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Implementation of a new Continuing Training Framework in Physics Didactics: Perspectives and Recommendations

Mohammed Rabih Raissouni¹ , Khalid Mahdi² , Mohammed Abid³ ,
Adnan Souri², Kenza Raissouni⁴

¹ Regional Center for Education and Training, Tangier, Morocco

² Abdelmalek Essaadi University, Tetouan, Morocco

³ Regional Center for Education and Training, Rabat, Morocco

⁴ Sidi Mohamed Ben Abdellah University, Fès, Morocco

*Corresponding author: khalidmahd@gmail.com

Abstract

Introduction. This study aims to evaluate the effect of continuous training of physics teachers, which was realized within the context of the cooperation between the Moroccan Government and the Government of the United States of America, and which aims, among other objectives, to reinforce the competences and the professionalization of the teachers. **Methods.** The research study group was composed of 62 teachers of physics from high and middle schools. The training lasted 5 days and included face-to-face lessons on the central concepts of physics and chemistry didactics and one of the active methods, namely inquiry-based learning. The analysis of a survey delivered online after three months of the mentioned training, aims at showing the impact of this kind of continuous training on the beneficiaries' classroom practices and the obstacles encountered. **Results.** The results indicate that this continuous training could not considerably change their classroom practices, due to administrative, didactic and working conditions problems. **Discussion.** Despite the aim of the training course, which was to encourage participants to change their approach in the classroom to adopt learner-centred practices, the results had only a limited impact. Consequently, it becomes crucial to consider the obstacles uncovered by this study as essential factors for improving the conditions of future continuing training courses.

Keywords

continuing training, physics didactics, active learning, classroom practice, learner-centered practices, inquiry-based approach

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Introduction

In Morocco, as in many countries around the world, the issue of learner performance in science is a hot topic. Indeed, the international survey TIMSS 2019 (Trends International Mathematics and Science Study), which measures the knowledge and skills of primary and middle school students in science and mathematics, placed Morocco among the latest countries in terms of learners' achievements in mathematics and science (Mullis et al., 2020).

Also, the report of the National Learning Assessment Program reveals that "In physics and chemistry, 74% of students in the third year of middle school have not acquired the minimum level of competencies required to continue their scientific studies in high school (secondary school)" (INE-CSEFRS, 2019). In addition, several studies have shown that there is a low performance of Moroccan students in physics at different educational levels (Chekour, Laafou & Janati-Idrissi, 2015; Nasser, Khouzai & Taoufik, 2017, Anwar et al., 2019).

On the other hand, the world today is rapidly developing. The information is widespread, and technology opens new opportunities and challenges every day (Sánchez-López, Pérez-Rodríguez & Fandos-Igado, 2019). Scientific research leads to many pedagogical innovations, which raises several questions about the appropriate methods for teaching science. Furthermore, both teachers and their quality of teaching are a crucial element in pupils' learning (Popova, Evans & Arancibia, 2016). Therefore, the preoccupation to improve the quality of teaching-learning is growing and it is accompanied by the emergence of a scientific debate on the choice of pedagogical and didactic approaches that can improve learners' performance (Segura-Robles, Parra-González & Gallardo-Vigil, 2020). To this end, the best academic performance is associated with the use of active teaching models and strategies (García & Arias, 2022).

However, several voices have called for a renewal of the teaching-learning process in physics to make it more attractive. Thus, they propose that this process should be based on students conducting their own investigations. All this is reflected today in the real implementation of new educational policies, in the impetus of new pedagogies and

METHODOLOGY AND TECHNOLOGY OF VOCATIONAL EDUCATION

educational reforms of the teaching of experimental sciences, particularly physics, by seeking to make learning more active and motivating (Robine, 2009).

Thus, Moroccan teachers are forced to respond to the new needs and demands of these changes (INE-CSEFRS, 2021), and to evolve in their professional context. They are confronted with the evolution of the social, technological and especially pedagogical environment (Mili, Erouihane & Toubi, 2021). To this end, continuous training is a means of ensuring that teachers adapt to new pedagogical, didactic and scientific developments, and can renew their teaching methods, encourage innovation in education and mobilize elements of knowledge and expertise in teaching practices to enhance the quality of student learning (Wei et al., 2009; Mahdi, 2018).

