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ORIGINAL RESEARCH ARTICLE

Intelligent solutions in education: How inclusive the Moroccan Digital Classrooms project is for different social groups

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ABSTRACT

The global changes caused by the health crisis of the COVID-19 coronavirus pandemic have significantly impacted education all over the world. Schools today have had to adopt distance learning models using digital tools to ensure the continuity of educational systems in different circumstances. For this reason and to ensure the continuity of education even in the event of future disruptions in Morocco (war, pandemic, natural disaster...). The Minister of National Education for Preschool and Sport has unveiled an initiative to establish digital classrooms within the educational institutions of the Kingdom. This innovative pedagogical approach, grounded in the utilization of digital tools, is specifically designed to bolster the instruction of science subjects, (Mathematics, Physics, and Life and Earth Sciences). This digital educational transformation has emerged as a highly suitable mode of learning, catering to a diverse array of social groups, including individuals with disabilities and refugees. The primary objective of this research is to assess the influence of digital classrooms on the performance of science educators operating within the Rabat Sale Kenitra region. The intention is to gauge how this technological implementation has affected their teaching methods and overall effectiveness. Furthermore, this study seeks to gauge the progression of this educational transformation and advocate for the wider adoption of digital pedagogy, extending its incorporation into the instructional strategies of other subjects. The ultimate goal is to promote inclusivity and level the playing field for all learners, ensuring equal educational opportunities for every student.

Keywords: digital classroom; flipped classroom; educational platform; pedagogical innovation; ICTE

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1. Introduction

At the beginning of 2020, the spread of the coronavirus COVID-19 around the world and the pressures caused by this pandemic imposed a radical change in all sectors, accelerating the digital transformation of educational systems in all countries.

In response to this challenge, the Moroccan education system has shown flexibility and adaptability by making massive investments to maintain contact between teachers and students. This has resulted in a significant digital transformation of teaching based on ICT and pedagogical innovations supported by educational platforms[1,2].

During the 2020–2021 school year, the Ministry of National Education adopted a hybrid pedagogical model that alternates between distance and face-to-face teaching to manage this ongoing situation.

At the start of the 2021–2022 school year, the Ministry of National

Education for Preschool and Sport announced that schools would adopt a pedagogical model that combines distance and face-to-face teaching. This model will be based on using smartphones as a digital tool and pedagogical platforms developed by the Department of National Education with the support of the Millennium Challenge Account-Morocco agency[3–6].

The new situation requires adapting the learning process by integrating information and communication technologies in teaching (ICT). This new pedagogical situation shows favorable professional disciplines.

We focus in this study on the impact of digital classroom projects on teachers on the one hand, on the teaching/learning process on the other hand, and the pedagogical techniques that can be adopted and associated with pedagogical platforms to achieve high-quality digital teaching and learning for various social groups and in different circumstances (war, pandemic...)[7–10].

Recently, there has been an increased desire to implement innovative pedagogical approaches, giving a prominent place to digital learning and optimal use of new technologies and digital tools to improve online learner autonomy by involving parents as fundamental actors[11,12].

The pedagogical methods that can be used to succeed in this digital teaching model must motivate learners and teachers to achieve favorable results and acquire new skills when there is no time or opportunity to travel[13,14].

Drawing on the experiences of other researchers and teachers around the world[3], this research relies on the added value of this learning model on the learning outcomes of learners and their parents to support learner autonomy through distance learning orientation and discover the joy of school in a new way.

This research is part of implementing a pedagogy that improves inclusivity and individualized learning through a concrete integration of ICT in teaching to achieve learner autonomy and support distance teaching to avoid obstacles that hinder student motivation towards this digital educational model.

The flipped classroom

In the wake of the recent health crisis, the education landscape has undergone a significant transformation, with institutions adopting a blend of face-to-face and distance teaching methods. This hybrid model has sparked discussions about its implications and the necessary pedagogical approaches in this new learning paradigm.

One such approach that has gained prominence is the flipped pedagogy. It revolves around the idea of students independently learning theoretical concepts through e-learning modules or readings, often remotely. Subsequently, students apply this knowledge in group settings within the classroom, utilizing digital tools for engaging activities, problem-solving, and debates. This method not only encourages self-directed learning but also promotes collaborative and interactive educational experiences[15].

