IOSR Journal of Research & Method in Education (IOSR-JRME)
e-ISSN: 2320–7388,p-ISSN: 2320–737X Volume 6, Issue 3 Ver. IV (May. - Jun. 2016), PP 156-172
www.iosrjournals.org

Perceptions of the Moroccan Students on the Integration of ICT in Scientific Higher Education

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Abstract: *Within the framework of a research aiming to evaluate the impact of the use of Information and Communication Technologies (ICT) in scientific higher education, we carried out a study dealing with 108 Moroccan students (40 males and 68 females) from various institutions of scientific higher education. The objective of this study is dual. It will allow on the one hand, to determine the perceptions of these students towards the use of ICT during the course session and practical works (PW); in addition, it will enable us to identify the most suitable teaching mode (traditional, integrating the ICT or hybrid) for a better learning of sciences within university. The results of our investigation show that the integration of ICT in scientific courses and PW is beneficial for the majority of students and can improve the quality of their learning. However, to help students in difficulty and bring more effectiveness during the teaching sessions, these tools should be used in appropriate techno teaching situations where other teaching materials are also exploited.*
Keywords*: ICT, Courses, Practical Works (PW), scientific higher education.*

I. Introduction

We have observed and for several years a revolution of scientific knowledge accompanied by the emergence and rise of information and communications technology (ICT). In front of this development, the integration of ICT in the institutions of the scientific higher education is required for the improvement of the quality of the students learning and the professional development of teachers of higher education.

From the perspective of pedagogical renewal and institutional modernization, Laure Endrizzi (2012) has evaluated, primarily in France, the contribution of these technologies in regard to the public policies deployed for one decade. She was interested in the evolution of the digital practices of the students and the teachers and in the potential influence of these practices on their expectations with regard to teaching in North America and Europe. She also concentrated on the added-value of these technologies in the light of the teaching-learning and the research methods which make it possible to appreciate it. The studies of Endrizzi showed that for a development of pedagogy in higher education, the implementation in the practices of teaching-learning forces to raise other challenges of which she declared: that of digital literacy for the two educational actors, students and teachers; that of the accompaniment by the professionals of pedagogical engineering and that of the recognition of the mission of teaching of teachers - researchers.

Karsenti and Larose (2005) situated the question of the pedagogical integration of ICT taking into consideration vaster scientific problems concerning the cognitive, epistemological and pragmatic foundations of the work of the teachers and their training. Barrette (2009) indicated that an effective integration of ICT must be subordinate to an adequate reflection on the pedagogical intensions and strategies.

In Morocco great efforts were deployed to diffuse ICT in the education system. The Ministry of National Education, of higher teaching, of management training and scientific research (MNE) expresses a great willingness to implement ICT in education, as it is conscious that this integration improves the quality of teaching and learning (MNE, 2008).

Moroccan researchers like Zerhane, Janati-idrissi, Khaldi, Blaghen & Talbi (2002); Benjelloun, Alami & Rebmann (2003); Aboussaouira & chehab (2008); Berrada & Chraïbi (2010); Droui & Kaaouachi (2010); Bouchaïb & Benjelloun (2011) studied the impact of the integration of ICT on the teaching-learning of the scientific disciplines within the university in Morocco.

The objective of our work will allow on the one hand to determine the perceptions of the Moroccan scientific students in regard to the integration of these technologies during the course sessions and practical work (PW); in addition to identify the most appropriate teaching method (traditional, integrating the ICT or hybrid) for a better learning of sciences in the university.

1. Problematic and theoretical framework

At the international scale, the integration of Information and Communication Technologies (ICT) within the institutions of scientific higher education constitutes a topic of important debate and discussion. This

integration starts to be evidenced by a growing number of recent researches. These researches were mainly centered on the study of the processes of teaching-learning and on the evaluation of sequences of teaching integrating ICT.

In order to make the sessions of the laboratory of science more formative, Riopel, Potvin and Raîche (2008) developed a computerized environment of human learning which allows the students of the classical mechanics to engage a process of scientific modeling by combining the Computer-Assisted Experimentation (CAX) and the Computer-Assisted Simulation (CAS). The experimentation of the developed environment was carried out with several groups of students (67 students). The results revealed that these students have engaged with some enthusiasm in a process of modeling by utilizing inductive and deductive stages of reasoning, 68% of them were able to use the developed environment for answers to questions about the scientific concepts previously discussed in class as well as completely new concepts. Furthermore 93% of these students seemed more interested by the experiment involving the learning environment than by the usual experiments.

In a School of Science of Education in Canada, Métioui and Trudel (2007) studied the explanations of the electrostatic phenomena advanced by students in 3rd academic year. In this topic area, they interviewed these students about some electrostatics phenomena such as the formation of lightning and the interaction between rubbed bodies, as well as the usefulness and the dangers associated with electrostatics.

Jacquet, Georges, Gourdange, Michiels and Poumay (2012) set up at the University of Liege (ULg, Belgium) an online space helping the students to solve their problems of physics by breaking up the processes of resolution and by taking knowledge with detailed feedbacks, in a way to improve as well their comprehension of mechanics as the resolution of problems as such. The experimentation of the physical space was set up to 933 students in Medicine and Dentistry of the University of Liege. The results revealed an important rate of connection (67%), but a large number of unique connections (36%). The objective and subjective data indicated that the physical space is useful for the students and helps them progress.

Within the institutions of Moroccan scientific higher education, the accent of the Moroccan researchers focused almost exclusively on the impact of ICT on the teaching and learning of the scientific disciplines in the school context (secondary education) and in business context (teacher training). Few researches were carried out to measure the effect of the integration of ICT in the institutions of Moroccan higher education.

Bouchaïb and Benjelloun (2011) identified the conceptual difficulties encountered by the students of the first university cycle in the field of electrostatics. They experienced, three consecutive years, the resources relating to the module of electrostatics of the site with free access University of Science Online[1] (UNISCIEL) with the first year students of the preparatory classes for engineering schools (CPGE). They concluded that the integration of these resources in a situation of tutored self-learning allows these students to get the maximum of profit from the activities suggested by the site and produces a cognitive conflict, even socio-cognitive, thus promoting an effective learning for a better appropriation of the studied concepts. These researchers announced that a teaching session enriched by the UNISCIEL is tiring for a facilitator teacher who alone has to ensure a technical and conceptual assistance for students and follow the learning progression of the group. This scenarisation is practical only for small groups because the stimulating teacher must grant to each student a minimum of time for an effective learning.

