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Evaluation of professional profiles and teacher training for developing physics competencies

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Abstract

The teaching of physics and its use as a means for developing different competencies requires teachers with a professional profile and an ideal teaching profile for it. For the above, it is necessary to have instruments to evaluate if the professional profile and the teacher's training allow them to reach the ideal profile to develop in the classroom the competencies requested in the physics courses at different educational levels. This study shows the procedure for designing, constructing and validating evaluation instruments for physics teachers, oriented to three agents, directors, teachers and students. As a result, the instruments obtained are shown, as well as the interpretation codes and peer validation carried out for these instruments. Finally, application cases are mentioned where these instruments have already been implemented in Mexico and Chile.

Keywords: Professional profile, teacher training, educational physics, competency-based model

Introduction

The teaching of physics is an essential foundation in the basic knowledge that any citizen should have as part of their competencies and skills for life; as mentioned by Noah (2014), Physics is part of reality and is one of the sciences that presents greater difficulty in its understanding by students, this difficulty is evident in the low pass rate of the discipline in schools at different educational levels (Ramirez, 2010).

Several studies have been conducted on teacher training from initial and continuing education on teachers' disciplinary knowledge (Abell, 2007; Gess-Newsome and Lederman, 1999; Loughran et al., 2012). In particular, Shulman (2005) mentions that seven elements distinguish teachers' professional knowledge:

- Content knowledge.
- General didactic knowledge.
- Knowledge of the curriculum.
- Didactic knowledge of the content.
- Knowledge of the students and their characteristics.

- Knowledge of educational contexts.
- Knowledge of the objective, goals, educational values and their philosophical and historical foundations.

Shulman thus identifies the difference between a pedagogical teacher and a professional teacher (content specialist). The teacher is not only the one who knows the contents of the subject but also the one who has the competencies, skills and strategies to make students develop competencies and skills simultaneously, based on the interest and abilities of the students.

There is also research on how to teach science; for example, Lorenzo (2017) describes the background that when a professional finished his career and wanted to be part of teaching, he only needed to participate by supporting another teacher who had more experience and then continued teaching, however, currently, it is necessary for the science teacher to develop his skills both professional (chemists, engineers, physicists, mathematicians) or scientific research and also acquire skills in the professional field of teaching (pedagogy).

On the other hand, Grossman (1990) mentions that the teacher possesses practical knowledge because it guides educational action and from which practical experience arises; practical knowledge originates from statements whose results are actions rather than propositions. At the same time, he distinguishes the following components of practical knowledge:

- Content and didactic knowledge.
- Knowledge of students and learning: knowledge of learning theories, student development, motivation, diversity work and gender issues.
- General pedagogical knowledge: organization, management and teaching methods.
- Knowledge of the curriculum: the curriculum and its development.
- Knowledge of the context: knowledge of the contextual variables in which the teacher operates.
- Self-knowledge: knowledge about beliefs and dispositions, as well as an educational philosophy.

On this basis, in a case study, Arriaga et al. (2017) perform an analysis of the results obtained by students in the Introduction to Physics course in the engineering faculty at a Mexican university against teacher training, identifying that teacher training is an indirect factor that influences student learning, in addition, that teachers possess minimal teaching knowledge that they inherited from their stage as students and that the professional teaching profile is a factor that significantly impacts student performance.

In reality, it is also necessary to consider the administrative situation related to “measuring” the knowledge that teachers have, particularly in school physics (discipline) and teaching skills; as an example, the work of Gómez et al. (2020) at the University of Guadalajara mentioned that, in order to collect information where it is possible to know the student’s school performance, the teacher’s knowledge and skills. Furthermore, since 2008, teachers have been evaluated through the National Examination of Knowledge and Teaching Skills (ENCHD), establishing the universal evaluation of teachers in Mexico, which is projected to be applied every three years, this at the primary, secondary and preschool levels. However, in the case of the university level, there is currently no “standardized” procedure or instrument that allows institutions to objectively evaluate professional profiles and teacher training for the development of competencies in general and in physics in particular.

Based on the above, this paper shows the results of the development and validation of instruments that evaluate the professional profiles and teacher training of physics teachers to develop student competencies.

Methodology

Competency-based teaching establishes the possibility of organizing learning content into units of complete meaning, solving one problem at a time, with solid interrelationships among its components. This characteristic allows the design of sequenced and integrated modules to develop competencies (Sánchez, 2012).

In this sense, efforts have been made to study the specific competencies developed in different university programs by various bodies, such as the Tuning Project, both in Europe and Latin America (Beneitone, 2007). In particular, the Tuning Latin America project studied in chapter 4.6, the Physics degree programs in 12 countries, including Mexico. In this report, 22 specific competencies are reported for Physics programs, which were obtained by consensus of professors from the 12 participating countries; however, the report itself comments that no recommendations are made on how to develop them and even less on how to evaluate them (Ramírez et al., 2013).

In the case of university education, there is no consensus on the general, specific, labor, social and other competencies to be developed; moreover, depending on the program and university, there are different evaluation models of these competencies. In the case of the evaluation of the professional profile and teacher training of teachers in general, and physics teachers in particular, in charge of developing these competencies, there are even fewer proposals for instruments or procedures (Arriaga, 2017, Campos, 2020, Gómez, 2021). Generally speaking, in the case of Mexico, study programs that have Physics courses require personnel with an adequate profile for students to obtain the knowledge, skills and competencies necessary for training; however, in the hiring of academic personnel, they only consider the professional profile (Gómez, 2021).