In such a context, Morocco has undergone a profound reform of the education system called the Strategic Vision 2015–2030. One of the objectives of this reform is to move from a pedagogy based on the one-way transmission of knowledge, on filling in and memorizing, to a pedagogy that targets intelligence. Thus, it is the learner who participates in the construction of his or her learning, which develops creative interaction between the teacher and the learner, promotes the development of competencies related to know-how and soft skills such as observation, expression, criticism, research and synthesis, and encourages the learner's initiative and develops his or her autonomy and insight in the era of digital technology and the profusion of knowledge (CSEFRS, 2015).

Hence, the vision proposed in lever 9 of the second chapter: the renovation of the teaching, training and management professions by opting for several principles, including continuous training leading to qualifications throughout the professional career of teachers (CSEFRS, 2015). Afterwards, the framework law n°51.17, was adopted in July 2019 which takes up the main lines of the strategic vision, through the modernization of the quality of teaching based on diversified and constantly renewed continuous training and in adequacy with the needs of the professional world of today as well as tomorrow (Gouvernement Marocaine, 2019).

In this perspective and as part of a cooperation between the Moroccan Government and the Government of the United States of America (Compact II), the agency MCA-Morocco (Millennium Challenge Account-M) was created in 2016. It is a public institution, responsible for the implementation of the Compact II program. This program proposes, among others, a new integrated model for the improvement of high schools called "Lycée Attahadi", which aims, among other objectives, the strengthening of skills and professionalization of administrative and pedagogical executives. The module of continuous training of the didactics of Physics is part of this framework. The beneficiaries are the teachers of Physics of the middle and high school (Millennium Challenge Account-Morocco Agency) (Compact II, 2015). The main competence of this module is that " At the end of this training, the beneficiaries will be able to mobilize and reinvest the central concepts of the didactics of physics - chemistry (conceptions, conceptual change and modeling, in addition to an inquiry-based approach) to interpret, analyze

and act effectively in professional situations to promote student learning". The training concerning this module lasted five days with an hourly volume of six hours per day. However, continuous training is demanded by the majority of teachers (Mahdi et al., 2015).

Also, several studies have suggested that teachers should receive continuous training in order to keep up with new didactic developments. Moreover, its impact on teachers' pedagogical competencies and professional development have been demonstrated (OCDE, 2019; Popova et al., 2016). Nevertheless, many beneficiaries of these trainings are dissatisfied with its contribution. Indeed, the quality of these trainings presents several weaknesses, in terms of the topics addressed; the poor institutional planning; the difficulties of mobilizing trainers and contributors who require indemnities to participate in training, as well as the low or non-participation of teachers in the proposed activities (Mili et al., 2021; Mahdi, 2021). And as a result, continuous training does not seem to have a positive impact on students' achievements (INE-CSEFRS, 2019). Within this framework, this research aims to find out to what extent continuous training has changed teachers' classroom practices towards learner-centered practices. As well as to identify the factors that may block this change. Hence, our research question can be formulated as follows:

To what extent could this continuous training of physics teachers change their classroom practices towards more Learner-centered practices?

The questions that arise are the following:

1. What are the teachers' views on continuous training in general and in the project "Lycée Attahadi" in particular?
2. How much has this continuous training changed their classroom practices?
3. What are the factors that block this change?

Literature review

In this paragraph we will present the central concepts of the didactics of the physical sciences which were the object of this continuous training, namely: the conceptions; the conceptual change; the modeling and an active approach of learning which is the inquiry-based approach. also, we will speak about the structure of the Moroccan educational system.

Secondary education Grade

The Moroccan pre-university education system is structured in such a way that it is composed of two main grades (COSEF, 1999):

1. The primary education grade divided into two: primary education (six years) and preschool education (two years).
2. The secondary education grade is divided into two parts: middle secondary grade

METHODOLOGY AND TECHNOLOGY OF VOCATIONAL EDUCATION

(three years) and qualifying secondary grade (three years), intended for elementary school graduates with primary school certificates

Conceptions

A conception is an underlying idea. It can explain various difficult situations to the learner (Astolfi, 1998). Similarly, Giordan & De Vecchi, (1987) define conceptions as a set of coordinated ideas and coherent, explanatory images used by learners to reason about problem situations, but more importantly he highlights the idea that this set reflects an underlying mental structure responsible for these contextual manifestations.

We can therefore conclude that conceptions are ideas specific to each person, and each person can construct a conception specific to him or her when faced with a situation

Conceptual change

Knowing the learners' pre-existing conceptions is the necessary starting point for any learning to be developed and changed. This change is called conceptual change. It is learning that modifies or restructures pre-existing conceptions. Learning is not just about gathering new knowledge or developing a new skill. In conceptual change, an existing conception is fundamentally changed, or even replaced, and becomes the conceptual framework that students use to solve problems, explain a phenomenon, and move through their world. To this end, Duit and Treagust (2003) consider that there are two types of conceptual change, named:

- Assimilation, weak restructuring of knowledge, or conceptual capture;
- Accommodation, strong (or radical) restructuring of knowledge, or conceptual exchange.

