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Study of the professional profiles and teacher training of physics teachers between Chile and Mexico

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ABSTRACT

The physics teachers require, in addition to knowledge of the discipline, development of skills that allow them to plan and implement teaching strategies that help students acquire knowledge of the different branches of physics and their usefulness in different contexts (Arriaga et al., 2017). Thus, teacher training plays a fundamental role and can be approached from two perspectives: initial training (profile) and in-service training (teacher training) (Gómez et al., 2020; Campos, 2020). In Latin America, particularly in Chile and Mexico, the training of physics teachers focuses on their professional profile, so it is necessary to deepen teacher training, so that an ideal profile is achieved to teach physics classes (Ramírez & Medina, 2022). In general, the teaching of teachers can be divided into two: 1) courses on the didactics of physics; and 2) courses on the educational model of the school (Arriaga et al., 2017). In the work we are presenting, a study was conducted about the training of the physics teacher, creating indicators to know the ideal profile of the teacher, and proposing training tools that allow the teacher to approach the ideal profile, and a comparison of the results of the study between teachers of Chile and Mexico.

Keywords: Enhancement; knowledge, Mathematics teachers, principals, professional develop Teacher training, professional profile, physics teaching.

1. Introduction

In Latin America, particularly in Mexico (even more than in Chile) there are no training and updating programs for Physics teachers, leaving this function to each educational institution (Sánchez and Huchim, 2015). The strategy used has been to generate postgraduate degrees for in-service teachers, regularly master's degrees in education, or failing that, offer courses in an isolated manner that mostly contain elements of general pedagogy and to a lesser extent disciplinary Physics courses (Campos and Ramírez, 2019). For this reason, those who practice the profession of Physics teachers at different educational levels, particularly at the university level, have diverse profiles ranging from graduates in Physics to engineers in various branches of technology, with master's and doctoral degrees in some cases.

If we start from the assumption that, due to their professional training, in-service teachers have the disciplinary knowledge required to be Physics teachers, what other factors are relevant to consider that a professional can adequately develop as a Physics teacher? In this regard, Merino (2002) affirms that being a good Physics teacher entails not only knowing the subject in depth, but also having skills in didactics and pedagogy, and, in addition, having researcher aptitudes and attitudes. Physics teachers must have solid knowledge in Physics, didactics and pedagogy, and open attitudes.
On the other hand, for Riveros, Jiménez and Riveros (2004), *"[Regarding physics teachers] There is an assumption that it is enough to know the discipline to be able to teach it. Nothing falser [...]. In general, it is necessary to know about didactics and pedagogy to articulate teaching, learning, evaluation, and group techniques, to develop strategies with the possibility of working satisfactorily.*

Based on the previous references (among many others), it can be considered that there is a consensus among some researchers and educational authorities, that to teach Physics, one must have a solid disciplinary knowledge of it, that is, an in-depth understanding of the topics of physics. discipline that teaches and its relationship with other areas of knowledge, but that this knowledge, although necessary, is not enough to be a good teacher (Merino, 2002; Riveros, Jiménez, Riveros, 2004; Ávila, Pérez, Santillán, 2008; Cañal, 2011). On the other hand, it has been identified that the majority of professors who teach Physics generally have little training in the specific didactics of the discipline, so when entering the teaching service, regardless of their age or the years they have of having After completing their professional studies, most are in a stage of novice teachers (Bromme, 1988; Reyes and Romero, 2011).

In other words, the fact that a teacher has years of teaching experience does not imply in advance that they have a solid pedagogical training that allows them to adequately carry out their functions, this is because teaching practice requires permanent training and updating, which although , in some cases it is a question of covering with training and updating courses that arise within the same educational institutions, it is well known that they are insufficient and inadequate in most cases.

Based on the above, this research proposed to study the professional profile and teacher training and updating of active Physics teachers, establishing a comparison between university level teachers from the Instituto Politénico Nacional and the Universidad Austral de Chile.

1.1. Professional profile and teacher evaluation

The way in which it can be identified how the teacher manages to generate in his students the knowledge of the content, as well as the achievement of competences, abilities, attitudes, and values; During a course, it is through the evaluation of teaching performance, which has become an element to ensure educational success, identifying the quality of teaching and creating interest in the teacher to improve.

