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EMOTIONAL TRAINING FOR PROSPECTIVE TEACHERS IN SCIENCE EDUCATION

María Brígido Mero
UDIMA University, Spain
E-mail: maria.brigido@udima.es

Ayar Rodríguez de Castro
University of Alcalá, Spain
E-mail: ayar.rodriguez@uah.es

Ana Lejárraga García, Irene Laviña Pérez, Verónica Nistal Anta
UDIMA University, Spain
E-mail: anamaria.lejarraga@udima.es, irene.lavina@udima.es,
veronica.nistal@udima.es

Abstract

Cognitive and affective interrelationships are increasingly gaining importance in educational literature, assigning emotions a prominent role in the teaching and learning process. This study aims to promote awareness among prospective teachers of their emotional vulnerability and the influence of affective and emotional aspects in the teaching of natural sciences, mathematics, and social sciences. The research had a dual purpose: to analyse the beliefs, attitudes, and emotions of prospective teachers regarding the teaching of these disciplines and to examine the impact on their beliefs and emotions after undergoing specific training. The study topic is justified by the growing attention emotions are receiving as decisive factors in learning processes and the persistent substantial gap in scientific education research, particularly in the realm of online teacher training. To address and analyse this gap, a descriptive quantitative survey study on beliefs, attitudes, and emotions towards the teaching of these courses before and after participation in a training program was designed. The analysis of the data revealed results consistent with previous studies. Specifically, the results demonstrated that prospective teachers showed more negative emotions, beliefs, and attitudes towards the teaching of natural sciences and mathematics compared to the teaching of social sciences. However, in all cases, improvements were observed after receiving specific training. These findings highlight the need to incorporate emotional improvement projects into online teacher training, particularly in the fields of natural sciences and mathematics.
Keywords: *distance education, emotional teaching, pre-service teachers, science education*

Introduction

New global trends in education and, in the Spanish context, the current educational act *Ley Orgánica 3/2020* amending the *Ley Orgánica de Educación 2/2006* (LOMLOE, 2020), aim to progressively transform the teacher's role in the new setting triggered by the communication and digital revolution (Abad et al., 2022). Said law, in line with the most groundbreaking international trends in the field of education, recurrently refers to certain aspects such as the "emotional and moral education" and the "promotion of the critical and scientific spirit''. Regarding the international context, the Sustainable Development Goals (SDGs), adopted by all United Nations Member States in 2015 (UN, 2015), have emphasized, among other matters, the importance of education in transversal values. This new scenario directly addresses

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teachers, who must put their role as educators before that of information providers. In a world in which access to contents and materials is rather easy, teachers must adapt to a new educational ecosystem where the formation of critical and reflective citizens is essential (Cobo et al., 2019; Fernández, 2020; Imbernón, 2020), starting with a reflection of what teaching today entails. As such, transversal, affective, and emotional education is presented as an essential component to improve the teaching skills of future teachers and increase their professional and academic efficiency, and, consequently, that of their future student body.

Until the last decade, affective factors, considered irrational and unscientific, were excluded from educational research. This explains the fact that cognitive aspects have been paid more attention in didactics research, especially in relation to the natural sciences (Mellado et al., 2014; Romero-Rincón et al., 2021; Vázquez & Manassero, 2007), leaving emotional and affective factors in the background. Luckily, more and more studies advocate teaching as an emotional practice (Puertas et al., 2018; Santander et al., 2020; Van Veen et al., 2005) and underline the importance of paying attention to the attitudes, emotions, and beliefs of current and future teachers as something that cannot be separated from cognition (Bachler et al., 2023; Egloff & Souvignier, 2020; Hargreaves, 2000; Zembylas, 2018), a basic pillar to improve the professional satisfaction of teachers (Kasalak & Dagyar, 2020). The turning point for the understanding and evaluation of affective variables in learning processes was in the 1990s. Since McLeod and Adams started talking about "affective dominion" in 1989 and with the emergence of concepts such as "emotional intelligence" (attributed to Salovey & Mayer in 1990), or "emotional illiteracy" (Goleman, 1996), research has taken great strides in the study of the emotional impact on learning from disciplines such as psychology, anthropology, or neuroscience. Specifically, neuroscience has revealed that emotions trigger brain connections that enable optimal cognitive and mental performance and promote creativity and learning (De la Barrera & Rigo, 2019; Domínguez, 2019; Mora et al., 2022). In this way, it can be argued that positive emotional states facilitate the teaching and learning process and that emotion is crucial for decision-making processes (Benavidez & Flores, 2019; Damasio, 2010; Li et al., 2020; López-Martínez et al., 2022; Mustafina et al., 2020), which are ongoing in classroom settings for both teachers and students. However, research to link emotional aspects and science didactics did not start until 2005 (Hugo, 2005; Martins & Borges, 2005).