Modeling

The physical and chemical sciences, which aim to explain the material world, have recourse, in addition to theories and laws, to modeling. The model has become an important tool in the scientific process and consequently the teaching programs of the physical sciences give it a primordial place. Indeed, these programs propose the notion of model, as early as the college grade, for example the particle model of matter, which is taught from the first year of college. A scientific model is an abstract, simplified representation of a system of phenomena that makes its main characteristics explicit and visible and can be used to generate explanations and predictions (Harrison, 2000).

Inquiry-based approach

The investigative approach is an educational method that aims to prepare students and involve them in learning knowledge and skills by engaging in planned, structured and open activities and by carrying out missions in a realistic environment that helps them to

describe and understand the real world around them. Therefore, learning in taking this approach is done through a process which includes the following stages: the problem situation, the learner's appropriation of the problem, the formulation of explanatory assumptions, the investigation, presentation and exchange of results, knowledge structuring and mobilization (Raissouni, Abid & Chakir, 2021).

Methods

Research design

In this research, we used a quantitative methodology to collect and analyze data from all teacher beneficiaries. The survey was developed and finalized before being shared with the participants after three months of the training course (February 2022). The purpose of this research is to learn about the effect of continuing training on the practices of physics teachers and the issues that block this change. This design allowed us to explore teachers' perspectives to understand how much these trainings can change their classroom practices.

Instrument

In this study, we used a survey questionnaire, validated by three experts (two Physics pedagogical supervisors and a teacher with long teaching experience). It is mainly composed of four sections: The first processes personal data of the respondents and includes gender, teaching experience, teaching grades and working area. The second addresses the opinions of participating teachers regarding continuing training in general. The third discusses participating teachers' opinions of "Lycée Attahadi" training. The fourth concerns the effect of this training on the classroom practices change and the obstacles to this change. The questions varied between closed questions, such as five-point Likert scale questions, with the following responses: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree, semi-closed questions and open questions.

Procedure of the data collection

After developing our survey using the Google Forms tool, we shared it via WhatsApp with the physics teachers who benefitted from this training (3 months later). Data collected from the respondents was analyzed using Microsoft Excel and SPSS software.

Sample

The total number of participants for this research was sixty-two physics teachers who benefitted from this continuing training. Table 1 provides general information about the teachers in question.

METHODOLOGY AND TECHNOLOGY OF VOCATIONAL EDUCATION

Table 1
Basic participants' data

		Percentage (%)
Type	Male	67
	Female	33
Experience	< 5 years	14.5
	Between 5 et 10 years	29
	Between 10 et 20 years	16.2
	> 20 years	40.3
Academic level	National Diploma (Bac + 2)	6.5
	Bachelor (Bac +3)	64.5
	Master	24.2
	PhD	4.8
Work grade	High school	41.9
	Middle school	58.1
Work area	Urban	82.3
	Rural	17.7
Regional Academy	Tanger-Tétouan-Al Hoceima	48.4
	Fès-Meknès	37.1
	Marrakech-Safi	14.5

The total population (n = 62) is composed of two-thirds men and one-third women. Also, the majority of the respondents were experienced teachers: 40.3% had been teaching for more than 20 years, while only 14.5% had been teaching for less than 5 years. Among all respondents according to academic level, 6.5% have a National Diploma, 64.5% have a bachelor's degree and 29% have a master's degree or higher, which shows that among the subjects of our survey there were quite a few teachers with high-level degrees. Regarding their work cycles, we found that the group is not homogeneous, it is composed of 41.9% of high school teachers compared to 58.1% of middle school. Of the total population based on school area, more respondents are teaching in the urban school area with 82.3% as compared to the respondents who are teaching in the rural school area with 17.7%. In the end, our population is distributed across the three pilot regions of "Lycée Attahadi" training: 48.4% from the Tangier-Tetouan-Al Hoceima, 37.1% from Fez-Meknes and 14.5% from Marrakech-Safi region.

Results

Our main objective is to study the impact of continuous training on teachers' classroom practices. To do this, we adopted a two-step approach. First, we analyzed respondents' views about continuous training in general. Second, we examined their specific views on the "Lycée Attahadi" training. Finally, we sought to determine the effect of this continuous training.

