Design and Experimentation of Digital Classroom for 21st-Century in Secondary Schools

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Abstract: *In this article, the design and experimentation of a technology-enhanced classroom branded as Classe21 are discussed. The project, which was carried out in four secondary schools in the Republic of Mauritius intended to examine the impact of innovative and creative pedagogies in the classrooms of tomorrow. Classe21, expected to be a concept classroom for innovative pedagogies that would equip schools with tools that are required to succeed in imparting 21st-century skills to the digital natives. It integrated technological, cognitive, pedagogical, and organizational aspects that would adequately prepare schools, educators, and students as a community to thrive in this information age. Classe21 proposed to offer the facilities and resources so that the teacher metamorphoses into a skilled 'technology-using educator'. Implementing such a learning environment has been made through proper use of hardware and software, adequate support and training to educators and students, and a robust technological environment to sustain the initiative. The ecosystem put in place provided a whole range of creative and collaborative options that yielded new teaching and learning patterns. The study revealed that this paradigm shift brought in the classroom the right enthusiasm and atmosphere to enhance the acquisition of 21st-century skills by learners thereby inculcating in them the necessary talents that the job market requires.*

Keywords: *Technology, Pedagogy, Innovation, Creativity, 21st-Century Skills*

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I.   Introduction

The 21st-century has seen a dramatic increase in the prominence and pervasiveness of digital technologies across many spheres of life. This has led to greater demands being placed on educators to integrate digital tools in their practice to facilitate more flexible, personalized, and relevant learning opportunities. This is not without challenge, be it at the micro-level (individual educators trying out novel technology-enhanced initiatives in their practice) or the macro-level (systems and policies that boost digital access within educational institutions). Indeed, the introduction of new technology requires proper planning, policy-making, and ongoing support.

It is widely accepted that technology integration in schools has the potential to enhance teaching and learning and provide students with learning experiences that other strategies cannot provide. In addition, the rise in

affordability of technology, the availability of the internet, laptops, projectors and tablet technology, has made technology integration more compelling (Lekawael, 2017). This emergence and rapid evolution of new technologies are shaping the knowledge highway in which people are communicating, collaborating, operating, and forming social constructs. These technologies are influencing the way people think, work, and live.

Demirbilek (2009) argued that technology would help enhance 21ˢᵗ-century skills, namely critical thinking and problem-solving skills, creativity, collaboration, and communication. Lux et al. (2017) revealed that the introduction of new curricula based on real-world problems brought by technology has provided scaffolding and tools to enhance learning, thus resulting in the unprecedented transformation of teaching and learning. Underpinned by constructivist theories, this shift in learning approach has aided to develop students' responsibilities as they pursued to construct their knowledge within a more fulfilling and meaningful context and subsequently enhance their understanding of the subject (Gregory, 2012). In line with the benefits of technology in education, emphasis should be laid on educators' role in encouraging technology integration. Indeed, the innovative atmosphere brought by technology has changed their role from knowledge transmitter to learning facilitator, knowledgeable guide, and knowledge navigator. This new role necessitates educators to gear their mindsets towards implementing a paradigm shift and restructure their pedagogical processes to suit the innovative technological setting. The incorporation of technology in the classroom will help educators create lessons that provide opportunities for learners to construct their knowledge and enhance problem-solving skills through simulation, manipulation, mind-mapping, guided discovery, and creative expression (Eickelmann and Vennemann, 2017).

Even though ICT shows this potential, the implementation of technology in schools seems to develop slowly and is far from reaching its target. Despite all the efforts, many countries are facing similar challenges whereby educators are not using the technology provided effectively. Chai et al. (2011) pointed out that educators use technology occasionally and more for information transmission rather than the promising benefits mentioned above. Some of the barriers to more holistic implementation are lack of access, resistance to change, lack of time, lack of training, and lack of technical assistance. Lack of training includes both technical training and pedagogical approaches. Research findings have also exposed that heavy workload, time-consuming, inadequate support, insufficient feedback, poor working conditions, and uncompensated work has decreased teacher motivation toward integrating technology in the classroom (Phelps & Maddison, 2008; Roland, 2010). Türel and Johnson's study (2012) reported that technical problems could also become a major hurdle for educators. These barriers include low connectivity, virus attack, and equipment failure.

It is argued that ICT does not improve learning per se, and will not make any difference simply by being used (Higgins, 2003). Many factors influence the seamless integration of technology in schools. Educators need adequate ICT skills to implement the technology and to have a high confidence level to use it in a classroom setting. Furthermore, educators require insights into the pedagogical role of technology integration, to enable meaningful usage in the teaching-learning process (Hennessy et al., 2005). As an agent of change, educators must be prepared to adopt the paradigm shift in learning and teaching because of technology integration (Avidov-Ungar & Shamir-Inbal, 2017). Moreover, technical support should be provided and continuous professional development in technology integration should be conducted from time to time. In short, all parties must collaborate to integrate technology in classrooms (Roblin et al., 2018).

