

Study of the dependence between the teaching-learning of physics and the ICT resources available to pupils in Moroccan high schools

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Abstract

The aim of this work is to study the dependence between the teaching-learning of physics and the various configurations of ICT logistics infrastructure available to Moroccan pupils at high schools and homes.

In this research, we distributed an individual questionnaire to pupils in class. Our sample is made up of 137 pupils, aged between 17 and 20, from five classes in the 2nd year of the SLE (Sciences of Life and Earth) and PC (Physics and Chemistry) branches, from three high schools in the city of Meknes. The analysis of the responses to this questionnaire was carried out statistically by the Excel 2007 software combined with the free software BiostaTGV.

The results obtained reveal the lack of harmonization in pedagogical action compared to ICT resources. This is defined by the existence of a non-binding relationship between the use of ICT infrastructures in Moroccan high schools and those available to the pupil at home. While being in a pattern of direct or indirect dependence, the factors: the pupil's gender, branch, schooling, personal possession of the minimal ICT-related structures, their use in inverted classroom, and the part of motivation pupils through their physics teachers to do internet research.

Keywords: Teaching-learning of physics, ICT resources, inverted classroom.

I- INTRODUCTION

The use of information and communications technology in education (ICT) greatly enhances the teaching and learning of physics [5]. This was confirmed in particular in a study related to teaching and learning electricity [4]. M.Riopel and al [9] shows that the combination of computer-aided experimentation (ExAO) and computer-aided simulation (SAO) increases to 93% learners' interest for the experimental approach. Such results [10] were related to the fact that teachers have changed their traditional practices through the development of new learning methods integrating all technological progress.

Prior knowledge of pupils' intentions to integrate ICT into teaching strategies is a prerequisite to making their use effective [1]. Therefore, inverted classroom presents itself as an information gathering tool and a teaching-learning vector applying the differential pedagogy [7].

We focused our work on the study of the dependence between the teaching-learning of the physics and the ICT resources available to pupils in the 2nd year of the Moroccan baccalaureate of the PC and SLE branches, in their high schools, and elsewhere to the count of the inverted class.

II- PROBLEMATIC

À l'occasion de séquences de plus en plus fréquentes parmi des cours de sciences physiques, la classe se trouve face à des situations d'inconvenance, par une absence - devenue structurale- de matériels expérimentaux. Alors que dans le continuum de la maîtrise de la méthodologie expérimentale et des contenus scientifiques annexes et connexes, des notions font figure d'objets d'apprentissages ou de leurs consolidations chez les élèves, comme ils font figure d'objets d'enseignement et de réflexions didactiques et pédagogiques chez le professeur.

Based on the basic principles of the inverted class, we tried to delineate the spectrum of dependencies between the mobilization of ICT resources and the teaching-learning of the physics, in Moroccan high schools and elsewhere.

RESEARCH QUESTIONS

Nous proposons donc de répondre à deux questions spécifiques à cette recherche:

- What is the spectrum of ICT materials and resources available to Moroccan pupils in the 2nd year baccalaureate, SLE and PC branches?
- Are pupils taking advantage of teaching resources (online courses, simulation, etc.) to use teaching-learning in the physics, using the material they have?

III- METHODOLOGIE

This research was conducted with a population of Moroccan pupils. The sample consists of 137 pupils from five classes of the 2nd year baccalaureate SLE and PC branches from three high schools in the city of Meknes.

The investigative tool is an individual questionnaire distributed to pupils in class, after having had the agreement of academic leaders overseeing our research and that of local officials of the national education.

The questionnaire consists of items related to:

- The personal information of pupils (gender, branch, scholarship);
- Information on school and personal infrastructures available to the pupil as logistical tools of communication (machines, connections, support, ...);
- Information on the mobilization of ICST by pupils within their high schools and elsewhere, for the benefit of teaching-learning of the physics.