Zerhane, Janati-Idrissi, Khaldi, Blaghen and Talbi (2002) worked out a hypermedia on CDROM treating the fundamental and practical aspects of immunology "Immuno-LOGY". These researchers tested this software to the students in initial training of aggregation and the teachers of science in continuous training. The results of the experimentation showed that the use of this software helps the various users react very favorably, progress and become more involved in their training.

Aboussaouira and Chehab (2008) have experienced self-learning software "Mediamtic" by training 580 students of the first year of the faculty of medicine of Casablanca. The study showed that the participating students were able to achieve several objectives (documentary specificity, erudition, communication ...) and had better success rates in final exam.

Berrada and Chraïbi (2010) carried out a comparative study between two experiments of distance learning undertaken in two Moroccan universities (engineering school and Faculty of Science). The two proposed devices are based on a socioconstructivist pedagogy supporting a student centered learning. Their results showed that the progressive and dynamic integration of a learning environment could facilitate the appropriation of the courses by the students of their institutions and would thus contribute to reduce the rate of failure and abandonment. These experiments also revealed several difficulties of technical, organizational and pedagogical side.

To remedy for the conceptual problems of the students in optics, Benjelloun, Rebmann and Alami (2003) tried out the use of a workshop java geometrical of optics (WJGO) with thirty-one second year university

[1] http://www.unisciel.fr/

students (section physics- chemistry) in Morocco. The results of their study showed that the use of the WJGO reveals the difficulties of the students who do not correctly conceptualize the formation of the image of a point by a mirror.

Nadia Benjelloun and her collaborators (2008) developed, for the students of the scientific sectors degrees, a scenario of teaching for the practical works (PW) of physics which is articulated around two supports. The first being based on software of simulations relating to manipulation addressed. The second was based on pedagogical tools comprising a handling of multiple-choice questionnaire and a plug with holes of practical works. The results revealed, on the one hand the satisfaction of the students for the use of the simulation software in parallel with manipulations and on the other hand, their motivation for the preparation of their PW and their enthusiasm for the dynamics of teamwork created by the report to hand in at the end of the session of PW.

Despite some resistances, it has been observed in Morocco, for about ten years a major change in the teaching practices in various scientific disciplines. Nevertheless, the main focus of research in the didactic of sciences was oriented more towards the study of the processes of teaching-learning and therefore towards the evaluation of sequences of teaching integrating the ICT. Accordingly, it seems essential to us to put emphasis on the advantages and the limitation of the integration of these technologies in the institution of scientific higher education in Morocco. The objective of our work consists on the one hand in surrounding the perceptions of the scientific students with regard to the use of ICT during the course sessions and practical work (PW). In addition, we intend to discover the most appropriate mode of teaching (traditional, integrating ICT or hybrid) for a better learning of sciences within university, to release the added -value which ICT bring to the learning of the science students and thereby to announce the barriers which prevent a successful integration of ICT.

We therefore propose to answer three specific questions of this research:

- What perceptions do students do of the integration of ICT during the course sessions and the scientific PW?
- Which is the most adapted mode of teaching for a better teaching-learning of sciences within university?
- What are the advantages and the limitations of the integration of ICT during the course sessions and the scientific PW?

II. Methodology

To identify the perceptions of the scientific students with regard to the use of the ICT in scientific higher education and to discover the added-value which these technologies bring to their learning, we collected 108 answers of scientific students (40 males and 68 females) coming from the institutions of higher education in Morocco to a questionnaire precisely prepared for this purpose. 68.5% of this sample are students of the Faculty of Science and Technology of Fez (FSTF), 19.4% are students of the National School of Applied Sciences in Fez (ENSAF), 6.5% are students of the National School of Arts and Crafts in Meknes (ENSAM), 2.8% are students of the Faculty of Sciences Dhar el Mehrez in Fez (FSDM) and 2.8% are students of the National Superior School of Data processing and Analysis of the Systems in Rabat (ENSIAS). The various students surveyed are of different sectors: physics (33.3%), chemistry (3.7%), biology (3.7%), data processing (14.8%), Mathematics-Computer Science-Physics (15.7%), Biology-Chemistry-Geology (23.1%) and Preparatory Cycle (5.6%). These questioned students are not of the same level of studies, 26.9% are in first academic year, 17.6% are in second academic year, 28.7% are in third academic year, 25.0% are in fourth academic year, whereas 1.9% are in fifth academic year.

2. Presentation of the questionnaire (Annex1)

Our questionnaire (see the annex) comprises 23 items (items with single-choice, items with multiple choices and open-ended questions) through which we tried to determine the perceptions of 108 students in the use of ICT in scientific higher education.

This questionnaire is mainly centered on:

- The degree of satisfaction of the students of the use of ICT (Power Point Presentations PPT, simulations, filmed experiments….) in scientific courses.
- The perception of the students of the use of the Computer-Assisted Experimentation (CAX) software and the Computer-Assisted Simulation (CAS) software in the sessions of practical works.
- The point of view of the students on the most appropriate mode of teaching (traditional, integrating ICT or hybrid) for a better learning of sciences within university.
- The added value which ICT brings to the learning of the students in the sciences.
- The limits of the integration of ICT during the sessions of the scientific courses and the Practical Works (PW).
- The expectations and needs of the students for a successful integration of ICT within the institutions of scientific higher education.

The handover of our questionnaire (presented in Annex) lasted 30 minutes and was conducted out of a part of the teaching sessions.

3. Data analysis methods:

Quantitative statistical analyses were carried out using the sphinx software. The open questions, aiming to obtain additional precise details and standard comments as for the pedagogical practices using ICT more and least likely to promote the learning of the students, were the subject of a qualitative analysis.