The purpose of this study was to design a concept classroom branded as *Classe21* and examine its impact in infusing 21ˢᵗ-century skills to learners It also intended through proper training and support, to endow teachers with skills and enthusiasm to become seasoned technology-using educators' *Classe21* integrated technological, cognitive, pedagogical, and organizational aspects in a flexible and safe environment.

The research questions examined in this study were:

1. Is there a significant difference from learning that pertains to factual knowledge and comprehension of the concepts while using *Classe21*?

2. Is there a significant difference in the achievement of students in *Classe21*?

3. How far does *Classe21* contribute in developing communication skills?

4. What types of critical thinking activities can be used for pedagogical purposes in a digital environment?

5. What is the impact of *Classe21* on collaborative learning?

1.1 Theoretical Background

Rapid developments in the digital world and increase in internet speed in recent years have resulted in significant changes in the way the world operates and communicates. It has also given the school community access to a vast range of information and resources. It is almost impossible to conceive future classroom environments that are not supported, in one way or another, by technology. Consequently, this has resulted in an urge for decision-makers to provide new technological tools. The increasing array of new digital options requires decision-makers to make an informed decision for their integration into education.

Educational institutions around the world are exploring the features of each new technology to enhance and transform curriculum, teaching, and learning. Schools can take advantage of technological devices in classrooms, as learners are already conversant with them, removing the need for technical familiarization (Azzurri, 2011). It should be noted that mobile digital devices such as tablets were not specifically designed for education and must be repurposed for pedagogical purposes (Traxler, 2010). As individual tablets need to be connected to the classroom network, careful attention should be given to network speed and capacity. It has been advocated that teaching in distributed, personalized environments with each student having a tablet (1:1 environment), will present a new set of challenges for educators, requiring them to acquire a new pedagogical set of skills. Research have pointed out that the success of 1:1 projects is reliant on the school context. Examples are - the readiness to embed vision and policy aligned with 1:1 computing; the teachers' attitudes and beliefs about 1:1 computing; the capacity to implement the innovation; and the support for technology adoption including technical support and continuous professional development of educators (Parry, 2011; Fleisher, 2012; Pegrum et al., 2013). If the school stakeholders are not open to the use of 1:1 devices to improve lesson delivery, and the policies and practice are not in place, limited success will be achieved.

Unlike the license one gets to become an educator upon recruitment, there is no set of courses and field experiences, that once completed, verifies one's credentials as an educator committed to using technology. Thus, it is the landscape of the education sector as a whole that demands a change in pedagogical approaches to adequately prepare schools, educators and students as a community to thrive in this information age. This change requires being a sustainable enterprise. Students need to master higher-order skills while being able to communicate and collaborate both face to face and virtually thereby accomplishing a common task creatively. Creativity, communication, collaboration and critical thinking are the skills of the 21ˢᵗ century.

1.2 Educator perspective

A technology-using educator can be defined as someone who:

- *Makes informed choices* by using technology wherever it increases student involvement in learning and not using it for tedious, confusing, or boring class activities. Such a teacher places student learning at the centre of the curriculum and decides how best to make it happen in the fast-paced environment of a modern

school. Sometimes this means using technology as a centrepiece of instruction, sometimes it means using technology as a minor part of a lesson, and sometimes it means not using technology at all.

- *Explores technology* by using it in the classroom while analysing its role in schools and society. The interworking of technology and its social, political, and economic implications are natural topics for classroom discussions. Students learning with a technology-using teacher are not just consumers of technology but creators and critics of it as well. They are aware of technology's power to improve education or impede it.
- *Promotes change* at the classroom, school building, and systems levels. Rather than 'change for the change's sake', change should be intended to make it possible for every student to reach her or his full learning potential. Technology becomes a "disruptive" force, constantly suggesting that there may be new and better ways to do things. Its very presence is already an invitation to rethink the way things are and the way things might be and to put into practice curriculum and instruction that build interest in learning for all students.

1.3 Evolving Practices in Classe21

In order to set the context for the new ecosystem of digital resources, it is helpful to explore some of the ways in which learning and teaching practice is increasingly evolving with the use of technology as shown in Table 1.