The answers to the questionnaire were the subject of a statistical study, by the combination of two software packages: Excel and BiostaTGV. First, we proceeded by a data processing by Excel 2007 software, the results of which were studied by BiostaTGV [2], a free software allowing to make statistics online, in this case, chi2 independence tests, by the link:

<https://marne.u707.jussieu.fr/biostatgv/?module=tests/chideux>.

IV- RESULTS AND DISCUSSION

IV-1 Personal information on pupils

Table 1 details some personal information of pupils. We note that there is in our sample:

- almost parity between gender (like the population in Morocco [8]);
- almost 60% of the pupils are from the PC branch (physics), while 40% is from SLE branch (life sciences and earth) ;
- 25% of the pupils are repeaters in the 2nd year of the baccalaureate (all SLE and PC branches);
- 70% pupils constantly have a smartphone against almost 20% that have not, the rest has one occasionally;
- almost 60% pupils have an internet connection at home against the 30% which do not have, the rest sometimes gets connected;
- almost 15% of the pupils did not give any response about their daily connection time for physics, against the 65% that get connected daily between less than ten minutes and over an hour, when almost 20% are never connected.

Possession of the smartphone or home connection is used as indicators of possibly other personal logistic structures of communication of the pupil that can be used in inverted classroom.

Items' themes	Modalities	Results	invalid Choices
gender	masculine	47,4%	2,2%
	feminine	50,4%	
branche	SLE	40,1%	1,5%
	PC	58,4%	
scholarity	Non-repeater	71,5%	3.7%
	repeater	24,8%	
smartphone possession	yes	70.8%	0,7%
	sometimes	5,9%	
	no	22,6%	
home connectivity	yes	62%	0.7%
	sometimes	6,6%	
	no	30,7%	
Pupil's daily time t spent on internet connection for physics	0h	23,4%	4,4%
	$0 < t \leq 10\text{min}$	12,4%	
	$10\text{min} < t \leq 20\text{min}$	7,36%	
	$20\text{min} < t \leq 30\text{min}$	13,9%	
	$30\text{min} < t \leq 60\text{min}$	24,8%	
	$60\text{min} < t \leq 90\text{min}$	1,5%	
	$90\text{min} < t \leq 2\text{h}$	5,8%	
	More than 2h	6,6%	

Table 1: Personal information about pupils

IV-2 Logistics arrangements of connectivity at schools:

Table 2 details the perceptions of pupils about the logistical arrangements of connectivity in high school. We find that pupils have taken positions with almost similar proportions on the school's internet connections and that of the laboratory of physics, indicating its permanent existence. However, in the high schools in our sample, only the classrooms that were equipped as part of the Moroccan program

GENIE (generalization of ICT in education) and administrations are connected to the internet. The same observation has been done by El Ouidadi.O and al [3]. Pupils have a misconception about internet connectivity in laboratories of physics.

For pupils' motivation to connect to the internet for tasks in the physics, only 5% of pupils are strongly encouraged by the teacher, against 50% of pupils who may be motivated at times and 45% who are never encouraged.

The culture of the use of ICT resources is barely settled in the practices of all actors. That's what has been observed precisely among teachers, in Quebec by Larose.F [6] and in Morocco by El Ouidadi.O and al [3].

Items' themes	Modalities	Results	invalid choice
connected high school	yes	70.8%	0,7%
	No	5,9%	
	I don't know	22,6%	
connected physics Laboratory	yes	62%	0.7%
	no	6,6%	
	I don't know	30,7%	
Part of incitation of pupils by the teacher to get connected to the internet for physics	always	1,5%	2,9%
	often	4,4%	
	sometimes	47,4%	
	never	43,8%	

Table 2: Perceptions of pupils on the logistical arrangements of high school connection

V- STATISTICAL STUDY

Since all the variables in our questionnaire are nominal except for two that are scaled, we chose to perform Chi2 independence tests and the results are as follows.

