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How do teachers, after their initial training, approach ramp research activities?

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This work aims to study what skills and to what degree our initial teacher training students have acquired after completing their Primary Education (PE) Degree studies. For this reason, at the end of the Didactics of Experimental Science (DES) subjects, we asked them to propose a laboratory activity for PE students to work on "The ramp as a machine". The students' worksheet had to contain: the curricular location, a contextualization to assess the everyday usefulness of this machine, a description of what it is and how to build it, the elements that characterize it, an investigation into the dependence of the applied force on the weight of the object and the slope of the plane, and a review of everything they had learnt. The results reveal both scientific and didactic achievements, during the training period and the persistence of worrying shortcomings (in particular, the inadequate use of language and the persistence of conceptual errors).

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Introduction

Sustainable Development Goal (SDG) 4 refers to the field of Education, specifically to "ensure equitable, quality and inclusive education and promote lifelong learning opportunities for all" (UNESCO, 2015), which is a key challenge for reducing social inequalities, for sharing a minimum welfare state or even for achieving other SDGs (e.g. how to live a healthier life or how to behave for sustainable development).

Teachers must be the protagonists in developing the SDGs and initiating this lifelong learning process (Rocard et al., 2007; Sala et al., 2020). From our perspective, teacher training is a key element of the SDGs. Therefore, our contribution will focus on this group.

Numerous studies highlight the abundant bibliography on initial teacher training from the perspective of what future teachers know (Loughran, 2007), and some point out recommendations to propose teacher training that is more focused on teaching practices that are useful and easily transferable. (Darling-Hammond, 2006; Zembal-Saul, 2017). Despite these recommendations, there are few studies that analyze the initial training of teachers and the effect we produce. In the Spanish context, we have been analyzing the different initial training proposals for a decade, either from the progression hypothesis (Hamed Al Lal et al., 2016) or from the integration of learning scientific content with a teaching approach based on inquiry and models (Jiménez-Liso et al., 2021). This article contributes to this line of analysis of initial training in Spain from the competency model as a reference for initial teacher training.

Different teaching models have been defined and discussed: traditional, behaviorist, technological, reflective, critical, constructivist, etc. (Martín-Sánchez and Groves, 2015). Currently, the competency model seems to be assumed as a reference for the professional development of teachers (Luengo et al., 2008; Bautista and Ortega-Ruiz, 2015; Barolli et al. 2019), although its meaning, the different levels of complexity and its implications have not always been explored in depth.

As can be seen, it not only affects universal access to this right but also to "quality education". A priori, this SDG is as exciting as it is complex since it is influenced by many factors: adequate legislation, appropriate financing, citizen support, and collective sensitivity, among others. However, although the above-mentioned factors are important, there is one that we believe to be decisive: the professionals involved in education.

Theoretical framework

In order to analyze our proposal for the initial training of Primary School teachers from this competence perspective, we need, on the one hand, to know the initial and exit points of the Degree at the University of Murcia, as well as to develop a theoretical framework on competences that allows us to analyze the progress (and resistances) of preservice teachers.

In the first place, we consider that teacher training is a continuous process of acquiring knowledge, skills, abilities, experiences, and so on, we believe that it is necessary to clarify how far we should go in the learning of each competence in each of the stages of this development. Thus, if we take as a reference the model of García et al. (2021), we should clarify how far are we going to go in "mastering the subject", in "planning and organizing work", in "adapting to differences" or in "working in a team" during initial teacher training? What will we do in relation to these professional competences in the next step: access to the teaching profession? We need to know not only how teachers arrive at a stage but also how they leave it.

Regarding how students arrive at initial teacher education centers, we recently reviewed the latest contributions on this issue and concluded that complaints about the lack of disciplinary and psycho-pedagogical knowledge were real and persistent. As stated, (Pro et al., 2022), they are not only due to the usual alternative conceptions of learning certain topics or to the lack of attention to the teaching of other contents (attitudes, skills, abilities, procedures) in science classes. There are also school experiences of future teachers that respond to undesirable models in Didactics of Experimental Science (DES) (Pro and Nortes, 2016), inadequate beliefs about what it means to be a good teacher (Cantó et al., 2016), and decontextualized and meaningless learning of pedagogical content.

Secondly, we must look at the specific competencies concerning DES to be developed by the Primary Teacher Degree (PTD) that are established in the Spanish educational laws (BOE, 2007) (Table 1).

Without focusing on an analysis of the curricular proposal, as others have done (e.g. Imbernón and Colén, 2014; Rebolledo, 2015; Manso, 2019), we must point out that four of the six competences refer to knowledge of a scientific nature. We would like to think that the inclusion of disciplinary content by the legislator does not intend to "repeat the training" that the future teacher should have received in compulsory education and that its acquisition had already been "certified in Secondary Education and in the University Entrance Exams". In addition, this idea of initial teacher training to compensate for previous studies does not meet the training needs around professional practices and erroneously assumes that the training needs of Secondary School students are similar to those of a future Primary Education teacher.

The objective of this article is to focus on one of these competencies (SC6—Table 1), to develop didactic materials and resources for an initial training task. Specifically, designing a laboratory script to teach what a ramp is, how it is built, how it works and what it is for, and where we can find it in everyday life. Under this objective, we are not going to contrast the curricular competences mentioned (Table 1) with other more generic ones (for example, Darling-Hammond and Bransford, 2005; Armengol et al., 2011; Zabalza, 2012; Ramírez et al., 2018; García

Table 1 Specific competences of DES in the PTD.

Competences in the teaching and learning of science in the PTD
SC1—Understanding the basic principles and fundamental laws of experimental sciences (Physics, Chemistry, Biology, and Geology).
SC2—Knowing the school curriculum of these sciences.
SC3—Posing and solving problems associated with science in everyday life.
SC4—Valuing science as a cultural fact.
SC5—Recognizing the mutual influence among science, society, and technological development, as well as relevant citizenship behaviors, to ensure a sustainable future.
SC6—Developing and assessing curriculum content through appropriate teaching resources and promoting the acquisition of basic competencies in students.

et al., 2021). Nor do we intend to see similarities and differences or compare them with other more specific scientific education (for example, Rivero et al., 2012; De Juanas et al., 2016).