The teacher profile is related to a series of personal behaviors that are rescued from the diversity of skills, values, attitudes, behaviors and cognitive styles of the teacher, which have an impact on the student's life, hence the construction of the teacher profile must remain in constant change (Alfaro and Gamboa, 2008). Furthermore, the characteristics of the teaching profile should generate in the student the interest in learning so that he/she can discern how to learn, as well as how to apply this knowledge daily, and thus have a transcendence through practice so that they are not forgotten, leading the teaching role not only to the student acquiring knowledge and having skills but also developing values for his/her personal and professional life.

According to Delors (1996), to achieve the teacher's professional profile, the conception of the learning process that facilitates the acquisition of skills provides general strategies for problem-solving. It is required to develop socio-affective skills since this will represent the most important point for achieving personal and professional competencies, both for the teacher and the student.

Currently, teachers must teach content and transmit learning experiences to motivate the students' capacity for wonder (Araque, 2017). Teachers are faced with new demands and challenges since, in addition to transmitting the knowledge of the curriculum, students must be taught to be self-learners of their learning.

Gimeno (1995) defines that the content of teaching is not something easy since it is not a list of topics (theoretical knowledge) that students learn, but what teaching contains is a series of data and information of various types, which also include behaviors, values, attitudes and thinking skills that are part of the sense and meaning that the particular subject has.

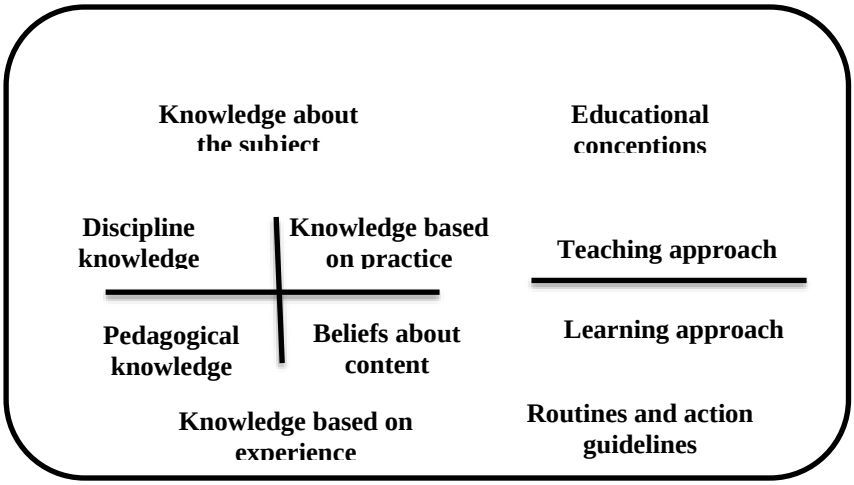

Figure 1. *Dimensions of teachers' practical professional knowledge (Cuevas, 2013).*

Figure 1 shows the relationship between the dimensions of content knowledge and the characteristics of teaching practice, identifying four types of subject matter knowledge (Grossman et al., 2005; López, 1999; Porlán and Rivero, 1998):

- Disciplinary knowledge of the subject: composed of the substantive knowledge that includes the discipline's content and concepts that allow linking the knowledge with other subjects; and the syntactic knowledge that are the means and procedures used in the field of study in order to generate new knowledge.
- Knowledge of the subject matter that comes from practice: composed of the teacher's professional experience in the field he/she teaches, where there is teacher reflection on the applicable knowledge of the subject matter under certain conditions.
- Belief about content: refers to subjective knowledge based on personal affective evidence, which influences the selection and treatment of content.
- Pedagogical knowledge of the subject: refers to how the content to be taught is learned, including identifying the topics, contents, and procedures that may present greater difficulty to learn and adding the educational strategies that can be used for each particular case.

When defining teaching competencies, Chan (2009) mentions that the teacher's responsibility is to "Manage the learning environment, interpret the expressions and behaviors of the learner and communicate with him/her to support the learning process." Based on this, we can consider that it is attached to everything mentioned above, how the teacher has to be involved in the student's process, identify the body language and maintain that motivation and interest in learning.

Figure 2 shows the relationship of training based on professional competencies to teaching competencies.