V-1 Remarks notes:

Our remarks notes are:

- We found that the frequency of invalid responses is very low, so we discarded them of the statistical study.
- Values of all the tables are percentages of a set total of 137 observations, except notification.

V-2 Tests chi2 of independence between the gender of the pupil and the other variables:

We studied the dependence between the following two variables V_1 (the gender of the pupils) and their V_i (branch, scholarity, smartphone ownership, home connection, knowledge about school laboratory internet connectivity, pupils duration of daily connection allocated to physics, motivation of the pupils by their teachers of physics to make internet research):

- V_1 : The gender of the pupil.
- V_i : The other variable.

We made the following working hypotheses:

- Null hypothesis H_0 : the two variables V_1 and V_i are independent.
- Alternative hypothesis H_1 : Both V_1 and V_i are dependent variables.

The results are shown in Table 3 below:

Crossing pupil gender with:	1-p	Accepted hypothesis
Branch	8,27%	H_0
Scholarity	82,82%	H_0
Knowledge about laboratory internet connectivity	77,29%	H_0
Smartphone possession	86,27%	H_0
Possession of a Home internet connection	95,91%	H_1 significantly
duration of daily connection allocated to physics	39,54%	H_0
Part of teacher's incitation to make internet research on physics	47,04%	H_0

Table 3: Results of tests chi2 independence between the gender of the pupil and other variables

V-2-1 For negative Chi2 independence tests

Chi2 tests have shown that there is independence between the gender of the pupil and other variables, namely: branch, education, knowledge on connectivity in high school, knowledge about connectivity at physics school laboratories, possession of smartphone, possession Internet at home, his daily connection time for physics, and motivation by the teacher to make internet researches for physics.

V-2-2 For positive chi2 independence tests

For the Chi2 test to be applicable, we have eliminated the modality " sometimes " because it corresponds to the boxes whose their theoretical effectifs were less than five. So, by crossing between the pupil's gender and the state of their home internet connectivity, the chi2 test explained their dependence, and the results are as follows:

Le tableau 4 croise entre les modalités de l'item (i) et celles de l'item (1d).

item (i) : pupil gender.

item 1d : Is your home connected to the internet?

gender \ item 1d	Yes	No	Total
Feminine	50	14	64
masculine	36	27	63
Total	86	41	127

Table 4: crossing between the gender of the pupil and his possession of Internet connection at home.

- Reading the total shows that:
 - ✓ As already known, our sample is characterized by gender parity.
 - ✓ 67.75% of pupils have homes connected to the internet, compared to 32.25% that they do not.
- The horizontal reading shows that:
 - ✓ Among girls pupils, 78.16% have homes connected to the Internet, compared to 21.84% who do not.
 - ✓ Of the boys pupils, almost two-fifths (57.17%) have homes connected to the internet, compared to 42.83% who do not.
- The vertical reading shows that:
 - ✓ Among pupils who have homes connected to the internet are girls with 58.14% against 41.86% for boys.
 - ✓ Among pupils who do not have home internet connections, boys are leading with 65.85% against 34.15% for girls.

We conclude that for the physics, the pupil's gender has no influence either on his/her school life or his/her own use of ICT, including his/her choices of revision and home schooling. It differs from this observation, the relationship between the gender of the pupil and the possession of Internet connections at home. On top of that, we think girls are looking for internet connections at home more than boys. So families with a daughter (SVT or PC) in the second year of the baccalaureate are equipped with permanent internet infrastructure at home more than the rest of the families.

V-3 Tests d'indépendances de chi2 entre la branche de l'élève et les autres variables :

We studied the dependence between the following two variables V₁ (the branch of the pupil) and V_i (pupil scholarship, smartphone ownership, home connection, knowledge about school laboratory internet connectivity, pupil duration of daily connection allocated to the physics, teacher incentive of doing research on the internet):

- V₁: The branch of the pupil.
- V_i: The other variable.

