International Journal on "Technical and Physical Problems of Engineering" (IJTPE)
Published by International Organization of IOTPE

ISSN 2077-3528
IJTPE Journal
www.iotpe.com
ijtpe@iotpe.com

June 2024 | Issue 59 | Volume 16 | Number 2 | Pages 32-36

CONTRIBUTIONS OF COMPUTER-ASSISTED EXPERIMENTATION IN PHYSICS

Z. Azar [1] **O. Dardary** [1,3,4] **J. Daaif** [1] **M. Tridane** [1,2] **S. Belaaouad** [1]

1. Laboratory of Physical Chemistry of Materials LPCM, Ben M'Sick Faculty of Sciences, Hassan II University, Casablanca, Morocco, azar.zineb@gmail.com, jabran.daaif@gmail.com, sbelaouad@yahoo.fr
2. Regional Center for Education and Training Casablanca Anfa, Casablanca, Morocco, tridan.malika@gmail.com
3. Laboratory of Educational Sciences and Philosophy and Humanities, Moulay Ismail University, Meknes, Morocco dardaryossama@gmail.com
4. Department of Sciences, ENS Meknes, Moulay Ismail University, Meknes, Morocco

Abstract- This study aims to highlight the contributions of computer-assisted experimentation in physical sciences among qualifying secondary school students. Our problem is structured around the following questions: What are the perceptions of physical science teachers on Computer Aided Experimentation? Does Computer-Assisted Experimentation help develop certain abilities in learners? To do this, we have opted to visualize the opinion of teachers concerning the CAEx. The results show that the latter would further promote student learning and success. It should be noted that this technique fits perfectly with the thinking of technology-oriented young people. In this study, we were able to clearly distinguish the didactic benefits attributable to the CAEx through the answers of the teachers questioned who showed that the latter facilitates the construction of skills and the development of certain capacities in the student such as: application of a scientific approach, problem solving, use of information processing technologies, group work, etc.

Keywords: CAEx, Qualifying Secondary, Physical Sciences, Teachers, Student.

1. INTRODUCTION AND PROBLEM

In Moroccan physical and chemical science laboratories, data collection is difficult and experimental induction with a hypothesis formulated by the learner is often rare. We see in the school environment that experiments only allow us to verify a law and do not favor an inductive approach or scientific investigation. To save time, the teacher often proceeds deductively and takes a shortcut by proposing the protocol himself, which leads to depriving the student of opportunities for reflection and investigation. The use of computers for control laboratory experiments in education is indicated by the acronyms CAEx (computer-assisted experimentation), which stands for Porter Robot in robotics education, RBL or MBL for robot-based laboratories, and microcomputer-based laboratories. The computerization of conventional experiments was the only emphasis of the initial such labs. The settings, visualization, and data analysis for each of these activities were severely constrained, and each activity had a unique interface and program for each experiment. The development of Windows and Macintosh information processing systems, has enabled the conversational and graphical components of the CAEx tutorials to be enhanced and made more easily accessible. A more open technological and didactic interface wasn't made until 1990 with Orphy, which was developed at the Conservatoire National des Arts et Métiers (CNAM) by Guy Lefèvre and the EVARISTE group. See Leroux (2002).

The CAEx typically includes: a sensor making a measurable physical quantity (electrical voltage, current intensity, etc.), an acquisition interface (analog-digital converter, motion sensor, magnetic field, etc.) and a computer capable of processing the measurements obtained using dedicated software. This technique is widely used in video-mechanics, from the 2000s using a webcam, a mini-film is built to determine the position, speed or acceleration of a moving object, (AVImeca is the most used by teachers of physical sciences). The particularity of the CAEx is to present the results in the form of graphs in real time, which helps the student to visualize the evolution of the experiment and the interaction of the variables at the same time. The complete experimental device authorizes the configuration of the experiment, being responsible for starting it, controlling its progress, acquiring the dependent variable and representing its evolution as a function of time or as a function of the independent variable.