Table1: Ways in which learning and teaching practice is evolving with the use of technology

From	Toward
"One size fits all" instruction.	**An emphasis on the learning process and enabling students to "learn how to learn"**. Teachers know that their students have different goals, strengths, gaps, interests, and ways to learn. They accommodate their students' diverse needs through differentiated instruction and opportunities to personalize learning. Technology efficiently facilitates this constructivist approach. Students work at their own pace and use technology to be more productive and better engaged in their learning. Students pursue their interests and use creativity to learn in multiple ways.
Teacher as the source of information and knowledge teacher-centred lecture-style instruction; Teacher as "the sage on the stage".	**A teacher who facilitates, guides, and activates students' learning (the "guide by the side")**. Teachers are designing lessons in which students are engaged through inquiry and project-based learning, allowing them to dive deeper into their learning. Teachers and students use content and information that gives them what they need to know, when they need to know it, and in a format that is accessible to them.
Teacher as sole director of learning.	**Teachers are guiding students to lead and take ownership of their own learning**. Teachers guide students to plan and follow their own learning "pathways" designed to promote personal growth, success and lifelong learning. Students have some choice in what they learn, how they learn, and how they demonstrate that they have achieved their learning goals.
Teacher who integrates little or no technology; learning in a physical space.	Flexible learning models and environments are enabled by technology. Students learn through multiple approaches such as intentional instruction, cooperative activities, and problem-solving/inquiry tasks. They use technology as tools to support them.

Teacher who uses limited approaches and technology to access professional learning.	**Teachers are a diverse group of life-long learners**. They engage in continuous self-directed and collaborative professional learning through digital content and multiple technology-enabled approaches. Teachers are exploring emerging pedagogies and learning how to effectively use technology by engaging in research and reflective practice.

The goal of education in the 21st-century is to prepare all learners to succeed in an ever-changing, technology-driven, and globally connected world by providing the means to develop the skills, competencies, and knowledge they need to succeed today and in the future. This goal is being facilitated by the *Classe21* initiative to improve the quality of instruction, personalize and deepen learning, provide flexible learning environments, and use technology tools and digital resources to engage and empower students to navigate their own learning pathways with confidence and success.

II. Material and Methods

2.1 Implementation of the Project

The implementation of the project included:

- equipment configuration and equipment delivery,
- school visits,
- educators' training,
- students' training,
- demo classes,
- on-site continuous support,
- survey on the use of ICT by educators,
- classroom observations,
- focus group interviews of educators and students; and
- investigation on technology integration.

2.2 Equipment configuration

Classe21 infrastructure needed to be robust and powerful. It was important to focus on the hardware aspect, complementary software and apps, a classroom management system (CMS), routers and repeaters.

2.3 School visits

Several planned visits were carried out in all four schools to assess the status of *Classe21* and prepare for the full-fledged implementation of the project. The school management ensured burglar proofing and painting of the identified classroom, replacement of old curtains with new ones and transfer of all equipment.

2.4 Educators' Training

One hundred and twenty four educators from the four selected schools were involved in the *Classe21* project. Through adequate training of educators, the project intended to harness the full potential of digital tools in creating,

constructing, capturing, managing, and sharing information and knowledge. To optimize the value of new technologies in the selected schools, it was important to give opportunity and resources to teachers and students to find innovative ways to use digital tools. However, to successfully exploit the full potential of these new technologies, organizational and pedagogical issues had also be taken into account. Indeed, the goal of introducing *Classe21* was not simply to deploy digital tools, but also to harness its power to enhance the teaching and learning environment. Without a proper technology integration strategy, it would not have been possible to create new teaching practices in the selected schools. Thus, educators training and professional empowerment were crucial for the success of this project. In this view, sessions of teacher training were carried out on the classroom management system, features of the student's tablets and android operating system.

The following batches of training were successfully carried out in all the selected schools:
Training batch no. 1: Introduce educators to the project, the 4Cs, and 21st-Century Skills
Training batch no. 2: Introduction to Tablets, Android Operating System, and Classroom Management System (CMS)
Training batch no. 3: Demo Classes to exemplify the use of *Classe21* to develop 21st-century skills of learners
Training batch no. 4: Educators training on SAMR (Substitution, Augmentation, Modification, and Redefinition) and devising lesson plans for *Classe21*

Training batch no. 1: *Introduce educators to the project, the 4Cs and 21st-Century Skills*

The "21st-century skills" movement has been on many policymakers' agenda since the beginning of this century. However, it is widely believed that four specific skills are the most important namely critical thinking, communication, collaboration and creativity (NEA, 2012). These features of 21st-century learning need educators to be involved in the dynamic learning process which is a multi-sensory, collaborative, and kinaesthetic learning experience integrated in the learning activities which enable students to achieve the 4Cs requirement (critical thinker, communicator, collaborator, creator) developing "a globally competitive personality" (Ismael, 2016).

Therefore, educators in all four schools were introduced to the project and the 4Cs through a plenary session whereby they were exposed to the importance of the above-named metacognitive skills. Media support was included to exemplify the development of these skills throughout a range of activities ranging from the use of edgy software like Paint 3D (Creativity) to Video Production (Communication). First-hand observations revealed that very few educators devised their lesson plans within the scope of the 4Cs. In fact, most of them agreed that their class activities tend to be more content-driven than otherwise. It is imperative to note that the *Classe21* training sessions aimed to address this shortcoming.

Training batch no. 2: *Introduction to Tablets, Android Operating System and CMS*

The concept of *Classe21* did not only rely on the hardware infrastructure but also on well-crafted support and response mechanisms. The hardware design (Annex 3) consisting of wireless connections between 40 tablets and laptops required proper connections for seamless performance during classes.