Teachers' views on continuing trainings

Ministerial continuous training days

One of the main objectives of the reforms which Morocco experienced, was the renewal of teaching methods by opting for several principles. Among these principles are the continuous qualifying trainings, but do these courses take place on a regular basis? Table 2 shows the number of continuous training days that the teachers received:

Table 2
Teachers training days

	0 days	Less than 6 days	Between 6 and 11 days	More than 11 days
Ministerial Training	45%	34%	11%	10%

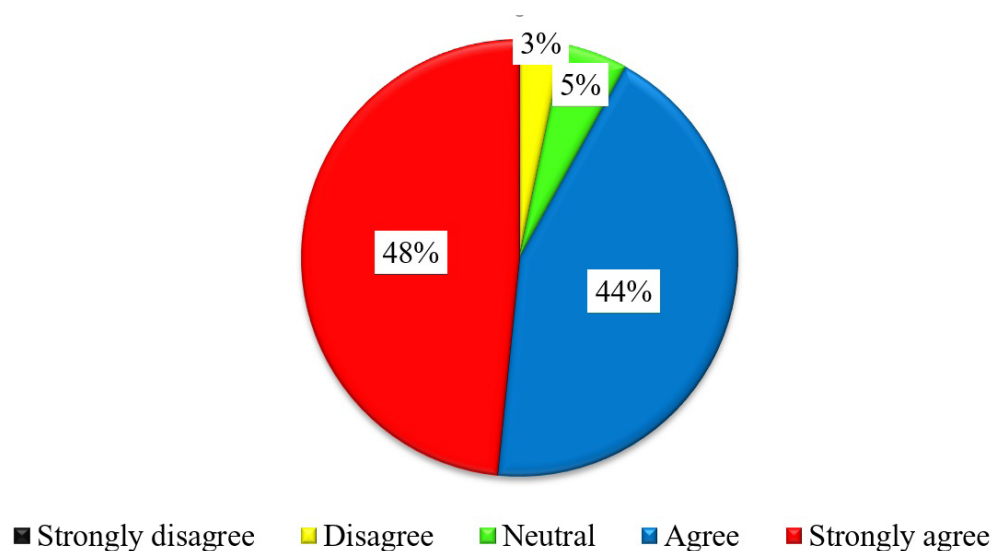
We note that almost half of the respondents have not received any continuing training (45%), while only 10% have received more than 11 days of training, which shows the enormous deficit in terms of continuing training programs.

The importance of continuous training for the enhancement of teachers' professional careers

Continuing training for teachers in general and physics teachers in particular can update them on all new approaches, and methods, and encourage innovation.

Figure 1 shows the opinion of the teachers regarding the importance of continuous training for the development of their professional careers by adapting to the pedagogical, didactic and scientific innovations

Figure 1
Importance of continuing training

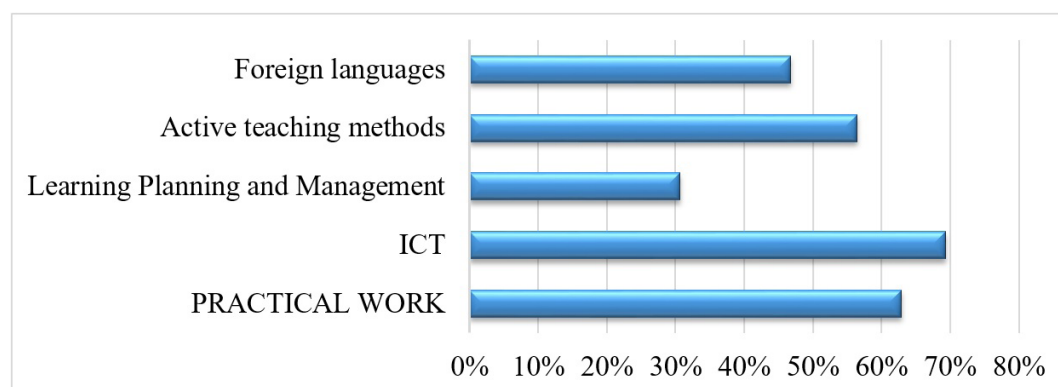


This figure shows that almost all teachers (92%) affirmed the importance of continuing training to develop their professional skills. These results are in perfect harmony with the results of other studies (Mahdi et al., 2014; Mili et al., 2021).

The needs of continuous training for teachers

For the success of any continuing training, the needs of the beneficiaries must first be taken into account. Figure 2 illustrates teachers' views on their main needs for continuing training.

