

Constraints Related to the Integration of Information and Communication Technologies in the Teaching of the Physical Sciences at the Level of the Moroccan Educational System

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Abstract

Objectives: This study allows us to examine the constraints linked to the integration of the information and communication technologies in education of physics and chemistry in public middle and high school in Casablanca (Morocco). **Methods/Statistical Analysis:** To carry out this research, we used the investigation method using a questionnaire in the region of Casablanca - Settat (Morocco), exactly in the provincial direction of Moulay Rachid-Sidi Othman during 2016/2017 school year. The target population of our survey is about 97 secondary school teachers: 31 in middle school and 66 in high school. To complete our study, we asked few questions to the directors of the targeted institutions, and some to the inspectors of physics and chemistry. **Findings:** It is clear that the different actors of education can have different opinions. The integration of ICTs in the education system in physical and chemical is a pedagogical priority; access and flexibility are two prerequisites for the successful integration of ICT in schools. This paper is limited to the presentation and analysis of data expressing the use of middle and high school teachers in integration of ICTs in the teaching of physical and chemical sciences in the region of Casablanca - Settat, collected as part of our research, by determining the obstacles and suggesting some solutions for a successful integration of ICTs. **Application/Improvements:** The Ministry of education must consider several obstacles before taking the next step towards a better integration of ICTs, and several levers that make this integration successful.

Keywords: Challenge, Integration, ICT, Morocco, Sciences of Physics and Chemistry

1. Introduction and Problem

Following the accelerated pace of technological development worldwide, Morocco, like all countries, is trying to renovate its education system so that it can improve the quality of teaching and learning in order to improve

skills through the effective use of Information and Communication Technologies (ICTs)¹.

The results of the "SITES M1²" survey show that the major obstacle to integrate ICTs in education was the lack of knowledge and skills of teachers in ICTs (Pelgrum and Anderson, 2001). This means that if we could train teach-

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ers well, we can finally ensure a successful integration into teaching. In the context of the emergence of new technologies and the role they seem to play in the teaching of science, a new techno-pedagogical environment is being established in the educational field, in order to integrate into the information and knowledge society. Morocco started it in 1999, in its education system through the operationalization of the national charter of education and training. This charter was devoted to the use of new information and communication technologies (article 10)³.

Morocco must invest more in the field of ICTs with a budget likely to build a new infrastructure based on new information and communication technologies, and a largely sufficient time interval allowing the different educational actors to reflect, ask themselves and evaluate each step before moving on to the next.

Morocco began in Rabat on Thursday October 8th, 1999, in its educational system by the operationalization of the national charter of education and training concerning the use of the new technologies of the information and the communication in the plan of emergence of the application of the NICTs and the primordial role that they can play in the teaching of the sciences, (the national charter of the education and the formation, lever 10)³.

Morocco is trying to create a techno-educational environment in the field of education (ICT in the service of education).

In this sense, Morocco has felt the important role that the use and integration of the new information and communication technologies in its education system seems to play. For this, the Moroccan government has developed since 2005, a strategic program “GENIE^{4,5}”, serving teachers, inspectors and directors of institutions, aiming at the generalization of information and communication technologies, with a view to integrating them into the education and training system, which was awarded on Wednesday in Paris the UNESCO King Hamad Bin Issa Al Khalifa Prize 2017 for the use of information and communication technologies in education^{6,7}.

Since then, according to the central management of this program, multimedia rooms have been installed in several schools, the main educational actors have benefited from many hours of planned training, and several workshops have been conducted to facilitate the use and integration of the new information and communication technologies in education. However, according to the preliminary findings and the indirect interviews we were able to, the implementation of these measures is very slow and the use of ICT in the Moroccan school is still limited. For it, it seemed very important to us to question this situation, through this study, a reflection on the different uses of the new information and communication technologies actually existing in the Moroccan education system as well as the obstacles that hamper these uses¹.

The “GENIE” program management has launched in its emergency plan (2009-2012) a strategy to promote, facilitate and enhance a pedagogical culture that promotes ICT in teaching and learning, and pointed out in its emergency plan (2009-2012) that according to the first phase of implementation of the program, an evaluation was made to review the inventory and especially the achievement of some objectives (training, equipment and multimedia rooms), to promote ICTs in teaching and learning (GENIE Program Directorate, 2012)⁸.

The World Economic Forum (WEF) recently released its report on Information and Communication Technologies (ICTs) globally “The Global Information Technology Report 2016”. This report ranks of 139 countries according to their level of ICTs development. For this year’s ranking Morocco is positioned at:

- ↓ 121/139: The quality of educational system;
(105/144 in 2013)
- ↓ 50/139: The importance of ICTs in the government’s vision;
(38/144 in 2013)
- ↓ 49/139: Government success in promoting ICTs;
(42/144 in 2013)

- ↓ 110/139: Internet access at school;
(95/144 in 2013)
- ↑ 65/139: ICTs use and government effectiveness.
(77/144 in 2013)

It is obvious that the GENIE program has brought new initiatives, it is quite clear that Morocco has advanced 8 ranks compared to 2013 in terms of the use of the new information and communication technologies, but we also find that it suffered a remarkable decline after the development of the GENIE program (2013). According to this data, it can be said that there is some use of ICTs, but it still some lacks in integration into the educational system.