Teachers were given hands-on training on the different features of the tablet, functions of the Android Operating System as well as the CMS. The latter has several strategic features designed to keep students focused and engaged in their learning – from absorbing information to creating content. The application supports interactivity, collaborative work and diverse individual learning styles. It also provides tools to organize lessons and assess students' progress as shown in Table 2 below.

Table 2: Key interactive features of the Classroom Management System

Key Interactive Features of the Classroom Management System	Description
Monitor & Control	To supervise the students better in their learning progress, the educator can monitor students' screens simultaneously
Blank Screen	Simultaneously displays a default or custom picture on students' tablets, mute their sound devices, and block their input device to stop them from working on the tablet and attract their attention towards verbal explanation by the educator.
Remote Command	The educator can remotely launch and close applications on a student's tablet, startup, reboot or shut down all students' tablets with only one mouse click.
Remote settings	The educator can set some common functions for the students remotely, such as the Display, Theme and so on. Besides those, instructors are able to lock the students' process to prevent them moving out of the CMS, and lock the students' screen.
Student Demonstration	By displaying one student's screen on other students' tablets, instructor can let the students share their work and highlight creative solutions or common problems.
Interactive Whiteboard	A whiteboard can be launched on the tablet so that the educator can invite students to draw on a common whiteboard together or let the students draw on individual whiteboards and monitor them or even select one student to draw and demonstrate to other students.
Assessment: Quiz, Survey & Response Competition	Allows educators to assess student progress by creating and administering quiz papers. Educators can view students' quiz results in real time.
Group Collaboration	Educators can organize students into virtual groups and facilitate group collaboration, peer tutoring, cooperative learning, group teaching.
File Distribution	To distribute the files to one or more students
File Collection	Collect files from one or more students

Educators were trained on how to set up a class and enrol students using the CMS. The different utilities within the CMS were lengthily elaborated to enable the educators to decide on the various possibilities of innovative and creative instructional strategies. For example, educators were briefed about the option of whole class against selective student's work broadcast through the CMS platform. Class Management in terms of Screen Broadcast, Interactive whiteboard, sending and receiving files, students' scrutiny, placing students in different groups, tablet 'silent mode' and automatic shutdowns were also practised.

Training batch no. 3: *Demo Classes to exemplify the use of Classe21 to develop 21st-century skills of learners*

In an education system that will soon be dominated by the proliferation of e-textbooks and digital devices, schools are increasingly looking to implement simple, efficient systems that allow educators to monitor progress and

leverage digital interface devices to increase students' productivity and acquisition of 21ˢᵗ-century skills and thus maximize learning potential (SVC, 2012).

The class demos were crucial to allow educators to assist how *Classe21* could be used to promote learning experiences geared towards student's development of 21ˢᵗ century skills. Indeed, the class demo was considered a chief component of teacher training as well as an important driver for paradigm change within the teachers' community. Therefore, class demo by *Classe21* team members with well-prepared lesson plans and pedagogical scenarios were carried out in all the four colleges.

Educators were empowered on the different ways to integrate the enhancement of 21ˢᵗ-century skills through pedagogical scenarios using the various features of the CMS. For instance, the acquisition of creativity and collaboration skills by students were facilitated using interactive whiteboard features of the CMS. Educators were also handed tablets to follow the activities given to students during the demo classes.

The assessment features of the CMS were also well appreciated by educators. In fact, the CMS also enabled different types of assessment to be created easily from existing pdf or doc files. Questions were set in the form of multiple-choice, true/false, and fill in the blanks. The responses through the CMS not only indicated the in-situ correctness of students' responses but also their overall progress during the activity. Teachers could watch the rate at which the students were attempting the questions and the number of correct answers for each student. The scripts were corrected almost immediately by the CMS as soon as the test was over from the available data-feed input by the educator during the paper preparation. Image versions of the corrected script along with the marks and correct answers were then sent to each student for review. Additionally, the teacher had the possibility to view the master copy of the assessment sheet with the success rate for each section. This was very helpful to enable educators to monitor assessment more professionally and decide on the most appropriate remedial activities thereafter (SVC, 2012).

Training batch no. 4*: Educators Training on SAMR and Devising Lesson plans for Classe21*

Lesson plans are one of the fundamental tools that educators use to decide on the sequence of instructional delivery in their classes. Devising lesson plans for Classe21 was therefore considered as a pivotal element of teacher training since it implied the integration of learning outcomes with respect to the 4Cs amongst others. Educators were introduced to the SAMR model of technology integration so that they start adopting a novel mindset.

The SAMR Model consists of the following four classifications of technology use for learning activities (Romrell, 2014):
- Substitution: The technology provides a substitute for other learning activities without functional change.
- Augmentation: The technology provides a substitute for other learning activities but with functional improvements.
- Modification: The technology allows the learning activity to be redesigned.
- Redefinition: The technology allows for the creation of tasks that could not have been done without the use of the technology.