However, the proliferation of mobile devices and the excessive time spent on them present a pressing social issue, particularly among adolescents. Smartphone addiction has become a genuine concern, diverting students' attention from their studies to social networks. Consequently, teachers often find themselves dealing with students whose minds are preoccupied with online interactions rather than the subject matter being taught.

Amidst these challenges, mobile learning applications have emerged as a potential solution. These applications can bridge social gaps for various marginalized groups, including people with disabilities, students facing mobility issues, and refugees[9,16–18]. By providing accessible and inclusive learning experiences, mobile apps can enhance the educational journey for individuals who might otherwise face barriers to traditional learning methods.

Additionally, parents, educators, and policymakers must collaborate in educating students about responsible technology usage. Digital literacy programs can empower students to use technology mindfully,

ensuring that it enhances their learning experience rather than detracting from it. Open communication between parents, teachers, and students can create awareness about the challenges associated with excessive screen time and smartphone addiction[18–21].

2. Materials and methods

This research results from a study conducted in Morocco which focuses on the influence of the digital classroom project on teachers of the math, physics, and earth sciences (or SVT) of the college cycle in the Rabat Sale Kenitra region.

2.1. Gander of sample

Table 1 shows the type of sample in Math, Physics, and Earth Sciences. The data is organized with information regarding the number of participants or samples in each discipline, their age ranges, and the gender distribution within each discipline.

Table 1. Range and gender of teachers' sample.

	Math	**Physics**	**Earth sciences**
Discipline	16	16	16
Range: Between 25 and 35 years old Between 35 and 45 years old More than 11 years 45	9 2 5	4 5 7	6 8 2
Gender	F/8 M/8	F/2 M/14	F/9 M/7

The flipped classroom methods contribute to reversing the nature of pedagogical learning activities in class (listening, reading, copying...) and at home (exercises, research...), requiring a digital medium.

Figure 1 shows the key lies in implementing a flipped education model that seamlessly integrates learning at home and in the classroom, facilitated by educational platforms. Yet, the effectiveness of digital classrooms for diverse social groups hinges on several critical factors. These include not only access to technology but also digital literacy, cultural sensitivity, incorporation of accessibility features, and supportive policies. Achieving true inclusivity demands a multifaceted approach[19,20]. Educational institutions and policymakers must prioritize bridging the digital divide by ensuring equal access to technology. Furthermore, comprehensive training and ongoing support for teachers are essential to guarantee that they can effectively navigate digital tools and cater to varied learning needs. Additionally, digital resources need to be thoughtfully designed, considering diversity and accessibility as core elements. By addressing these aspects, educational institutions can create an environment where digital classrooms serve as a platform for inclusive and equitable learning experiences, ensuring that education is accessible and beneficial for all students, regardless of their background or abilities[21–23].

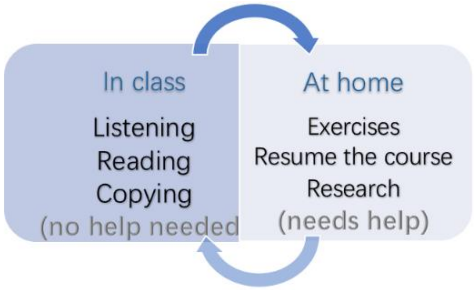

Figure 1. Learning activities in class and at home.

Combining the flipped classroom approach with the digital classroom project has allowed for the unification of all students to develop the course without exception collectively.

This digitization of learning using educational platforms consists of dedicating more time to production, educational activities, and individualized student support[7], which affects the time allocated to course preparation and pedagogical scenarios.

2.2. Educational platforms

WOOCLAP via MOODLE:

Wooclap is a real-time question-and-answer system that allows interaction with the public via computer, tablet, or smartphone. The application allows us to collect and instantly process online and SMS answers. It is a tool for class and audience engagement. Wooclap can be used in face-to-face, online, or dual-mode courses. Professors and trainers in higher education use Wooclap to engage students in their learning. The Wooclap platform was designed in collaboration with colleges and universities in France and Belgium[22–25].