According to the majority of studies (Viau, 1987; Barton, 2005; Page, et al., 2000; Alberganti, 2000; Marcotte and Sabourin, 2000), computer-assisted instruction aids in students' learning. But according to

Registered: 230907 Reserved: 231219 | Article Info: 1767 | Accepted: 240525 Available: 240630

other studies (Tilidetzke, 1992; Yea and Zadnick, 2000; Burchfield and Gifford, 1995), employing CAx has drawbacks. Despite some contradictory results, all of these writings emphasize the pedagogical importance of using CAEx as valid pedagogical tools in the illustration of scientific concepts; potential that we have exploited in this research. The experimental teaching of the physical sciences in our establishments is increasingly neglected in favor of theoretical teaching. The reasons often mentioned are: the dizzying increase in the number of students, the under-equipment of laboratories with adequate equipment for practical work, the lack of training in the field of practical work.

For this reason, it seemed interesting to us to ask these questions:

- What are the perceptions of physical science teachers on Computer-Assisted Experimentation?
- Does Computer-Assisted Experimentation develop certain abilities in learners?

To answer this problem, we will first focus on the methodology used. To address the issues raised by the situation, we shall present and evaluate the data gathered.

2. METHODOLOGY

In two provincial directorates of the Ministry of Education and National Training - Sidi Bernoussi and My Rchid, which are part of the Casablanca-Settat regional academy - the surveys are conducted during the 2020-2021 academic year. The rationale behind selecting these paths is to aid in the research process. The population targeted by our study is made up of 100 qualified secondary school physical science teachers. In order to know their perceptions on the use of CAEx in the teaching of physical sciences, and the relationship of this teaching to the development of certain abilities in learners, we collected their opinions by means of an anonymous questionnaire which contained closed questions. We processed the results with Excel software.

The questionnaire includes the following axes:

- General information (sex, age group, university degree);
- Perceptions of teachers on the use of CAEx in the teaching of physical sciences;
- The relationship between CAEx and capacity development;

3. RESULTS AND DISCUSSION

3.1. Profiles of Our Population

76% of our population are male and 24% are female. This difference is due to the nature of the school subject, which is preferred by men rather than women. According to a study by Y. El Madhi in 2014 in the Khemissat region (Morocco) women are more attracted to life and earth sciences (SVT). For the age group, we notice that Figure 1 shows that the majority of our population (78%) is made up of young teachers, which is an interesting factor, since they are part of the connected generation. In fact, the Ministry of Education and Training recently hired 102,000 contract teachers recruited between 2017 and 2021, these are usually laid off, with an average age of 24.

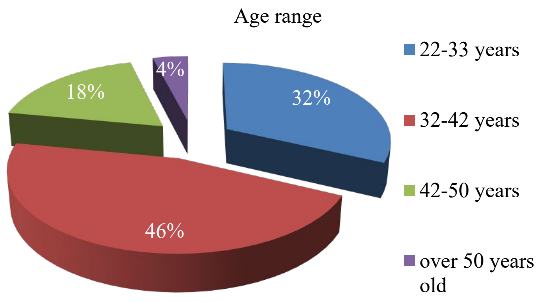


Figure 1. Distribution of physical science teachers by age

Regarding the university degree, Figure 2 shows that more than half of the teachers (56%) have a bachelor's degree, which correlates with the results found before, since half of the population is young, and entry into the regional centers of Education and training professions in recent years requires a license.

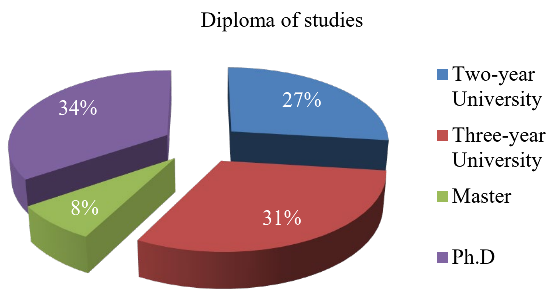


Figure 2. Percentage of SSC teachers by university level

3.2. Perceptions of Physical Science Teachers on the Use of CAEx

Table 1 indicates the degree of agreement of teachers with these statements:

Table 1. Perceptions of teachers on the use of CAEx in physical sciences

	Yes	Rather Yes	No	Rather No
The CAEx allows us to get closer to the laboratory equipment	44%	42%	6%	8%
When the interface is unknown, it is difficult to locate the malfunction	18%	31%	40%	11%
The visual aspect of data in graphical form helps students better understand	48%	46%	6%	0%
Problems at the beginning of the experiment become rarer over time	52%	40%	6%	2%
Classes with CAEx are interesting because you can see what is happening in real time	22%	33%	20%	25%
Use of the software requires computer knowledge	20%	21%	59%	0%
The use of CAEx saves time	45%	45%	6%	4%

Teacher responses confirm that computer-assisted experimentation is a highly valued teaching tool. For the first statement, we note that the majority of respondents (86% the sum of Yes and Rather Yes answers) declare that the CAEx remains a very relevant laboratory instrument, but it is necessary to note the importance of maintaining certain laboratories with the traditional experimental method, because students must learn to handle laboratory instruments well, and they must also understand the why and how of the steps of the protocol. (Caron, 2007). Concerning the second statement, the teachers are divided into two groups, the first group (49% sum of yes and rather Yes) affirms that if the interface is unknown, it is difficult to locate the dysfunction, whereas the second group (51% sum of no and rather no) think the opposite. According to Aubrun and Ruby (in Levy, 1995, p. 41), the difficulties encountered can come from several different sources, namely: hardware (possible defects in sensors, in particular adapters, interface, card, disturbing electrical environment), software (software defect) and computer hardware, teacher workload (several different requests from students, difficulty in quickly identifying the level of malfunction).

For the third statement, we see that the majority of teachers (94% sum of Yes and rather Yes) find that the visual aspect of data in graphical form helps students to understand better. According to Durey (in Toussaint, 1996, p. 210), the visual representations associated with real-time captures make it possible "to assemble and reinforce relationships between real physical phenomena and the meaning of representative curves". It is clear that the CAEx makes it possible to concretely see the measurements taken and the results on clear graphics. As for the fourth statement, most of the teachers surveyed (92% sum of Yes and Rather Yes) affirm that the problems at the start of the experiment become rarer over time. In general, the CAEx remains easy to use despite the malfunctions that they can occasionally cause. Concerning the fifth statement more than half of the teachers (55% sum of Yes and rather Yes) find that the courses with the CAEx are interesting because we can see in real time what is happening what is correlated with the results found for the third statement.

According to Marchand (1999, p. 90), "software dedicated to the teaching of physical sciences is very interesting since it is more favorable to the development of the student's autonomy, asking him to mobilize his intellectual faculties to solve with his own ways of thinking the problem he encounters". For the sixth statement, more than half of the answers (59% percentage of No) declare that the use of the software does not require computer knowledge. A study carried out by (Beaufils and Salame, 1989) shows that part of the difficulties encountered when using computerized means in the physical sciences came from an insufficient mastery of the basic uses of software, in particular at the level of the syntax of expressions. mathematics for use in modeling software. Concerning the last statement, 90% (percentage of Yes and rather Yes) of the teachers affirmed that the use of the CAEx saves time. The time saved by CAEx makes it possible to use and compare several measurement methods (Reisenauer, 2016).

3.3. CAEx and the Development of Capacities in Learners

We note that more than 90% (the sum of Yes and Rather Yes) of these teachers agree that the CAEx helps to apply a scientific approach, solve the problems encountered, facilitates the development of capacities to use appropriate technologies of information processing, to adopt attitudes useful for scientific teamwork and to deal with new situations based on what they have learned. Based on research on educational robotics, we can infer that the primary goal of using CAEx with students is to help them develop specific skills like problem-solving techniques, formalizing their thoughts, socializing, and learning a range of concepts (Denis, 1993a; Denis and Baron, 1993). We can also find other positive effects of the use of CAEx such as developing the autonomy of the student and his rigor, training in communication and developing motivation (Page, et al., 2000).

