):

- Inform and communicate to the public as well as to other stakeholders about ICT policy in the education and training system.
- Create an institutional framework for continuing professional development of ICT teachers;
- Implement a proactive digital tablet acquisition policy for high school and college students participating in the project;

V.2. Recommendations for digital development in schools

Recommendations to the public authorities (government, MENETFP):

- Equip secondary schools and train actors (teachers, students, administrative and technical staff) to build a digital culture at school
- Provide all institutions participating in the project with adequate ICT infrastructure (digital equipment, computer rooms and a functional Internet);

Recommendations to ENEACI and DTSI Project Managers

- Introduce teachers to the use of ICT tools (smartphones, tablets, computers, etc.) in distance learning;
- Experience mobile continuous learning with tablets and smartphones;
- Train teachers in the ICT technologies use in the pedagogical approach.
- Train educational actors (principals and administrative staff, teachers and students) to use computers and digital tools.

Recommendations to the Institution's Project Principals

- Sensitize the teachers about the use of digital resources in education;
- Sensitize the schools' actors of the project (administrative and technical staff, parents of students) how to use the digital resources for education (tablets, smartphones, laptops).

IV.3. Recommendations concerning teachers' professional development

Recommendations to the public authorities (government, MENETFP):

- Strengthen teachers training on ICT integration in teaching and learning;
- Establish an information, sensitization and extension framework on national and local policies for the introduction of ICT in Côte d'Ivoire;
- Institute a support system for teachers to acquire laptops more easily (subsidies, tax exemption, etc.)

Recommendations to ENEACI and DTSI Project Managers

Develop teachers of the ENEACI project to use digital resources in teaching and learning;

Strengthen the capacities of pedagogical supervisors in primary and secondary education in educational production engineering and tutorial engineering.

IV.4. Recommandations regarding the use of ICT in student learning

Recommendations to the public authorities (government, MENETFP):

- Put in place ICT integration strategies in the official curriculum as a specific subject;
- Introduce students to the use of ICT tools (smartphones, tablets, computers, etc.);
- Popularize the use of digital resources by students in and out of the classroom

Recommendations to ENEACI and DTSI Project Managers

- Introduce teachers to coach students on strategies and practices for using ICTs in learning.

CONCLUSIONS

The impact of ICT integration on the quality of teaching and learning is undeniable.

This basic study shows the existence of a political context conducive to the integration of digital resources in Côte d'Ivoire's teaching and learning system, in particular through a judicial and legal system that is appropriate in application.

Similarly, institutions of excellence offer a promising implementation framework. Indeed, the commitment and determination of the school principals and coordinators are perceptible. They are a guarantee of the effectiveness of the project.

In addition, various experiences of distance learning initiated or in future for the benefit of teachers and educational supervisors at all levels of the education and training system are real assets that will make it possible to achieve the development goals of digital schools at the service of the quality in learning.

In this respect, the ENEACI project is already a promising project both in terms of its scope and its innovative model in the field of STEM materials development.

It is important to deal with the constraints revealed by this basic study, particularly related to the lack of infrastructures and digital resources, lack of training of the main actors (school leaders, teachers coordinating STEM subjects and students), teachers' lack of mastery of technology, lack of ICT in the curriculum and low use of digital resources in pedagogy and learning

The implementation of the recommendations of the study will partially or completely cope with the difficulties and constraints of this project at the start-up.

It is on this condition that the ENEACI project will make a decisive contribution to the development of education through the familiarization of stakeholders with digital tools and the acquisition by Côte d'Ivoires' students the 21st century skills.

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APPENDICES

TERMS OF REFERENCE

AFRICAN INITIATIVE OF DIGITAL SCHOOL

BASIC DATA ANALYSIS AND REPORT - ROCARE-CI ABIDJAN

1. Introduction and context

GESCI, the Global Initiative for Distance Learning Communities, is a non-profit organization established by the United Nations ICT Task Force. GESCI, headquartered in Nairobi, Kenya, provides strategic advice to relevant ministries in developing countries on the effective use of information and communication technologies (ICTs) in knowledge societies accessible to all. See.

GESCI, in partnership with the MasterCard Foundation and the Ministries of Education of Côte d'Ivoire, has committed to an African Digital Schools Initiative (ADSI) (2017-2019). It is a vast program for the implementation of an efficient, sustainable and reproducible model of the development of the digital school in its entirety at the level of secondary education, which will promote the development of the student's skills of the 21st century, learning outcomes and preparation for the knowledge economy in the workplace. The ADSI model is built around two approaches to capacity building for ICT use:

• A phased approach to whole-school development in the use of ICT, which allows schools to evolve towards electronic maturity ranging from "initiation" to "activation", to "maturity" and "trust".

• A phased approach to teacher development for the use of ICTs, which enables teachers to progressively acquire electronic skills, ranging from "initiation" to "technological knowledge" to "deepening knowledge And the "creation of knowledge".