Moodle is the most widely used free online learning platform (Learning Management System or LMS). Developed from pedagogical principles, it allows the creation of community learning around content and activities. “Moodle” is the abbreviation of Modular Object-Oriented Dynamic Learning Environment. That takes advantage of many features developed for pedagogical purposes to communicate and interact[26].

Method:

To support teaching with digital tools and reinforce the learning of science subjects, the project of digital classrooms in schools aims to integrate digital into class practices.

The Moodle platform allows to define and create custom roles with well-defined permissions:

- Teacher Administrator: the manager of the platform.
- Teacher Editor: cannot modify the course or manage groups.
- Non-editor teacher: he can change the course and has access only to his group’s activities.
- Students: they can access the resources and activities proposed to them.

Figure 2 presents the homepage of the pedagogical platform created with a learning management system and officially used in the digital classroom project.

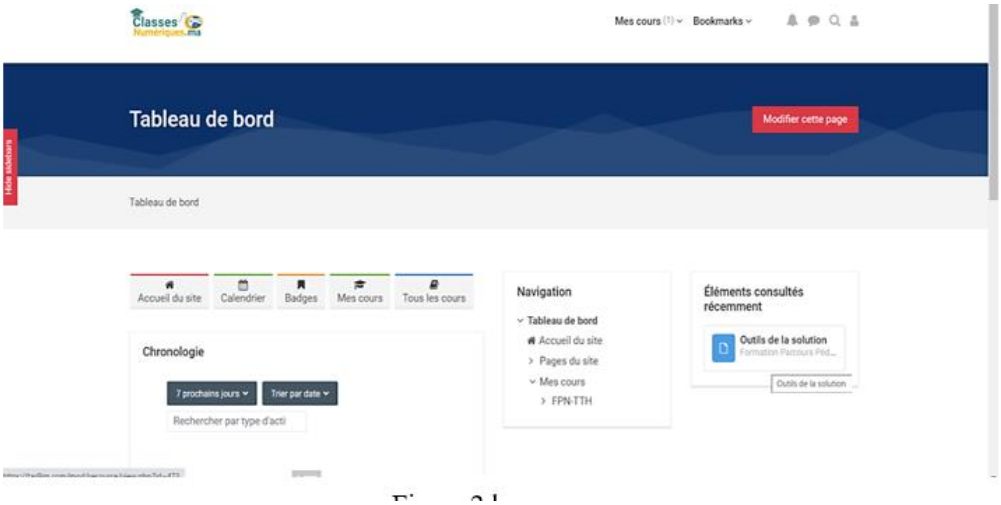

Figure 2. Home page of the proposed digital environment for student learning.

Digital classroom projects can facilitate collaboration among teachers by allowing them to share resources, lesson plans, and best practices online. This can lead to a more collaborative teaching community.

3. Results

Initially, The digital classroom model has many advantages that can be seen as a pedagogical innovation strategy aimed at strengthening science education, but the majority of traditional pedagogical approaches are not always adequate for this digital perspective. The results presented in the research show that the flipped classroom has many advantages that contribute to defining a new process of digital education that can be considered compatible and remedial to the strategy of digital learning for a range of obstacles that hinder the reinforcement of scientific learning and the autonomy of the student in their manipulation of resources cited in a digital space.

- To understand very well, the students have time at home to review courses and come to class with questions.
- Students are satisfied to be able to know the content of the session in advance.
- Weaker students are more taken care of.
- Methods of mutual aid and cooperation can be implemented. The flipped classroom strategy promotes student autonomy.

This digital pedagogical model gives rise to the creation of pleasure and motivation in the teaching/learning process.

This requires more investment than in a traditional approach. Teachers must apply project-based learning (which requires creating a triggering situation).

In all these phases, digital tools support diversifying practices, productions, and data consultation, facilitating information exchanges and differentiating and regulating each student's learning.

3.1. The correlation between smartphone use and academic achievement

Questions about using digital tools and the combination of flipped classrooms and digital classes aim to list the activities that most marked them during the year, in a positive manner initially, and then negatively.