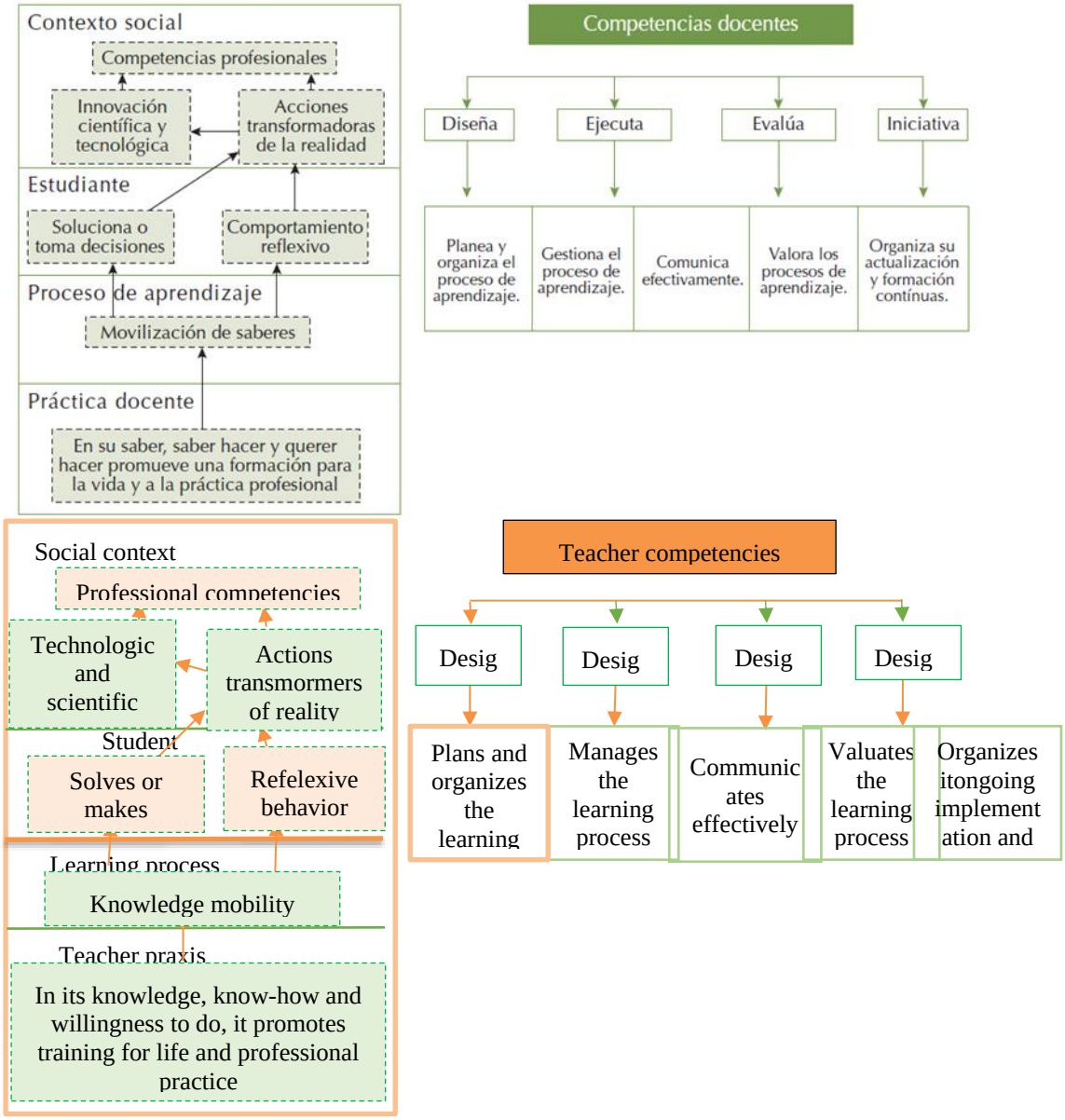

Figure 2. *Competency-based training (Torres & et al. 2014).*

How it is possible to identify how teachers manage to generate content knowledge in their students, as well as the achievement of competencies, skills, attitudes and values during a course, is through the evaluation of teaching performance, which has become an element to ensure educational success, identifying the quality of teaching and creating in the teacher the interest to improve.

Martínez-Chairez and Guevara-Araiza (2015) define the evaluation of teaching performance as a systematic process of interest to make value judgments on the quality of the fulfillment of teaching responsibilities in teaching-learning and the development of students through ongoing monitoring.

For SEP (2014), teacher evaluation guidelines mean "to 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 achievements

obtained in a given time that allow an assessment to be made, as well as to make known the strengths and areas of opportunity for the improvement of the function."

Teacher evaluation should be a routine exercise based on the collection of evidence that can help educational institutions to identify teachers' work, their areas and areas of opportunity for improvement.

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

In order to carry out a teacher evaluation, it is necessary to have several evaluation models, because none alone can offer concrete results of the multiple and varied activities that a teacher performs in an institution and that he puts at risk to fulfill his pedagogical work (Pacheco et al., 2018).

There are several models for carrying out teacher performance evaluations: peer evaluation model, self-evaluation model, evaluation through student opinion, and model through the evidence integration process. It is important to point out that the purpose of the teacher evaluation process is to offer support to the processes, without limiting itself to obtaining and accumulating evidence, but rather to transform it into decisions and actions that ensure quality educational processes aimed at improving teaching (Darling-Hammond, Wise and Pease, 1983; Howard and McColskey, 2001).

Based on the above, in this paper, the teacher profile is analyzed according to Shulman (2005) based on the professional knowledge of teachers, which is distinguished by seven elements:

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

On the other hand, for the teacher evaluation, the teaching competencies established by SEP (2007) were taken into account, which includes the following points:

- Continuous training: Organize continuous training throughout the career.
- Mastery of knowledge: Master and structure knowledge to facilitate meaningful learning experiences.
- Process planning: Plans teaching and learning processes according to the competency-based approach and places them in broad disciplinary, curricular and social contexts.

- Application of competency-based strategies: Effectively, creatively and innovatively implements teaching and learning processes to their institutional context.
- Process evaluation: Evaluates teaching and learning processes with a constructive approach.
- Autonomous learning environments: Build environments for autonomous and collaborative learning.
- Comprehensive training environments: Contributes to the generation of an environment that facilitates students' healthy and comprehensive development.
- Participation in projects: Participates in the school's continuous improvement projects and supports institutional management.

For this study, qualitative approach research, an exploratory, the descriptive, descriptive, correlational and explanatory scope is contemplated, based on Hernández-Sampieri et al. (2018), as shown in Figure 3.