Table 2. Capacities developed by learners with regard to the use of CAEx in physical sciences

	Yes	Rather Yes	No	Rather No
Apply a scientific approach	64%	32%	4%	-
Solve problems	56%	43%	1%	-
Use appropriate technologies for data processing	45%	46%	9%	-
Reason rigorously	55%	35%	6%	4%
Work as a team	67%	29%	3%	1%
Adopt attitudes useful for scientific work	46%	47%	4%	3%
Dealing with new situations based on what has been learned	60%	33%	5%	2%

4. CONCLUSION

In this work, we questioned the contribution of the CAEx in the teaching of physical and chemical sciences in high schools in the region of Casablanca - Settat, through an anonymous questionnaire. We can deduce that when computer-assisted experimentation is used in the physical sciences, designed by Nonnon (1986) as an aid to the development of scientific thought, promotes autonomous learning in the student, the acquisition of new skills and the transfer of these skills to other learning objects. In this study, we were able to clearly distinguish the didactic benefits attributable to the CAEx through the answers of the teachers questioned who showed that the latter facilitates the construction of skills and the development of certain capacities in the student such as: application of a scientific approach, problem solving, use of information processing technologies, group work, etc. In conclusion, it can be said that teaching with pedagogical tools based on CAEx would further promote learning and, therefore, student success compared with experimental teaching using traditional experience. It should be noted that this technique fits perfectly with the thinking of technology-oriented young people.

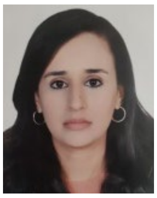
RECOMMANDATIONS

This study can provide support for different didactic views on experimental practice, particularly when it comes to the growth of practical work in the physical sciences employing CAEx, for research in didactics. In an effort to encourage students' autonomy and involvement in the creation of their own knowledge, it can facilitate reflection on interactions between student groups and between students and teachers. To be able to draw a more general conclusion, it would be an intriguing line of inquiry to try to corroborate these results with a larger sample by carrying out more such studies in different scientific areas.