III. Results and Discussion

1. ICT and personal uses

The analysis of the responses given by the scientific students concerning the various uses of the computer allows us to raise the following results. These results are summed in the TABLES 1 and 2.

The results of Table 1 show that a significant number of students 38.9% spend each day more than 4 hours in front of a computer. Thus it is noticed that the computer occupies a rather important place at 54.6% of the questioned students. Therefore 70.1% (50.9% + 10.2%) of the questioned students have a good, even a very good level towards the use of the computer tools.

TABLE1. Personal information on the use of the computer on behalf of the scientific students

		Percentage
Time_Use_Computer - How long on average do you estimate to spend each day in front of a computer?	Less than 1h	10.2%
	Between 1h and 2h	21.3%
	Between 2h and 4h	29.6%
	More than 4h	38.9%
P_Computer - Which place does the comp uter occupy in your life?	Useless	0%
	Not really important	12.0%
	Rather important	54.6%
	Essential	33.3%
Control_Computer - How do you evaluate your level of control of the computer tools and multimedia?	No response	0.9%
	Very weak	0.0%
	Rather t weak	1.9%
	Average	36.1%
	Good	50.9%
	Very good	10.2%

TABLE 2 shows well the various uses of the computer apart from the sessions of teaching on behalf of the scientific students.

TABLE 2. Various uses of the computer for the scientific students.(The number of citations is higher than the number of observations due to multiple responses (11 at the most)).

Computer_uses- Do you use the computer for :		
	Nb Cit.	Percentage
To distract yourself (games, music, films…).	77	71,3%
To communicate with your colleagues (chat).	79	73,1%
To participate in social networks (Face book, Twitter ....).	92	85,2%
To collaborate with other students.	48	44,4%
To participate in forums.	32	29,6%
To reach complementary contents related to the courses (demonstrations, simulations, filmed experiments .....).	60	55,6%
To do exercises problems and old exams in link with the contents of the course.	71	65,7%
To prepare presentations.	102	94,4%
To follow online courses (e-learning)	45	41,7%
To improve your intellectual level, your general knowledge and widen your scope of knowledge in sciences.	78	72,2%
Others	4	3,7%
TOTAL OBS.	**108**	

In addition to these uses, it should be noted that 3.7% of the questioned students manage to develop applications outside of the sessions of teaching.

It clearly appears from these results that the use of the computer is advantageous for these university students who are native of numeric and adept with the technology, and which will have, certainly, a favorable impact on the quality of their learning in sciences.

2- Satisfaction degree of the students to the use of ICT in the sessions of the scientific courses

The results of our investigation show well that the whole of the questioned students (100%) have already followed, in classrooms, one or more scientific courses integrating the ICT in general. Therefore 84.3%

of these scientific students, of different sectors, have a very positive vision toward the use of ICT in the scientific courses in classrooms.
The analysis of their positive and negative justifications concerning this use is summarized in TABLE 3.

TABLE 3. Views of the scientific students concerning the use of the ICT in the scientific courses. (The number of citations is higher than the number of observations due to multiple responses).

Perception_Use_ICT_Courses - Are you for the use of the ICT in the scientific courses?				
Attitude	**Percentage**	**Standard comments**	**Nb. Cit**	**%**
Favorable	**84,3% (91)**	The ICT instigate and enrich the content of the course.	70	64.8%
		The ICT generate a deep comprehension of the abstract concepts of the course.	48	44.4%
		The ICT accelerate our learning and help us receive the maximum of information in little time.	55	50.9%
		The ICT introduce more reality during the session of the course and facilitate the memorizing of the concepts.	47	43.5%
		The ICT increase our concentration to follow the course.	33	30.6%
		The ICT increase our motivation to learn the course.	47	43.5%
		The ICT increase our participation during the course.	27	25.0%
		The ICT help us do more practical exercises during the sessions of the course.	35	32.4%
		The ICT positively influence on our results and increase our chances of success.	27	25.0%
		Not justified favorable responses.	3	2.8%
Unfavorable	**15,7% (17)**	The ICT accelerate just the presentation of the course	15	13.9%
		The ICT make more difficult the control of abstract concepts of the course.	12	11.1%
		The regular and frequent use of ICT often causes the trouble and disadvantages our learning.	11	10.2%
		The use of the ICT reduces our concentration to follow the course.	13	12.0%
		The ICT do not help the teachers to adapt the learning to the level and to the rhythm of each student.	10	9.3%
		The use of the ICT does not constitute a help to our success.	6	5.6%
		Not justified unfavorable responses.	0	0.0%

The analysis of the favorable justifications of the students (84.3%) also shows that the use of the ICT has several advantages for the scientific students. For this purpose, this use enriches and instigates the contents of the course. It positively influences the motivation, the participation, the concentration and the learning of the science students. It introduces more reality during the teaching session. It generates a deep understanding of the abstract notions of the course and it helps the students to benefit from the time remaining to make more exercises of application during the course.

In contrast, 15.7% of the students having answered to our questionnaire consider that the use of the ICT is not always adequate nor always relevant. The analysis of their unfavorable justifications shows well that this use brings additional complexity during the teaching session. It only helps accelerate the presentation of the courses. It often causes the boredom and disfavor the learning of the students. It reduces their concentration to follow the course. It does not help the teachers to adapt the learning to the level and to every student's rhythm and it doesn't constitute a help to their success.

These results help us deduce that the integration of the ICT in the scientific courses is certainly advantageous for the majority of the university students and that it can improve the quality of their learning. However, to help the students in difficulty and to introduce more reality during the teaching session, these tools should be used in situations based on techno pedagogical approaches where other supports of teaching (board, handout ...) are also exploited.

2.1 The perception of the students to the use of the simple power point presentations in the scientific courses

The answers collected of the students show us that the whole of the students (100%) profited, in classrooms, of the Power Point presentations in scientific courses. Indeed 16.7% of these students are very satisfied with the use of PPT during the sessions of the courses, 37.0% are satisfied, 30.6% are little satisfied and only 9.3% are not satisfied with this use. The rest, a rate of 6.5%, did not express their attitudes concerning this use.

A preliminary analysis of the justifications provided by these students revealed to us the following results (see TABLE 4).