We made the following working hypotheses:

- Null hypothesis H₀: the two variables V₁ and V_i are independent.
- Alternative hypothesis H₁: Both V₁ and V_i are dependent variables.

The results are shown in Table 5 below.

Pupil branch crossing with:	1-p	Accepted hypothesis
Scholarship	>99,99%	H ₁ very significantly
Knowledge about laboratory internet connectivity	69,03%	H ₀
Smartphone possession	5,32%	H ₀
Possession of a Home internet connection	52,73%	H ₀
duration of daily connection allocated to physics	>99,99%	H ₁ very significantly
Part of teacher's incitation to make internet research on physics	49,44%	H ₀

Table 5: Results of chi2 tests of independence between the branch of the pupil and other variables

V-3-1 For negative Chi2 independence tests

The chi2 independence tests were negative at the crossroads between, on the one hand, the pupil's branch, and on the other hand, his/her knowledge of the connectivity of the physics laboratory, his/her possession of a smartphone, his/her possession of the Internet at home, and his/her perception of incentives by his/her physics teacher to do internet research for physics. The statements of the pupils are indistinguishable from their branches, and so are the null hypotheses H₀ that have been retained.

V-3-2 For positive chi2 independence tests

For the pupil's branch, there is a very significant dependence (of p-value <1%) with:

the schooling of the pupil, his/her daily duration of connections to the internet that he/she allocates to physics. The details are as follows:

V-3-2-1 Crossing between the branch of the pupil and his/her scholarship

Table 6 crosses between the modalities of item (ii) and those of the item (iii).

item (ii) : Pupil branch.

item (iii): Pupil scholarship.

Branch \ Scholarship	Non-repeater	repeater	Total
SVT	41	15	56
PC	74	2	76
Total	115	17	132

Table 6: crossing between the branch of the pupil and his scholarship

- According to the totals:
 - ✓ 57.58% of our sample is pupils of section PC against the 42.42% who are of section SVT.
 - ✓ the majority of pupils are non-repeaters in the 2nd year of baccalaureate with 87.12% against 12.88% who repeat the year.
- The vertical reading shows that:
 - ✓ 64.35% of the non-repeating pupils are of PC section against the 35,65% of which are of section SVT.
 - ✓ the trend is reversed for repeating pupils, are SVT section pupils who take the lead with a vast majority of 88.24% against almost 11.76% of which are section PC.
- The horizontal reading shows that:
 - ✓ 73.21% of SVT pupils are non-repeaters compared to 26.79% who are repeaters.
 - ✓ Among PC pupils, two repeating pupils are observed representing 2.63% against 97.36% who are non-repeaters.

So, we can conclude that the PC branch attracts more pupils and knows fewer failures compared to the SVT branch.

V-3-2-2 Crossing between the branch of the pupil and duration of daily connections to the internet it allocates for internet researches on physics:

For the Chi2 test to be applicable, we have eliminated two modalities ([60min/j ; 90min/j] et [90min/j ; 120min/j]), because they correspond to the boxes whose theoretical effectifs were less than five. So, by crossing between the pupil's branch

and his/her duration of the daily searches on the internet that he/she allocates to physics, the results are as follows:

Table 9 crosses between the modalities of item (ii) and those of item (1e1).

Item (ii) : pupil branch.

item (1e1): What is the duration of daily researches on the internet allocated to physics?

item 1e1 Branch	0h/day	between 0h/day and 10min/day	between 10min/day and 20min/day	between 20min/day and 30min/day	between 30min/day and 1h/day	More than 2h/day	Total
SVT	17	15	7	4	6	2	51
PC	15	2	3	15	27	7	69
Total	32	17	10	19	33	9	120

Table 9: crossing between the branch of the pupil and the duration of daily connection allocated to internet researches on physics.