Based on these arguments, the importance of paying attention to the affective and emotional aspects of teaching to improve classroom practice becomes clear. It is accepted that, especially in the earliest educational stages, preschool and primary school, acquiring transversal and emotional skills is key, but said competencies will be impossible to promote if teachers do not acquire them first (Escolar et al., 2017; Mora et al., 2022). In this regard, numerous studies indicate that the teacher's memories of the attitudes, beliefs, and emotions linked to the different subjects during their school years are transferred to their teaching, and this should be a concern, particularly regarding the teaching of negative emotion-generating subjects, like the natural sciences (Bravo et al., 2022; Brígido et al, 2013). The teachers' affective projection upon the teaching of the natural sciences and their possible effect on the students is a critical area of analysis in education. This interaction between the educators' emotions and their influence in the teaching-learning process is grounded on the "emotional contagion" theory, which suggests that the teachers' emotional states are passed on to their students and that this has a significant impact on their educational experience (Houser & Waldbuesser, 2017; Mottet & Beebe, 2002). In this sense, the expression of negative emotions by the teachers during natural sciences teaching can have detrimental consequences on their students' education. First, negative emotions, like fear or anxiety, can reduce the students' motivation and interest in the learning process; when students feel their teachers' negative attitudes and emotions, they can also develop them towards the natural sciences, which, at the same time, reinforces the dissatisfaction and the negative feelings of the teachers, leading to a negative feedback

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cycle. To counteract this phenomenon, teachers must be aware of the influence that their own beliefs, attitudes, and emotions have on the educational process and seek strategies to manage and modify them effectively, especially since this relationship has been demonstrated in all dimensions of the teaching-learning process (Brígido et al., 2012; Herrera & Vázquez, 2020). Therefore, specific training in the management of emotional skills, both during initial training and in lifelong training programs, is a must particularly because teachers themselves demand improvements in emotional competence training (Cejudo & López-Delgado, 2017; Donahue-Keegan, et al., 2019; García-Vila et al., 2022; Porras et al., 2020; Sepúlveda et al., 2021).

The Mejores Docentes project

UDIMA's training programme #MejoresDocentes (#BetterTeachers), developed in the 2020-21, 2021-22, and 2022-23 academic years and directed by lecturers from five different disciplines at two Spanish universities, was born out of the need to foster critical and reflective teacher profiles, based on metacognitive approaches, the potential of which to improve efficiency in teaching processes has been amply demonstrated (Duman & Semerci, 2019; Laso et al., 2019). The target was to make teachers aware of their duty to promote new skills and knowledge to help their students respond to a changing world, such as emotional education, digital competence, and education for sustainable development and gender equality, among others. This is reflected in new regulations and plans that are turning the early education of teachers into a veritable challenge, especially in terms of online training (Aneas-Novo et al., 2019; Naylor & Nyanjom, 2021).

During the 2022-23 academic year, the programme focused on the idea of teaching as an emotional practice. A space for multidisciplinary reflection was created through meetings and training workshops to complement the basic training in emotional and strategic skills, helping teachers to become more aware of, assess and self-regulate the attitudes, beliefs and emotions triggered by the teaching of the sciences and mathematics.

Research Problem

Recent studies show that teachers believe that they are not sufficiently prepared in terms of pedagogic techniques and classroom practice (Imbernón, 2019; OECD, 2019). The BetterTeachers training programme addressed this issue by focusing on the impact of emotions, one of the most complex and least studied variables, which play a decisive role in teaching and learning. As noted, one of the variables that play an emotional role in teaching is the subject matter; however, studies on this are few and far between. Despite this gap in educational research, it has been proven that learning and teaching the natural sciences create more negative attitudes, beliefs, and emotions than the social sciences (Bravo et al., 2022; Brígido et al., 2013; Park & Flores, 2021), and that specific training programs bring improvement across the board (Borrachero et al., 2017; Bravo et al., 2022; Mellado et al., 2014). This, however, is yet to be proven in online training contexts, a gap that this project intended to fill.