REFERENCES

[1] P. Leroux, "Partner Machines for Learners and Teachers - Study in the Context of Educational Project Support Environments", Education, University of Maine, pp. 842-855, Decembre 2002.
[2] R. Viau, "Computer-Assisted Teaching, Qualitative Assessment Collegiate Pedagogy No 2 Pilot", Open Edition Books, Babel on Education, pp. 20-29, 1987.
[3] R. Barton, "Supporting Teachers in Making Innovative Changes in the use of Computer-Aided Practical Work to Support Concept Development in Physics Education", International Journal of Science Education, Vol. 27, No. 3 pp. 345-365, 2005.
[4] B.J. Page, D.L. Delmonico, J. Walsh, N.A. L'amoreaux, C. Danninhirsh, R.S. Thompson, A.D. Evans, "Setting up Online Support Groups Using the Palace Software", Journal for Specialists in Group Work, Vol. 25 No. 2, pp. 133-145, 2000.
[5] M. Alberganti, "At Robot School? Computers, School and your Children", Paris, Calmann-Levy, Cybermondes, pp. 220-245, 2000.
[6] A. Marcotte, G. Sabourin, "Final Study Project in Biology with Computer-Assisted Experimentation - Project Report Presented as Part of the Getting Off the Beaten Track", Competition, Quantum Leap, Montreal, College Ahuntsic, pp. 419-429, Canada, 2000.
[7] R. Tilidetzke, "A Comparison of CAI and Traditional Instruction in a College Algebra Course", Journal of Computers in Mathematics and Science Teaching, Vol. 11, No .1, pp. 53-62, 1992.
[8] S. Yea, M. Zadnik, "Newton, we Have a Problem", Australian Science Teachers' Journal, Vol. 46, No. 1, pp. 9-18, 2000.
[9] M.L. Burchfield, V.D. Gifford, "The Effect of Computer-Assisted Instruction on the Science Process Skills of Community College Students", Annual Meeting of the Mid South Educational Research Association, pp. 215-224, 1995.
[10] Y. El Madhi, "Constraints Linked to the Integration of ICT in the Teaching of Life and Earth Sciences in Morocco", European Scientific Journal, Vol. 10, Issue 34, pp. 114-125, 2014.
[11] A. Caron, "Evaluation of Educational Tools Using Computer-Assisted Experimentation (ExAO) to Illustrate a Scientific Concept Students' Perceptions of the Teaching of Scientific Concepts: Research Report", Cegep Marie-Victorin, pp. 331-342, 2007.
[12] J.F. Levy, "For Rational Use of Computers in Secondary Education", EPI (Association Enseignement Public and Informatique), INRP (National Institute of Educational Research), pp. 198-205, 1995.
[13] J. Toussaint, M. Develay, A. Durey, "Applied Didactics of Physics-Chemistry - Training Elements for Teaching", Editions Nathan, pp. 98-105, Paris, France, 1996.
[14] D. Marchand. "Data Acquisition and Processing: Some Ideas for Making Good Use of it", In P. Nonnon, M. Vivet, (Eds.), Educational Robotics, The 5th International Conference on Educational Robotics, 1999, pp. 342-359.
[15] D. Beaufils, N. Salame, "What Experimental Activities with Computers in Science Teaching?", Aster, Vol. 8, No. 8, pp. 55-69, 1989.
[16] M. Reisenauer, "Contributions of Computer-Assisted Experimentation (ExAO) in Secondary Education in 2nd BC Class: Research Report", Luxembourg, Robert Schuman High School, September, pp.120-136, 2016.
[17] B. Denis, "Measuring Some Cognitive Effects of Using Control Technology", B. Denis (Ed.), Control Technology in Elementary Education, NATO ASI Series, Vol. 116, pp. 183-213, 1993.
[18] B. Denis, G.L. Baron, "Regards on Educational Robotics", The Fourth International Conference on Educational Robotics, INRP, New Technologies and Education, pp. 205-213, Paris, France, 1993.
[19] P. Nonnon, "Computer-Assisted Science Initiation Laboratory, Montreal", University of Montreal, Faculty of Educational Sciences, pp. 147-154, 1986.
[20] N. Jad, K. Raouf, K. Elkababi, M. Radid, "Teaching Practices of Scientific Awakening Related to Management of Representations of Primary School Learners: Inspectors' Viewpoints", International Journal on Technical and Physical Problems of Engineering (IJTPE), Issue 50, Vol. 14, No. 1, pp. 50- 56, March 2022.
[21] I. Echchafi, Y. Bachra, A. Benabid, M. Berrada, M. Talbi, "Evaluation of Higher Education Pedagogy for Continuous Improvement: A Case Study", International Journal on Technical and Physical Problems of Engineering (IJTPE), Issue 49, Vol. 13, No. 4, pp. 179-185, December 2021.
[22] O. Dardary, M. Tridane, S. Belaaouad, "Pedagogical Practices and Academic Achievement in the Era of Global Pandemics", International Journal on Technical and Physical Problems of Engineering (IJTPE), Issue 54, Vol. 15, No. 1, pp. 81-86, March 2023.
[23] O. Dardary, M. Tridane, S. Belaaouad, "Correlational Analysis of Information and Communication Technologies' Integration in Direct and Distance Teaching", International Journal of Interactive Mobile Technologies, Vol. 17, No. 12, pp. 61-73, 2023.
[24] Z. Azar, O. Dardary, J. Daaif, S. Benmokhtar, S. Belaaouad, "Contribution of Experience in the Acquisition of Physical Sciences Case of High School Students Qualifying", International Journal of Advanced Computer Science and Applications, Vol. 13, No. 7, pp. 384-390, 2022.

BIOGRAPHIES



Name: **Zineb**
Surname: **Azar**
Birthday: 01.03.1990
Birthplace: Casablanca, Morocco
Bachelor: Materials and Quality, Ben M'Sick Faculty of Sciences, Hassan II University, Casablanca, Morocco, 2011
Master: Process Engineering and Quality Control, Faculty of Sciences Ain Chock of Casablanca, Hassan II University, Casablanca, Morocco, 2013
Doctorate: Didactics of Physics Sciences, Ben M'Sick Faculty of Sciences, Hassan II University, Casablanca, Morocco, 2022
The Last Scientific Position: Lecturer, Physics and Chemistry, High School, Casablanca, Morocco, Since 2014
Research Interests: Physics, CAEx, Didactics
Scientific Publications: 8 Papers, 1 Thesis