TABLE 4. Perceptions of the scientific students after the learning of one or more scientific courses presented by the PPT.(The number of citations is higher than the number of observations (108) due to multiple justifications)

Appreciation_PPT / Justifications_ Appreciation PPT	No response		Not satisfied		Little satisfied		Satisfied		Very satisfied	
	Nb Cit.	Freq.	Nb Cit.	Freq.	Nb Cit.	Freq.	Nb Cit.	Freq.	Nb Cit.	Freq.
No response	7	6.5%	0	0%	7	6.5%	9	8.3%	3	2.8%
The PPT ensure a good presentation of the course.							11	10.2%	8	7.4%
The PPT make the course more clear and more assimilated					1	0.9%	20	18.5%	8	7.4%
The PPT increase the incentive to follow the course.							2	1.9%	5	4.6%
The PPT help us to save time and to learn more during the session of the course.							3	2.8%	4	3.7%
PPT increase our concentration to follow the course.							5	4.6%	1	0.9%
PPT enrich and energize the contents of the course.							9	8.3%	5	4.6%
The use of PPT accompanied by a handout help us benefit fully from the explanations of the teacher.							1	0.9%	1	0.9%
The PPT accelerate the presentation of the course, it will be difficult for us to follow the rhythm of the teacher.			1	0.9%	5	4.6%				
The PPT make the course boring.			3	2.8%	9	8.3%				
The PPT decrease our concentration to follow the course.			1	0.9%	5	4.6%				
The PPT make more difficult the control of the abstract concepts of the course.			5	4.6%	9	8.3%				
The impact of PPT on our learning remains always depending on the nature of the subject taught.					2	1.9%	2	1.9%		
The PPT summarize just the contents of the course, they do not detail the transitions between the steps.			2	1.9%	3	2.8%				
For an assimilation of the abstract notions of the course, the detailed demonstrations on the table remain essential during the session of teaching.			1	0.9%	6	5.6%				
For a better learning, the integration of simulations in the slides is well recommended.					1	0.9%				
The pedagogy adopted by the teachers to teach a course through the PPT influences our learning.			1	0.9%						
The way in which the course was scripted is a factor which influences our learning.			2	1.9%	4	3.7%	1	0.9%		
The PPT do not promote an interaction between the students and their teachers.			3	2.8%	1	0.9%				

It clearly appears from these results that, according to the nature of the scientific subject taught, the PPT presentations enrich and energize the course content by making it clearer and more motivating. However, these presentations are not sufficient to make the scientific course easy to assimilate. To increase the concentration of the students and facilitate to them the understanding of the phenomena and the scientific laws, these presentations must be integrated into pedagogically adequate situations of learning, accompanied by the detailed demonstrations on the board and enriched by other ICT tools (explanatory Diagrams, simulations, filmed experiments..) developing the reasoning of the students on sciences. Didactic and techno pedagogic

competences of the Professor remain still the key elements of a successful use of slides projected in a session of the scientific course because the teacher's role doesn't limit itself to the simple presentation of the information to the learner who must control the use of technology and know how to integrate it in its teaching.

2.2 Satisfaction degree of the students of the scientific courses integrating the simulations.

According to the results of our questionnaire, 65.7% of the students have already benefited, during the sessions of teaching, at the scientific courses integrating simulations. Indeed, the majority of these students adopt a favorable attitude concerning this use. 34.3% of them are satisfied thus that 22.2% are very satisfied.

For better determining the perceptions of the scientific students of the use of simulations in their various scientific courses, TABLE 5 summarizes the arguments which these students advance to justify their attitudes towards this use.

TABLE 5. Perceptions of the scientific students after the learning of one or more scientific courses integrating simulations.

(The number of citations is higher than the number of observations (71) due to multiple justifications).

Appreciation_simulations_course	**No response**		**Not satisfied**		**Little satisfied**		**Satisfied**		**Very satisfied**	
Justifications	**Nb Cit.**	Freq.	**Nb Cit.**	Freq.	**Nb Cit.**	Freq.	**Nb Cit.**	Freq.	**Nb Cit.**	Freq.
No Response	1	0.9%	1	0.9%	6	5.6%	19	17.6%	9	8.3%
The Simulations create a distance to reality.			1	0.9%	1	0.9%				
The simulations help us to better consolidating our theoretical knowledge; they generate a deeper comprehension of the phenomena.							13	12.0%	12	11.1%
The simulations complement and put into practice the magisterial course.							6	5.6%	5	4.6%
The simulations bring us closer to reality.							5	4.6%	4	3.7%

The Analysis of the justifications of the students also shows which simulations bring them closer to reality. The simulations complete and put into practice the lecture and help develop the comprehension of the scientific phenomena. These declarations help us to deduce that the integration of simulations in a scientific course can positively influence the learning of the students in science.

2.3 Perceptions of the students on the use of the filmed experiments in the scientific courses

The analysis of the responses given by the scientific students enables us to note that 43.5% of them already followed in classrooms, one or several scientific courses integrating the filmed experiments. Consequently, a majority of them (23.1%) are satisfied, and (13%) are very satisfied with this use.

An analysis of the justifications achieved by the scientific students having a positive / negative perception relating to the use of the filmed sequences of teaching in scientific courses showed us the following results (see TABLE 6).

TABLE 6. Perceptions of the scientific students after the learning of one or more scientific courses integrating the filmed sequences of teaching.

(The number of citations is higher than the number of observations (47) due to multiple justifications).

Appreciation_Sequences_filmed	**No response**		**Not satisfied**		**Less satisfied**		**Satisfied**		**Very satisfied**	
Justifications	**Nb Cit.**	Freq.	**Nb Cit.**	Freq.	**Nb Cit.**	Freq.	**Nb Cit.**	Freq.	**Nb Cit.**	Freq.
No Response	3	2.8%	1	0.9%	1	0.9%	11	10.2%	6	5.6%
The filmed sequences recorded in French make the scientific phenomena difficult to assimilate.					1	0.9%				
The filmed sequences make the session of teaching like an entertainment session; they reduce our concentration to follow the course.					2	1.9%				
The filmed sequences support the link							2	1.9%	3	2.8%

between the scientific phenomena and the experimental practice.										
The filmed sequences encourage our learning and crystallize our ideas.							11	10.2%	7	6.5%
The filmed sequences encourage us to better follow and increase our motivation to learn the course.							1	0.9%	4	3.7%

These results show clearly that the filmed sequences of teaching can increase the concentration and the motivation of some students, by supporting their learning in science.