This research intended to analyse the beliefs, attitudes, and emotions of prospective teachers about the teaching of the natural sciences and mathematics, and if these improve after participating in the training programme.

To summarize, the questions addressed in the present work were:
1. What are prospective teachers' beliefs, attitudes, and emotions about teaching the natural sciences and mathematics? Are there any differences regarding social sciences teaching?
2. Do beliefs, attitudes, and emotions improve after participating in a training programme designed for a virtual environment?

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3. Is there a relationship between their beliefs, attitudes, and emotions and the teaching of mathematics, natural sciences, and social sciences?

Research Methodology

General Background

An ad hoc Virtual Classroom was created to implement several formative and reflective activities related to emotional aspects of interest for future educators, as well as to conduct experimental exercises with prospective teachers. This classroom, which used the Moodle platform, was conceived as a virtual space for accessible, engaging, and personalized learning, with the educational objective of operating as a meeting point for trainee teachers and as a forum to roll out the project's initiatives and activities.

The project's progression highlighted the potential of this virtual space to be more than just a training room, acting as a collaborative space for the creation of teaching strategies from a transversal perspective. In addition, it worked as a forum for open discussion within a community of educators and future teachers, facilitating the exchange of knowledge, concerns, reflections, and experiences related to their teacher training programs.

The perceptions of participants were collected through a structured questionnaire designed with the primary aim of identifying beliefs, attitudes, and emotions regarding the teaching of the natural and social sciences among students from various university teacher training programmes. The questionnaire was handed over to participants at the beginning of the project (March 2022) and at its conclusion (June 2022), with the goal of not only outlining their conceptions and prejudices but also assessing whether the activities and discussions triggered by the project had an impact on these perceptions. The pre-and post-project surveys were an organic part of the project's design, and all participants were required to answer the questionnaires.

The project was open to all members of the Department of Education at UDIMA, and invitations were extended to all current and prospective teachers interested in taking part in the initiative. The project was advertised in the university's virtual classrooms, where students in various teacher training programs were invited to participate. The project's value as a supplementary educational opportunity proved to have a strong appeal among prospective teachers, and a significant number of students enrolled in the university's main teacher training programmes volunteered to take part.

Sample

The sample comprised 61 students sitting different BA and MA degrees at UDIMA's Faculty of Psychology and Education during the 2022-2023 academic year; 40% of participants were enrolled in the MA Degree in Secondary School Training (any speciality); 27% in the BA Degree in Primary Education; and 17% in the BA Degree in Early Childhood Education. The remaining 13% came from the MA Degree in Education and ICT (e-learning). By gender, the sample comprised 55 (90.2%) females and 6 (9.8%) males, figures which reflect the predominance of female students in teacher training programmes. Most of the participants (78%) claimed to have teaching experience, 22% of which had a track record between 1 to 3 years and 3% over 10 years. 60 participants answered the initial questionnaire (98.36%) and 42 (68.85%) the final questionnaire. The number of participants who took part in both questionnaires was 41 (67.21%).

Despite the seemingly limited size of the sample, it is important to note, first, that this number is representative of the student body taking UDIMA's online teacher training

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programmes, accounting for approximately 5% of all students taking BA and MA programmes; second, it is worth emphasising that the sample stands out in that a substantial percentage of participants possess prior teaching experience, which renders their impressions concerning teaching, specifically its emotional aspects, particularly valuable. Furthermore, the study unfolds in an online teaching environment, which allows for more personalised attention to participants and, thus, for greater project efficiency. In this context, we believe that this study represents the profile of future teachers graduating from our university in terms of their emotional perception of teaching and their understanding of the profession's significance in this regard.

Therefore, the sample can be regarded as representative of UDIMA's teacher training student bodies, whose profile presents distinctive features vis-à-vis those in other universities. UDIMA supports a personalized and online teaching model that fosters transversal and holistic training for future teachers and uses platforms and training resources that are not effective in other teaching environments, such as overcrowded classrooms. Training initiatives regarding emotional aspects could not have been paid the same degree of personalised attention had the sample been larger.