Table 2 shows that there is a significant portion of students, 46.153% strongly agree and 38.461% simply agree, rely on smartphones as their primary means of doing homework. This statistic highlights that the vast majority of teenagers consider the smartphone as a tool for searching and simulating information that offers a myriad of innovative means and methods provided by the disciplined use of the Internet and educational platforms...

Table 2. Students who rely on using smartphones to prepare their homework.

Response	Number	Percentage
Strongly disagree	4	1.923%
Disagree	4	1.923%
Neutral	24	11.538%
Agree	80	38.461%
Strongly agree	96	46.153%
Total	208	99.998%

The Pearson correlation is based on the following equation:

$$r = \frac{\sum xy - nx - y}{\sqrt{\sum x^2 - nx^{-2}}\sqrt{\sum y^2 - ny^{-2}}}$$

X: The total degree of dependence on controlled smartphone use;

Y: Degree Total school success;

r = 0.897.

Table 3 shows the relationship between addiction to controlled smartphone use and academic achievement, where the value of the Person's correlation coefficient was r = 0.897. This means that there is a strong correlation between addiction to smartphone use and academic achievement. Controlled smartphone use can be a solution to higher academic achievement. Thus, the validity of the hypothesis has been proven, which states that there is a statistically significant correlation between addiction to random digital resources and academic achievement among the study sample, the percentage of certainty is (95%), with a probability of making an error of 5%.

Table 3. The correlation between smartphone addiction and academic success.

Significance level	Sample volume	Person correlation coefficient	Indication level
The total degree of dependence on controlled smartphone use	208	0.897	At indication threshold (0,05)
The total degree of school success			

3.2. According to the digital classroom project and the flipped classroom

To determine the results of the association between the digital classroom project and the flipped classroom pedagogy, various interviews with teachers, parents, and students were carried out to reveal the level of inclusiveness of this pedagogical digitalization for the different social groups.

Figure 3 confirms that teaching in digital classrooms encourages students to watch courses at home, and make their smartphones useful. This facilitates more immediate and varied forms of assessment, enabling teachers to gauge student understanding in real time and adjust their teaching accordingly.

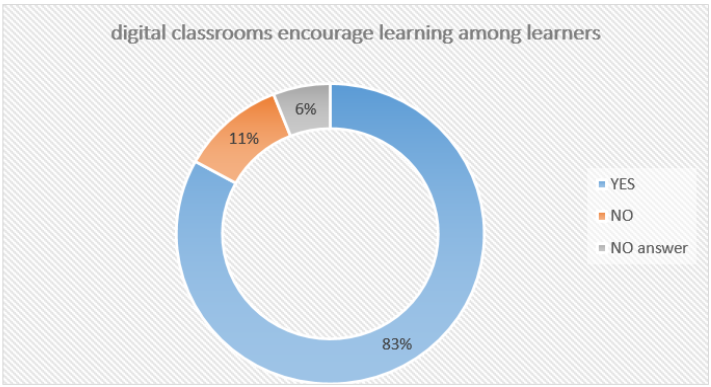

Figure 3. Percentage of students who found that watching courses in video capsules at home is motivating.

Teaching in digital classrooms encourages students to watch courses at home, and make their smartphones useful.

Figure 4 shows that absentee students can follow and copy their courses without help and digital tools can empower teachers to be more creative and innovative in their lesson planning. They can experiment with various teaching methods and multimedia elements to make learning more engaging.

Figure 5 proves that the flipped methods and digital classroom projects can lead to a shift in the roles of teachers from being the primary source of information to becoming facilitators of learning. Teachers may need to adapt their pedagogical approaches to foster more student-centered and inquiry-based learning.