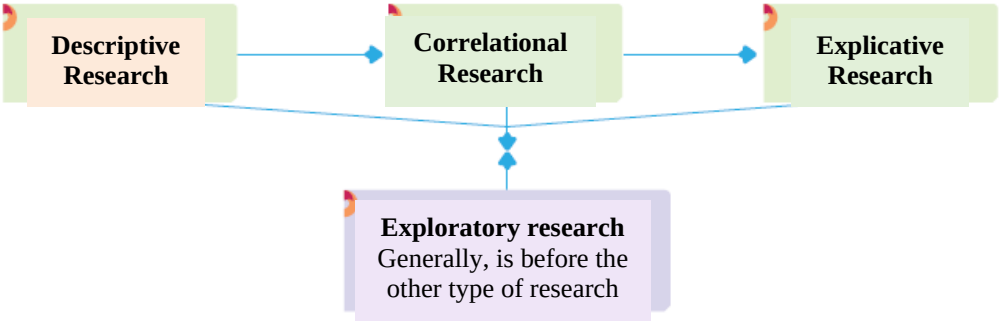

Figure 3. *Scope of the research (Hernández-Sampieri et al., 2018).*

In addition, it is based on the typology of Campbell and Stanley (1966), using the symbology generally used in texts on experiments to identify each of the teachers, as shown in Table 1.

Table 1. *Basic symbology for experimental designs (Hernández-Sampieri et al., 2018).*

R	Random assignment. When it appears, it means that the subjects have been randomly assigned to a group.
G	Group of subjects or cases (G1, group 1, G2, group 2, etc.).
X	Treatment, stimulus or experimental condition (presence of some level or modality of the independent variable).
0	A measurement of the subjects of a group (test, questionnaire, observation, etc.).
-	Absence of stimulus ("zero" level in the independent variable). Indicates that it is a control or control group.

The observer's role is carried out by using interviews with various questions, as shown in Figure 4.

Figure 4. *Suggested order of formulating questions in a qualitative interview (Hernández-Sampieri et al., 2018).*

They are described below:

- General questions: They start from global approaches to address the topic of interest. Typical of open-ended interviews.
- Exemplifying questions: These serve as triggers for further exploration. The interviewee is asked to provide an example of an event, occurrence or category.
- Structural questions: The interviewer asks the respondent for a list of concepts as a set or categories.

In addition, according to Mertens' (2010) classification, there are opinion, expression of feelings, knowledge, sensitive, background and simulation questions. While Hernández-Sampieri et al. (2018) maintain a suggested order for formulating questions in a qualitative interview.

For the elaboration of the interviews, a mixture is made between the types of questions according to Grinnell et al. (2014) and the classification of Mertens (2010), so the following questions are formulated: general questions to exemplify, structural, opinion, knowledge, sensitive and background questions. Likewise, according to Sampieri et al. (2018), the order suggested for formulating questions is used.

When using the interviews, a format will be applied to evaluate the qualitative interview conducted, and as an instrument, the data collection of the evaluations and the student's performance.

For data analysis, the Hernandez-Sampieri et al. (2018) proposal for choreography is used (Figure 5).

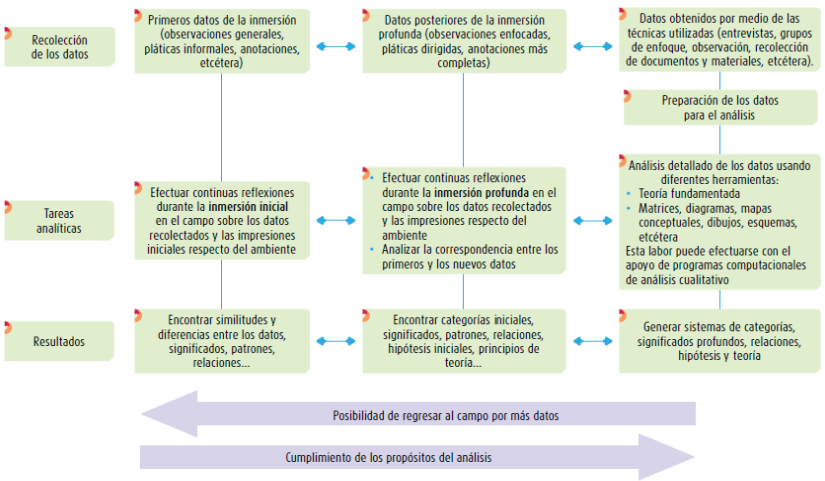

Figure 5. *Proposed "choreography" of the qualitative analysis (guidelines of potential tasks for the researcher).*

Instruments

The instrument designs have different purposes, the first one being the interview with the directors (career heads, school or faculty directors, and rectors, among others), which was conducted to know the context of the school, the teachers and the physics academy, in all its characteristics; the interviews with the teachers seek to identify the characteristics of the teachers, such as teaching practice, the development of competencies and experiences in the classroom. Finally, the student interviews seek to identify the competencies they developed in the Physics subjects or learning units, how they observe the teacher, and the teacher evaluation,

an instrument designed collegially to obtain information from the teachers by the students. The instruments are shown below.