Data Collection and Analysis Procedures

This research is a descriptive quantitative study in the type of a survey. The data were obtained from a validated questionnaire by Brígido (2014). The questionnaire included two basic categories, with three subcategories referring to the teaching of natural sciences, mathematics and social sciences:

The questionnaire includes two basic categories:

1. Attitudes and beliefs towards teaching. This includes questions related to attitudes and self-regulation beliefs, attitudes and self-efficacy beliefs and attitudes and beliefs towards teaching. The participants had to choose an answer from a series of statements on a five-choice Likert scale ranging from "strongly agree (5)" to "disagree (1)."

2. Emotions towards teaching. The participants must point out which of the thirteen emotions they feel in relation to different statements.

With the purpose of validating the internal consistency of the questionnaire, the Cronbach's alpha test (internal consistency index) was undertaken, yielding a result of .775, which suggests that it is a reliable tool, meaning that its measurements are stable and consistent. Results between .70 and .95 are regarded as reliable (Barrios & Cosculluela, 2013). For data coding, values pertaining to different emotions were grouped into the following categories:

• Positive emotions: joy, love, hope, happiness.
• Neutral emotions: compassion, humour, surprise.
• Negative emotions: anxiety, rage, fear, rejection, sadness, embarrassment.

Participants answered the questionnaire in Google Forms at the project's beginning and end. After collection, data went through standard protocols, such as depuration, coding (identification of the subjects and their choices in the different questionnaire items), and computer recording before further analysis with the statistical package SPSS. The Kolmogorov-Smirnov test was carried out to verify the normality of score distribution, and the result showed that none of the variables presented a normal distribution, so non-parametric tests were selected for further analysis. The Wilcoxon test was used to establish significant differences in the results collected before and after the project. The Wilcoxon statistic (Z) and its bilateral critical level (bilateral asymptotic significance), with a 90% confidence level, were calculated.

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Research Results

Attitudes and Beliefs Towards Teaching

Table 1 presents the mean results concerning attitudes and beliefs towards the teaching of the natural sciences and mathematics (NSM) and the teaching of the social sciences (SS), as well as the results of the Wilcoxon test.

Table 1
Trainee Teachers' Attitudes at the Beginning and End of the Project

	Statements	**Mean Pre-Project**	**Mean Post-Project**	**Wilcoxon statistician**	*p*-value
	Below you will find a series of statements concerning inclusive education, which you should read carefully. Please tick the box that reflects your level of agreement or disagreement with each statement: 5 Strongly agree; 4 Somewhat agree; 3 Indifferent; 2 Somewhat disagree; 1 Strongly disagree.				
SOCIAL SCIENCES	**[1SS]** [I shall try to be patient and understanding with my students in the social science subjects at all times] (*)	4.85	4.88	-.276	.783
	[2SS] [When I do not understand a social science concept that I have to explain to my students, I shall spend less time on it] (*)	1.41	2.02	-2.492	.013
	[3SS] [When I am unsure about social science concepts that I have to explain, I shall find information through different means] (*)	4.78	4.85	-.351	.726
	[4SS] [I believe my training has been appropriate for social science teaching] (**)	3.68	4.02	-1.783	.075
	[5SS] [I shall like my way of imparting a social science class to be evaluated] (**)	4.44	4.59	-1.269	.204
	[6SS] [I shall try to avoid my students asking me questions about complex social science issues] (**)	1.29	1.80	-2.012	.044
	[7SS] [I shall feel able to carry out practical social science activities with the students] (**)	4.39	4.59	-1.999	.046
	[8SS] [My students would not improve even if I increased my effort in social science class] (**)	1.29	1.54	-1.075	.282
	[9SS] [I would like to compliment my social science classes with examples, diagrams and summaries that help explain concepts] (***)	4.83	4.90	-1.000	.317
	[10SS] [I would like to prepare my social science classes in depth] (***)	4.78	4.76	-.250	.803
	[11SS] [I shall try to establish relationships between the social science concepts that I must teach my students] (***)	4.78	4.73	-.465	.642