Figure 2
Continuing training needs



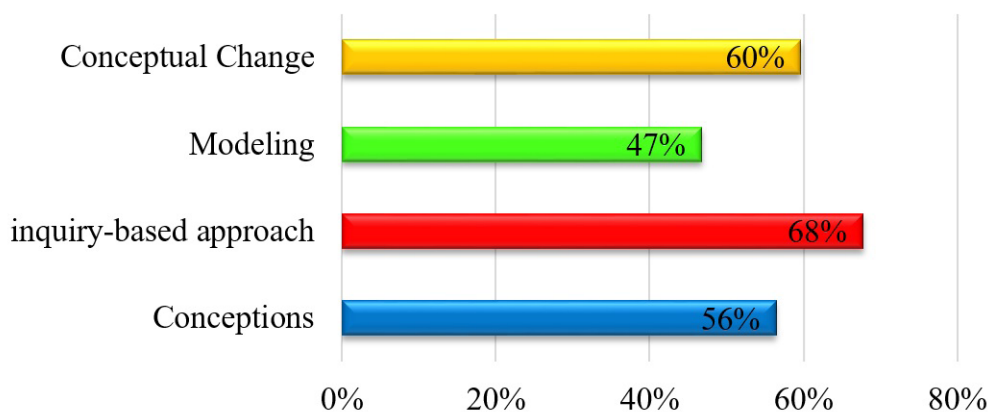
In terms of their continuing training needs, teachers first chose ICT and practical work (69% and 63% respectively), followed by active teaching methods and foreign languages (57% and 47% respectively). However, only 31% need training in education planning and lesson management. Therefore, the Ministry must take these points of view into account, and extend continuing training especially in ICT, practical work and active learning methods to improve the teaching and learning process.

Teachers' opinions on the proposed themes in the "Lycée Attahadi" training

Proposed topics

In the "Lycée Attahadi" training, four topics were proposed in the physics didactics module. The figure 3 shows the importance of the proposed topics for the beneficiary teachers.

Figure 3
Importance of the proposed topics



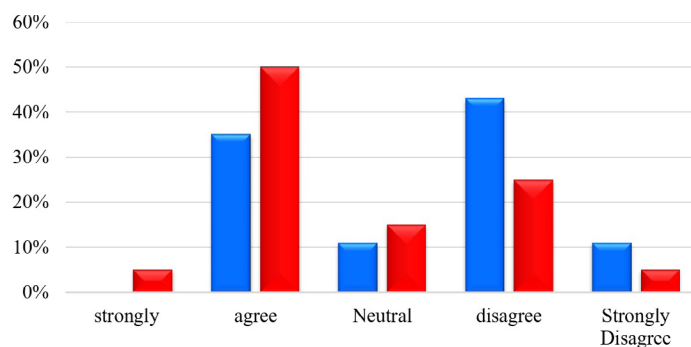
In the opinion of the teachers, the inquiry-based approach is the most important topic, followed by conceptual change and conceptions, while modelling is the least important topic. This shows the extent to which the inquiry-based approach is adopted by the teachers of Physics, especially since it is recently noted in the new programs of the middle school. This shows the importance of the investigative approach for teaching physics, which was recently noted in the new middle school curriculum (MEN, 2015).

The time and duration of the training

According to the statistical results concerning the opinion of teachers on the adequacy of the time and duration of training, differences were found between the opinions of teachers in the two cycles. Figure 4 shows their opinions.

METHODOLOGY AND TECHNOLOGY OF VOCATIONAL EDUCATION

Figure 4
Time and duration of the training

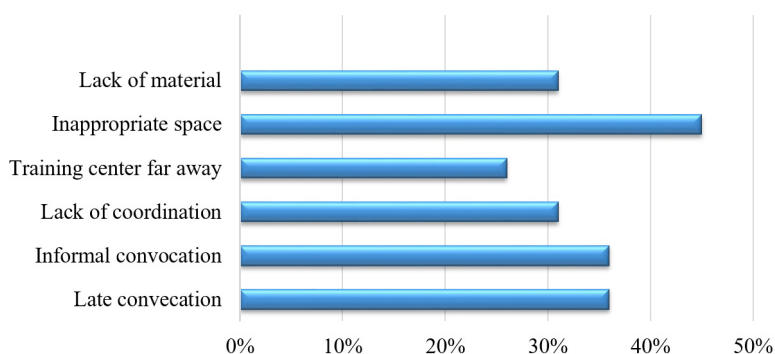


According to this figure, more than half of Middle school teachers find the training time and duration appropriate. Whereas, almost a quarter have a different opinion. However, high school teachers' view is practically the opposite (more than half find that the training time and duration inappropriate). This is due to several factors, mainly because of the difference in the curriculum lengths of the two grades.