3. Perceptions of the students concerning the most appropriate mode of teaching during the sessions of the course.

We will now explore the impact of the ICT on the learning of the scientific courses, by the university students, and will evaluate the most appropriate mode of teaching for a better learning of these courses within the university.

TABLE 7 summarizes the attitude of the students, according to their specialization, concerning the most appropriate mode of teaching for a better learning of the scientific courses.

TABLE 7. Point of view of the students, according to their sector, concerning the most appropriate mode of teaching for a better learning of the scientific courses.

Sector / Appropriate_Mode_ Teaching _Courses	Physics	Chemistry	Biology	Computer science	MIP	BCG	Preparatory cycle
No response	4.6% (5)	0.9% (1)	0.0% (0)	0.0% (0)	1.9% (2)	0.9% (1)	0.9% (1)
A traditional teaching (course given to the board)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)
A modern teaching based on the ICT	3.7% (4)	0.9% (1)	0.0% (0)	3.7% (4)	2.8% (3)	0.0% (0)	0.9% (1)
A hybrid teaching integrating several supports (Board, Handout, ICT)	25.0% (27)	1.9% (2)	3.7% (4)	11.1% (12)	11.1% (12)	22.2% (24)	3.7% (4)

The results of this table show that 78.7% of the surveyed students, of different sectors, are for a hybrid teaching integrating several supports (Table, handout, ICT).

A preliminary analysis of the justifications provided by the whole of the scientific students concerning the most adapted mode of teaching for a better teaching-learning of the scientific courses revealed the following results (see TABLE 8).

TABLE 8. Perceptions of the students about the most appropriate mode of teaching for a better learning of the scientific courses.

(The number of citations is higher than the number of observations due to multiple justifications).

Appropriate_Mode_Teaching_scientific_Courses - For better learning of sciences, you opt for:			
Adopted mode of teaching	**Percentage**	**Standard comments**	**Percentage**
No response	**9.3% (10)**		
A traditional teaching (course given to the board)	**0% (0)**		
A modern teaching based on the ICT	**12.0% (13)**	Modern teaching gives us desire to learn and to follow the course.	0 .9% (1)
		Not justified responses.	11.1% (12)
A hybrid teaching integrating several supports (Board,	**78.7% (85)**	The hybrid teaching helps us to learn more during the session of teaching.	16.7% (18)

Handout, ICT)		Hybrid teaching remains the most effective method to support the learning of all the subjects without any exception.	4.6% (5)
		Hybrid teaching enriches and instigates the contents of the course, it ensures an animated and well diversified courses.	8.3% (9)
		Hybrid teaching helps the teacher to reinforce his course and to more explain the difficult points during the session of teaching.	8.3% (9)
		Hybrid teaching fights against the boredom, laziness and monotony during the session of teaching.	2.8% (3)
		Hybrid teaching gives us desire to learn and to follow the course.	0.9% (1)
		Hybrid teaching makes it possible to support the abstract notions of the course.	7.4% (8)
		Hybrid teaching helps us benefit from various learning methods which complement each other.	7.4% (8)
		Not justified responses.	41.7% (45)

The results of our investigation help us to deduce that a regular and efficient exploitation of ICT in a session of teaching accompanied by the detailed demonstrations on the board and a handout reiterating the essential of the course, remain the most favored approach by the majority of the scientific students (78.7%). This mode of hybrid teaching can generate meaningful effects as for the understanding of the concepts, the phenomena and the scientific laws.

4. Satisfaction degree of the students of the use of CAS, CAX, CAM and/or CAD during the sessions of practical works (PW)

The analysis of the responses given by the scientific students enables us to note that 64.8% of them already assisted with one or more sessions of PW incorporating the Computer-Assisted Experimentation (CAX) software, the Computer-Assisted Simulation (CAS) software, the Computer Aided Design (CAD) software, the Computer Aided Manufacturing (CAM) software and/or the Computer Aided Drafting (CAD) software.
A preliminary analysis of the justifications of the students (64.8%) concerning their perceptions of the use of the ICT during the sessions of practical works raised the following results (see TABLE 9).

TABLE 9. Justifications of the scientific students concerning their perceptions of the use of the ICT during the sessions of practical works.
(The number of citations is higher than the number of observations (70) due to multiple responses).

Perception_software_use_PW - Are you for the use of CAS, CAX, CAD, CAM and/or CAD software during the sessions of practical works (PW)?				
Attitude	**Percentage**	**Standard comments**	**Nb. Cit**	**Percentage**
Favorable	**58.3% (63)**	The use of such software helps us develop our observation and our scientific reasoning.	46	42.6%
		The use of such software helps us confront simultaneously the abstract and the concrete.	38	35.2%
		The use of such software helps us better retaining the scientific concepts and exerts a positive influence on our learning.	31	28.7%
		The use of such software increases our motivation for the scientific studies and the experimental practice.	35	32.4%
		The use of such software helps us save time and make more experimental activities during the session of PW.	29	26.9%
		The use of such software helps us achieve manipulation even in the case of expensive equipment, not available or defective.	43	39.8%
		Not justified favorable responses.	2	1.9%
Unfavorable	**6.5%(7)**	The use of such software creates a distance to reality.	5	4.6%
		Classical manipulation enables us to interact directly with the hardware	7	6.5%

		and brings closer us more of the phenomenon studied.		
		Classical manipulation gives ourselves a sense of responsibility and promotes a better learning of the scientific concepts.	6	5.6%
		Not justified unfavorable responses.	0	0%

The results in TABLE 9 show that among the 64.8% of the students having used one or more software during the sessions of practical works, a large part of them (58.3%) has positive perceptions towards this use. The analysis of their favorable justifications shows well that this use is essential in so far as it helps develop their observation and their scientific reasoning by confronting simultaneously the abstract and the concrete. It helps increase their concentration, their incentive and their creativeness. It helps save time and to make more experimental activities during the session of practical works, and even to perform manipulations in the case of expensive equipment, non availability or defectiveness.