Table 2. *Interview instrument for managers.*

Order of interview	Question Class	Question
		Context and Teaching Questions
General	General	How many students does the school have?
Complex	Exemplify	What are the physics subjects with the highest failure rates?
Complex	Opinion	What do you think this is due to?
Complex	Opinion	Do they have a relationship with the teachers? Or is it just a student situation?
Complex	Knowledge	How many teachers do you have in the academy/department in charge of physics?
Complex	Exemplify	What is the failure rate in physics subjects?
Complex	Opinion	Do you consider that the teachers have the right profile and why?
Complex	Opinion	Do you consider the profile related to the activities the teacher develops in the classroom?
Complex	Exemplify	Does the school/university propose an adequate academic profile for physics subjects?
Complex	Opinion	In your experience, which profile do you think is the most suitable?
Complex	Knowledge	Do you have any characteristics for the teaching profile of the school/university?
Sensitive	Knowledge	In hiring personnel, do you consider that you comply with the school/university's regulations?
Sensitive	Opinion	If you were to change anything in hiring academic staff, what would it be?
Sensitive	Knowledge	How do you evaluate teachers at school/university?
Sensitive	Knowledge	How is it decided to allocate the workload?
Sensitive	Knowledge	Do you have teacher training programs?
Complex	Knowledge	How do you choose these courses?
Complex	Knowledge	Who teaches them?
Complex	Background	Do you have a physics laboratory?
Complex	Background	Do you have personnel in charge of the laboratory?
		Questions about students
General	General	How many students do you have per physics course?
Complex	Knowledge Sensitive	How are students evaluated?
Complex	Background	Are there activities to support students in the learning units they fail, specifically in physics?
Complex	Background	Are there extracurricular courses to improve pass rates?
Complex	Background	If they exist, what are they and who teaches them?
Sensitive	Knowledge	How many students use them?
Sensitive	Knowledge	Are there any physics clubs or workshops?
Complex	Knowledge	Do students compete in challenges, congresses, in Physics subjects?
		Questions about the physics academy/department
Complex	Knowledge	How often do you evaluate physics learning unit/subject programs?
Sensitive	Knowledge	What is the process like?
Sensitive	Knowledge	Does the academy make presentations at the school on student projects?
Closing	Knowledge	How is the linkage between the academies?

Table 3. *Interview instrument for Physics teachers.*

Teacher Interview				
Question No.	**Order of interview**	**Question Class**	**Ask**	**Knowledge-based categorization**
1	General	General	Full name.	General Information
	General	General	Career/Degree	Content knowledge
	General	General	Master's Degree, Yes/No Which one?	Content knowledge
	General	General	Doctorate Yes/No Which one?	Content knowledge
5	Complex	Exemplify	Do you have training courses on teaching skills Yes/No Which ones?	Knowledge of the curriculum
	Complex	Exemplify	How many years of teaching experience do you have teaching physics courses?	Knowledge of the curriculum
	Complex	Exemplify	Do you also teach at the Higher/University level?	Knowledge of the curriculum
	Complex	Exemplify	How often do you receive teacher training from your institution?	Knowledge of the curriculum
	Complex	Exemplify	Have you taken training on your own that contributes to the teaching profile of physics courses?	Knowledge of the curriculum
	Complex	Opinion	Do you consider that your academic profile is adequate to teach physics? Why?	Knowledge of the objectives/ Knowledge of the curriculum
	Complex	Opinion	Do you consider that your academic profile has a different impact on the knowledge and skills of your students compared to other profiles? Why?	Knowledge of the objectives/ Knowledge of the curriculum
	Complex	Opinion	Do you consider the length of the semester to be adequate for the program contents? Why?	General didactic knowledge/ Knowledge of objectives
	Complex	Opinion	Do you perform laboratory practices to explain some physics topics?	Didactic knowledge of the content/ Knowledge of contexts
	Complex	Opinion	How many per semester?	Didactic knowledge of the content/ Knowledge of objectives
	Complex	Background	Is the physics laboratory equipment available at the school sufficient? Explain your answer	Content knowledge/ Didactic knowledge of the content.
	Sensible	Exemplify	What strategies do you use in the classroom?	General didactic knowledge/ Content didactic knowledge
	Complex	Exemplify	Are physics projects or competitions held at the school? Yes/No How often?	General didactic knowledge / didactic knowledge of the content.

Sensible	Exemplify	Do you use the evaluation criteria established in the Physics academy/department? Why?	General didactic knowledge/ Content didactic knowledge
Complex	Exemplify	Do you liaise with other academies/departments, and why?	Curriculum knowledge/ didactic content knowledge
Sensible	Sensitive	The failure rate in its AU is: High 68% to 100%, Medium 34% to 67%, Low 0% to 33%.	Knowledge of the students and their characteristics/knowledge of the educational contexts.
Sensible	Sensitive	What is the intervening factor?	Knowledge of the students and their characteristics/ Knowledge of educational contexts
Complex	Background	Do you provide extracurricular activities for your students? Explain your answer	Didactic knowledge of content/knowledge of educational contexts.
Complex	Exemplify	How do you know that your students learned the Physics related topics?	Knowledge of the students and their characteristics/ Didactic knowledge of the content
Complex	Opinion	For you, what is teaching?	Knowledge of the objectives/ didactic knowledge of the content.
Complex	Knowledge	What are your goals in teaching?	Didactic knowledge of the content/ Knowledge of educational contexts
Complex	Opinion	What is an apprenticeship for you?	Didactic knowledge of the content/ Target knowledge
Complex	Opinion	What is the purpose of the evaluation for you?	General didactic knowledge/ Target knowledge
Complex	Opinion	For you, what makes a good teacher?	Knowledge of the objectives/ didactic knowledge of the content.
Complex	Opinion	What are the qualities of a good teacher?	Knowledge of the objectives/ Knowledge of the curriculum
Complex	Exemplify	What are the actions you take to achieve student learning?	Didactic knowledge of the content/ Target knowledge

Complex	Opinion	Which aspects of your job do you find rewarding and which not?	Knowledge of the objectives/ Knowledge of educational contexts
Sensible	Sensitive	What do you think is the main cause if your students are not learning?	Knowledge of the students and their characteristics/ Target knowledge
Closing	Opinion	Mention the causes or reasons why you are a teacher.	Knowledge of educational contexts/ Knowledge of objectives