Administrative problems encountered

During the training the majority of beneficiaries expressed their dissatisfaction because of several administrative problems, Figure 5 shows their opinions.

Figure 5
Administrative problems



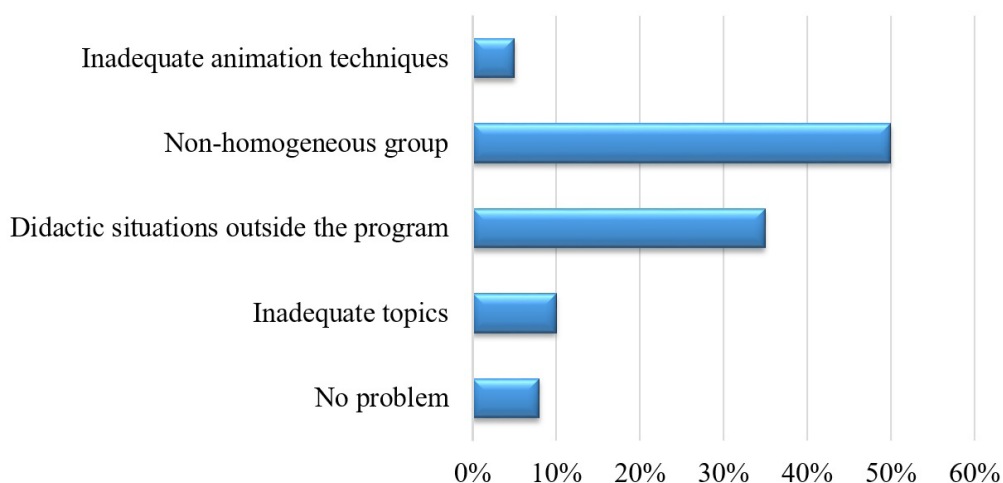
According to the teachers' opinions shown in figure 5, the main problem is due to inadequate workplace. Indeed, these spaces do lack basic infrastructure and necessary equipment, such as computers, internet access and well-equipped toilets. Moreover, some Continuing training was done in noisy primary schools. Also, beneficiaries express their dissatisfaction because of the late receipt of invitations (in most cases before one

day from the start of the training) and through a non-formal way (via WhatsApp for example). In addition, lack of coordination and the long distance from the training center are among the problems.

Didactic problems encountered

The main obstacles encountered during this training are didactic problems that can negatively influence the course of the training. Figure 6 shows these main problems:

Figure 6
Didactic problems



According to figure 6, the main didactic issue was the non-homogeneity of the training group of teachers from different teaching grades (Middle and High school), in addition to the didactic situations used outside the Moroccan school curriculum.

Impact and obstacle of "Lycée Attahadi" training

After three months of the mentioned training, we tried to find out how much this training has been able to change teachers' practices, as well as the main difficulties that block this change.

The impact of "Lycée Attahadi" training

Each continuing training course leads to a change in the behavior and teaching practices of the teachers involved. To this end, this continuing training aims to promote a shift in the teaching methods of physics teachers towards learner-centred approaches, in this case

METHODOLOGY AND TECHNOLOGY OF VOCATIONAL EDUCATION

active learning methods, more specifically inquiry-based learning. Table 3 presents the participants' opinions on the real changes brought about in the beneficiaries' teaching practices.

Table 3
The opinions on teaching practices.

Mean	Standard Deviation	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	This continuing training program:
Percentage (%)							
2.06	0.20	1.6	4.9	16.1	53.2	24.2	1- has encouraged teachers to exploit students' conceptions
2.13	0.22	1.6	4.9	17.7	56.4	19.3	2- has encouraged teachers to begin lessons with a triggering situation
2	0.21	1.6	1.6	17.8	53.2	25.8	3- has encouraged teachers to encourage students to formulate hypotheses
2.03	0.21	1.6	1.6	19.4	53.2	24.2	4- has enabled teaching methods to evolve towards active methods
2.12	0.22	1.6	3.2	19.4	58.1	17.7	5- has enabled teaching practices to evolve towards learner-centred practices

This table indicates that a substantial number of respondents (77.4%) express disagreement or strong disagreement regarding the encouragement of teachers to exploit students' conceptions through the continuing training program. Similarly, a majority of participants (75.7%) disagree or strongly disagree with the idea that this training prompts teachers to commence lessons with triggering situations. Furthermore, nearly 79% of respondents strongly disagree or disagree with the notion that the training motivates teachers to prompt students to formulate hypotheses. Conversely, a significant portion of respondents (78.4%) either strongly disagree or disagree that the same training facilitates the evolution of teaching methods towards active methodologies. Finally, almost three-

quarters (75.8%) of respondents strongly disagree or disagree that the training contributes to the evolution of teaching practices towards learner-centered approaches.