However among the 64.8% of the students having used one or more software during the sessions of PW, a minority of them (only 6.5%) deplores this virtual use and opts for a classical handling of equipment. These students declare that the direct use of the equipment gives them more responsibility, brings them more closely to the studied phenomenon and promotes a better learning of the scientific concepts.

It can be inferred from these results that in a session of practical works, the use of the ICT is essential because it can exert a positive impact on the learning of the phenomena and scientific concepts at the majority of the scientific students. But the direct manipulation of the material, the real observations and experiments can give the students a sense of responsibility and bring them more closely to reality.

4.1 Point of views of the scientific students on the use of CAS, CAX, CAD and/or CAM software in parallel with classical manipulations approached.

The analysis of the responses given by the students (64.8%) having profited from a use of CAS, CAX, CAD and/or CAM software lasting the sessions of PW shows that 51.9% among them adopt a favorable attitude with regard to a use combining the two approaches (a classical manipulation of equipment + a use of the software).

The cross-analysis of the responses of the students as for their perceptions concerning the only use of the software and a use combining the two approaches (traditional manipulations + software) is summarized in TABLE 10.

TABLE 10. The most appropriate practice during the sessions of PW & Attitudes of the students.

Perception_use_ software_PW / **Perception_Calssical manipulation +software**	**Favorable**	**Unfavorable**	**Total**
No response	0.9% (1)	0.0% (0)	0.9% (1)
Favorable	48.1% (52)	3.7% (4)	51.9% (56)
Unfavorable	9.3% (10)	2.8% (3)	12.0% (13)
Total	58.3% (63)	6.5% (7)	64.8% (70)

The results of TABLE 10 show well that among the 58.3% of the students who are for the use of the software during the practical sessions of PW, a great part of them (48.1%) choose a use combining the two approaches (classical manipulation + software) whereas among the 6.5% of the students who are against the use of the software lasting the practical sessions of PW, 3.7% of the latter are for a use combining the two approaches.

An analysis of the justifications achieved by the 64.8% of students having a positive / negative perception in connection with the use of the two approaches (classical manipulation + software) during the sessions of practical works, showed us the following results (see Table 11).

Table 11. Perceptions of the students about the use of the two approaches (classical manipulation + software) during the sessions of practical works. (The number of citations is higher than the number of observations (70) due to multiple responses).

Perception_Calssical manipulation +software - During the sessions of PW, do you prefer a use of CAS, CAX, CAD and/or CAM software simultaneously with classical manipulations addressed?

Attitude	Percentage	Standard comments	Nb.Cit	Percentage
Favorable for both approaches	**51.9% (56)**	The use of such software in parallel to the manipulations discussed enables us to confront the abstract and the concrete during the sessions of PW.	12	11.1%
		The use of such software in parallel to the manipulations discussed promotes the learning of the scientific phenomena.	25	23.1%
		The use of such software in parallel to the manipulations discussed helps us compare and verify the results obtained during the classical manipulation.	7	6.5%
		The use of such software in parallel to the manipulations addressed helps us save time and to make several experiments during the session of PW.	1	0.9%
		The two approaches are complementary and even indispensable during the session of PW.	3	2.8%
		Not justified favorable responses.	17	15.7%
Unfavorable for both approaches	**12.0% (13)**	The sole use of such software is sufficient during the sessions of PW.	1	0.9%
		The classical handling of equipment is the most appropriate method for a control of the concepts discussed during the sessions of PW.	2	1.9%
		The use of both approaches decreases our concentration during the session of PW.	2	1.9%
		The use of both approaches requires more time during the session of PW.	2	1.9%
		The use of both approaches contributes to an overlapping of knowledge during the session of PW.	2	1.9%
		Not justified unfavorable responses.	5	4.6%

The results of this table, resulting from the declarations of the students, show that in a session of practical works, a use of CAS, CAX, CAD and/or CAM software in parallel with classical manipulations addressed allows a large part of students simultaneously to confront the abstract and the concrete, to compare and to verify the results obtained during the classical handling and that can promote the learning of the students in science. These results help us to deduce that in a session of practical works, a classical manipulation using material illustrated by the ICT (CAS, CAX, CAD and/or CAM software) would be more effective as it could contribute to a thorough comprehension of the concepts and scientific phenomena.

5- Perception of the students of the effectiveness of the ICT in scientific education (courses, DW, PW)

The analysis of the answers given by the scientific students enables us to note that 83.3% of them are for a teaching of sciences (courses, PW, DW) integrating ICT. The justifications provided by the students reveal important opinions (see TABLE 12).

On the basis of these results (see TABLE 12) we can deduce that, according to the nature of the scientific subject taught, the integration of ICT in scientific education (courses, DW, PW) has several advantages at 83.3% of the scientific students surveyed.

Table 12. Attitude of the students concerning a teaching of sciences (courses, PW, DW) integrating the ICT. (The number of citations is higher than the number of observations (108) due to multiple responses).

Perceptions_teaching integrating_ICT - Are you for a teaching of sciences (courses, PW, DW) integrating the ICT within your university?			
Attitude	**Percentage**	**Standard comments**	**Percentage**
Non response	**8.3% (9)**		

Favorable	**83.3%(90)**	The ICT illustrate and clarify more the abstract concepts developed during the session of teaching.	**16.7% (18)**
		The ICT develop our imagination and our scientific reasoning.	**3.7% (4)**
		The ICT have a favorable impact on our learning.	**16.7% (18)**
		The ICT promote the link between the scientific concepts and the experimental practice.	**5.6% (6)**
		The ICT encourage us to learn more during the session of teaching.	**6.5% (7)**
		The ICT help us to save time and to participate more during the session of teaching.	**3.7% (4)**
		The ICT help us to familiarize ourselves with the evolution of the new technologies.	**4.6% (5)**
		The ICT improve the quality of teaching.	**10.2% (11)**
		The use of the ICT remains always dependent on the nature of the subject taught.	**6.5% (7)**
		The ICT help us to make more virtual experiments which bring us closer to reality.	**0.9% (1)**
		Not justified favorable responses.	**34.3% (37)**
Unfavorable	**8.3%(9)**	The ICT decrease our concentration to follow the course.	**0.9% (1)**
		Not justified unfavorable responses.	**7.4% (8)**

6- Teachers training for the use and integration of the ICT & point of view of the students.