But we also need to know the status of the acquisition of professional competences after the initial training stage. In this regard, numerous contributions have been made (Martínez-Chico et al., 2014; García-Barros, 2016; Rivero et al., 2017; Pro Chereguini et al., 2017, 2018; Hierrezuelo et al., 2022). Despite all these contributions, they are still insufficient to have a complete diagnosis of the exit profile from the initial training stage. Rather, we know that there are specific competencies that, regardless of the initial teacher training model followed, future teachers must have acquired: recognizing and selecting content, analyzing activities, knowing basic ideas for managing a class, planning a learning sequence, design teaching materials, and resources, propose tests to assess student learning…

In the field we are dealing with—experiences in PE with devices and machines—there are contributions on how to work on these contents in an innovative way, close to the learner's life and implicit competences (e.g. Blanchard, 2004; Criado and García-Carmona, 2011; Worth, 2022).

In our initial training proposal, a situation was proposed to future teachers, common in teaching work, of designing a laboratory practice around ramps, so that they could put into play the competences, knowledge, and skills acquired in their initial training. In the following section, we broadly describe the participants in this study and their previous experience in Science Education, as well as the instructional sequence developed on the topic "ramps" in question. And we pose the following research question:

What specific Science Education competencies are revealed through the task "design the ramp experiment"? Specifically, do the documents analyzed make it possible to assess the following competencies:

- Adequacy to the curriculum (SC2a): At what educational level do future teachers place your proposal? (Problem 1)
- Adequacy to the curriculum (SC2b): Is the language used in the script appropriate for the level at which it is directed? Have conceptual errors crept into the documents? (Problem 2)
- Contextualization (SC3b): How have you contextualized the laboratory activity? (Problem 3)
- Problematization (SC3a): Do they present adequate instructions to build the machine? How do you define and identify the elements of this machine? (Problem 4)
- Scientific knowledge (SC1a): How do you approach the study of the relationship between the applied force and the weight to go up the ramp? And between the applied force and the slope? (Problem 5)
- Scientific knowledge (SC1b) What fundamental ideas have worked with experience? (Problem 5)
- At what educational level do prospective teachers place their proposal? (Problem 1).
- How did they contextualize the laboratory activity? (Problem 2).
- Do they provide adequate instructions for building the machine? How do they define and identify the elements of this machine? (Problem 3).
- How do you approach the study of the relationship between the applied force and the weight to be lifted up the ramp, and between the applied force and the slope? (Problem 4).
- What key ideas have you worked on with the experience? (Problem 5).

For understandability, two coefficients have been used: Fernandez Huerta's (revised readability index and associated difficulty) (Law, 2011) and Crawford's (1989). The first refers to the ease of being read. Thus, the higher its value, the lower the reading difficulty. The values are associated with some qualitative assessments: very easy, easy, somewhat easy, normal, somewhat difficult, difficult, and very difficult. According to the authors, the students of 3rd PE cycle (5th and 6th grade; 11–12 years old), should obtain a value greater than 70. Regarding the second, it calculates the years of schooling necessary to understand a text in Spanish. If you start reading at the end of 1st PE cycle (1st and 2nd grade; 7–8 years old), you shouldn't spend more than 4.5 years.

The results of these previous questions can contribute to the development of the last three specific Science Education competences (SC4, SC5, and SC6) but we cannot measure them with a single classroom task, instead, we will focus exclusively on carrying out a documentary analysis of the scripts prepared by future students. teachers and reflect on the competence development of future teachers that these documents reveal.

Methodology

We have used a diagnostic and exploratory research design based on a documentary analysis (Bowen, 2009) of the productions of the pre-service teachers at the end of the Science Education course.

Participants and context. The group consisted of 75 students in the 3rd year of the PE Degree at the University of Murcia (60 women and 15 men), but—for reasons beyond the control of the research—we only have data from 50 (40 women and 10 men).

The ages of the participants ranged from 19–20 years old (32 students), 21–30 years old (13 students), and 31–40 years old (5 students). More than 80% had attended compulsory education in public schools. Slightly more than 30% had passed the Baccalaureate of Science. Despite this, the average grades in the DES subjects of the PE Degree were slightly higher than 6.

There are three DES subjects in the PE syllabus. Their teaching guides are shown in Table 2.

In recent work (Pro Chereguini et al., 2018), we describe and justify what has been done with respect to DES in the Degree. As for the specific topic of the teaching and learning of "Devices,

Table 2 DES subjects in the PE degree.

Subject	Year	Teaching guide	Dur.
Didactics of Experimental Science in Primary Education	2nd	https://aulavirtual.um.es/umugdocente-tool/htmlprint/guia/RKsZMPWL9SsBaVQcqSphnTBKJ2SYYSGuoFVQgUMEcMbzCUT744t	6 credits
Teaching and Learning in the Natural Environment I	2nd	https://aulavirtual.um.es/umugdocente-tool/htmlprint/guia/R45H3zRVpHAEU6JpLYBrM20by1TOaM7ZOIEFL7WKpO5pePAUZLR	6 credits
Teaching and Learning in the Natural Environment II	3rd	https://aulavirtual.um.es/umugdocente-tool/htmlprint/guia/R85HY61SZE9w9SaD3Canha3NEQPmfu7j7DZhQZriXzG9Ynpqagj	6 credits

Table 3 Teaching sequence on the ramps.

Students' tasks	Sequence of contents: Teaching and learning about devices, machines and appliances
1	- Presence of the subject in the PE curricula.
2	- Clarification of fundamental scientific content based on concept maps (one of the ramps is shown in ANNEX 1).
3	- Resolving everyday issues related to the topic.
4	- Carrying out laboratory experiments on the subject: 1st and 2nd gender levers; fixed and mobile pulley; and the ramp (the latter is shown in ANNEX 2).
5	- Search for resources on the topic (textbook, comics, films, simulators).
6	- Identification of the learning difficulties of the topic (listed in ANNEX 3). - Analysis of Primary School pupils' answers and identification of correctness, errors, or ambiguities in their answers.
7	- Proposals for a sequence of activities, with a constructivist approach at two educational levels (for 1st and 3rd cycle), including competences and sub-competences, contents, type of activity, and duration of each one.
8	- Presentation and justification of examples of student worksheets for PE for some activities. - Design of worksheets for other activities in the proposals.
9	- Review of what has been learned in the lesson.