It is clear that the different actors of education can have different opinions. However, this paper is limited to the presentation and analysis of data expressing the use of middle and high school teachers in integration of ICTs in the teaching of physical and chemical sciences in the region of Casablanca - Settat, collected as part of our research, by focusing on:

- Attitudes of middle school and high school teachers for the integration of the new information and communication technologies into physical and chemical sciences education in the Casablanca - Settat region;
- Barriers hindering this integration;
- Levers for successful integration of ICTs.

2. Concept Headings

2.1 Methodology

To carry out this study, a survey was conducted in public middle schools and high schools located in the region of Casablanca - Settat (Morocco), exactly in the provincial direction of Moulay Rachid-Sidi Othman, which contains a total of 144 professors of secondary education of PCS (physical and chemical sciences) during the 2016/2017 school year.

2.1.1 Presentation of the Sample

The target population of our survey is 97 secondary school teachers: 31 in middle school and 66 in high school.

To complete our study, we asked some questions to the directors of the targeted institutions, and some to the inspectors of physics and chemistry.

To collect information on constraints related to the successful integration of the new information and communication technologies in the physical and chemical sciences, we used an anonymous questionnaire as an investigative tool. This questionnaire contains 45 questions addressed to PCS teachers, some are closed and some are opened, which are intended to provide clear answers on the fundamental axes of the survey:

- Personal information: Age, gender, frame, university level, year of recruitment, seniority in the cycle, direct hiring or not, establishment of work, provincial direction, Training Establishment...
- State of the existing infrastructure;
- Activities of PCS teachers with their personal computers;
- Type of use of ICTs in class:
- Degree of computer skills;
- Internet access and use of the internet;
- Existing materials in target institutions
- Use of Computer Assisted Experiments (CAEx);
- Training of teachers in ICTs: Duration and degree of satisfaction;
- Barriers to integration of ICTs in the classroom
- The levers to allow integration of ICTs.

3. Results and Discussion

The results collected from the questionnaire are represented in the form of tables and figures. The processing of

the results was done by Microsoft Excel.

3.1 Profiles of Our Population

3.1.1 The Dominant Gender of Our Population

74% of our population is male and 26% are female.

24.5% of this population was hired directly without any educational training.

This difference is due to the nature of the school subject, which is preferred by boys rather than girls. Besides girls are more attracted to life and earth sciences (LES), according to a study of Y. ElMadhi² in 2014 in the khemisat region (Morocco).

3.1.2 Age Range of Our Population

The Figure 1 shows that more than half of our population (58%) are young teachers which is a good factor, since they are part of the connected generation, in fact recently the Ministry of Education and Training has hired over 54,000 contract teachers in just 2 years, the latter are usually licenciers, with an average age of 24 years.

3.1.3 University Level of Our Population

The Figure 2 shows that more than half of the teachers 55.5% have a license which coincides with the above results since more than half of the population is young

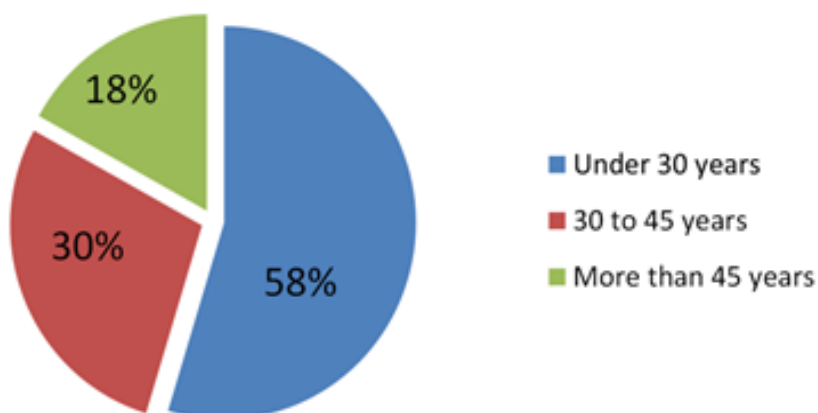


Figure 1. Distribution of PCS teachers by age.

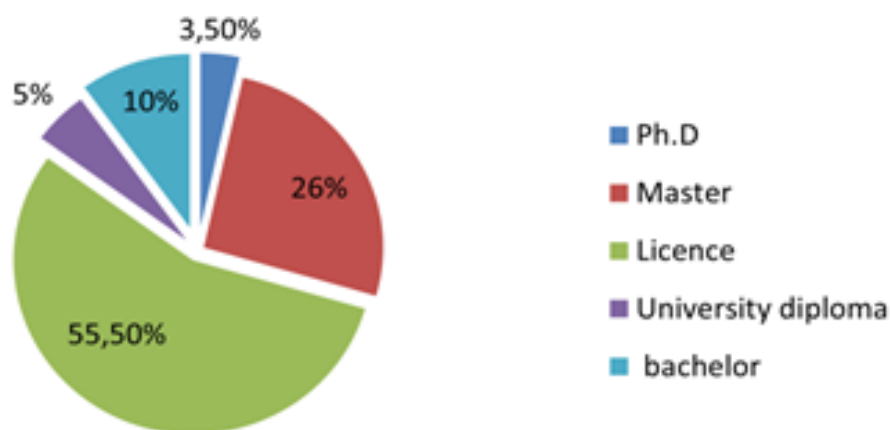


Figure 2. Percentage of PCS teachers by university level.

and entered the Regional Centers of the Professions of Education and Training for the last six years requires the degree of the license, and for contract teachers too.