As elicited by Puentedura (2013), it encourages the modification or redesign of mobile learning and problem-solving activities such that learners maximize their benefits from technology. The SAMR model may be considered as a taxonomy of lesson planning for digital classrooms although elements from existing Bloom's taxonomy can be considered.

Commonly, lesson plans only translate to the Substitution Level on the SAMR scale. Thus, learners' creativity and technological emancipation are limited only to the use of existing software. This training was oriented towards empowering the educators to create Classe21 lessons at least from the Augmentation to the Redesign Levels. They were thus encouraged to visualize their Classe21 sequences through the lenses of the 4Cs and SAMR model before actually drafting their lessons. Feedbacks from teachers were very encouraging since many of them highlighted the importance of a digitally based lesson plan to remind them of the importance of the 4Cs and SAMR whilst using technology. Altogether, these e-lesson plans are opening the doors for advanced opportunities of creating a repertoire of resources for sharing among educators.

Training Evaluation Form and Observations of demo classes – Observations were done during demo classes and a training evaluation form was used to know the views of educators about what they liked most about the training and how to improve it.

2.5 Onsite Pedagogical Support

To further motivate the educators, ongoing pedagogical support were being provided to educators by resource persons involved in Classe21 projects and posted in the schools.

2.6 Students' Training

Classe21 aimed to integrate technologies to support students in ways that were not previously possible, thus creating new teaching and learning possibilities. Active and collaborative learning environments facilitated by *Classe21* intended to contribute to the creation of a knowledge-based student population. It was believed that introducing *Classe21* would fundamentally enhance and enrich the learning environment by providing learners with the opportunity to develop 21st-century skills. They would thus become productive and informed citizens in a learning environment where teachers engage with learners.

Students were trained on the Android version of the CMS whereby they needed to practice on a range of activities with incremental difficulty. Each class was run with a minimum of two resource persons where the second one acted more as a facilitator.

2.7 Educator's Report Form

As per the research requirements, for every lesson conducted using *Classe21*, the educator was required to fill an Educator's Report Form

III. Results and Discussion

3.1 School visits

The respective rectors showed a lot of interest in the project and extended all the necessary facilities required. Educators and students were very enthusiastic and frequently willing to use *Classe21* for their lessons. Towards the end of the project, classes were running smoothly and educators of various subject areas were regularly using *Classe21* to successfully promote a constructivist approach and infuse 21st-century skills among students.

3.1.1 Training Evaluation Form

Below is a summary of the responses that were collected from the training evaluation forms used to obtain feedback from educators.

What did you like the most about the training?
"This training will help us to see and explore technology in another way useful to us"
"The training was performed in an interactive way; thus sharing the necessary information was a success"
"It was useful as doing it by ourselves was difficult"
"Useful and enriching for the proper use of Classe21"
"The merging of subject content and technology"
"Training was concise and contents very well delivered"
"The training session was done through collaborative learning"
"The SAMR part"

How do you hope to change your practice as a result of this training?
"It will help us use applications and attract students' attention with videos and pictures; rapid quiz to test student"
"I personally would use similar techniques to teach in an interactive way"
"To encourage more student participation in class"
"Practice will definitely evolve since I intend to use the tools provided at least once per week with each class. This will help students to conceptualize more and by extension understand the concepts"
"More visual learning especially to demonstrate experiments"
"ICT will be used in all my classrooms since students will be actively engaged in the teaching and learning process; new skills will be developed; evaluation of students will be more effective"
"Will surely include Classe21 for teaching grammar because technology helps getting all the students' attention"

What additional training would you like to have in the future?
"How to design group presentations"
"Technical support training to be able to tackle network issues"
"The time frame was too short master efficiently all the different tools and equipment – more training required"
"Training on the system to make it more user-friendly"
"Training based on class management; training on dealing with low ability students"
"Additional trainings on technical support; to be more independent in case of problems"

From the above responses, it was evident that training and professional development for teachers is an important component of successful approaches to technology integration. These understandings complement current views on how to enable more meaningful and effective use of technology in formal education. Certainly, teachers still need technical and pedagogical support tailored to individual abilities. Similarly, we cannot ignore the needs highlighted by teachers themselves such as technical help, administrative support, and consistent training specific to teacher's needs and informal networks for learning (IEA, 2006). However, longer training sessions and ongoing professional support seemed most desirable. Such support should also go beyond teaching skills in technology use and focus on the effective pedagogical use of the technology to support teaching and learning aims.

3.1.2 Observations of demo classes

During the demo classes, it was satisfactory to note the following:
- The majority of tablets retained their charge during the whole session.
- The WIFI connectivity in Classe21 was excellent and allowed rapid uploading and transfer of files.
- Almost seamless logging to the CMS.
- Students were focused on tasks during class activities.