Table 4 Sub-competencies included in the Test.

Laboratory script	Implicit sub-competences
Curricular placement	To know the official curriculum of PE and to locate the contents and activities in the different grades and cycles.
Contextualization	Contextualize the carrying out of an activity based on everyday events.
Assembly or construction	To teach how to construct devices, machines, and apparatus from schematic drawings and to explain their usefulness.
Identification of elements	Identify and define the quantities used to study the device, machine, or apparatus.
Research: measurement, tabulation, and conclusions	Plan research to study the qualitative relationship between variables. Measure magnitudes in different situations and tabulate the results. Draw conclusions from the data and information collected.
Revision	Identify the key ideas of what has been done in the activity.

machines and apparatus", it was addressed in the third subject and its contents are listed in Table 3.

In a teacher training model based on the acquisition of competences, we must refer to these competences in order to assess the effectiveness of what we are working on with future teachers. In this sense, there are two that they must acquire through the three subjects:

a. To know the basic guidelines of DES in order to adapt teaching proposals to PE, which promote the personal development of students and the sustainability of planet Earth, as well as gender equality, equity, and respect for human rights.
b. Plan innovative teaching proposals on science content in PE, which promote the development of scientific thinking and knowledge, a critical attitude, and autonomy.

In both competences, reference is made to teaching proposals, which means that the future teacher must be able to propose different types of activities, recognize the contents or competences implicit in them, identify the pedagogical intention, and design worksheets for PE pupils. It does not seem necessary to justify the role of experimental activities and their laboratory scripts at this stage of education. Finally, we would like to point out that the participants had completed the compulsory training related to DES (including the teaching practice).

Information collection instrument. We asked them to design a laboratory script or worksheet for PE students, with predetermined characteristics (see ANNEX 4). In Table 4, we list the units of information and implicit sub-competences.

In addition, two transversal variables have been introduced, common to almost all the sections of the script: the comprehensibility of the text for PE students and the appropriateness of the use of scientific terminology (possible conceptual errors).

Treatment of information. The treatment of the information collected has been predominantly qualitative, although quantitative values have been used for some indicators. To describe the results, we have kept the sections of the laboratory script: location, contextualization, identification and construction, research (measurement, analysis, and conclusion), and review.

As we indicated in the theoretical framework for understandability, we use the coefficients of revised readability and associated difficulty (Law, 2011; Crawford, 1989). The coefficients have been derived mathematically; we believe that the values that determine suitability should be revised as they correspond to times when reading initiation took place earlier than it does today.

Results

Curricular placement. As for the level at which the scripts were aimed, the majority (45 cases, 90%) indicated that it was aimed at 3rd cycle (5th and 6th grade PE; 10–12 years old); for the first cycle (1st and 2nd grade PE; 7–8 years old) only A6 and A19 (4%) did so. Three did not indicate to whom it was addressed, although it seems that it was for 5th or 6th grade.

Contextualization of the experience. Contextualization can have different purposes: to motivate learners, to connect with everyday facts, phenomena or events, or to challenge learners.

Before going into the subject matter, we would like to point out that, no matter how much literary fiction is used, "impossible situations" should not be posed: for example, using a board to

Table 5 Contextualization reading ease.

FH's coefficient-contextualization	Crawford's coefficient-contextualization
Group average: 75.68	Less than 3 (4th): 2
Standard deviation: 10.19	Less than 4 (5th): 8
No. of cases > 70: 40/50	Less than 4.5 (6th): 13
Difficulty level: Very easy-easy: 18/50	
For 4th, 5th and 6th year of PE: $2+16+22=40/50$	

climb a tree (A10), a 2-metre shelf (A9 and A17) or a roof (A44). Nor can we speak of the ramp as a machine when an object is dropped down an inclined plane (A14, A29, A36, A41, and A50). We discuss this later.

Leaving aside the "unusual locations" or errors, a first description of the results of this section could be made according to the use they give to the ramp. Thus, we have: "To lift objects into cars, lorries, vans…" (21 cases, 42%), "To transport heavy objects (in construction, removals…)" (10 cases, 20%) and "To overcome steps, a ladder…" (6 cases, 12%).

A high percentage used a story or an "infantilized" narration to contextualize the experience (36 cases, 72%); therefore, characters such as "Rampín", "Rampita" (both of them meaning "Little ramp"), "Carretín" ("Little cart")… appeared. Only three (A1, A13, and A27) used a historical story (the construction of the pyramids in Egypt) with no main characters and they talked about pharaohs, slaves, soldiers…

The more social contextualization was written in the first person and told the story of a 9-year-old boy with a physical disability who needed to use the ramp to get to school with his wheelchair (A3). Another (A21) also mentions the problem of urban obstacles to movement, but in a more descriptive and less emotional style.

As for other aspects, the analysis revealed that 40 of the scripts (80%) posed questions after the text, to check whether the students, to whom the document was addressed, had understood the situation and the intentionality of the experience.

With regard to the readability of the language used, the two coefficients mentioned in the section "Methodology" have been calculated (see Table 5).

As for conceptual errors, there are expressions that are not scientifically adequate; for example, "the ramp forms a very acute angle" (A41) or "the ramp is used to lift the weight of things" (A16). Others are difficult to interpret: "machines need the power of fuels such as electricity" (A33), "machines use energy to do something" (A24), or "machines do not change the effort" (A31). Finally, there are several (5 cases, 10%) who speak of a ramp as a machine for "lowering" objects, which is a major conceptual error (A14, A29, A36, A41, and A44).

Definition and construction of a ramp. All tried to define what a ramp is. The majority identified it as "machine" (40 cases, 80%) and "effort-saving" (44 cases, 88%); both aspects were appreciated by 34 cases (68%). In addition, "incline" (42 cases, 81%), "height" (38 cases, 73%), "weight" (24 cases, 48%), and "length of ramp" (12 cases, 24%) were mentioned in the definition, although not always adequately.

With regard to the elements, all the scripts incorporated the drawing of a ramp, and in 41 cases (82%) identified one (not always correctly), as shown in Table 6.

However, there were errors in the representations: the normal (A19), the weight (A16, A17, A19, A22, A24, A43, and A48), and the F (A29, A31, A36, and A50) were badly drawn; confusion between inclination and reaction of the plane (A50).