3.2 Existence of the Computer Structure in Targeted Institutions

The results obtained show that (41%) of the questioned teachers claim to have a computer structure at the central level and only (30%) have an internet connection in their establishments.

For the institutions involved in this study, only 31% are equipped with a multimedia room. School managers' report that students' weekly access to multimedia

rooms is quite limited, most physical and chemical sciences and computer teachers use these rooms on the order of one hour to two hours per week, contrary to the program GENIE (Generalization of Information and Communication Technologies in Education) that aims the access of the student to the multimedia room of 3 hours per week, according to the director of the program "GENIE" Mrs Ilham Laaziz.

3.3 PCS Teachers' Activities on Personal Computers

The Figure 3 shows that most teachers have computers (95%). The Figure 3 shows how long the computer has

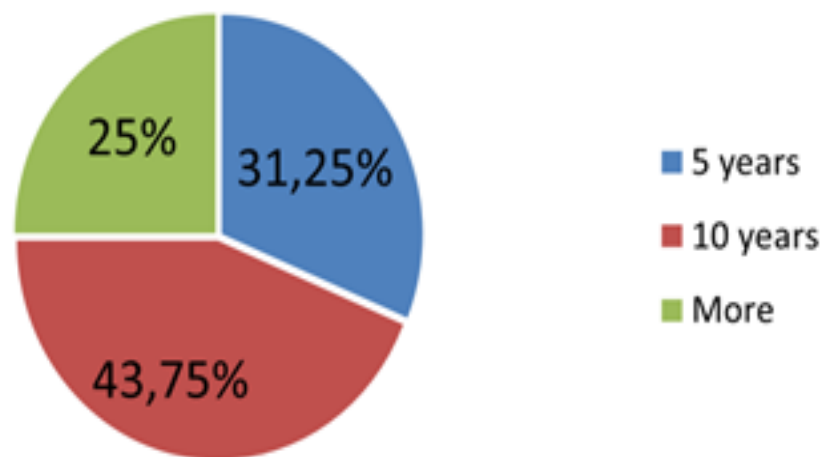


Figure 3. The duration of PCS teachers' possession of a computer.

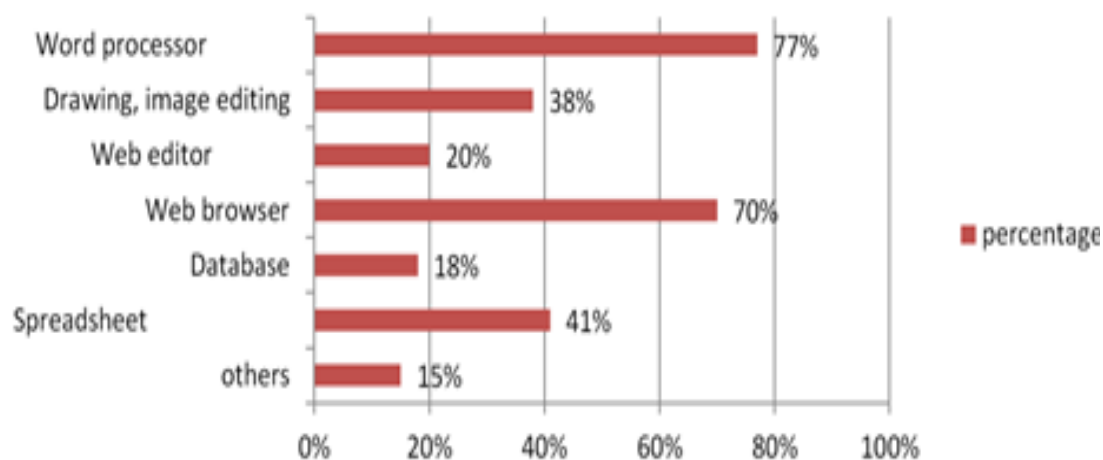


Figure 4. Use of software regularly outside the classroom.

been in possession, since they are no longer expensive; they also come with different shapes, sizes and prices.

In addition, 98% of teachers with computers have access to the internet, considering the importance of the internet in our days, the ease of internet access and the low price of the internet connection. 40% use it to prepare courses, (90%) to download physics and chemistry courses, and 36% use sequences found on disciplinary sites.

The majority of teachers do these activities regularly out of the classroom, (Figure 4).

3.4 ICT use by PSC Teachers in Class with Students

The Figure 5 revealed that: more than 50% of the teachers questioned have never integrated new information and communication technologies in education, the age of these teachers is between 45 and 60 (Figure 5), those teachers are old generation, while 45% of teachers use the new information and communication technologies in the class (those teachers are new generation).

The countries of Northern Europe are those where the use of the new technologies of communication and technologies by teachers is the most important and most widespread, by way of example this percentage reaches

90% in Finland, in this country most teachers report using digital tools especially for individualized learning purposes.

In France, according to a 2008 Ministry of Education survey, 64% of secondary school teachers use ICST. In 2011, according to the Profetic survey of the French Ministry of Education, 77% of teachers use ICT with their students, at least once a week (MEN-PROFETIC, 2011).