Martínez-Chairez and Guevara-Araiza (2015), defines the evaluation of teacher performance as a systematic process being of interest to issue value judgments on the quality of compliance with teaching responsibilities in teaching-learning and in student development, through permanent monitoring.

For the Secretary of Education of Mexico (SEP, 2014), the teacher evaluation guidelines mean, "evaluate", the degree of compliance with the functions and responsibilities established by the institution of belonging, and the quality with which the function is carried out. in terms of performance and the achievements obtained in a certain time that allow an assessment to be made, as well as to publicize the strengths and areas of opportunity for the improvement of the function".

When talking about carrying out a teacher performance evaluation, it is necessary to define the profile, which a good teacher must have within the school context, defining the knowledge, skills, and attitudes that a teacher should master, the evaluation needs, the conditions of a disciplinary nature and the use that will be given to the results obtained from the process. However, there are aspects that are common when defining a good teacher (Dewar, 2002; Coe et al., 2014), being the mastery of knowledge, teaching strategies and methods, educational commitment, as well as the relationship that establish with students.

Based on the above, in this work the teacher profile is analysed based on what was mentioned by Shulman (2005) based on the professional knowledge of teachers, which is distinguished by seven elements:

- Knowledge of the content.
- General didactic knowledge.
- Knowledge of the curriculum.
- Didactic knowledge of the content.
- Knowledge of students and their characteristics.
- Knowledge of educational contexts.
- Knowledge of the objective, the purposes, the educational values, and the philosophical and historical foundations.

On the other hand, for the teacher evaluation, the teaching competencies established by the SEP (2007) were considered, which include the following points:

- Continuous training: Organize your continuous training throughout your professional career.
- Mastery of knowledge: Masters and structures knowledge to facilitate meaningful learning experiences.
- Process planning: Plans the teaching and learning processes based on the competency-based approach, and places them in broad disciplinary, curricular, and social contexts.
- Application of competency-based strategies: Put teaching and learning processes into practice in an effective, creative, and innovative way in your institutional context.
- Process evaluation: Evaluates the teaching and learning processes with a formative approach.
- Autonomous learning environments: Build environments for autonomous and collaborative learning.
- Comprehensive training environments: Contributes to the generation of an environment that facilitates the healthy and comprehensive development of students.
- Participation in projects: Participate in continuous improvement projects at your school and support institutional management.

In addition, teacher training in general and physics at any educational level depends on various agents and regulatory contexts. Among the agents are the professors themselves, the directors of the institutions, the students, and graduates of the different academic programs, while the contexts include the academic programs, the physical conditions (classrooms and laboratories), the equipment (computing, experimental, among others), employment situation, collaboration networks (academies, associations, schools, among others). Studying these agents and conditions would make it possible to make teacher training proposals based on research results, beyond the personal perceptions of the agents themselves.

2. Method

2.1. Research design

In this research, the qualitative research paradigm is used since it seeks to know how individuals -in this case physics teachers and directors related to physics programs- perceive and process the professional profile and teacher training of the physics teacher. (Hernández et al, 2018). Based on this paradigm, a correlational study was selected (Bisquerra et al, 2009) since it is intended to relate the professional profile and the teacher training of the physics teacher through the interview of two agents, teachers, and managers.

The designs of the instruments have different purposes, the first being the interview with managers (heads of career, school or faculty directors, rectors, among others), which was carried out to know the context of the school, teachers and about the physics academy, in all of them its characteristics; the interviews with teachers seek to identify the characteristics of teachers, such as teaching practice, the development of skills and experiences in the classroom.

For the elaboration of the teacher evaluation instrument, the work done during the summer of 2019 as part of Gómez's doctoral thesis work (2021) is resumed. For this work, adjustments were made to the original instrument, taking as a sample authorities from the Universidad de Guadalajara, the Instituto Politécnico Nacional (both from Mexico) and the Universidad Austral de Chile (Chile), since there was no instrument to evaluate the teacher in both institutions, for which it was carried out based on the information of the teaching competences of agreement 447 of the Ministry of Public Education in Mexico (SEP, 2007). The expert validation methodology (Hernández-Sampieri et al, 2018) was used for the process of validation and reliability of the instrument; The group of experts was made up of 7 PhDs in educational physics, two from the Universidad de Guadalajara, one from the Instituto Politécnico Nacional, one from the Universidad Autonóma del Estado de Hidalgo, one from the Universidad Politénica de San Luis Potosí (all in Mexico). , one from the Universidad Austral de Chile (Chile), one from the Universidad de La Sabana (Colombia), as well as a PhD in International Education, an expert in research methodology, and a PhD in Advanced Technology, an expert in physics teaching at the baccalaureate, both from the Instituto Politécnico Nacional (Mexico).