Table 6 Representations of the ramp in the scripts (irrespective of success).

Graphic resources	Proposals	Percentage
Image with all elements (Fa, P, and α)	10	20
Image with some elements (Fa and P)	7	14
Image with some elements (Fa and α)	10	20
Image with one element (α)	15	30
Image without elements	8	16

Fa applied force, R resistance or weight, and α angle of slope.

Table 7 Readability of definition and construction.

FH's coefficient—definition	Crawford's coefficient—definition
Group average: 77.44	Less than 3 (4th): 4
Standard deviation: 7.53	Less than 4 (5th): 12
No. of cases >70: 46/50	Less than 4.5 (6th): 28
Difficulty level: very easy-easy: 18/50	
For 4th, 5th and 6th year of PE: $4+12+26=42/50$	

As for the proposed set-ups, 15 scripts (30%) used laboratory materials (support, metal ramp, clamp) and 30 (60%) used more everyday materials (books, boxes, pebbles, marbles, etc.); five (A8, A14, A18, A22, and A38) made "confusing" drawings or explanations. On the other hand, almost all (46 scripts, 92%) used a mobile with wheels as the object to be raised (or lowered); the others (4 scripts, 8%) used a ball or an object without wheels.

As for the measurement of the intervening forces, the applied force was measured in 35 cases (49%). The objects proposed were a spring (17/35 cases) (greater elongation, greater force), "by hand" with thread or rope (3/35) (sensory appreciation), and the dynamometer (15/35 cases).

The measurement of weight was done in 4 cases (8%) and, in these cases, the dynamometer was mentioned. In 25 scripts (50%) the weight variations were produced by introducing different numbers of weights, stones, marbles, etc.

Measuring the inclination by means of the protractor was mentioned in 12 cases (24%). Allusion to how to vary the slope was made in 28 cases (76%).

Regarding the readability of the language used, the two coefficients are mentioned in the theoretical framework. The values are summarized in Table 7.

Finally, several terminological errors were found: "it is an object that is lifted from the ground and used to carry very heavy things" (A11); moving "a load", "a mass" or "a weight" instead of an object (A14, A16, A24, A31, A33, and A41); and "amount of slope" (A11). Even difficult-to-understand expressions were made: "the elements of a ramp are base, height, and length" (A42) or "the angle must always be 30° or 60°" (A36 and A44).

There are other strictly conceptual errors: saying that it is a machine when an object is dropped on the plane, already mentioned (A14, A29, A36, A41, and A44); stating that "with a ramp less work is done" (A50); pointing out that "the effort depends on the force and the space traveled" (A42); indicating that "it consists of three elements: applied force, weight or resistance, and inclination or reaction of the plane" (A19). The latter (A19) refers to the "normal" and the trigonometric expression of the law of the ramp (wrongly).

Research: relationship between variables and drawing conclusions. Regarding the variables involved, 42 scripts (84%) included the dependence of Fa and *P*, and 48 (96%) the relationship between Fa and *α*. The study of both was contemplated in 42 cases.

All scripts incorporated explanatory drawings, but only 15 scripts (30%) represented all possible situations (for both relationships).

As for data collection in the study of the 90 relationships mentioned, the primary school students had to make a few measurements: two measurements in 70 of the relationships and three in the remaining 20. There are three (A6, A19, and A25) that used a string or a thread to measure *F*, so the effort data had qualitative values ("a lot-quite a lot-a little" and "a lot-average-a little-not at all").

Regarding the tabulation of the data, only 10 scripts (20%) explicitly asked for it, both in the relationships between Fa and *P* and between Fa and *α*. Participants A36 and A50 included a table of fall times. The others posed the contrasts with expressions such as "in experience 1, more force is made when…" or "in experience 2, less force is made when…".

In general, the research processes were well organized: specification of the relationship to be studied, explanatory drawings, data collection, tabulation (only when incorporated), and contrast of values obtained. As for questions that allowed conclusions to be drawn in each of the studies, we should point out that 20 scripts contemplated it (40%) in the case of the relationship between F and *P*; while in the other study (Fa and *α*) only 16 (32%) did so.

With regard to the readability of the language used, the two coefficients mentioned in the section "Methodology" were calculated. The values are summarized in Table 8.

As in other sections, there are terminological confusions: "we will use different masses" (A16 and A33), "measure the amount of slope" (A11), "place the weight" (A14, A24, and A41), "overcome resistance" (A20), "measure the amount of force…" (A25 and A43) and "add weights" (A24, A42, and A48).

But we also find conceptual errors: "measure the time to raise (or lower) a mobile" (A4, A14, A29, and A50), "change the handle to appreciate the effort in three different situations" (A36), "more road, more effort" (A42), confuse "length of a spring and the elongation of the spring" (A17), confuse "height and inclination" (A42); "dragging a ball only depends on the mass" (A50).

Review of what has been learnt. The majority of the scripts (31.62%) used incomplete sentences in this section; 12 (24%) used concrete but open questions; 5 (10%) used both; and A36 and A50 did not include this section.

In relation to the definition of what a ramp is, 42 dashes gave the possibility of identifying it as a machine; 39 that it saved effort; and 12 that it was a rigid solid. The three characteristics were addressed in 10 dashes (A1, A13, A23, A27, A28, A37, A39, A40, A46, and A47).

Table 8 Readability of the research.

FH's coefficient—research	Crawford's coefficient—research
Group average: 77.00 Standard deviation: 8.88 No. of cases >70: 43/50 Difficulty level: Very easy-easy: 19/50 For 4th, 5th and 6th year of PE: $2 + 17 + 24 = 43/50$	Less than 3 (4th): 6 Less than 4 (5th): 17 Less than 4.5 (6th): 12

Regarding the ramp elements, 29 gave the opportunity to refer to the F; 24 to the *R* and 32 to the slope or *α*. All three elements were alluded to in 15 scripts.

Finally, as for the relationships between the intervening variables, 42 dashes alluded to the relationship between Fa and *P*; while 40 to that of Fa and *α*. The two relationships were mentioned by 37.