As it shown in our investigation (Table 13), 74.1% of the university students opt for a teacher training in the use and the suitable integration of the ICT in the sessions of teaching.

Table 13. Teachers training for the use and integration of the ICT & point of view of the students. (The number of citations is higher than the number of observations (108) due to multiple responses).

Point of view_teachers_training - Do you think that the teachers are better trained with the use and the integration of ICT in a session of teaching?			
Attitude	**Percentage**	**Standard comments**	**Percentage**
No response	**15.7% (17)**		
For	**74.1% (80)**	To provide a better teaching - learning during the session of teaching.	**9.3% (10)**
		To disseminate the information with much more clearness and precision.	**10.2% (11)**
		To know how to use these tools advisedly.	**11.1% (12)**
		To know how to integrate the ICT into the good moment.	**6.5% (7)**
		To know how to present well and organize their courses.	**6.5% (7)**
		To help the teachers who have difficulties concerning these uses.	**7.4% (8)**
		To follow the evolution of technology.	**0.9% (1)**
		Not justified favorable responses.	**44.4% (48)**
Against	**10.2% (11)**	Our teachers control the use and the integration of the ICT in a session of teaching.	**1.9% (2)**
		The pedagogy adopted to teach a scientific concept remains the most important.	**0.9% (1)**
		Not justified unfavorable responses.	**7.4% (8)**

From these results we can deduce that for a renewal of the profession and professional practice, the teachers must profit, as a preliminary, from techno-pedagogical training. This training will help them better know the way in which they can teach and make learn by the slant of ICT, to conceive sequences of teaching and to adapt objects (real or virtual) to their teaching while having up to date knowledge in a sector which evolves very fast.

7. Statistical Analysis

7.1 Test of Chi2

To get an idea about the relationship between the place which the computer occupies in the life of the students and their perceptions of the use of the ICT in the scientific courses, we carried out the test of independence of Chi2 after the crossing of the following variables:

- **Perception_Use_ICT_Courses:** The perceptions of the students of the ICT use in the scientific courses.
- **P_Computer:** The place that the computer occupies in the life of the scientific students interrogated.

We drew the following working hypotheses:

- **H'0:** The Place that the computer occupies in the life of the students doesn't depend on their perceptions of the ICT use in the scientific courses.
- **H'1 :** The Place that the computer occupies in the life of the student depends on their perceptions of the ICT use in the scientific courses.

TABLES 14 and 15 sum up the results we found:

TABLE 14 : Dependence between the place that the computer occupies in the life of the students and their perceptions of the use of ICT in the scientific courses.

Perception_ICT_Use_Course / P_computer	For	Against	Total
Not really important	9.3% (10)	2.8% (3)	12.0% (13)
Rather important	42.6% (46)	12.0% (13)	54.6% (59)
essential	32.4% (35)	0.9% (1)	33.3% (36)
Total	84.3% (91)	15.7% (17)	100% (108)

Note: The framed slots are those for which real manpower is definitely higher (lower) than theoretical manpower. The values of the table are the percentages on the whole established on 108 observations.

TABLE 15: The results of Chi2 Statistical Test

Chi2	The degree of freedom : ddl	Interval of critical probability : 1-P	Decision
6,85	2	96,75%	The dependence is significant

These results reveal that the place that the computer occupies in the life of the students depends on their perceptions of the use of the ICT in the scientific courses. These results confirm the maintenance of the H'1 hypothesis and the dismissal of the H'0 hypothesis.

It clearly appears from our results that for the 84.3% of students opting for the use of the ICT in the scientific courses, the computer occupies a rather important place (42.6%) even essential (32.4%) in their student life. These results help us deduce that the majority of the scientists students questioned are natives of digital and skilful with technology.

IV. Conclusion

According to the results of our study, it arises initially that 84.3% of students opting for the use of the ICT in scientific courses are natives of digital and skilful with technology. Indeed the computer occupies in the life of the majority of them a rather important place (42.6%) even essential (32.4%).

In addition, the questioned university students do not all have the same degree of satisfaction with the use of simple PPT in the sessions of the scientific courses. However, they declare a great satisfaction towards the use of simulations and the filmed sequences of teaching in the courses. In fact, to gain the best profit from it, these presentations must be integrated into pedagogically adequate situations of learning, accompanied by the detailed demonstrations on the board and enriched by other ICT tools (simulations, videos clips ..) developing the student's reasoning in science.

A regular and effective exploitation of ICT in a course session accompanied by detailed demonstrations on the board and a handout reiterating the essence of the course remains the most appreciated mode of teaching for the majority of the scientific students (78.7%). This hybrid teaching can encourage a reinforced understanding of the concepts, the phenomena and the scientific laws.

Among the 58.3% of the students having a positive perception towards the use of CAS, CAX, CAM and/or CAD software during the sessions of practical works (PW), a great part of them (48.1%) opts for a use of this software in parallel with classical manipulations approached. These results show that in a session of practical works, a classical manipulation using experimental equipment accompanied by the ICT (CAS, CAX, CAM and/or CAD software) would be more useful because it could positively improve the learning of the students in sciences.

The results of this work show that the teaching of sciences within the university requires a suitable use of ICT based on an adequate pedagogy based on a hybrid teaching (ICT, board, experimental equipment, handout) for an effective learning.

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Annex: Questionnaire

Questionnaire to identify the perception of the students to the use of ICT in scientific higher education

This questionnaire is anonymous; the results will be confidential and will be only useful for our study. Thank you to answer frankly and without hesitation.

I- Personal information :

1- You are: ☐ Male ☐ Female

2- What is your institution?

3- What is your sector of study?

4- What is your level of study?