The outcomes depicted in Table 3 indicate that a majority of participants (more than 75%) opted for responses like "Strongly disagree" or "Disagree" across all items. Notably, only a minority (less than 1.7%) opted for "Strongly agree." Among the five items, the highest mean pertained to item 2, where participants indicated that the continuing training program has prompted teachers to initiate lessons with a triggering situation, with a mean value of 2.13 and a standard deviation (SD) of 0.22. In contrast, the lowest mean was associated with item 3, suggesting that the training encourages teachers to prompt students to formulate hypotheses (Mean = 2; SD = 0.21).

Obstacles that hinder change in classroom practice

Teachers' views were explored to find out the main problems limiting the impact of this training. Figure 7 shows the main obstacles to this practice change.

Figure 7
Obstacles facing the change of practices

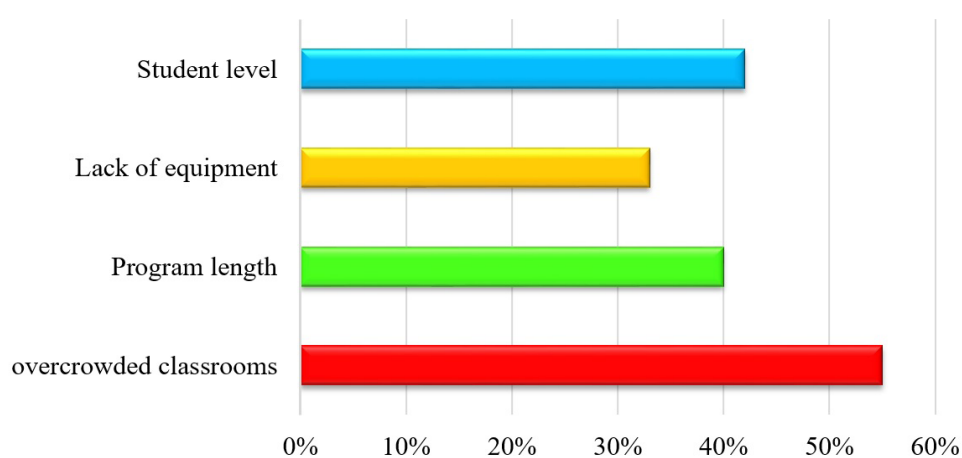


Figure 7 shows that having overcrowded classrooms is the first factor limiting the change in teachers' practices. To this end, several studies find it difficult to use active methods to teach physics in crowded classrooms (Raissouni, Abid & Chakir, 2021). The second factor is the students' low level. Indeed, Christine Couture et al. stated that the adoption of an inquiry-based approach to teaching physics and chemistry requires a certain autonomy of students, as well as a certain scientific background (Couture et al., 2015). The next factor is the length of the curriculum, which means that teachers have insufficient time to finish it, thus making it even more difficult to use active methods. These results are very similar to other research that indicates that time management problems are among the main obstacles to the use of the active methods in physics teaching

METHODOLOGY AND TECHNOLOGY OF VOCATIONAL EDUCATION

(Monod-Ansaldi & Prieur, 2011). Finally, the last factor is the lack of materials, which limits practical work in Moroccan classes (Taoufik et al., 2016; Mahdi, 2021). Therefore, it blocks the integration of the inquiry-based approach.

Discussion

In this study, we aimed to find out to what extent continuous training for physics teachers could change their classroom practices towards more learner-centered practices. Our research showed that almost half of the respondents had not benefitted from any continuing training days. This shows the enormous deficit that exists in this area. However, almost all of the respondents (90%) expressed their needs, which focus mainly on ICT, practical work and active teaching methods. These results have a great similarity with the research findings of (Mahdi et al., 2015).