- According to the totals:
 - ✓ Almost 60% of our samples are PC pupils versus 40% SVT pupils.
 - ✓ A little less than 25% of pupils never do internet research on physics, compared to the 75% who do them with different durations.
- Following the horizontal reading:
 - ✓ For pupils who do not connect to the internet for physics, there are 30.3% of those in the SVT section, compared to 21.7% of those in the PC section.
 - ✓ For SVT pupils connecting to the internet for physics, a peak of 29.4% is recorded in the interval]0min/j ; 10min/j]. The value drops almost half in intervals]10min/j ; 20min/j] and]30min/j ; 60min/j]. Low values of 7.8% and 3.9% are to be attributed respectively to the intervals]20min/j ; 30min/j] and more than 2h.
 - ✓ For PC section pupils connecting to the internet for physics, a peak of 39.1% is recorded in the time interval]30min/j ; 60min/j]. The value drops to 21.7% in the interval]20min/j ; 30min/j]. Finally, the values of 10.1% and 4.3% and 2.9% are observed respectively for the intervals:]0min/j ; 10min/j],]10min/j ; 20min/j] and more than 2h.
- Depending on the vertical reading:
 - ✓ On the interval]0min; 20min], there is a predominance of pupils doing internet research for physics, nearly 81.5% for SVT pupils, compared to almost 18.5% for PC pupils.
 - ✓ On the interval [20min; 60min], the trend of pupils doing internet searches for physics is reversed by 80.7% representativeness for PC pupils, and therefore 19.3% for SVT pupils. Almost the same for the interval of more than 2 hours.

We conclude that most SVT pupils are getting bored of internet physics research compared to PC pupils.

V-4 Chi2 independence tests between the duration of the pupil's connection to the internet for physics and other variables

We studied the dependence between the following two variables V_1 (the pupil duration of Internet connection allocated to physics by the pupil) and V_i (smartphone ownership by the pupil, the pupil's home connection, the motivation by the professor to do internet):

- V_1 : The daily duration of internet access granted by the pupil to physics.
- V_i Other variable.

We made the following working hypotheses:

- Null hypothesis H_0 : the two variables V_1 and V_i are independent.
- Alternative hypothesis H_1 : Both V_1 and V_i are dependent variables.

The results are shown in Table 10 below:

Crossing of the daily duration of internet access granted by the pupil to physics with:	1-p	Accepted hypothesis
smartphone possession	10,23%	H_0
home Internet possession	91,48%	H_0
the incentive by the professor to do internet research	99,95%	H_1 very significantly

Table 10: Results of chi2 independence tests between the daily duration of the pupil's connection to the internet for physics and other variables.

V-4-1 For negative Chi2 independence test

In the physical sciences, the daily duration of pupils' connection to the internet for physics has no influence either on the possession of a smartphone or of Internet connection at home.

V-4-2 For positive chi2 independence tests

In this case, for the Chi2 test to be applicable, we eliminated two modalities (always and often), because they correspond to the boxes whose theoretical effectifs were less than five. The results are as follows:

Table 11 crosses between the Item arrangements (1e1) and those of the item (1e2).

1e1 item: What is the duration of weekly research on the internet that you allocate to physics?

1e2 item: Does the professor incite you to do some research on the internet for physics?

item 1e1 \ item 1e2	sometimes	never	Total
oh/day	6	24	30
between 0 and 10min/day	10	5	15
between 10min and 20min/day	6	4	10
between 20min and 30min/day	7	8	15
between 30min and 1h/day	22	12	34
Total	51	53	104

Table 11: crossing between encouraging the pupil by his/her teacher of physical sciences to connect to the internet for physics and the duration of allocated daily web researches.