The analysis of the results of the questionnaire (Figure 6) also showed that most teachers use simulations, animations, videos and images in class, given the nature of school subject, they can replace the experience in case of lack of materials or unavailability of conditions to do the experiments, it remains a quick solution to achieve similar results in a fairly short time interval and does not require preparation (it is still a “troubleshooting” solution, but actually neither the simulation nor the videos can replace the experiments whatever its quality), it must not replace concrete experimentation, if it is feasible. The contact with the living being, the use of instruments and techniques, the awareness of the natural complexity brought by real experimental manipulations, are irreplaceable. Instead, we will simulate experiments that are too long, too expensive, too delicate, too dangerous, and so on, to be carried out concretely in class. The simulation

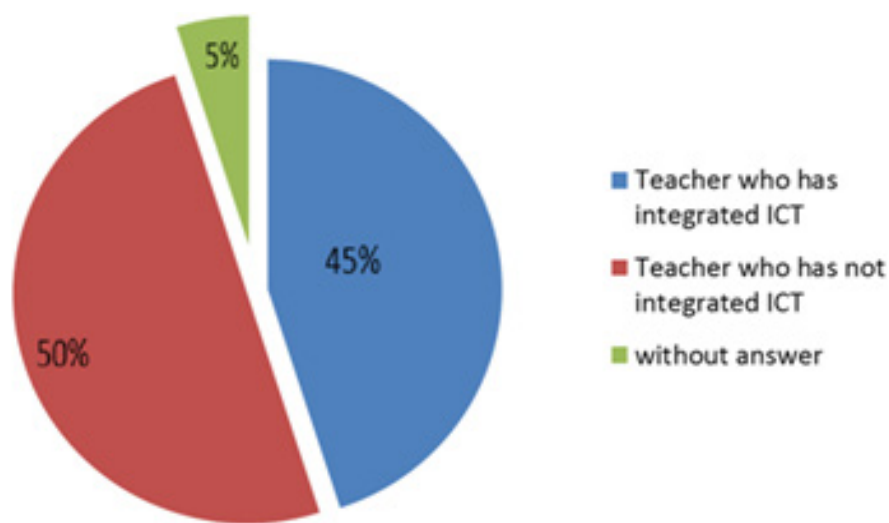


Figure 5. Percentage of PCS teachers integrated ICT in class.

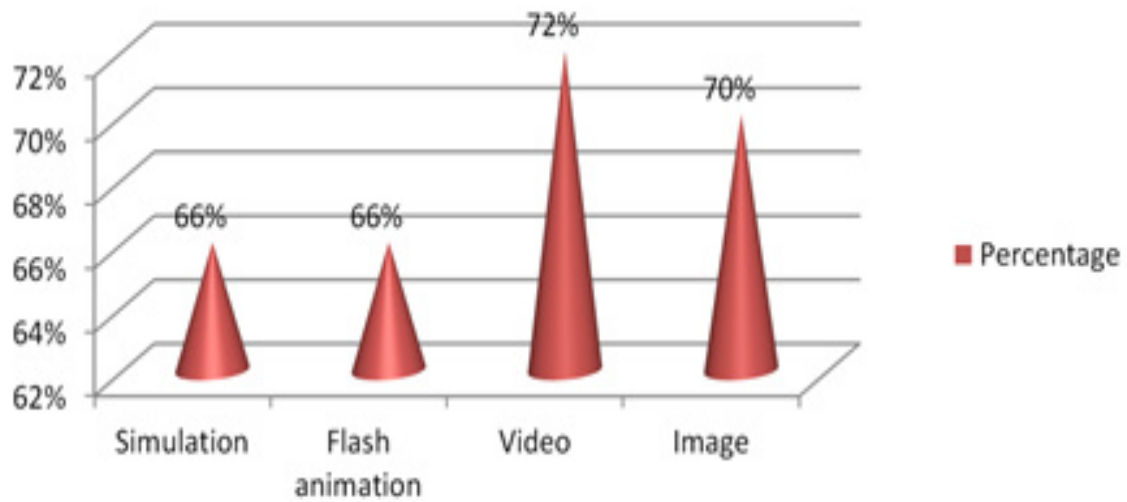


Figure 6. Using simulations, animations, videos and images in the classroom.

Table 1. Physical application software used by PCS teachers in class

Application software	Percentage
Logger pro	38%
Latis pro	13%
LabQuest Emulator	25%
Avimeca	34%
Others	5%

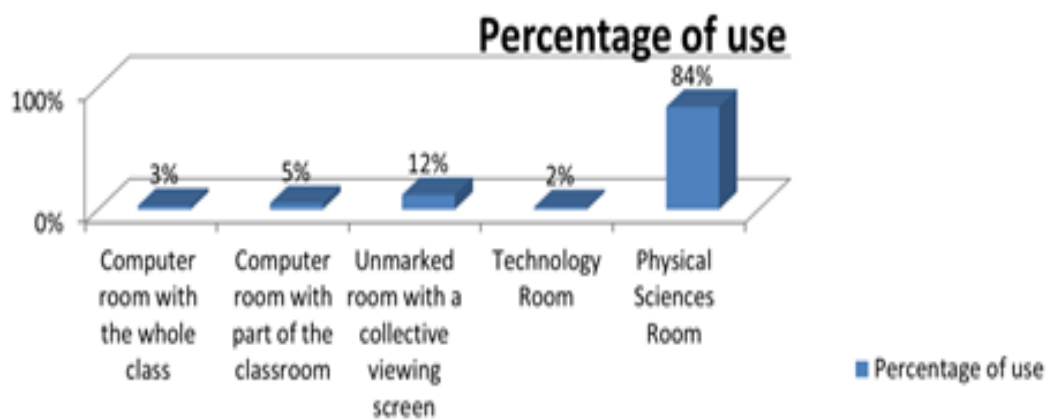


Figure 7. Percentage of locations of ICT use.

or a video of a practical experience can however find its place in addition to actual practical work, if this simulation avoids the repetition of tedious routine operations, so most teachers prefer video instead of a simulation, it can be more real to students than animation flash, as shown in the Figure 6.