Discussion of the results

Curricular placement. Most of the participants have tried to adapt the proposals, with greater or lesser success, to the characteristics of the students at whom they are aimed: use of stories, everyday materials, type and size of letters in the script, drawings and illustrations, etc., although this does not presuppose that they know the curriculum. In fact, the curriculum in force at the time of the experiment (CARM, 2007) focused on building machines and appreciating their usefulness, but did not include studying the quantitative dependence between variables or the law of the machine, not even in the third cycle.

The very high percentage of choices for the third cycle (5th and 6th grade; 11–12 years old) may have several explanations: that they consider the study of the ramp to be more appropriate at this level; that they are uncomfortable making proposals for the first (1st and 2nd grade; 7–8 years old) or second cycle (3rd and 4th grade; 9–10 years old), as Criado et al. (2010) point out; that they feel more confident in the third cycle; or even a combination of these interpretations, as they are not mutually exclusive. We have no data to know the reasons for the choice. In any case, we should not forget the most important thing: the choice of level conditions the language used, and the extent of learning.

Contextualization. We do not know whether the presence of contextualization in the scripts is due to the acquisition of competences in the initial training or to the approach of the activity; given the "way" in which the participants have carried it out, we are more inclined towards the first option. In any case, a few qualifications should be made.

Firstly, we think that posing impossible situations as a starting point is not coherent with what is intended in this section; in fact, we think that one can go from motivation to confusion, due to not understanding the situation that is presented. The sub-competence "contextualizing a laboratory experience" requires students to have close references (facts, phenomena, events), to see the usefulness of what they are going to do, to attract the student's attention, and to generate curiosity.

As for the style of storytelling, almost three out of four participants have resorted to the children's story. This is undoubtedly a very valid resource to motivate (Corni and Fuchs, 2021) and the use of characters—such as "Rampita" (Little ramp"), "Carretín" ("Little cart") or similar—may be appropriate at the lower levels of this educational stage. However, the "humanization of objects" does not always make sense, especially in 5th or 6th grade of Primary Education. At these levels, it can even be a decontextualizing aspect. Moreover, in general, the stories are very flat, unemotional, unmotivating. etc.

Historical stories or those which draw attention to social problems seem to be more appropriate. With them, we can show the importance of scientific discoveries in the quality of life or incorporate desirable values for any citizen in science classes. We know that, in some of the DES subjects they had taken, press reports, advertisements, or videos had been used, but none of the participants used these resources.

Finally, it seems appropriate to rely on their usefulness to initiate the study of the ramp. The links to transport, to the reduction of effort, or to facilitate the overcoming of obstacles make it possible to generate many situations to contextualize the activity. It can also be useful to pose questions after the introductory text, always with the aim of focusing attention on what is going to be done in the experience.

Construction and identification of ramp elements. With regard to teaching how to assemble or build this machine, they had no problems; by means of a simple text and the corresponding drawings they were able to explain clearly how to do it. Only 10% had difficulties (those who dropped an object down the ramp, instead of carrying it up), not so much because of the skill or dexterity required for the construction, but because of the conceptual error.

We also think it is appropriate that they define the ramp as a machine that saves effort, and we do not think it is inappropriate to refer to terms such as inclination, weight, height, etc., obviously if this is done in a scientifically correct way that is appropriate to the pupils' knowledge and experience.

However, the identification of the magnitudes to study the ramp is somewhat more complex. It is true that the *F*, the weight, or the slope can be easily identified in a drawing and that intuitively they are not difficult to recognize. But it is also true that they require conceptualization, measurement, units… Our inclusion in this discussion is due to the fact that we cannot ignore the fact that they are included in the official curriculum.

However, at this stage, students have difficulties with the vectorial representation of the forces involved: Fa, *P,* and much more with the "normal" or frictional force (Mora and Herrera, 2009). It would require students to know beforehand that: "force and weight are vector magnitudes", "the direction of the weight of an object is independent of the surface on which it rests", "weight has two components: one parallel to the ramp and the other perpendicular to the ramp", "the normal is the reaction of the plane to the component of the weight perpendicular to the plane", etc. And probably none of these statements are understood or internalized by PE students. We were surprised by their answers because we had worked on these difficulties in our intervention (see ANNEX 3).

As for the materials mentioned in the scripts, we believe that the use of books or boxes is appropriate, although the use of more conventional laboratory materials does not overly complicate their handling. We also think that the use of trolleys with wheels is appropriate, as it reduces friction and makes the experiment easier to carry out; however, it should be stressed that the machine we are studying is the ramp and not the wheels of the trolley or car that we are moving along the plane.

We think that, in the third cycle, dynamometers with appropriate scales (some have 5 divisions measuring 0.2 instead of 10 divisions of 0.1) can be used to measure applied force or effort, or weight. But, especially if you are going to do qualitative studies, it is also not bad if you can appreciate it sensorially by sight (if you use a spring) or touch (if you use a thread).

As for the slope, the conveyor can be used, although primary school pupils may have problems (Fuentes et al., 2020). Among the technical difficulties are: making the vertex coincide with the point of contact of the plane with the ground and reading the values of α (there are transporters with divisions of 0.2 and not 0.1). It is possible to appreciate whether the ramp is more or less inclined, without quantifying its value.

Research on ramps. Almost all participants seem to be clear about several ideas: that PE students are able to study the relationships between Fa and the *P* of the object they have to climb and between Fa and the steepness of the slope; and that they should make several measurements for each relationship to be able to compare the results. Some of us do not share this optimism (Criado et al., 2010). Of course, a very clear script and many illustrations would be needed to ensure that these beliefs do not remain wishful thinking.

However, it would be more than debatable whether, in both processes, it is aware that the value of one variable must be fixed in order to study the relationships between the others. We have known for a long time that the control of variables is not intuitive and that it has cognitive requirements that are typical of formal thinking (Pro, 1998). Perhaps, and only at the end of the stage, it would be sufficient for them to reach the conclusion that "if the weight is greater, more effort must be made to lift it" and that "if we increase the slope, more effort must be made"; both statements are direct relationships between two variables.

The procedures used to measure the forces involved in the proposals for the third cycle (dynamometer and elongation of a spring) seem to us to be appropriate. Measurement with a string or a rope requires significant differences between the values of the weight of the mobile or the angle of the slope to be sensorially appreciable.

The procedures used to vary the weight (using weights, pebbles, chickpeas, etc.) or the slope (putting books on and taking them off or moving the clamp with the laboratory equipment) are also appropriate. They seem appropriate for the whole stage.