☐ 1st year ☐ 2nd year ☐ 3rd year ☐ 4th year ☐ 5th year

II-CT and personal uses:

5- Do you have a personal computer?

☐ Yes ☐ No

6- Do you have an internet connection?

☐ Yes ☐ No

7- How long on average do you spend each day in front of a computer?

☐ Less than 1h ☐ Between 1h and 2h ☐ Between 2h and 4h ☐ over 4h

8- Which place does the computer occupy in your life?

☐ Useless ☐ Not really important ☐ Rather important ☐ Essential

9. How do you estimate your level of control of the tools data-processing and multi-media?

☐ Very weak ☐ Rather weak ☐ Average ☐ Good ☐ Very good

10. Do you use the computer?

(You can tick several boxes)

- ☐ To entertain yourself (games, music, films…).
- ☐ To communicate with your colleagues (chat).
- ☐ To participate in social networks (Facebook, Twitter ....).
- ☐ To collaborate with other students.
- ☐ To participate in forums.
- ☐ To reach complementary contents related to the courses (demonstrations, simulations, experiments filmed .....).
- ☐ To make exercises; problems and old exams in link with the contents of the course.
- ☐ To prepare presentations.
- ☐ To follow online courses (e-learning)
- ☐ To improve your intellectual level, your general knowledge and to widen your scope of knowledge in sciences.
- ☐ Others

III-Satisfaction degree of the students to the use of the ICT in the scientific courses.

11- During your training, did you receive one or more scientific courses integrating Information and Communication Technologies (ICT)?

☐ Yes ☐ No

12- Did you receive one or more scientific courses presented by Power Point?

☐ Yes ☐ No ☐ No, but I would like

12-1 If so, did you appreciate this use?

☐ Not satisfied ☐ less satisfied ☐ Satisfied ☐ Very satisfied

Why? ----------

13- Did you receive one or more scientific courses integrating simulations?

☐ Yes ☐ No ☐ No, but I would like

13-1 If so, did you appreciate this use?

☐ Not satisfied ☐ Little satisfied ☐ Satisfied ☐ Very satisfied

Why? ----------

14- Did you receive one or more scientific courses integrating the filmed sequences of teaching?

☐ Yes ☐ No ☐ No, but I would like

14-1 If so, did you appreciate this use?

☐ Not satisfied ☐ Less satisfied ☐ Satisfied ☐ Very satisfied

Why? ----------

15- Are you for the use of ICT in the scientific courses?

☐ Yes ☐ No

15-1 If so, explain:

(You can tick several boxes)

- ☐ The ICT instigate and enrich the content of the course
- ☐ The ICT generate a deep comprehension of the abstract concepts of the course.
- ☐ The ICT accelerate our learning and help us to receive the maximum of information in little time.
- ☐ The ICT introduce more reality during the session of the course and facilitate the memorizing of the concepts.
- ☐ The ICT increase our concentration to follow the course.
- ☐ The ICT increase our motivation to learn the course.
- ☐ The ICT increase our participation during the course.
- ☐ The ICT help us to do more practical exercises during the sessions of the course.
- ☐ The ICT positively influence on our results and increase our chances of success.

☐ Other specify :

15-2 If not explain:

(You can tick several boxes)

☐ The ICT accelerate just the presentation of the course.
☐ The ICT makes more difficult the control of abstract concepts of the course.
☐ The regular and frequent use of the ICT often causes the boredom and disadvantages our learning.
☐ The use of the ICT reduces our concentration to follow the course.
☐ The ICT do not help the teachers to adapt the learning to the level and to the rhythm of each student.
☐ The use of the ICT does not constitute a help to our success.
☐ Other specify :

IV- Perception of the students to the use of the ICT in the sessions of practical works

16- During the sessions of practical works, did you use the Computer-Assisted Experimentation (CAX) software, the Computer-Assisted Simulation (CAS) software, the Computer Aided Design (CAD) software, the Computer Aided Manufacturing (CAM) software and/or the Computer Aided Drafting (CAD) software ?

17- Are you for the use of CAX, CAS, CAD, CAM and/or CAD software during the sessions of practical works PW?

☐ Yes ☐ No

17-1 If so, explain:

(You can tick several boxes)

☐ The use of such software helps us to develop our observation and our scientific reasoning.
☐ The use of such software helps us to confront simultaneously the abstract and the concrete.
☐ The use of such software helps us to better retaining the scientific concepts and exerts a positive influence on our learning.
☐ The use of such software increases our motivation for the scientific studies and the experimental practice.
☐ The use of such software helps us to save time and to make more experimental activities during the session of PW.
☐ The use of such software helps us to achieve manipulation even in the case of expensive, not available or defective equipment.
☐ Other specify : ----------

17-2 if not explain:

(You can tick several boxes)

☐ The use of such software creates a distance to reality.
☐ Classical manipulation allows you to interact directly with the material and make you more closer of the studied phenomenon
☐ Classical manipulation gives ourselves a sense of responsibility and promotes a better learning of the scientific concepts.
☐ Other specify : ----------

18- During the sessions of PW, do you prefer a use of CAX, CAS, CAD and/or CAM software simultaneously with classical manipulations addressed?

☐ Yes ☐ No

18-1 If yes, why?

18-2 If not, why?

V- Perception of the students on the effectiveness of the ICT in the scientific teaching

19- Are you for a teaching of sciences (courses, PW, DW) integrating the ICT within your university?

☐ Yes ☐ No

19-1 justify your answer:

20- Would you wish that your teachers use more the ICT in a session of teaching?

☐ Yes ☐ No

20-1 Justify your answer:

21- For better learning of sciences, you opt for:

(You must tick one box)

- ☐ A traditional teaching (course given to the board).
- ☐ A modern teaching based on the ICT.
- ☐ A hybrid teaching integrating several supports (Board, Handout, ICT).

21-1 Justify your answer:

22- Do you think that it is necessary that the teachers are better trained with the use and the integration of ICT in a session of teaching?

☐ Yes ☐ No

22-1 Justify your answer:

23- Would you have other remarks or useful information to be communicated to us in connection with the integration of ICT in the teaching?

Thank you to have answered our questions