3.2 Onsite Pedagogical Support

Whilst the issue of technology integration is influenced by a range of systemic factors that operate at different levels of an education system, the primary enabler of "innovation in education" remains the initiative of individual teachers who are expected to appreciate the benefits afforded by ICTs. However, teachers have long been described as conservative and generally resistant to many aspects of change in their work (Lortie, 2002). A great number of teachers remain "cautious onlookers" as opposed to being "enthusiastic innovators" when it comes to digital technology (Crook, 2008). One way to circumvent this hesitation of educators was to encourage sharing of good practice among colleagues in the different schools involved in the Classe21 project. Such networking has been reported to increase teacher learning in terms of subject-specific and pedagogic knowledge and skills, strengthen motivation, and encourage teachers to actively try out new practices (Kerr et al., 2003; Muijs et al., 2011).

3.3 Students' Training

Training sessions were carried out with students in the presence of their educators. During the training sessions, all students were able to log in easily to the CMS, participate in the technology-enhanced class, and manipulate the different Apps. The success of the training classes was also demonstrated by the fact that students were able to participate fully in the demo classes where the lessons were geared towards the development of their 21st-century skills. Thus, with the enthusiasm of the rectors and educators involved in the project, together with the on-site pedagogical support, students benefitted fully from *Classe21* and developing their 21st-century skills through lessons in various subjects.

3.3.1 Comments from Educator's Report Form observing students' training

Samples of the comments gathered from the analysis of the Educator's Report Form were as follows:

"Very good exercises, well appreciated by students; real learning takes place"
"Classe21 & its tools are very appropriate for this type of exercises where students have to focus on their own writings in order to improve their performance"
"Very good experience. Tools of Classe21 are perfect for listening comprehension for HSC students"
"Easier to monitor student's work; the ability of students to adapt to the new setting was encouraging; saves time; better insight into specific problems related to a few topics instantly; helps avoid the inconveniences of traditional correction"
"A creative way to conduct a test; it facilitates correction; easier to evaluate individual answers; very interesting resource; should have more sessions for this class"
"Enhanced students' interest & participation; a swift yet detailed way to monitor student's performance; ease correction - instantaneous results may be provided to students; eco-friendly practice - no paper used
"Better insight into how students respond under different working conditions; avoids the hassle of paperwork & deciphering what students sometimes write; instantaneous overview of performance with regards to specific questions as provided by percentage analysis"
"Digital equipment and innovative setup provided by Classe21 is very helpful to deliver lessons and gain students' attention'
"There is a transformation in the way I now teach; innovative pedagogies are now possible; students are very enthusiastic; it is the classroom of the future"

"Possible to incorporate more digital contents in my lessons; use of interactive whiteboard capture the attention of students";

"More engagement of students in the lesson"

"Classe21 equipment make it possible to enhance pedagogical practices; students seem to learn better and remember more"

"Classes are more interactive and student-centred"

"Classe21 setup helps to increase students' participation and collaboration; more hands-on activities"

"Group presentations of projects are easier and innovative"

"Easier to launch and correct multiple-choice questions using the CMS; easy to monitor in which questions particular students are getting wrong answers"

"Students of all Grades are always willing to work in Classe21 which is an innovative space with many technological facilities"

"Technology integration in lessons is easier and the possibilities seem endless"

"Several students can be sent to the interactive whiteboards at the same time; more student participation and active learning taking place:"

3.4 Answers to research questions

Qualitative analysis of Educators' report form after using *Classe21* and focus group interviews of both educators and students have been used to answers the five main research questions. The results pointed to the success of *Classe21* in infusing 21st-century skills into learners.

Table 3: Answers to research questions

Research Questions	Sample compilation of Educators' report form after using *Classe21* and focus group interviews of both educators and students
1. Is there a significant difference from learning that pertains to factual knowledge and comprehension of the concepts while using *Classe21*?	• *"Use of Classe21 promotes learning and comprehension of concepts in several ways. I am able to connect my mobile for students to view videos, pause, screenshot, visualize, post, explain. There is no need to draw each time. This saves time. Thus, more time is available for a deeper explanation, exploration, and discussion of concepts. Classe21 is a productivity tool."* • *"In mechanics topics, for example, we need to visualize forces and drawing in different colours helps in comprehension."* • *"Students are able to visualize different cultures and almost travel around the world. It definitely helps in understanding concepts in Sociology."* • *"As the curriculum is bulky in Design and Technology, I use my mobile phone or iPad to project pdf and videos for discussion. It helps to keep students focused and interested. Engagement of learners aids comprehension of concepts."* • *"Our teacher show concepts step by step, real-size, and how to draw isometric diagrams."* • *"Projection of answers helps in rapid correction of questions, discussion, and clearing of misconceptions."* • *"Students' knowledge of concepts improved as they could form mental models through brainstorming and visualization."* • *"Classe21 helps me to demonstrate artists' work which facilitates discussion and understanding in Arts and Design."*
2. Is there a significant	• *"Classe21 equipment make it possible to enhance pedagogical practices; students seem to learn better and remember more"*