We think that the inclusion of the tabulation procedure is feasible; in fact, the use of tables, to represent the association of data of different variables, is carried out from a very early age (the use of emoticons is very widespread, even in Early Childhood Education). It is surprising, therefore, the limited number of participants who include it (especially in the cases in which the vector representations mentioned above were included).

Finally, it seems appropriate to us to pose questions that facilitate the contrast of values and the establishment of conclusions. Assuming, as we have said, that students will find it difficult to infer "desirable relationships" independently, we believe that anything that helps to induce them in a targeted way is useful.

Review of what has been learnt. It is positive that almost all of them included in the script a recapitulation of what they had done; as -in another case- we ignore the influence of the approach of the activity.

To a large extent, the appropriateness of the strategy used (incomplete sentences, closed or open questions, etc.) depends to a large extent on the didactic intention. Completing sentences is not new for PE pupils (especially at the first levels of the stage). However, it also responds to a more traditional approach, with single answers and little room for personal contributions.

Short, concrete but open-ended questions seem to us to be more appropriate. They invite recall and reflection on what has been done, which is an important metacognitive element.

Regarding the language used. As we have said, the level chosen determines the language and the type of questions. In this sense, in general, we value positively the length, the layout, the font size and, to a lesser extent, the illustrations. However, we have data on the quality of communication (FH and Crawford coefficients) in the sections Contextualization, Construction and Research. Based on these, we can say:

a. the mean value of the group's FH's coefficient is similar in all three sections and is significantly higher than 75, which we consider appropriate. The highest standard deviation corresponds to Contextualization; this is understandable as it is the longest text.
b. more than 80%, in all three sections, obtained values above 70, the limit used as acceptable, as noted above. In addition,

the number of scripts -40/50 (contextualization), 42/50 (definition) and 43/50 (investigation)- is appropriate for 4th, 5th and 6th grades of Primary Education, which we consider quite acceptable.

c. in terms of difficulty, the values "Very easy" and "Easy", obtained by 18 or 19 of the participants, are considered adequate, which is clearly inappropriate.
d. As for Crawford's coefficient, the values are more varied in each section. There is no suitable script for the first cycle and, for the third cycle, it ranges from 23 (contextualization) to 44 (construction).

We performed a statistical contrast of the values of the three sections using Student's t-test and obtained that there were no significant differences. On the other hand, we applied Pearson's r coefficient and obtained statistically significant relationships between the three pairs of items ($r = 0.44$; $r = 0.55$; $r = 0.53$; significance level $p = 0.01$). Among the possible interpretations of these results, there seems to be a consistency in the participants' ease of understanding.

We believe that "knowing how to communicate with students in writing" is not a competence exclusive to Language Teaching. We should also pay attention to it in DES, since, among the competences to be acquired, is the use of appropriate scientific language without forgetting that there are terms that do not have the same meaning in Science and in everyday life (Jiménez, 2003; Pedrinaci, 2012).

Conceptual errors. This aspect concerns us, not only because of its existence but also because of its extent. We have argued that "those who know, need not know how to teach", but we have also pointed out that "those who do not know, do not know either". In our case, conceptual errors typical of other educational levels have crept in (Pro, 2005; Criado and García-Carmona, 2011).

Reviewing the responses, we can make a catalog of conceptual errors:

- inappropriate expressions are slipped in. Some of them highlight the difficulty participants have in expressing themselves in writing; obviously this limitation is not exclusive to our subjects, but it is very important for working with science.
- there are terminological confusions. These are difficult to eradicate as they usually come from the inappropriate use of some terms in everyday language: effort instead of work, energy as equivalent to force, energy as something inside bodies, moving weight, load or mass instead of objects, overcoming resistance, etc.
- knowledge unsuitable for this age group is included. We could talk about the "normal" or "plane reaction", the components of weight, vector representations of the intervening forces, trigonometric functions, etc. On the other hand, we believe that the relationships between variables can and should be worked on qualitatively, especially when mathematical learning is limited.
- worrying conceptual errors appear: considering the ramp as a machine when an object slides down; indicating that, with a ramp, less work is done; saying that machines do not change the effort; pointing out that the effort depends on the force and the space traveled; evaluating the force in terms of the time it takes to climb an object to a certain height.

Conclusions

We must begin by saying that the proposals made by the participants show that there has been learning in some professional competences. Although, critically, the results could be improved for having completed the initial training stage, it is also true that their answers show significant progress in relation to the situation from which we started.

We have been able to perceive that, when they can choose the educational level to which they are directed, they opt for the upper grades of PE. As we said, the choice may be due to many reasons, but we are concerned that they may reflect that we are only training to meet the needs of children in 4th, 5th, and 6th grades.

We find particularly remarkable the naturalness with which they took on board the need to contextualize the laboratory activity. It is clear that the contextualization is not as desirable as we would have liked, but it is an achievement compared to the usual introductions made in textbooks for this type of activity.

The naturalness with which future teachers in initial training assume the need to contextualize the laboratory activity coincides with many previous works where this learning progression on contextualization of teachers in initial training is pointed out (Hamed Al Lal et al., 2016; Lupión-Cobos et al., 2017; Rivero et al., 2011).

The instructions for building the ramps and the illustrations to define them can be considered adequate and clear. However, scientific and didactic shortcomings are detected with the elements and their representations. The future teachers do not seem to differentiate between what they use to learn and what they can use to teach.

In some of the scripts, instead of using a dynamometer, they used sensory perceptions (the vision of the elongation in the case of using springs or the sensation of touch when using a rope). This seems to us to be an appropriate decision. Although the use of a dynamometer is not excessively complex (except for the readings in which each division measures 0.2), these options require a qualitative treatment of the data collected.

Another aspect that we consider worrying is that, in general, they have assumed that quantitative relationships between variables can be carried out in PE and, even more so, that pupils at this educational level are capable of carrying out controls of variables. As we have said, we believe that dependencies can be studied from a qualitative perspective (the greater the weight, the greater the force applied; the greater the inclination, the greater the force). Excessive quantification of data can complicate scientific competence because it is mediated by mathematics.

They have also shown that experimental processes should not be limited to measuring and testing laws. The collection and tabulation of data, the contrasting of values, and the drawing of conclusions project a different image to that given to experimentation; we exchange a testable intention for an inquiring one.