- Reading the total shows that:
 - ✓ 49% of pupils say they are sometimes motivated by their physical science teachers to do internet research for physics, against almost the same part (50.9%) that is never seen to be incited.
 - ✓ Among pupils, a large population of 28.8% never connects to the internet to do internet research for physics, against 71.1% who does, but each at his/her own pace.
- The vertical reading shows that pupils respond with:
 - ✓ " sometimes " with almost 12% for pupils who use the web on the intervals]10min/j ; 20min/j] and]20min/j ; 30min/j], followed by those doing web searches in intervals]0min/j ; 10min/j] and]30min/j ; 60min/j] whose percentages are respectively 19.6% and 43.1%. While 11.7% of the respondents by " sometimes " do not connect.
 - ✓ " never " with 45.2% for those who do not connect. Then comes the interval]30min/j ; 1h/j] with 22,6% and 15% for the interval]20min/j ; 30min/j]. It remains the intervals]0min/j ; 10min/j] and]10min/j ; 20min/j] for which the percentages are played around almost 8,5%.
- Horizontal reading shows that:
 - ✓ Very far ahead are pupils who do not connect to the web and say that they are never encouraged to do so with 80% against 20% that they are sometimes.
 - ✓ For the interval]0min/j ; 10min/j], the pupils who answered with "sometimes"

came first with 66.6%, then those who answered "never" with 33.3%.

- ✓ For the intervals $]10min/j ; 20min/j]$ and $]30min/j ; 1h/j]$, pupils respond with "sometimes" and "never" with almost 60% and 40% respectively. While a slight parity between these two modalities is noted on $]20min/j ; 30h/j]$.

We conclude that they are hardly perceptible the incentives of pupils by their physical science teachers to do internet research on physics. They are played between "sometimes incited" and "never be incited", and yet a little less than 40% of pupils seek internet content on physics for periods between 20min / d and 1h / d. such an initiative must be strengthened and institutionally supervised.

V-5 Chi2 independence tests between encouraging pupils to connect to the Internet by their physics teachers and other variables:

We studied the dependence between the following two variables V_1 (invitation of the professor for internet researches) and V_i (pupil's possession of a smartphone, pupil's home internet connection):

- V_1 : incitement of the pupil by the teacher of the physical sciences to make internet research on physics.
- V_i Other variable

We made the following working hypotheses:

- Null hypothesis H_0 : the two variables V_1 and V_i are independent.
- Alternative hypothesis H_1 : Both V_1 and V_i are dependent variables.

The results are shown in Table 12 below:

Crossing of the physical sciences teacher's incitement for the pupil to make internet research on physics with:	1-p	accepted Hypothesis
smartphone possession	51,34%	H_0
Home Internet possession	70,7%	H_0

Table 12: Results of chi2 independence tests between encouraging the pupil by his/her teacher of physical sciences to make internet research on the physical and other variables

The chi2 independence tests between the two variables V_1 (incitement of the pupil by the teacher of the physical sciences to make internet research on physics) and V_i (Smartphone ownership by the pupil, possession of home Internet connection) were negative.

So for the physical sciences, the incentive of the pupil by the teacher of the physical sciences to make internet research on the physics has no influence either on the

possession of a smartphone or on the possession of an Internet connection at home.

VI- CONCLUSION

The study we conducted allowed us to identify logistical structures related to ICT and which are either in high schools or at home, available to Moroccan pupils in the second year of the baccalaureate, PC and SVT branches. We also noted some facets of the independence between the premobilization of ICT resources in the context of the inverted classroom, and the learning of the physical sciences.

The results obtained reveal a disparity in pedagogical action with respect to ICT resources. Thus the teaching-learning of the physical sciences is still far from the competition between the efforts and structures available to high schools and those to the homes of Moroccan high school pupils. While being in a pattern of direct or indirect dependence, the factors: the pupil's gender, branch, schooling, personal possession of the minimal structures related to ICT, his use in reverse classroom of ICT resources, and the role of the physical science teacher to motivate their pupils. But in general, the culture of the use of the TICE resources in class in the physical sciences or at home of Moroccan high school pupils, struggles to settle in the practices of all the actors of teaching-apprenticeships in the 2nd year of the baccalaureate, SVT branch and PC.

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