	difference in the achievement of students in *Classe21*?	• *"Due to extensive visualization and discussion of concepts, students can recall them easily in the exams."* • *"Photograph of students' answers, both right and wrong, are taken, projected, and discussed. This has increased achievement."* • *"As a result of using Classe21, students' confidence to answer questions related to abstract concepts improved."* • *"Performances of students in 'Oral English' classes are recorded and then projected in Classe21 for discussion and improvement."* • *Use of interactive features such as animations text, pictures, graphics, and sounds, engages students thus preventing misbehaviour and improving performance in assessments."*
3.	How far does *Classe21* contribute in developing communication skills?	• *"Very good experience. Tools of Classe21 are perfect for listening comprehension for HSC students"* • *"Can communicate more through group work and project work in the Classe21 setting."* • *"Group presentations of projects are easier and innovative"* • *"Some students do Science subjects, others Economics. In the General Paper class, all of them come together. Discussion, communication, and sharing of ideas are facilitated with tools available in Classe21."*
4.	What types of critical thinking activities can be used for pedagogical purposes in a digital environment?	• *"Engaging students in interactive, multisensory and hands-on activities in Biology using tablets promote critical thinking skills."* • *"Real-world application of knowledge in the digital classe21 environment using videos, graphical representations and drawings in Design and Technology helps support critical thinking."* • *"Modelling thought processes using technology in my Design and Technology lessons foster critical thinking."* • *"Problem-solving in my Business Studies classes using scaffolding techniques helped student develop critical thinking skills."* • *"Using the different whiteboards in small groups and developing arguments in General paper enhances critical thinking."*
5.	What is the impact of *Classe21* on collaborative learning?	• *"Group problem solving is enhanced with the five interactive whiteboards available."* • *"The interactive whiteboards are used as a shared workspace."* • *"Sending files and sharing resources using the tablets boosts collaboration."* • *"The different interactive whiteboards used as group workstations provide tremendous opportunities for collaborative problem-solving in Accounts."* • *"The tablets, interactive whiteboards, and versatile desks facilitated the setting up of collaborative teams for project-based learning in Ecology."* • *"I use classe21 to enable students to work in groups for creation and sharing of resources in Economics."* • *"Our teacher records Biology practical in the laboratory are later project them in Classe21 using the different whiteboards. We can then discuss in groups under the teachers' guidance of how techniques can be improved."*

IV. Conclusion

The *Classe21* project has given rise to a new vision of technology as a global, interactive, hands-on, and dynamic pedagogical tool through which students can develop new learning experiences and 21ˢᵗ-century skills.

Classe21 is an innovative space where each learner has access to a tablet PC and the educator can provide instruction to the whole class or part thereof via a laptop. The laptop and the tablet PCs contain a classroom management system (CMS) to enable monitoring and exchange of information among all the devices via a Wi-Fi hotspot. The classrooms are also equipped with several interactive whiteboards. The whole ecosystem, hardware, software, virtual environment, and physical layout provided a whole range of creative and collaborative options that have led to new teaching and learning patterns with the use of technology.

Pedagogically, teaching in distributed, personalized environments with each student having a tablet (1:1 environment) posed a new set of challenges for teachers, requiring them to acquire a new set of instructive skills. Previous lack of experience with technology prevented several educators to make full use of *Classe21*. Thus, educators required extensive training on Classroom Management System (CMS) software and demo classes to be able to evaluate and select the most appropriate features for use in *Classe21*. They were enlightened about the various features of the CMS coupled with repeated hands-on to facilitate and activate learning thus promoting the use of technology while delivering a lesson. Educators were also encouraged to engage in ongoing continuous professional development (CPD) with the use of technology. Indeed, one of the aims of the *Classe21* project was to make educators a diverse group of lifelong learners. Interestingly, through *Classe21*, educators explored emerging pedagogies and learning how to use technology effectively through reflective follow-up and sharing of good practices.

Furthermore, during the training of educators, emphasis was laid on the need to plan lessons focusing on the development of students' 21st-century skills namely creativity, communication, collaboration, and critical thinking. The constructivist approach to teaching and learning was branded as being the prime carrier of knowledge delivery and teachers were encouraged to plan their lessons in such a way as to shift the onus of knowledge ideation on the learners. Comments from Training Evaluation Forms revealed that there was an intent to redesign lesson procedures to incorporate elements of reflective and autonomous learning practices in classroom settings. Additionally, the training of educators on the SAMR model of technology integration enabled them to diversify their instructional methods with respect to the use of technology in *Classe21*.