The language used is appropriate according to the coefficients applied. In any case, we are concerned about excessive childishness in the Contextualization or revision of what has been learnt.

But we are most concerned about the terminological, expressive, and conceptual errors. This is even more striking when, according to the proposal, they carried out exercises in which they had to identify errors and successes in the answers of primary school pupils. They seem to find it easier to spot other people's mistakes than their own.

However, this should not be an argument for "repeating the training" that should have been acquired at other educational levels. Lack of scientific knowledge can and should be made compatible with the acquisition of the professional knowledge needed as a teacher at this stage of education. Therefore, we must continue to review what we contribute from the DES in the PE Degree.

Data availability

All data in this paper are available and can be requested from the authors.

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References

Armengol C, Castro D, Jariot M, Massot M, Sala J (2011) El Practicum en el Espacio Europeo de Educación Superior (EEES): mapa de competencias del profesional de la educación. Rev Educ 354:71–98. https://sede.educacion.gob.es/publiventa/descarga.action?f_codigo_agc=19674

Barolli E, Nascimento W, Oliveira J, Villani A (2019) Desarrollo profesional de profesores de ciencias: dimensiones de análisis. Rev Electrón Enseñ Cienc 18(1):173–197. http://revistas.educacioneditora.net/index.php/REEC/article/view/368

Bautista A, Ortega-Ruíz R (2015) Teacher professional development: International perspectives and approaches. Psychol Soc Educ 7(3):240–251. https://doi.org/10.25115/psye.v7i3.1020

Blanchard JM (coord) (2004) Enseñar ciencias en la Escuela. Proyecto LAMAP. Pau-Education, París, pp. 76–94

Bowen GA (2009) Document analysis as a qualitative research method. Qual Res J 9(2):27–40. https://doi.org/10.3316/QRJ0902027

BOE (2007) Orden ECI/3857/2007, de 27 de diciembre, por la que se establecen los requisitos para la verificación de los títulos universitarios oficiales que habiliten para el ejercicio de la profesión de Maestro en Educación Primaria. BOE 312:53747–53750

Cantó J, Pro Bueno A, Solbes J (2016) ¿Qué ciencias se enseñan y cómo se hace en las aulas de educación infantil? La visión de los maestros en formación inicial. Enseñ Cienc 34(3):25–50. https://doi.org/10.5565/rev/ensciencias.1870

CARM (2007) `la educación primaria en la Comunidad Autónoma de la Región de Murcia. CARM

Corni F, Fuchs HU (2021) Primary physical science for student teachers at kindergarten and primary school levels: Part II—Implementation and evaluation of a course. Interchange 52(2):203–236

Crawford AN (1989) La comprensibilidad de textos en español del nivel primario. Fórmula y gráfico. En: Rodríguez JL (ed) Leer en la escuela: nuevas tendencias en la enseñanza de la lectura. Pirámide, Madrid, pp. 274–283.

Criado A, García-Carmona A (2011) Proyecto Curricular Investigando Nuestro Mundo (6–12). Investigando las máquinas y artefactos, Diada, Sevilla, http://hdl.handle.net/11441/39922

Criado A, García-Carmona A, Cañal P, Illescas M (2010) Acerca de los conocimientos iniciales de los escolares de primaria sobre las máquinas y artefactos. In: Abril AM, Quesada A (eds) Actas XXIV Encuentros de Didáctica de las Ciencias Experimentales, julio. Servicio Publicaciones de la Universidad, Jaén, pp. 760–765

Darling-Hammond L (2006) Reforming teacher preparation and licensing: debating the evidence. Teacher education. Major themes in education. Globalisation. Stand Teacher Educ 5:95–124

Darling-Hammond L, Bransford J (2005) Preparing teachers for a changing World. What teachers should learn and what be able to do. Jossey-Bass, San Francisco

De Juanas A, Martín R, González M (2016) Competencias docentes para desarrollar la competencia científica en Educación Primaria. Bordón 68(2):103–120. https://doi.org/10.13042/Bordon.2016.68207

Fuentes E, Saiz Sáenz ML, Pinzón Piñeros DF (2020) Errores sistemáticos en el uso del transportador. Rev Bol Redipe 9(12):300–319. https://doi.org/10.36260/rbr.v9i12.1157

García M, Biencinto C, Carpintero E, Villamor P, Huetos M (2021) Percepción del nivel competencial del profesorado de Educación Primaria y Secundaria. ¿Hay diferencias contextuales? Relieve 27(1):Art.2. https://doi.org/10.30827/relieve.v27i1.20798

García-Barros S (2016) Conocimiento científico conocimiento didáctico. Una tensión permanente en la formación docente. Campo Abierto 35(1):31–44

Hamed Al Lal S, Rivero A, Martín del Pozo R (2016) El cambio en las concepciones de los futuros maestros sobre la metodología de enseñanza de las ciencias durante un programa formativo. Rev Eureka Sobre Enseñ Divulg Cienc 13(2):476–492

Hierrezuelo JM, Franco J, Blanco A (2022) Uso de dilemas socio-científicos para el desarrollo de habilidades de pensamiento crítico en docentes en formación inicial. Percepciones del profesorado. Rev Interuniv Form Profr 36(1):99–122. https://doi.org/10.47553/rifop.v97i36.1.92435

Imbernón F, Colén MT (2014) Los vaivenes de la formación inicial del profesorado. Una reforma siempre inacabada. Tend Pedag 24:265–284. https://revistas.uam.es/tendenciaspedagogicas/article/view/2106

Jiménez MP (2003) Comunicación y lenguaje en las clases de Ciencias. En: Jiménez MP (coord) Enseñar Ciencias. Graó, Barcelona, pp. 55–72.