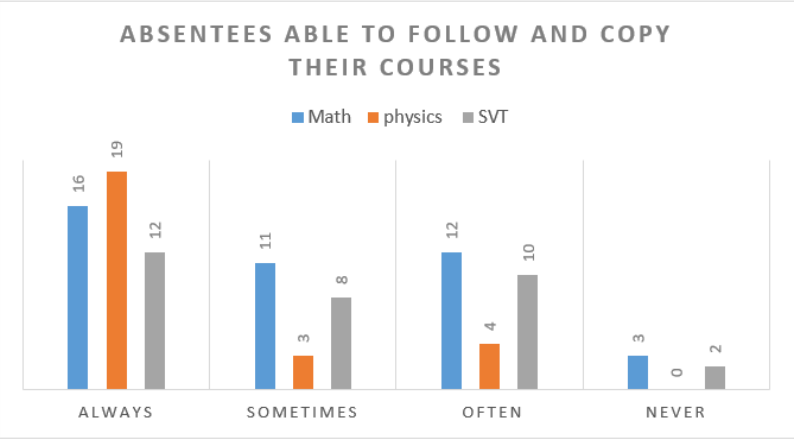

Figure 4. Percentage of absent students who watch video capsules at home.

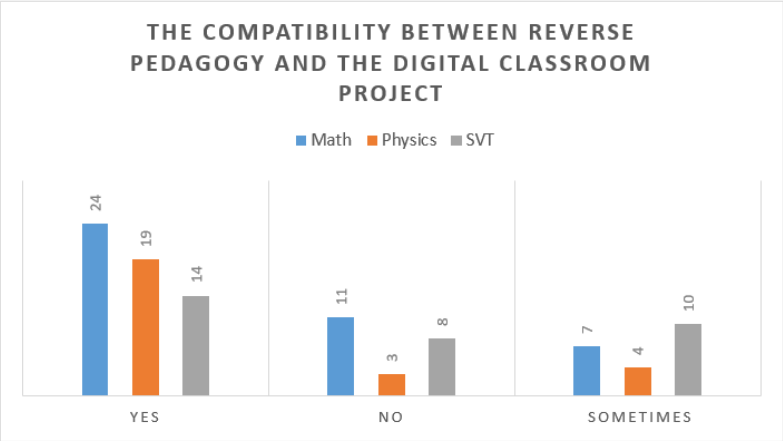

Figure 5. The compatibility between reverse pedagogy and the digital classroom project.

The inclusivity of digital classroom projects for different social groups can vary significantly based on several factors, including access to technology, digital literacy, socio-economic status, and educational policies. Here are some key considerations regarding the inclusivity of digital classrooms:

1). Access to technology:

Advantages: Digital classrooms can be inclusive when students have access to the necessary technology, including computers, tablets, and internet connectivity. In many cases, digital resources can level the playing field, providing access to educational materials that might not be available otherwise.

Challenges: The digital divide is a significant barrier. Students from low-income households or underserved communities may lack access to the required technology and internet connections, which can exacerbate educational inequalities.

2). Digital literacy:

Advantages: Digital classroom projects can enhance digital literacy skills, which are increasingly important in the modern world. Students from all backgrounds can benefit from improved digital literacy.

Challenges: Some students and families may have limited experience with technology, making it more challenging for them to navigate digital learning environments effectively.

3). Language and cultural diversity:

Advantages: Digital classrooms can be inclusive when they provide resources and materials that cater to linguistic and cultural diversity. Multilingual resources and culturally relevant content can support diverse student populations.

Challenges: Insufficient support for students with limited English proficiency or those from culturally diverse backgrounds can lead to exclusion.

4). Special needs and disabilities:

Advantages: Digital classrooms can be designed to be inclusive by providing accessibility features such as screen readers, closed captioning, and adaptive technologies that support students with disabilities.

Challenges: Ensuring that digital resources are accessible to all students, including those with disabilities, requires careful planning and compliance with accessibility standards.

5). Socio-economic status

Advantages: Digital classroom projects can offer educational opportunities regardless of socio-economic status. Open-access educational resources can be particularly beneficial for those who cannot afford traditional educational materials.

Challenges: The affordability of necessary technology and the availability of high-speed internet can limit access for students from lower socio-economic backgrounds.

6). Educational policies and support

Advantages: Inclusive digital classrooms often result from supportive educational policies and initiatives that aim to bridge digital divides, provide training for teachers, and ensure equitable access to resources.

Challenges: Inadequate policies or lack of funding can hinder the development of inclusive digital classrooms, perpetuating educational disparities.

7). Teacher preparedness:

Advantages: Well-trained teachers can use digital tools effectively to cater to diverse student needs, making digital classrooms more inclusive.