Table 4. *Codebook for the teaching interview*

Variable	Category	Subcategory	Code	Questions
Professor	G1	-	6 (teachers)	0
Teacher interview	General Information	General		1
		CDidacticodeContent		2,3,4
	Exemplify	CDidacticoGeneral		16,17,18
		CdeCurriculo	5	5,6,7,8,9,19
		CDidacticodeContent	1	16,17,18,19,23,30
		CdeAlumni		
		CdtheObjectives		
	Opinion	CDidacticoGeneral		12,227
		CdeCurriculo		10,11,29
		CDidacticodeContent	5	13,14,24,26,28
		CdelosContextosEducativos	1	13,31,32,33
		CdtheObjectives		10,11,12,14,24,26,27,28,29,31,32,33
	Background	CDidacticodeContent		15,22
		CdelosContextosEducativos		
	Sensitive	CdeAlumni		20,21,32
		CdelosContextosEducativos	1	20,21
		CdtheObjectives		
	Knowledge	CDidacticodeContent		
		CdelosContextosEducativos		

For the development of the teacher evaluation instrument, we worked during the summer of 2019, taking as a sample authority from the University of Guadalajara, the National Polytechnic Institute (both from Mexico) and the Austral University of Chile (Chile) since there was no instrument to evaluate the teacher in both institutions, so it was made based on the information of the teaching competencies of the agreement 447 of the Ministry of Public Education in Mexico (SEP, 2007). Furthermore, the expert validation methodology (Hernández-Sampieri et al., 2018) was used for the validation and reliability process of the instrument; the group of experts was made up of 7 doctors in educational physics, two from the University of Guadalajara, one from the National Polytechnic Institute, one from the Autonomous University of the State of Hidalgo, one from the Polytechnic University of San Luis Potosí (all in Mexico), one from the Austral University of Chile (Chile), one from the Universidad de La Sabana (Colombia), as well as a Doctor in International

Education expert in research methodology and a Doctor in Advanced Technology expert in physics teaching at the high school level, both from the Instituto Politécnico Nacional (Mexico).

Table 5. *Interview instrument for students taking Physics.*

Interview with students		
Order of interview	**Question Class**	**Question**
General	General	Full name
General	General	Physics subject(s) taken
General	General	Your physics teacher takes you to the lab to do practical exercises.
Complex	Opinion	Do you consider that the internships you have completed are sufficient?
Complex	Sensitive	Your physics teacher takes you to do activities outside the lab and classroom.
Complex	Opinion	Your teacher has told you about the importance of physics.
Complex	Opinion	It has told you examples of its impact on society.
Complex	Opinion	Do you think that the strategies your teacher uses in the classroom help you learn?
Complex	Opinion	Why?
Complex	Opinion	Does your teacher check that you are learning in class?
Complex	Opinion	What does he do?
Complex	Knowledge	Do you consider that your teacher prepares his class and organizes it according to the syllabus?
Complex	Knowledge	Does your teacher perform a diagnostic test to identify your prior knowledge?
Sensitive	Background	Did you link the course topics to activities in your daily life?
Complex	Knowledge	Did your professor request the development of projects during the semester?
Complex	Opinion	Does your teacher use technological tools to achieve your learning?
Complex	Opinion	Did your professor present the framework to you at the beginning of the semester, to let you know how he/she would evaluate you?
Complex	Knowledge	Does your teacher meet the evaluation criteria?
Complex	Knowledge	What does your teacher do that you consider important for student learning?
Complex	Opinion	Does the school have physics advisories?
Complex	Opinion	Have you participated?
Complex	Opinion	Why?
Closing	Opinion	Do you like physics?

This instrument (Table 7) is proposed to be applied at the end of the semester to a sample of students per group, where each professor who taught the physics courses during that period is evaluated; in this survey, questions are asked about the work of the teachers, their didactic characteristics and teaching-learning techniques.

The teaching performance evaluation instrument is detailed in a format with 25 questions on the Likert scale. The objective of this evaluation is to identify points of improvement in the teaching-learning processes for physics courses.

In the interpretation scale, according to the points obtained quantitatively, a qualitative evaluation is obtained, giving the following ranges of values as shown in Table 6:

Table 7. *Table of interpretation of the teaching evaluation for each competency (Source: Prepared by the authors).*

	Teaching competencies	Interpretation scale				
		Not desirable	Regular	Good	Very good	Excellent
1	Continuous training.	0-5	6-10	11-15	16-20	21-25
	Mastery of knowledge.	0-3	4-6	7-9	10-12	13-15
	Process planning.	0-7	8-14	15-21	22-28	29-35
	Application of competency-based strategies.	0-8	9-16	17-24	25-32	33-40
5	Process evaluation.	0-6	7-12	13-18	19-24	25-30
	Autonomous learning environments.	0-10	11-20	21-30	31-40	41-50
	Comprehensive training environments.	0-7	8-14	15-21	22-28	29-35
	Participation in projects.	1	2	3	4	5
	Final result	**0-47**	**48-94**	**95-141**	**142-188**	**189-235**

The questions are as follows (Table 8):

Table 8. *Instrument of questions to students about their Physics II teacher (Source: own elaboration).*