Jiménez-Liso MR, Martínez-Chico M, Avraamidou L, López-Gay R (2021) Scientific practices in teacher education: the interplay of sense, sensors, and emotions. Res Sci Technol Educ 39(1):44–67. https://doi.org/10.1080/02635143.2019.1647158

Law G (2011) Error in the Fernandez Huerta Readability formula. https://linguistlist.org/issues/22/22-2332.html

Luengo J, Luzón A, Torres M (2008) El enfoque por competencias en el desarrollo de políticas de formación del profesorado. Entrevista a Claude Lessard. Profr Rev Curríc Form Profr 12(3):16, https://revistaseug.ugr.es/index.php/profesorado/article/view/20493

Loughran JJ (2007) Science teacher as learner. In: Abell SK, Lederman NG (eds) Handbook of research on science education. Erlbaum, Mahwah, NJ, pp. 1043–1065

Lupión-Cobos T, López-Castilla R, Blanco-López A (2017) What do science teachers think about developing scientific competences through context-based teaching? A case study. Int J Sci Educ 39(7):937–963. https://doi.org/10.1080/09500693.2017.1310412

Manso J (coord) (2019) La formación inicial del profesorado en España: Análisis de los Planes de Estudios tras una década desde su implementación. Secretaría General Técnica, Madrid.

Martín-Sánchez M, Groves T (2015) La formación del profesorado. Nuevos enfoques desde la teoría e Historia de la Educación, Faren House, Salamanca

Martínez-Chico M, López-Gay R, Jiménez-Liso R (2014) ¿Es posible diseñar un programa formativo para enseñar ciencias por Indagación basada en Modelos en la formación inicial de maestros? Fundamentos, exigencias y aplicación. Didáct Cienc Exp Soc 28:153–173. https://doi.org/10.7203/DESs.28.3153

Mora C, Herrera D (2009) Una revisión sobre ideas previas del concepto de fuerza. Latin-Am J Phys Educ 3(1):72–86. http://www.lajpe.org/jan09/13_Cesar_Mora.PEf

Pedrinaci E (coord) (2012) 11 ideas clave. El desarrollo de la competencia científica. Graó, Barcelona.

Pro A (1998) El análisis de las actividades de enseñanza como fundamento para los programas de formación de profesores. Alambique Didáct Cienc Exp 15:15–28

Pro A (2005) Estudio de las Máquinas y Aparatos en Educación Primaria. En E.Banet, M.Jaén y A.Pro: Didáctica de las Ciencias Experimentales II. Diego Marín, Murcia, pp. 204–222

Pro A, Pro Chereguini C, Cantó J (2022) Cinco problemas en la formación de maestros y maestras para enseñar ciencias en Educación Primaria. Rev Interuniv Form Profr 97(36.1):185–202. https://doi.org/10.47553/rifop.v97i36.1.92510

Pro A, Nortes R (2016) ¿Qué pensaban los estudiantes de la diplomatura de maestro de educación primaria sobre las clases de ciencias de sus prácticas de enseñanza? Enseñ Cienc 34(1):7–32. https://doi.org/10.5565/rev/ensciencias.1762

Pro Chereguini C, Pro Bueno A, Serrano Pastor FJ (2017) ¿Saben los maestros en formación inicial qué subcompetencias están trabajando cuando diseñan una actividad de enseñanza? Enseñ Cienc 35(3):7–28. https://doi.org/10.5565/rev/ensciencias.2205

Pro Chereguini C, Pro Bueno A, Serrano Pastor FJ (2018) ¿Cómo utilizan los maestros en formación inicial sus conocimientos didácticos en el diseño de una prueba experiencial para evaluar subcompetencias de estudiantes de educación primaria? Enseñ Cienc 36(2):43–62. https://doi.org/10.5565/rev/ensciencias.2498

Ramírez A, González N, Salcines I (2018) Las competencias docentes genéricas en los Grados de Educación. Visión del profesorado universitario. Estud Pedag 44(2):259–277. https://doi.org/10.4067/S0718-07052018000200259

Rebolledo T (2015) La formación inicial del profesorado de Educación Primaria y Secundaria. En Alemania, España, Finlandia, Francia y Reino Unido. Estudio comparado. Rev Esp Educ Comp 25:129–148. https://doi.org/10.5944/reec.25.2015

Rivero A, Azcárate P, Porlán R, del Pozo RM, Harres J (2011) The progression of prospective primary teachers' conceptions of the methodology of teaching. Res Sci Educ 41(5):739–769. https://doi.org/10.1007/s11165-010-9188-z

Rivero A, Martín del Pozo R, Solís E, Azcárate P, Porlán R (2017) Cambio del conocimiento sobre la enseñanza de las ciencias de futuros maestros. Enseñ Cienc 35(1):29–52. https://doi.org/10.5565/rev/ensciencias.2068

Rivero A, Porlán R, Solís E, Rodríguez F, Hamed S, Martín del Pozo R, Ezquerra A, Azcárate P (2012) Aprender Enseñar Cienc Prim. Copiarte, Sevilla

Rocard M, Csermely P, Jorde D, Walberg-Henriksson H, Hemmo V (2007) P. McLaren P, Giarelly J (eds) A renewed pedagogy for the future of Europe. Report EU22-845. Directorate-General for Research Science, Economy and Society, Brussels

Sala A, Punie Y, Garkov V, Cabrera M (2020) LifeComp. The European framework for personal, social and learning to learn key competence. *Донну* (European C, Issue September). https://doi.org/10.2760/302967

UNESCO (2015) Educación 2030. Declaración de Incheon y Marco de Acción para la realización del Objetivo de Desarrollo Sostenible 4. https://unesdoc.unesco.org/ark:/48223/pf0000245656_spa

Worth K (2022) El Mundo Divertido de PEEP. Explora las rampas. http://www.peepandthebigwideworld.com/es/educadores/curriculum/educadores-de-cuidado-infantil-familiar/14/las-rampas/

Zabalza M (2012) Las competencias en la formación del profesorado: de la teoría a las propuestas prácticas. Tend Pedagóg 20:5–32. https://revistas.uam.es/tendenciaspedagogicas/issue/view/TP20

Zembal-Saul C (2017) Minding the research–practice gap: promising approaches for continuous innovation in science teacher education. http://tv.us.es/congreso-internacional-sobre-investigacion-en-la-didactica-de-las-ciencias-iii/

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Competing interests
The authors declare no competing interests.

Ethical approval
This study, following the guidelines of the ethics committee of the University of Murcia, is exempt from requiring ethical approval. However, its development has been carried out in accordance with the ethical standards established in the 1964 Declaration of Helsinki and its subsequent amendments or comparable ethical standards.

Informed consent
The authors declare that informed consent was obtained from all study participants.

Additional information
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