Challenges: Insufficient training and professional development opportunities for teachers can hinder their ability to create inclusive digital learning environments.

4. Discussion

In summary, the impact of digital classroom projects on teachers extends beyond the classroom itself and touches on various aspects of their professional and personal lives. While these projects offer numerous advantages in terms of teaching and learning, they also bring about challenges that require careful consideration and support from educational institutions and policymakers. Teachers who receive proper training and ongoing support are more likely to navigate these challenges effectively and harness the benefits of digital classroom projects for the benefit of their students.

According to the questionnaire:

- It’s possible in math because the exercises require a huge explanation.
- By using this method some teachers cannot work with students because subjects require memorization, and the teacher must write the summary.
- This flipped classroom method would facilitate learning in most scientific subjects through digital classes and allow for more group work with parental involvement.
- It allows us to see the course several times with the teacher’s explanation.
- It encourages us to prepare for the course in advance.
- The videos should make it easier for students to understand the course better.
- It helps us remember the course.

4.1. Difficulties anticipated during the session

The integration of technology in education can sometimes blur the boundaries between work and personal life for teachers, as they may find themselves grading assignments and responding to emails outside of traditional working hours but on the other side:

To identify the difficulties and obstacles encountered, a range of questions were asked at the beginning of each session:

- Have you watched the lesson at home?
- If yes, how many times have you watched it?
- Did you understand the lesson?

Group work in the digital classroom also resulted in some trial and error related to the arrangement of tables, the size of the room, the allocation of students, and the composition of teams. Students only focus on technical difficulties, such as mastering applications, self-training pressure, and working under urgency.

Computer equipment presents obstacles that hinder the integration of digital classrooms. It is essential to have access to computers (or tablets) to address the following difficulties:

- Work not completed.
- Access to digital resources in class.
- Ability to easily record audio/video to send productions to teachers.

Digital classrooms require the use of computer tools, which requires the presence of equipment in schools.

According to the professional competence framework published by the Quebec Ministry in 2020 (“Professional Competence Framework: Teaching Profession”), the professional competencies of teachers are based on three principles:

- Act for the education and learning of students.
- Know how to act autonomously based on the characteristics of the situation.
- Base teaching on the current state of knowledge.

The digital education method is seen as a revolution in schools. The era of the blackboard and chalk is over! Now, the world talks about interactive touchscreens and artificial intelligence for learning at school. Indeed, one of the most enjoyable uses of digital technology in the classroom is the numerous possibilities it offers, such as offering diverse and varied content. Which computer equipment should be chosen for your school? Several choices of digitized tools give teachers freedom and autonomy in presenting lessons to be covered in class.

Students are motivated by the integration of digital means (tablets, smartphones, computers...) and are involved in the educational process.

- Breaking the ice hinders parental engagement in the learning process.
- Students who do not easily understand the lesson have the time to review it several times at their own pace in the form of video capsules.
- The level of students is improved through collaboration in class.
- Learners work with a certain freedom regarding the development of courses and are not prepared for the change of pace in classes.

Teachers need help to work with digital and computer equipment and create their digital learning platforms (ENT). Many students need access to computers or tablets due to their family situations. Teaching sciences with digital class methods requires going to the classroom to help students, which involves innovation

and project pedagogy.

Technical Challenges: Teachers may face technical issues and challenges when implementing digital tools in the classroom. This can be frustrating and time-consuming.

Digital Divide: Not all students have equal access to technology and the internet at home, which can create disparities in learning opportunities. Teachers may need to navigate these disparities when assigning digital assignments or homework.

Overwhelming Workload: Implementing digital classroom projects can sometimes result in an increased workload for teachers. They may need to create or adapt digital materials, troubleshoot technical issues, and provide support to students who are struggling with technology.

Privacy and Security Concerns: Teachers may have concerns about the privacy and security of student data when using digital tools. They need to ensure that students' personal information is protected and used responsibly.

Lack of Training: In some cases, teachers may not receive adequate training and support in using digital tools effectively, which can lead to frustration and ineffective use of technology in the classroom.