Teachers know that their students have different goals, strengths, gaps, interests, and ways to learn. They try to accommodate their students' diverse needs through differentiated instruction and opportunities to personalize learning. Harmonizing this approach, *Classe21* aimed to encourage students to study using their own learning style. Instead of a "one size fits all" instruction, *Classe21* laid emphasis on the learning process and enabled students to "learn how to learn". In this context, the use of the CMS allowed for differentiated instructions whereby grouping of students with specific needs could be applied. This feature was prominently attempted by various educators who wanted to highlight key ideas, misconceptions, and common errors in specific areas. Consequently, various training sessions were streamlined towards the use of differentiated instruction in a variety of subjects.

Classe21 also enabled flexible learning models and environments where students learned through multiple approaches such as intentional instruction, cooperative activities, and problem-solving tasks. Specially designed tables and chairs were provided to the students to allow for individual and/or group configurations as and when the need arose. This helped to bring forth the flexibility to change the traditional setting, which usually used to be teacher-centred, to the new set-up, which focused on the learner. Indeed, the group setting noticed increased collaboration and communication among learners.

Moreover, the tablets provided to students helped to draw their focus closer to learning as opposed to the lecture style of whiteboard and marker with the teacher as the "sage on the stage". Hence, *Classe21* allowed students to dive deeper into their learning. In addition, numerous assessments were carried out in various subjects using the quiz features of the CMS. The digital scripts were corrected immediately and automatically by the CMS as soon as the tests were over. Thus, image versions of the corrected script along with the marks and correct answers were sent to

each candidate and allowed formative assessment to take place. Furthermore, the teacher had the possibility to view the master copy of the assessment sheet with the success rate for each section. This was very helpful in enabling educators to monitor assessment adequately and decide on the most appropriate remedial activities thereafter.

During demo classes, students showed great appreciation of the new learning environment. Their growing interest in learning the routine kinds of stuff in a new mode made them ask contextual questions without hesitation thus showing their active participation in class as opposed to their passivity in a traditional setup. With the use of technology in *Classe21*, students worked at their own pace, were more productive, and engaged in their learning, and use creativity to learn in multiple ways. Thus, they were endowed to own what they were doing and eventually value their own work.

The practical realization and success of *Classe21* in schools depended largely on the educators' motivation to adopt and integrate digital technologies within their usual work practices. Data from the four schools confirmed that most teachers were already familiar with the use of technological devices and with initial sessions of training and support extended to them, they are willing to take full advantage of this opportunity to redefine their pedagogy and enhance the motivation and 21st-century skills of students. Their attitude should be lauded as changes in pedagogical practices are challenging and modifications to learning environments have to be shouldered by the educators themselves (Tallvid, 2014).

In 1929, Dewey claimed that the reality of education is not found in books, laboratories, or classrooms, but in the minds of the individuals who are engaged in educational practices. Similarly, Tondeur et al. (2008) argue that the adoption of educational innovations can only be understood when teachers' beliefs are taken into account. The OECD (2015) reports that the key to enabling the potentials for teaching and learning with digital technologies is the teachers' professional development, well aligned with their beliefs about their practice. Hence, pedagogically focused professional development for teachers well in line with their belief is a critical element that will afford teachers and schools the ability to unpack and examine the ways *Classe21* can be used to achieve the school's vision. Consequently, training sessions, class demo and continuous educators support form an important part of this project.

Additionally, the support of school management for directing technological change within the educational community was considered a premium determinant for *Classe21*'s success. Leadership and support for technology must be present from all of those involved in a school, including teachers, administrators, family members, and students themselves (ISTE, 2008). According to positive responses from educators and their motivation during the training sessions, there certainly appears to be a link between teachers' perceptions of supportive school leadership and beneficial technology use. Many research studies have highlighted the importance of the type of school leadership to encourage technology-enhanced practices in formal school settings (Law et al., 2008; Zhao & Frank, 2003).

A study by Dwyer et al. (1997) emphasized that for the integration of ICTs to be effective and sustainable, administrators themselves must be competent in the use of the technology, and they must have a broad understanding of the technical, pedagogical, administrative, financial, and social dimensions of ICTs in education.

Beyond the fundamental pillars mentioned above, issues related to the robustness of laptops, tablets and networks need careful planning to ensure the sustainability of any 1:1 program. However, the use of technology should not be emphasized at the expense of pedagogy and content. What is important in the field of technology is how it is used to support learning and teaching, and the development of 21st-century skills. The challenge is to encourage teacher innovation as well as enhance academic rigour and student performance.

The study revealed that *Classe21* could offer increased opportunities for teachers to transform their practices by providing them with more effective teaching and learning tools. Through *Classe21*, it is believed that educators will be able to use innovative and creative pedagogies in their lessons and rise to the challenge of preparing students for an ever more complex and cognitively demanding world. This will fundamentally enhance and enrich the learning environment by providing learners with the opportunity to learn 21ˢᵗ-century skills. Thus, active and collaborative learning environments facilitated by *Classe21* will contribute to the creation of a knowledge-based student population. They will consequently become productive and informed citizens in a learning environment where teachers engage with learners.

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