The process of construction and validation of the instrument is reported in detail by Ramírez, Medina and Gómez (2023), and it

was applied in a distance mode through forms in Google Forms, the addresses are freely accessible in the following links (currently only in Spanish Language): https://forms.gle/UWcC1ydqqzXPtcyQ9

2.2 Sample selection

Originally, the project was aimed at knowing and correlating the professional profile and teacher training of physics teachers at the college level of the Universidad Austral de Chile and the Instituto Politécnico Nacional. So, the sample was proposed as non-probabilistic, taken for convenience in these communities by voluntary participants (Hernández et al, 2018). However, two conditions arose that modified the original sample proposal:

- The Universidad Austral de Chile entered a work stoppage process in the months of July and August, for which reason the data collection in this period was interrupted.
- The dissemination of results in academic events (AAPT, GIREP) aroused interest in participating in the study by professors from other institutions and levels, for which reason the research group decided to "open" participation to them since the nature of the study did not change. non-probabilistic and voluntary sample.

With the above, there is a sample of 38 responses for the interview of teachers and 7 of managers, the details are shown later in the results section.

The final instruments, already validated and built as a Google Forms form, present the following questions:

Interview for teachers

1. Full name
2. Institution where you currently work
3. What is your major/undergraduate degree?
4. Do you have a master's degree? Yes/No Which one?
5. Do you have doctoral studies? Yes/No Which one?
6. Do you have training studies on teaching skills? Yes/No Which ones?
7. How many years of teaching experience do you have teaching physics courses?
8. At what educational level (s) do you teach?
9. How often do you receive teacher training from your institution?
10. Have you taken training on your own that contributes to the teaching profile of physics courses?
11. Do you consider that your academic profile is adequate to teach physics? Why?
12. Do you consider that your academic profile has a different impact on the knowledge and skills of your students compared to other profiles? Why?
13. Do you consider the duration of the semester adequate with respect to the contents of the program? Why?
14. Do you do laboratory practices to explain some physics topics?
15. How many per semester?
16. Is the physics laboratory material that the school has enough? Explain your answer.
17. What are the didactic strategies that you use in the classroom?
18. Are there physics projects or contests at school? Yes/No How often?
19. Do you use the evaluation criteria established in the Physics academy/department? Why?
20. Do you link with other academies/departments? Why?
21. The failure rate in your course is: High 70% to 100%, Medium 30% to 70%, Low 0% to 30%
22. What is (are) the factor(s) involved (n)?
23. Do you do extracurricular activities for your students? explain your answer
24. How do you know that your students learned the topics related to Physics?
25. For you, what is teaching?
26. What are the purposes that you pursue when teaching?
27. What is learning for you?
28. What is the evaluation for you?
29. For you, what is a good teacher?
30. What qualities does a good teacher have?
31. What are the actions you take to achieve student learning?
32. What aspects of your job do you find rewarding, and which do you not?
33. If your students do not learn, what do you think is the main cause?
34. Mention the causes or reasons why you are a teacher.