Loss of Human Connection: Overreliance on technology can sometimes lead to a loss of face-to-face interaction between teachers and students, which is an important aspect of the learning experience.

4.2. Solutions envisaged

- Organize continuous training for teachers who are unable to create their digital learning platforms[11].
- Have projectors and screens to work with the whole class.
- Work with students on exercises in the classroom, requiring the adaptation of tables to facilitate movement.
- Have a high-performance computer or tablet for good image resolution[13].

5. Conclusions

The digital classroom model offers numerous advantages and allows teachers to practice their profession more flexibly while creating new ways to connect with their students and engage parents[10–12]. This study suggests that it is time to start using smartphones as a pedagogical tool in the classroom and to take advantage of their many benefits, the main one being the possibility of being self-sufficient in the digital learning process[20].

Digital classroom projects can have a significant impact on teachers, both positive and negative, depending on how they are implemented and integrated into the educational system. Here are some of the key ways in which digital classroom projects can affect teachers:

- **Enhanced Teaching Resources:** Digital classroom projects often provide teachers with access to a wide range of digital resources, such as educational apps, websites, and multimedia content. These resources can help teachers create more engaging and interactive lessons.
- **Personalized Learning:** Digital tools can enable teachers to personalize learning experiences for their students by tailoring instruction to individual needs and learning styles. This can lead to better learning outcomes.
- **Increased Efficiency:** Technology can streamline administrative tasks for teachers, such as grading and attendance tracking, allowing them to focus more on teaching and less on paperwork.
- **Professional Development:** Engaging with digital classroom projects can encourage teachers to develop their digital literacy and teaching skills, which can be valuable for their professional growth.

- **Access to Data and Analytics:** Digital tools often provide teachers with data and analytics on student performance. This data can help teachers identify areas where students may be struggling and adjust their teaching strategies accordingly.

Practically, this learning method based on inverted pedagogy gives students great energy to make more effort. They have become more interested in learning, thanks to the advantages provided by these innovative methods.

Digital education offers immense potential, but it's not without its drawbacks. Issues related to access, equity, and the 'digital divide' need to be addressed to ensure that all students have equal opportunities to learn. Additionally, successful digital education requires more than just access to technology. It demands the development and integration of digital, human, and financial resources. Teachers need to not only master the technical aspects but also possess strong didactic and pedagogical skills to effectively use digital tools in the classroom.

Moreover, it's important to recognize that digital education is not a replacement for traditional teaching methods but a supplement. The essence of teaching, the connection between the educator and the learner, the mentorship, and the guidance, remain indispensable. Digital tools can enhance this interaction but cannot replace it entirely.

Despite these challenges, digital education will continue to evolve due to various factors such as technological advancements and the increasing demand for flexible learning options. However, its success hinges upon the holistic development of the educational ecosystem. This includes the continuous training of teachers, ensuring equal access to technology for all students, and integrating digital literacy into the curriculum.

The concept of digital classrooms stands out as a beacon of hope in the realm of education. It offers a flexible and adaptable approach that can cater to diverse circumstances, be it a global health crisis or issues related to accessibility. It represents an evolution in pedagogy, transforming traditional classrooms into interactive hubs of learning where students can engage with content in innovative ways.

To fully harness the potential of digital classrooms, there needs to be a concerted effort to include it in the new learning reform and the ongoing training and development programs for teachers. It's not just a technological shift but a philosophical one, emphasizing the importance of staying abreast with the digital age while upholding the core values of education—knowledge dissemination, critical thinking, and holistic development of students.

In conclusion, while there are challenges on the path to the global digitalization of teaching in Morocco, the philosophy of digital classrooms presents an exciting opportunity. With the right training, resources, and mindset, this approach can revolutionize education, making it more accessible, engaging, and relevant for students in the contemporary world. It's not just a strategy for today's challenges but a vision for the future of education.

Author contributions

Conceptualization, HB and MB; methodology, HB; software, HB; validation, HB, MB and MT; formal analysis, HB; investigation, HB; resources, HB; data curation, DEK; writing—original draft preparation, HB; writing—review and editing, MT; visualization, AS; supervision, MT; project administration, HB; funding acquisition, AS. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

The authors declare no conflict of interest.

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