1. Did the activities proposed by your teacher promote the use of new technological tools (prezi, virtual platforms, etc.) and traditional ones (Word, PowerPoint, etc.)?	Reply
A. Always B. Almost always C. Sometimes D. Almost never E. Never	
2. Did he ask for your opinion regarding his way of developing the class and consider it in an evident way?	Reply
A. Always B. Almost always C. Sometimes D. Almost never E. Never	
3. Did the way in which your teacher explained and developed the topics demonstrate his or her mastery of them?	Reply
A. Always B. Almost always C. Sometimes D. Almost never E. Never	
4. In each topic, did it clearly explain its application in everyday life and related to what you learned in other courses?	Reply
A. Always B. Almost always C. Sometimes D. Almost never E. Never	
5. Did the activities you carried out have a logical sequence and went from the most basic to the most complex, according to the characteristics of your group?	Reply
A. Always B. Almost always C. Sometimes D. Almost never E. Never	
6. For each activity, did you clearly explain the competencies and purposes of the topic and the evaluation criteria to be developed?	Reply
A. Always B. Almost always C. Sometimes D. Almost never E. Never	
7. Throughout the course, did the professor favor your learning through collaborative strategies such as problem-based and project-based learning?	Reply
A. Always B. Almost always C. Sometimes D. Almost never E. Never	
8. In each module, did the teacher identify what you already knew about the topic and what you had learned in other courses to apply activities appropriate to the group's needs?	Reply
A. Always B. Almost always C. Sometimes D. Almost never E. Never	
9. Did the activities motivate you to learn and promote your personal development in terms of practice of values, achievement of your aspirations and attention to your training needs?	Reply
A. Always B. Almost always C. Sometimes D. Almost never E. Never	

10. Did your teacher propose creative activities, using the resources available at the school, that helped you to reflect and deepen the topics and competencies developed? A. Always B. Almost always C. Sometimes D. Almost never E. Never	Reply
Did he/she ask you to read articles, books and websites related to the course topics and encourage you to reflect on them critically? A. Always B. Almost always C. Sometimes D. Almost never E. Never	Reply
12. Did he/she guide and motivate you to use information technologies to find, classify, compare, organize and exchange information to complement your learning? A. Always B. Almost always C. Sometimes D. Almost never E. Never	Reply
13. Did your teacher promote activities for you to self-evaluate or evaluate your peers, inviting you to be proactive and respectful of their achievements? A. Always B. Almost always C. Sometimes D. Almost never E. Never	Reply
14. Through dialogue, did your teacher encourage and respect your opinion and those of your classmates when doing the activities and receiving your evaluation? A. Always B. Almost always C. Sometimes D. Almost never E. Never	Reply
15. Did you promote activities that fostered your civic, ethical and ecological awareness in the classroom or through school projects? A. Always B. Almost always C. Sometimes D. Almost never E. Never	Reply
16. Through class activities or participation in school events, did your teacher promote a taste for reading and the correct way to write down your ideas? A. Always B. Almost always C. Sometimes D. Almost never E. Never	Reply
17. Did he/she evaluate your learning based on clear criteria and give you the necessary feedback so that you could overcome your mistakes? A. Always B. Almost always C. Sometimes D. Almost never E. Never	Reply
18. Did you identify and address your questions in a clearer and clearer manner and allow your peers to help you better understand the subject? A. Always B. Almost always C. Sometimes D. Almost never E. Never	Reply
19. Did your teacher motivate you to overcome learning deficiencies or strengthen your competencies through remedial activities? A. Always B. Almost always C. Sometimes D. Almost never E. Never	Reply
20. Through the evaluation instruments used (rubrics, checklists, portfolios), did your teacher promote your self-reflection and that of your classmates? A. Always B. Almost always C. Sometimes D. Almost never E. Never	Reply
21. During the activities, did your teacher motivate the construction of rules for the healthy coexistence of the group and helped to comply with them through dialogue with those who did not follow them? A. Always B. Almost always C. Sometimes D. Almost never E. Never	Reply
22. Did your teacher promote your participation and that of your classmates in school campaigns focused on developing life skills, healthy habits and social participation? A. Always B. Almost always C. Sometimes D. Almost never E. Never	Reply
23. Throughout the course, did your teacher ask you to review and analyze materials or sites written in a second language, making it clear which competencies you should develop? A. Always B. Almost always C. Sometimes D. Almost never E. Never	Reply
Did your teacher propose innovative activities that were contextualized to the needs of your group and allowed you to comment on their effectiveness and relevance? A. Always B. Almost always C. Sometimes D. Almost never E. Never	Reply
25. Through classroom activities, did your teacher promote your sense of belonging to the school and help you generate an awareness of its care and cleanliness of areas? A. Always B. Almost always C. Sometimes D. Almost never E. Never	Reply

The work is done in a codebook with a Likert-type attitude scale, as shown in Table 9, where each question is assigned the category as appropriate, based on the heteroevaluation instrument by students of Rosario et al. (2016).