Interview for authorities

1. Name
2. Executive position held
3. How many students does the school have?
4. What are the physics subjects with the highest failure rate?
5. What do you think is the reason for this?
6. Are the causes related to the teachers? Or is it just a student situation?
7. How many teachers do you have in the physics academy/department?
8. Does the school have an established profile to teach physics subjects? Otherwise
9. What is the failure rate in physics subjects?
10. Do you think that the teachers have the right profile? Why?
11. Do you consider that the profile has any relationship with the activities that the teacher develops in the classroom?
12. Is the academic profile proposed by the school/university for physics subjects adequate?
13. In your experience, which profile do you think is the ideal one?
14. In the hiring of personnel, do you consider that it complies with the regulations of the school/university?
15. If you had to change something in the recruitment of academic staff, what would it be?
16. How does the school/university evaluate teachers to teach physics courses?
17. How do you decide to assign the workload?
18. Do you have teacher training programs?
19. How do you choose those courses?
20. Who teaches them?
21. Do you have a physics laboratory?
22. Do you have personnel in charge of the laboratory?
23. How many students do you have on average per physics course?
24. How are students evaluated in physics courses?
25. Are there activities to support students in the physics learning units that they fail?
26. Are there extracurricular courses to improve pass rates?
27. If they exist, what are they? and who teaches them?

28. On average, how many students use them?

29. Are there clubs or Physics workshops?

30. Do the students compete in challenges, congresses, in Physics subjects?

31. How often are the programs of the learning units/physics subjects evaluated?

32. How is the process?

33. Does the academy/department make presentations to the school about their students' projects?

34. How is the relationship between the academies?

3. Results

When analysing the responses to the questionnaires shown in the previous section, the following trends are obtained:

- Eight executives from Mexico (IPN, Universidad Autónoma de San Luis Potosí, Universidad Politécnica de San Luis Potosí), Chile (Universidad Austral de Chile) and Colombia (Universidad de La Sabana) have responded so far.
- The educational levels of the managers are high school, university and postgraduate.
- The average number of students who study physics in the management units and programs is around 2,000 students.
- The range of courses offered covers all branches of theoretical physics, experimental work, and the uses of physics in engineering (such as electrical circuits).
- It is attributed that the problems in learning physics must do in a general way with the lack of training in physics and/or not having the physics profile of the teachers. However, students are also considered to be responsible for failure rates in physics courses.
- The average failure rate in physics courses is 50%, however, the interviewees consider that the professors under their charge have the profile to take physics courses.
- The managers consider that the ideal profile to be a professor of physics courses is that of a physicist, however, they consider that it would be convenient to already have experience or teacher training.
- In relation to the hiring processes, in general, it is considered that a pedagogical training process should be required as part of the updating and renewal of teachers' contracts.
- Now, no consensus was found on the evaluation process that is carried out on teachers, the assignment of workload or courses to be taught, depending on different criteria, even within different faculties of the same institution (as in the IPN).
- All managers state that their institutions have teacher training processes to offer their teachers, however, there are no clear criteria for the selection of courses or processes by teachers, for example, in some cases these courses are mandatory, while in others they are totally at the teacher's choice.
- All managers state that they have both physics laboratories and personnel specifically assigned to attend the experimental sessions.
- The evaluation of students in physics courses varies depending on the level and the corresponding program, ranging from the traditional exam to performance rubrics and laboratory practices.
- In general, extracurricular and/or support activities for students to learn physics such as clubs, workshops, contests, among others, are not considered.
- The average evaluation of physics courses is every 3 years, generally by institutional requirement. This evaluation process varies by level and institution.
- Although project presentations by students are considered, they are not considered regular and/or important.
- The directors consider that although there are departments and/or academies where the physics courses are located, there is no link between their members and even less with the rest of the academies and/or departments of the schools.

The physics teacher requires continuous training, both disciplinary and didactic. The profile of the physics teacher in Mexico is more disciplinary while in Chile it is a little closer to the teaching profile, therefore, the training options have a different orientation. The impact of both the profile and teacher training on the development of student competencies is still the subject of research (Ramírez, Medina, Gómez, 2022).

However, as mentioned in the introduction to this article, creating a formal training program that could be common to the Universidad Austral de Chile and the Instituto Politécnico Nacional de México is extremely complex due to the differences in the structure of both institutions. some of which are listed below:

- The profile of the professors in both institutions is different, in the IPN they generally lack training in didactics and pedagogy, their strength being their disciplinary training in Physics. While, at the Universidad Austral de Chile, a Physics teacher generally requires a degree in Physics to be able to practice, which implies (unlike Mexico) a strong component of pedagogy and didactics in training (Ramírez, Medina, Gomez, 2023).
- The instances in charge of designing and providing training to teachers in general and of Physics in particular, have different standards and origins, while at the Universidad Austral de Chile it is carried out by the faculty of sciences of the university itself (in the case of updating Physics teachers) at the Instituto Politécnico Nacional is carried out by the Department of Educational Training and Innovation, which does not currently have a specific program for the training of Physics teachers.
- There are formal learning options such as postgraduate programs, which can be oriented towards the training and updating of physics teachers, however, these are not mandatory for teachers.
- There are non-formal learning options, however, these depend on the teacher's willingness to participate, in addition to not necessarily receiving recognition from the university as part of the teacher's training and curriculum.