Computer Assisted Experiment (CAEx) application software used by the physical and chemical sciences classroom teachers, as Table 1 shows.

Figure 7 shows the places of the new information and communication technologies use:\.

3.5 Other Types of Use of ICT in the Classroom

Tables 2 shows that course experience, simulation, video and animation are the most use of the information and communication technologies by the physical and chemical teachers in class, because they require a computer use and preparation, it is clear that digital files are more easy to carry and more. Unlike the paper document, whether

written or printed, the digital document separates the presentation (layout techniques) from the information (text composition, data). Multimedia (still or moving image, video, sound) can be inserted inside the digital document. Its production and communication technique can be summed up in four main software families: word processing tools, spreadsheets, e-mail software, document management software.

The Figure 8 shows the elements and partners that encourage teachers to use the new information and communication technologies in the analysis of the questionnaire.

From the Figure 8, it is clear that the personal interest of the teachers of the physical and chemical sciences is the most important motive that drives them towards the integration of information and communication technologies in their lessons with their students. Secondly come the conception of teaching, then the students.

What is interesting in this research is that the colleagues, the program and the ministry are with the latest

Table 2. Percentage of types of ICT use

Types of use	Percentage
Course experience, simulation, video, animation	85%
Demo Help	17%
Exercises	10%
Correction of exercises	10%
Directed work	12%
Research activity	8%
Search for information online	7%
Evaluation, QCM ...	12%
Consultation of encyclopedias, dictionaries, databases	8%
Other Uses	5%

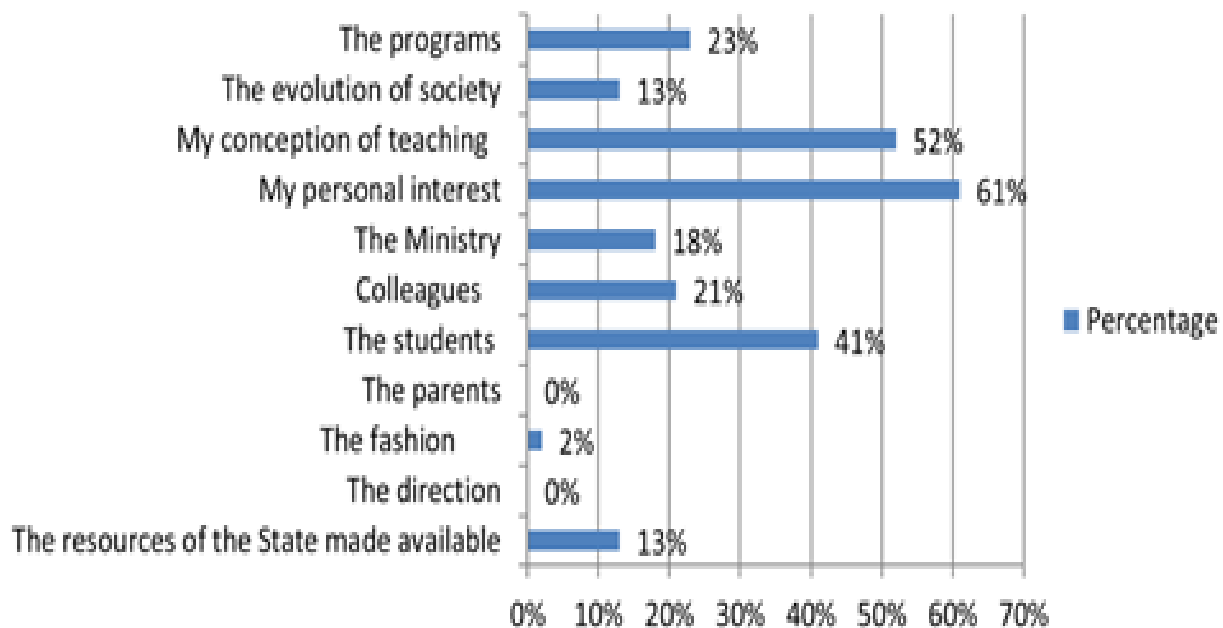


Figure 8. Percentage of elements and partners encouraging teachers to use ICTs.