Name: **Oussama**
Surname: **Dardary**
Birthday: 03.07.1991
Birthplace: Khouribga, Morocco
Bachelor: Computer-Electronics, Faculty of Sciences and Technology, Hassan II University, Mohammedia, Morocco, 2013
Master: Teaching and Training of Physics and Chemical Sciences, ENS of Casablanca, Hassan II University, Casablanca, Morocco, 2016
Doctorate: Didactics of Physics Sciences, Ben M'Sick Faculty of Sciences, Hassan II University, Casablanca, Morocco, 2020
The Last Scientific Position: Assist. Prof., Higher Education of Sciences' Didactic, Department of Sciences, ENS Meknes, Meknes, Morocco, Since 2021
Research Interests: Physics, ICT, Didactics
Scientific Publications: 12 Papers, 1 Thesis

Name: **Jabran**
Surname: **Daaif**
Birthday: 10.09.1992
Birthplace: Casablanca, Morocco
Bachelor: Mathematical Sciences and Computer Science, Department of Mathematics and Computer Science, Ben M'Sick Faculty of Sciences, Hassan II University, Casablanca, Morocco, 2013
Master: Software Quality, Department of Mathematics and Computer Science, Ben M'Sick Faculty of Sciences, Hassan II University, Casablanca, Morocco, 2015
Doctorate: Education Sciences and Technology, Ben M'Sick Faculty of Sciences, Hassan II University, Casablanca, Morocco, 2021
The Last Scientific Position: Lecturer, Higher Education of Education Sciences and Technology, Department of Physical Chemistry of Materials, Ben M'Sick Faculty of Sciences, Hassan II University, Casablanca, Morocco, Since 2022
Research Interests: Education Sciences, Education Technology, Training and Engineering and Science Teaching
Scientific Publications: 12 Papers, 1 Thesis

Name: **Malika**
Surname: **Tridane**
Birthday: 03.01.1967
Birthplace: Casablanca, Morocco
Bachelor: Physical Chemistry, Chemistry Department, Ben M'Sick Faculty of Sciences, Hassan II University, Casablanca, Morocco, 1990
Master: Physical Chemistry, Faculty of Sciences, Mohammed V University, Rabat, Morocco, 1992
Doctorate: Physical Chemistry, Ben M'Sick Faculty of Sciences, Hassan II University, Casablanca, Morocco, 1999 - National Doctorate in Physical Chemistry, Ben M'Sick Faculty of Sciences, Hassan II University, Casablanca, Morocco, 2006 - University Accreditation in Physical Chemistry and Didactics, Ben M'Sick Faculty of Sciences, Hassan II University, Casablanca, Morocco, 2016
The Last Scientific Position: Prof., Higher Education, CRMEF Casablanca, Settat, Casablanca, Morocco, Since 2022
Research Interests: Physical Chemistry, Education Sciences
Scientific Publications: 80 Papers, 4 Projects, 1 Thesis
Scientific Membership: Regional Center for Education and Training Casablanca Anfa, Casablanca, Morocco

Name: **Said**
Surname: **Belaaouad**
Birthday: 05.05.1964
Birthplace: Casablanca, Morocco
Bachelor: Physical Chemistry, Ben M'Sick Faculty of Sciences, Hassan II University, Casablanca, Morocco, 1988
Master: Physical Chemistry, Ben M'Sick Faculty of Sciences, Hassan II University, Casablanca, Morocco, 1990
Doctorate: Physical Chemistry, Ben M'Sick Faculty of Sciences, Hassan II University, Casablanca, Morocco, 2002
The Last Scientific Position: Prof., Higher Education, Department of Physical Chemistry of Materials, Ben M'Sick Faculty of Sciences, Hassan II University, Casablanca, Morocco, Since 2002
Research Interests: Physico-Chemical Properties, Crystal Structures and Valorizations of New Phosphates Condensed, Engineering of Training and Didactics of Sciences and Techniques
Scientific Publications: 179 Papers, 8 Projects, 1 Thesis