Regarding the Lycée Attahadi training, the participants encountered some administrative and logistics problems, mainly the late reception of the convocations by informal means; the lack of coordination and the long distance from the training center. In addition, didactic problems, mainly the heterogeneity of the group which is composed of middle and high school teachers, and the proposed didactic situations are beyond the Moroccan curriculum, which influences the participation of teachers in the proposed activities. These results are partially similar to the results of another study on a similar ministerial formation (Mahdi et al., 2014; Mili et al. 2021).

On the other hand, this training aimed to change the participants' classroom practices towards more learner-centered practices, but the results showed that its effect is minimal. The main obstacles were: the overcrowded classes, the low level of the students, the heavy-loaded curriculum and the lack of materials. These results are coherent with many previous studies (Raissouni, Abid & Chakir, 2021; Couture et al., 2015).

Conclusion and perspective

Although the Ministry of Education wants to establish a system of continuous training for teachers, based on the pilot experience named "Lycée Attahadi", to guarantee academic success. This training faces a series of obstacles that should be resolved in the future. Hence, in this research we first identified these main obstacles, then we gave some suggestions. This research reveals the following results:

- In Morocco, there is a huge deficit in terms of continuing training, although almost all the respondents (90%) have expressed their needs, which focuses mainly on ICT, practical work and active teaching methods;
- The teachers had encountered problems at the administrative level relating to the workspace, the late receipt and non-formal way of invitations, lack of coordination and long distance of the training center;
- The teachers encountered some didactic problems relating to the non-

METHODOLOGY AND TECHNOLOGY OF VOCATIONAL EDUCATION

homogeneity of the training group (including teachers of middle and high schools) and to the didactic situations proposed outside the Moroccan school curriculum;

- The impact of this training on the practices of teachers in class is minimal (77% say that the impact is less than 40%) and the main obstacles to changes in practices are: overcrowded classes, low level of students, length of the program and lack of equipment.

It can be concluded that this training, which aimed to mobilize and reinvest the central concepts of the didactics of physics - chemistry, could not achieve all these objectives.

To remedy these problems, the main suggestions are as follows:

- Develop a sustainable and intensive annual continuous training schedule. taking into account the needs of teachers;
- The beneficiaries choose themselves the topics and the training period that suits them;
- Accompany beneficiaries after training to consolidate good practices;
- Take into account during training the real classroom conditions: the overcrowded classes, the low level of students, the length of the curricula and the lack of materials;
- Reduce the number of days and hours of training for quality training and not quantity;
- Each academy must have its own training center, well equipped and with its own human resources.
- Form homogeneous training groups according to their work cycle;
- Exploit the didactic situations of the Moroccan school curriculum.

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Author Contributions

Mohammed Rabih Raissouni – Conceptualization, Methodology, Formal analysis. Mohammed Rabih Raissouni played a key role in designing the study, developing the methodology, and conducting the formal analysis of the data.

Khalid Mahdi – Investigation, Data curation, Writing – Original Draft. Khalid Mahdi was responsible for gathering data, curating it, and contributing to the initial draft of the manuscript.

Mohammed Abid – Validation, Visualization, Writing – Review & Editing. Mohammed Abid validated the results, created visual representations, and participated in the review and editing process of the manuscript.

Adnane Souri – Supervision, Project administration. Adnane Souri provided overall supervision of the project, managed administrative aspects.

Kenza Raissouni – Validation, Visualization, Writing – Review & Editing. Kenza Raissouni assisted Mohammed Abid in the overall validation of the results, created visual representations, and participated in the review and editing process of the manuscript.

Author Details

Mohammed Rabih Raissouni – Teacher of sciences' didactic at Regional Centre for Education and Training Professions, Tanger, Morocco; ORCID ID: <https://orcid.org/0000-0002-6221-3736>; e-mail: raissounirabih@gmail.com

Khalid Mahdi – Teacher Researcher of Computer Sciences and Education Sciences at Abdelmalek Essaadi University, Tetouan, Morocco; ORCID ID: <https://orcid.org/0000-0002-4235-9375>; e-mail: khamlidmahd@gmail.com

Mohammed Abid – Teacher Researcher at Regional Center for Education and Training Professions, Rabat, Morocco; ORCID ID: <https://orcid.org/0000-0002-7427-2215>; e-mail: profabidmed@gmail.com

Adnan Souri – Teacher Researcher of Computer Sciences at Abdelmalek Essaadi University, Tetouan, Morocco; e-mail: adnan.souri@gmail.com

Kenza Raissouni – Ph.D. Student at Sidi Mohamed Ben Abdellah University, Fès, Morocco; e-mail: raissounikenza@gmail.com

Conflict of Interest Information

The authors have no conflicts of interest to declare.