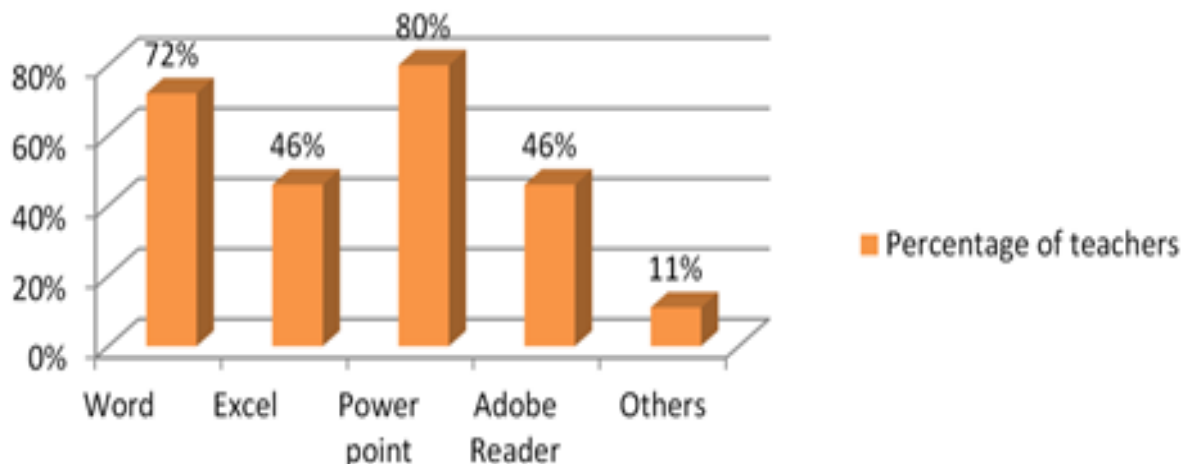


Figure 9. Basic software used in class by PCS teachers.

motives and partners that encourage teachers to use the ICTs, according to the questioned teachers, instead of being the first as planned.

The Figure 9 shows the basic software's used in class by the physical and chemical science teachers.

The results show that the physical and chemical teachers use text and images more than tables or others tools,

combined the text and images as slides of power point file, it gives more clarity, beauty and simplicity to lessons. Hence the advantage of reinforcing the teachers' acquisition in office tools through certified training programs such as the Microsoft Office Specialist (MOS) or the International Computer Driving License (ICDL)¹².

3.6 Degree of Mastery of ICTs by Teachers

The Figure 10 shows that 61% of teachers do not sufficiently master ICT and 6% have no concept in computer science and the use of the internet, which constitutes one of the constraints related to the successful integration of the new information and communication technologies in the physical and chemical sciences.

3.7 Existing Materials in Targeted Establishments

It is very clear that the presence of a video projector in schools is essential to present some figures, videos, simulations, parts of courses or whole courses to facilitate the teaching-learning process of the physical and chemical sciences. This use cannot be done without a computer; it

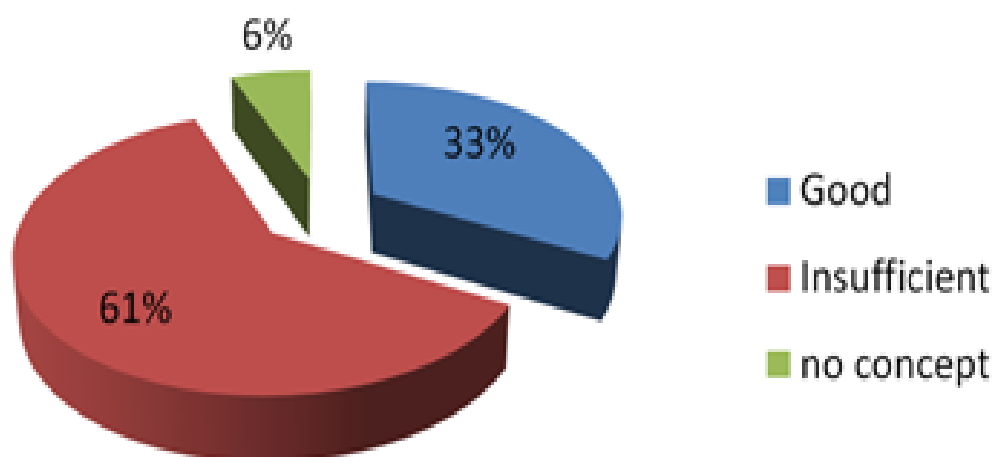


Figure 10. Degree of mastery of ICTs.