4. Conclusions

Physics teacher training programs, in general, are oriented to meet the needs of universities and/or schools in their physics programs. Sometimes this training is carried out by physics professionals and not by experts in the teaching of the discipline. This situation is notorious when comparing teacher training between Chile and Mexico, where in the former it is more common for teaching experts to carry out teacher training, while in Mexico it is more common for physics professionals (physicists). or preferably doctors in Physics). This situation makes it difficult to create a training program that can be common for teachers from both countries in general and particularly for the Universidad Austral de Chile and the Instituto Politécnico Nacional de México.

Teacher training in general and physics at any educational level depends on various agents and regulatory contexts. Among the agents are the professors themselves, the directors of the institutions, the students, and graduates of the different academic programs, while the contexts include the academic programs, the physical conditions (classrooms and laboratories), the equipment (computing, experimental, among others), employment situation, collaboration networks (academies, associations, schools, among others). Studying these agents and conditions would make it possible to make proposals for teacher training based on research results, beyond the personal perceptions of the agents themselves.

4.1. Training recommendations

Based on these in the last two points of the previous section, the research team decided to propose training actions in both non-formal learning and non-formal learning, both aimed at serving physics teachers and incorporating the results derived from this research.

As part of the formal learning and training of physics teachers, the group decided to implement the Curriculum Development and Contemporary Educational Theories course, an optional course for the Doctor of Science in educational physics at Instituto Politécnico Nacional. This course will be taught in the first semester of 2023.

At the time of writing this article, 9 students are registered to take the course, with the following distribution and profile:

- 2 IPN professors (both undergraduate level).
- 1 professor from the Universidad de Guadalajara.
- 1 high school teacher from the state of Guerrero (in Mexico) and from the Mexican Physics Society.
- 1 teacher from the Secretary of Education of the State of Guanajuato (México) and principal of a primary school.
- 1 professor from the Francisco Morazán University of Honduras.
- 2 professors from the Universidad de Santiago de Chile.
- 1 professor from the Francisco José de Caldas University of Colombia.

Some of the results obtained in this research are considered in the course program and activities. It is expected to contribute at the end to the training and updating of teachers, who in their entirety teach physics courses at different educational levels.

On the other hand, as part of the continuous training of all teachers and in particular Physics teachers, activities in a non-formal environment can be considered. In this sense, one of the important strategies are the seminars. In the case of this research, the seminar "Educational Physics Talks" was proposed and implemented, which is aimed at the general public, but specifically at Physics teachers (Ramirez, Escobar, Castrejón, 2022). In this seminar, research results in learning physics were shared, so that the participating teachers can incorporate them into their daily practice, in addition to sharing with experts in the area and receiving feedback. These types of exercises are not common in the area of physics teacher training, since generally, seminars of this type are oriented either to purely pedagogical and didactic aspects in general or otherwise to purely disciplinary aspects of physics topics.

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This seminar was carried out in two editions in 2022 and it is intended to continue with it in 2023. The format of the seminar was in distance mode through the Zoom platform and in transmission and reproduction through the YouTube channel of the postgraduate course in Educational Physics of the IPN (https://www.youtube.com/playlist?list=PLFTuaY5ueFjf983EONVSBqNYlocNcn1el), so that the largest number of teachers could participate. Researchers from the IPN (5), Universidad La Salle México, Universidad de Guadalajara (2), Universidad Agrícola de Honduras, Universidad Autónoma Chapingo, University of California, Educational System of Japan, University of Colorado, Tecnológico de Monterrey, Universidad de La Sabana de Colombia and Autonomous University of San Luis Potosí. There was an average attendance of 20 teachers per session from Mexico, Chile, the United States, Honduras, Costa Rica, Colombia and Ecuador.

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