Table 9. *Codebook for teacher evaluation.*

Variable	Category	Subcategory	Code	Questions
Professor	**X1**	**-**	**25 (students)**	**0**
Teacher evaluation	Continuous training	Always	5	1,2,23,24,25
		Almost always		
		Sometimes		
		Almost never		
		Never	1	
	Mastery of knowledge	Always	5	3,4,5
		Almost always		
		Sometimes		
		Almost never		
		Never	1	
	Process planning	Always	5	4,7,8,10,18,23,24
		Almost always		
		Sometimes		
		Almost never		
		Never	1	
	Application of competency-based strategies	Always	5	1,4,5,6,9,10,11,12
		Almost always		
		Sometimes		
		Almost never		
		Never	1	
	Process evaluation	Always	5	6,13,17,18,19,20
		Almost always		
		Sometimes		
		Almost never		
		Never	1	
	Autonomous learning environments	Always	5	1,7,9,10,11,12,13,16,19,20
		Almost always		
		Sometimes		
		Almost never		
		Never	1	
	Comprehensive training environments	Always	5	9,13,14,15,21,22,25
		Almost always		
		Sometimes		
		Almost never		
		Never	1	
	Participation in projects	Always	5	
		Almost always		
		Sometimes		
		Almost never		
		Never	1	

Conclusions

This paper has shown the trajectory of the design and construction of evaluation instruments for both profile and teacher training for teachers of physics areas, particularly in the environment of Mexico, but not limited exclusively to this country. The instruments shown and validated are fundamentally qualitative; hence the validation processes also shown are fundamentally in that paradigm, specifically validation by experts (Hernández-Sampieri, 2018),

However, any instrument beyond the formal validation must be applied to determine its viability. In this sense, this battery of instruments has already been applied as a sample of its usefulness, the first case of which is its use in the baccalaureate system at the University of Guadalajara (Gómez, 2021, Gómez et al., 2020). In this sample application, reported in detail by Gómez et al. (2021), it can be seen that from the information obtained from the interviews with the director (administration), teachers and students of a high school at the University of Guadalajara, the Ven diagram (Figure 6) is obtained, where the logical relationships between the three agents involved in the teaching-learning process are graphically observed:

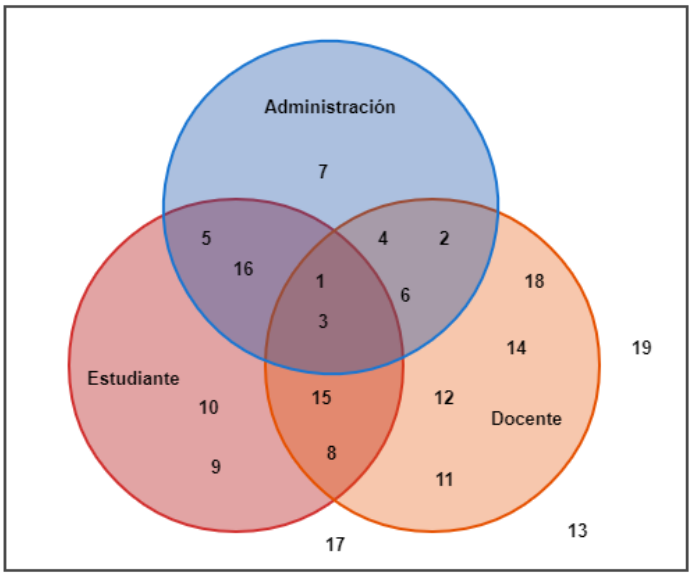

Figure 6. *Venn diagram of the logical relationship of the interviews.*

Where:

1. Mastery of knowledge. Suitable profile.
2. Adequate laboratories to carry out practices.
3. Conduct olympics.
4. Institutional training.
5. Extra-institutional training.
6. Teacher training.
7. Classrooms with projector and material for the teaching-learning process.
8. Laboratory practices
9. Teacher evaluation.
10. Teaching-learning process.
11. Collegiate work.
12. Didactic planning
13. Didactic strategies.
14. Evidence of learning.

15. cross-cutting tests
16. Attrition rate
17. Influence on Motivation
18. Traditional class
19. Competency-based class

With this application, it was possible to show that these findings are related to the research on the teacher's impact on student results, specifically in Physics (Arriaga et al., 2017). They mainly identify the need for the teacher, in addition to his academic profile (which is the selection to teach), to perform updates at least in the disciplinary, technological and pedagogical areas; how pedagogical and technological tools for the development of competencies to students, participation in physics seminars, forums of experience in the physics classroom, the use of simulators for physics practices, to generate in students the interest, restlessness, motivation, the ability to be amazed and get hooked by learning in science, in addition to how to apply such knowledge to their lives (Araque, 2017) since it is observed in the results that these strategies generate a positive effect on students; however, it is necessary that this can be reflected in the classroom, and can be evaluated by teacher co-evaluation (among peers) with a checklist and at the same time feedback on the process is provided.

Thanks to the use of the designed instruments, in the application at the University of Guadalajara, it was possible to confirm that the teacher's profile is fundamental to ensure that the student is capable (at the end of his training) of demonstrating the level of competencies acquired, obtaining the manifestation of theoretical and conceptual mastery. Furthermore, this allows identifying that the teacher should not only know the profession but should also acquire knowledge about pedagogy, which will have an impact on the student by taking into account the competencies, skills and strategies that are required so that they, in turn develop an interest in learning and develop the necessary competencies (Gómez, 2021).

With this, the design of the questions for teacher evaluation at the campus was developed based on the competencies; and the student competency evaluation instrument was adopted as part of the teacher evaluation process.

In addition, it should be noted that the implementation of these processes was carried out for the entire high school, both for the hiring of teachers and the application of the teacher evaluation by students. The University's Departmental College approved these processes.

On the other hand, the use of these instruments has begun to be used to analyze teacher training and the profile of physics teachers at the Universidad Austral de Chile (Ramírez and Medina 2022), where at the moment (the application and analysis of the instruments continue) it has been possible to intuit that the physics teacher, in general, requires continuous training, both disciplinary and teaching. The profile of the physics teacher in Mexico is more disciplinary, while in Chile, it is closer to the teaching profile and, therefore, the training options have a different orientation.

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