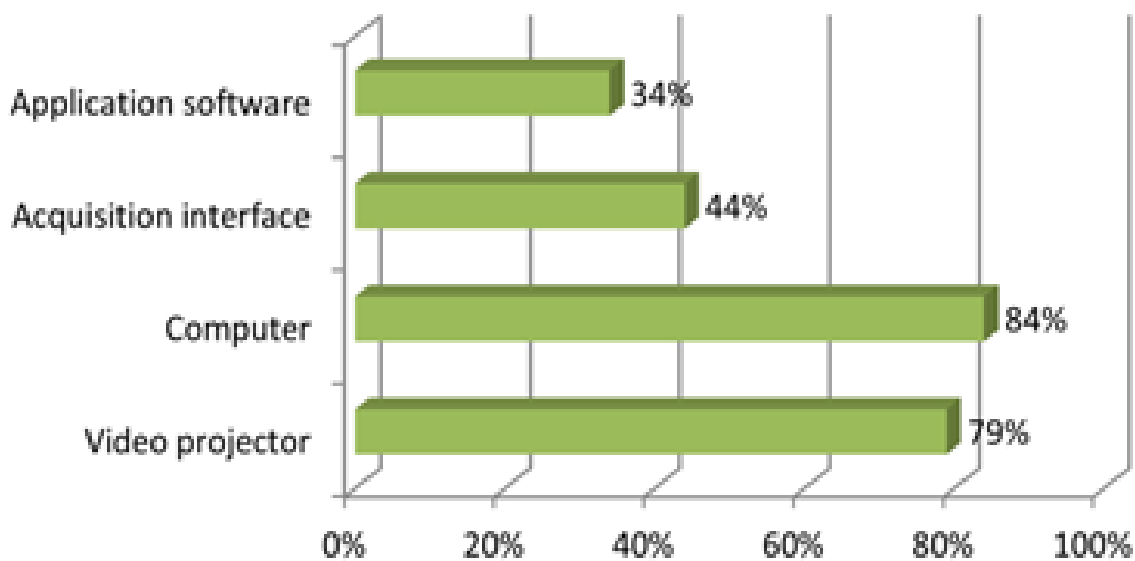


Figure 11. Existing equipment at the establishment.

is less important because teachers can use their own laptops in case of possession (Figure 11).

Concerning the acquisition interface and the application software, it is not available in all establishments because it is fragile, too expensive and are not very easy to handle, it requires more attention and computer and electronic skills to integrate it into the lessons.

3.8 Obstacles and Brakes on the Use of ICT

In addition, ignorance or lack of knowledge of ICT, 67% of teachers questioned claim that their working conditions are unfavorable. And 90%, the majority considers that the use of ICT is a waste of time although it motivates students. In addition, according to the results of the questionnaire, the use of ICT in class (59% of teachers in our population) requires too much preparation time.

The results of the questionnaire allowed us to highlight other obstacles to the use of ICTs including:

- Program too charged (21%);
- Many students in class room (90%);
- Lack of permanent technician in the establishment (100%);
- Lack of teacher motivation by the ministry (90%);
- The equipment is not reliable enough; there is always a risk of failure in the presence of students (82%);
- The priority of multimedia rooms is given to other learning;
- Cultural and linguistic concerns (43%);
- The main obstacle that hinders the exploitation of the multimedia room by the teachers of the SPC is the lack of these rooms in their establishments (69%), these rooms, if they exist, are often closed or sometimes even abandoned, because lack of maintenance;
- Insufficient teacher training in ICTs¹⁰;

In 2014 Y. ElMadhi^{9,10} was able to find the majority of these obstacles in life and earth sciences (ELS) in the delegation of khemissat (Morocco).

School principals also argue that the main obstacle that hampers the operation of the multimedia room by PCS teachers is the lack of these rooms in their institutions and the training of teachers in the field and the overcrowding students, these rooms are often closed or sometimes even abandoned, due to lack of maintenance. This has already been reported in the Marrakech Academy.

3.9 The Levers to Allow the Use of ICT

Almost all teachers (95%) reported that a video projector in the physical and chemical sciences classroom is a necessary condition for the use of ICT, in fact most of the time, it is the only solution if there is no material, and it can also save time. Some (2%) think that the presence of an interface is also necessary.

First of all, we must insist on the training of teachers by motivating the older ones (Some think that it must be made obligatory 7%, others think that the training must be paid 3%), and install the necessary equipment (multimedia rooms, computers, video projectors, interactive whiteboards...), then to accompany the teachers in their use, by encouraging teachers integrating ICTs and help non-integrators to get there¹¹.

Build a new program and curriculum based on the use of the new information and communication technologies and showing their usefulness, so the students can see what it's like to integrate it, get used to it and then use it or help use it (some prefer that ICTs must be used by teachers only, because it requires some skills¹². Others see that some students very talented, they can easily learn how to use ICTs, view the use of computers and tablets today. We can all agree this new generation of teachers and student will not hesitate to use the ICTs for their ability for adapt and open to the new technologies and its tools¹³⁻¹⁵.

Let's try to understand information and communication as an object of knowledge^{16,17}.

At the end of the Conference, Qingdao's "UNESCO" Declaration on ICT and Post-2015 Education was adopted. The 22 points of the Declaration reflect the prin-

ciples, objectives and recommendations for the relevant use of digital tools in education^{18,19}.

- Involve the school in ICT education whose knowledge and use is essential in today's world.
- Harness ICTs to foster inclusive, equitable, quality education and adopt a continuous learning process.
- Evaluate the potential of free software in a perspective of democratization and development of access to knowledge.
- Ensure the development of skills in the use of ICT in the primary and secondary cycles.
- Ensure the development and ongoing training of ICT education stakeholders

Essential too, is providing opportunities for use and implementation of information technology in the language classroom in order to boost teachers' confidence and enhance their experience. This applies to institutions as well as to individuals. Therefore, ICT literacy should become an academic requirement for candidates planning to enter teacher training schools; and training should focus more on how ICT can be applicable to course content²⁰.

3.10 ICT Teacher Training

68% of teachers in our population have already received ICT training offered by the Ministry of National Education. Figure 12 shows how satisfied they are with this training.

A minority of only 10% is satisfied with the training offered by the Ministry, while the majority with a 68% percentage is no longer satisfied, so we need to review the ICTs teacher training systems of the PCS. These results are in agreement with the previous results because the new teachers recruited in the last two years were hired directly without any training, in spite of all the late attempts to train them in the holidays, it is still modest considering the number of recruits, the training budget, regional centers of teaching and training trades and the need to place them in classes in order to fill the huge lack of teachers.