ADSI is working on a two-year program running from June 2017 to May 2019. This is scaling up its pilot project - like:
Geographically, an extension of the program to 20 school principals, 200 science, technology, English and mathematics (STEM) teachers;

At the institutional level, the participation of government institutions at the national level (ICT, curriculum, teacher development and evaluation institutes, departments and ministries) At the local level (schools, communities, departmental and regional directorates) in the development and implementation of the program (including monitoring, evaluation and learning). The program is structured around three essential objectives:

1) promote ICTs to build a viable, sustainable and replicable model of teacher professional development;

(2) to equip teachers with pedagogical practices and methods that will enable learners to acquire knowledge, develop attitudes, values and higher-level skills relevant to the needs of the market and society;

3) develop and make functional a systemic and systematic approach to the development of the school as a whole through the successful integration of ICT. In these TDRs, GESCI solicits research experts from ERNWACA-CI for the analysis of the study on initial assessment - in connection with the analysis of preliminary data collected in 20 schools in Côte d'Ivoire, as well as t the report. The experts will carry out the mission in consultation with the technical team of the GESCI-ADSI partner, the program manager, the Côte d'Ivoire project coordinator and the senior education specialist.

Research questions from the ADSI program

1. Institutionalization: What is the overall situation of the African Digital Schools Initiative (ADSI) project in terms of historical factors, education, policy and reform that can support or limit implementation and expansion of the ADSI project in Ivory Coast?

2. Development of digital schools: What is the level of academic ability for the pedagogical integration of ICT in teaching and learning STEM in the classroom?

- What policies are in place at school (micro) and out of school (macro) to help make better use of ICT in the classroom?
- What were the deployment characteristics in terms of objectives, planning, support and resources for the expansion of the ADSI project in schools in Côte d'Ivoire?

3. Teacher development: what is the level of teacher preparation for the pedagogical integration of ICTs into teaching and learning STEM in the classroom?

• To what extent do teachers use ICTs in STEM teaching practices in the classroom?
• What is the level of competence of teachers for the professional integration of ICT in the classroom?

6. Learners: What are students' attitudes towards the use of ICT in STEM?

• To what extent do learners use ICTs in STEM classroom activities, assignments and projects?

• To what extent do learners improve STEM outcomes with the integration of ICT in the classroom?

The preliminary study will focus on the first questions in each domain related to the context and level of ICT use in ADSI schools prior to the deployment of the intervention.

Strategic objective of the study: to determine the status and context of ICT use in teaching and learning STEM in schools of the ADSI project in Côte d'Ivoire.
Specific objectives of the study:

1. Institutionalization: assess the level of institutionalization of national strategies for the pedagogical integration of the use of ICT in STEM and the teaching of other subjects in relation to the development policy of teachers, programs, student teachers and teachers in service, tutoring and management methods;

2. Development of digital schools: analyze the conditions, needs, resources and priorities of schools in relation to ICT in STEM teaching and learning; specify the level of digital development of schools;
3. Teacher development: analyze teachers' skills and practices for the use of ICT in STEM; to clarify the ability of teachers to use computers;

4. Student learning: to assess learner knowledge of the early 21st century in relation to STEM and experiences, as well as attitudes towards the use of ICT in learning STEM both at school and outside the school setting; specify the performance of STEM students in national knowledge acquisition tests.

1. Scope of work

The preliminary study focuses on three main objectives:
• Present a start-up report with a proposal for performing the data analysis including:

a.. A review of the literature and documentation on the ADSI concept notes

b. A review of data collected in Côte d'Ivoire project schools

c. A proposal for a mixed methodological approach for the analysis of the quantitative (survey) and qualitative data sets

• Perform data analysis such as:

a. Cleaning preliminary data
b. Preliminary data analysis

• The report including :

a. A draft summary of the preliminary report

b. A final student report that incorporates revisions based on the technical balance sheet.

Date	Activity.	Place	Results
August 14-28, 2017	Meeting - GESCI-ADSI technical team / documentation review / dataset.	Abidjan	**Start-up report -** preliminary study and detailed plan for conducting the data analysis, report writing - including the mixed methodology for quantitative and qualitative analysis, and draft draft report plan**.**
September 15-22, 2017	Cleaning up preliminary data. Preliminary data analysis.	Tête à tête / en ligne	**Data analysis report of the mixed methodology -** interviews, transcripts, target groups, survey and classroom observation.
October 2-16, 2017	Preparation of the first draft report with preliminary results.	En ligne	**First draft report of the preliminary study -** with preliminary results based on the rereading of the GESCI-ADSI technical team.
October 28-31, 2017	Final report of the study (which incorporates the comments of the GESCI-ADSI technical team) and a complete kit (on the preliminary study process and the instruments)	Online	**Copy of the final report evaluation kit**

4. Indicative timetable of deliverables

• **Inception Report** - with preliminary file analysis, data collection, improved methodology, and draft plan for data analysis and reporting. - **August 28, 2017**

• **Data analysis report** - analysis of the mixed methodology for interviews, focus groups, survey and all classroom observation data. - **September 22, 2017**

• **Presentation of the first report** of the preliminary study to gather the comments of the management of ADSI - **October 16, 2017**

• **Final report of the preliminary** study incorporating reviews based on the reviews, as well as the procedure and instruments of the study kit. - **31st of October 2017**

5. Terms of payment

• validation of the start-up report - 10%

• submission of the data analysis report - 30%

• submission of the first preliminary report - 30%

• validation of the final report of the preliminary study - 30%

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