Unsatisfied teachers expressed their dissatisfaction with the situation of the new information and communication technologies in our educational system in Morocco, and offered the following suggestions as a response to the preferred type of training, as Table 3 shows.

The majority of the teachers surveyed (83%) declare a request for ICT training, especially in the following areas, as Table 4 shows.

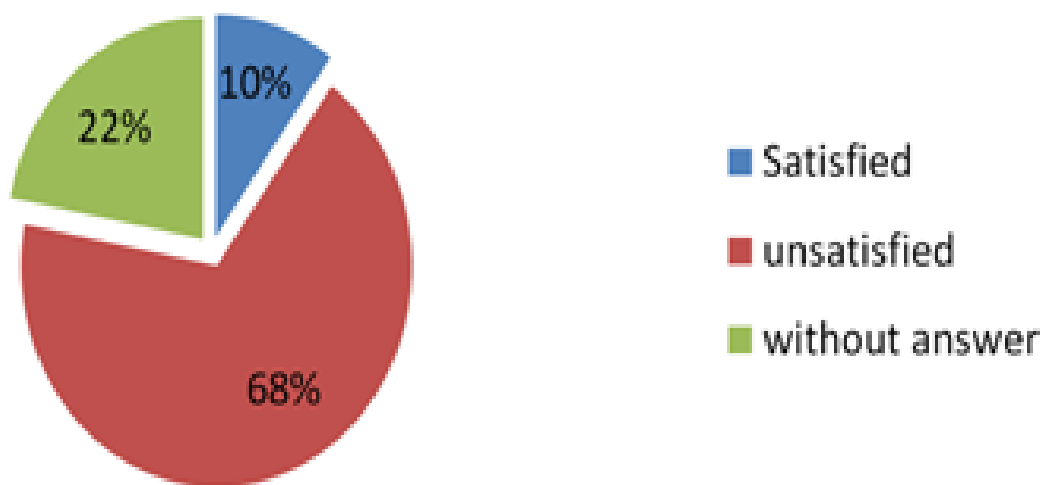


Figure 12. Satisfaction of PSC teachers in ICT training.

Table 3. Suggestions for ICT training

Suggestion	Percentage
Continuous training	66%
Periodic seminars	30%
ICT support	54%

Table 4. PCS teacher training fields

Type of training	Yes	No
Use of educational software	89%	11%
Creating Web pages	48%	52%
Training in videos animated by the association Educ' images: setting up a scenario, filming and then digital editing (use of digital camcorders, computer editing). Then application with the students.	74%	26%
Training in computer-assisted experiments (CAEx)	87%	13%
Other suggestions: PDF - Power point - Websites		

Given the importance of the CAEx and the use of the educational software in the lessons of the physics and chemical sciences, most of the teachers questioned demand a request for complete training by the experts, in order to improve their pedagogical methods to ensure a good integration of the new technologies of the information and communication in class.

Some demand a request for complete training in videos animated by the association Educ' images, in order to set up a pedagogical scenario.

Some others are interested in creation of educational websites to facilitate access to information for their students.

4. Conclusion

We have just seen that information and communication technologies are still very little integrated in education,

among the main constraints that hinder the integration of ICTs in the physical and chemical sciences in schools in the region of Casablanca - Settat, direction Provincial Moulay Rachid-Sidi Othman are:

- Program too charged (21%);
- Many students in class room (90%);
- Rarity of useful educational digital resources (17%);
- Lack of permanent technician in the establishment (100%);
- The lack of ICTs culture of teachers;
- The equipment is not reliable enough; there is always a risk of failure in the presence of students (82%);

- Cultural and linguistic concerns (43%);
- Lack of multimedia rooms; Limited access to these rooms;
- Insufficient teacher training in ICT;

We believe, therefore, that teachers need to be accompanied towards efficient integration of ICT in their daily teaching practices²¹. In order to achieve a successful integration of information and communication technologies, it will be necessary to mention some levers to ensure this integration. Here are some suggestions for the different actors of education:

- Invest more time in learning and using ICTs;
- Follow training (by the ministry, online, ...);
- Motivate learners: Push the new generation to use ICTs.
- Reserve a place for ICTs in each course planning.

The integration of ICTs in the education system in physical and chemical is a pedagogical priority; access and flexibility are two prerequisites for the successful integration of ICT in schools. The Ministry must consider several obstacles before taking the next step towards a better integration of ICTs, and several levers that make this integration successful:

- Increase the time volume of the ICTs training;
- Provide good training for PCS teachers and school officials;
- Motivate older teachers to integrate ICTs and encourage the teachers whom integrate it;
- Provision of digital materials to facilitate access to information.
- Invest more in infrastructure and equipment as part of the “GENIE” project;

- Production of digital teaching resources compatible with the Moroccan context.

Finally, all physical and chemical teachers require the presence of the resources available in the manual in digital form and their coherent organization with respect to the program under study. This study allowed us to pinpoint the constraints linked to the successful integration of Information and Communication Technologies (ICTs) into Physical and Chemical Sciences teaching (PCS) at the middle school and high school level, and therefore, these constraints can be overcome by the willingness and mutual help of all persons and leaders of this sector working in the Ministry of National Education.

5. Compliance with Ethical Standards

Ethical approval: This article does not contain any studies with animals performed by any of the authors.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent was obtained from all individual participants included in the study.

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Conflicts of interest: We have no conflicts of interest to disclose.

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