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[1NSM] [I shall try to be patient and understanding with my students in the natural sciences and mathematics subjects at all times] (*)	4.78	4.76	-.247	.805
[2NSM] [When I do not understand a natural sciences and mathematics concept that I have to explain to my students, I shall spend less time on it] (*)	1.44	1.90	-2.196	.028
[3NSM] [When I am unsure about natural sciences and mathematics concepts that I have to explain, I shall find information through different means] (*)	4.85	4.83	-.322	.748
[4NSM] [I believe my training has been appropriate for natural sciences and mathematics teaching] (**)	3.15	3.71	-2.581	.010
[5NSM] [I would like my way of imparting natural sciences and mathematics classes to be evaluated] (**)	3.95	4.17	-1.178	.239
[6NSM] [I shall try to avoid that my students ask me questions about the complex natural sciences and mathematics context] (**)	1.37	1.73	-1.487	.137
[7NSM] [I shall feel able to carry out practical natural sciences and mathematics activities with my students] (**)	4.49	4.44	-.144	.886
[8NSM] [My students would not improve even if I increased my effort in natural sciences and mathematics classes] (**)	1.56	1.78	-1.019	.308
[9NSM] [I would like to complete? my natural sciences and mathematics classes with examples, diagrams and summaries that help explain concepts] (***)	4.63	4.66	-.243	.808
[10NSM] [I would like to prepare my natural sciences and mathematics classes in depth] (***)	4.76	4.59	-.758	.448
[11NSM] [I shall try to establish relationships between the natural sciences and mathematics concepts that I must teach my students] (***)	4.61	4.71	-1.155	.248

Note. (*) self-regulated attitudes and beliefs, (**) self-efficacy attitudes and beliefs, (***) attitudes and beliefs towards teaching methods

The analysis of the data suggests that, generally, project participants had positive attitudes and beliefs towards teaching, especially towards the social sciences and less so towards the natural sciences and mathematics.

Significant differences were attested in six items (shadowed in grey), with values that suggest improvement in some of the respondents' perceptions. Some of these results indicated an improved perception of self-efficacy, which means that respondents think that their teaching aptitudes have improved after the project, in both the social sciences and the natural sciences and mathematics. However, other values were lower after the project, for instance concerning spending less time in teaching when the subject matter is not well understood (again, concerning both the social sciences and the natural sciences and mathematics), although these differences were not significant.

Using Wilcoxon's statistic, with a 90% confidence level, to establish the significance of differences in pre- and post-project answers (Table 2), it was found that significant differences

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between the means pertaining to the social sciences and the natural sciences/mathematics existed in four statements ([5], [8], [9] and [11]) pre-project, whereas only two statements ([5] and [9]), presented significantly different means post-project. Across the board, the teaching of the social sciences triggers more positive beliefs and attitudes than the teaching of mathematics and the natural sciences.

Table 2

Comparison of Means in Pre-project and Post-project Answers according to Wilcoxon's Statistic

Statements	Pre-Project				Post-Project			
	Mean SS	Mean NSM	Wilcoxon statistician	*p*-value	Mean SS	Mean NSM	Wilcoxon statistician	*p*-value
[1]	4.85	4.78	-1.342	.180	4.88	4.76	-1.406	.160
[2]	1.41	1.44	-.325	.746	2.02	1.90	-.603	.546
[3]	4.78	4.85	-.378	.705	4.85	4.83	-.333	.739
[4]	3.68	3.15	-1.379	.168	4.02	3.71	-1.240	.215
[5]	4.44	3.95	-3.466	.001	4.59	4.17	-2.315	.021
[6]	1.29	1.37	-.647	.518	1.80	1.73	-.288	.773
[7]	4.39	4.49	-.511	.609	4.59	4.44	-1.136	.256
[8]	1.29	1.56	-1.663	.096	1.54	1.78	-1.194	.232
[9]	4.83	4.63	-1.903	.057	4.90	4.66	-2.226	.026
[10]	4.78	4.76	-.333	.739	4.76	4.59	-1.150	.250
[11]	4.78	4.61	-1.807	.071	4.73	4.71	-1.193	.855

In this way, before participating in the project, prospective teachers indicated that they intended to support their classes with examples, diagrams and summaries and to establish relationships between the concepts they have to teach their students, and also that they would like their students to evaluate their teaching methods, in all instances to a greater extent when teaching the social sciences than the natural sciences or mathematics. Furthermore, they did not believe that their students' performance in the natural sciences or mathematics would improve if they invested more effort in teaching. After participating in the project, students still thought that they would support their classes with examples, diagrams and summaries and that they would like their teaching methods to be evaluated, but, again, to a greater extent when teaching the social sciences than with the natural sciences or mathematics.

Emotions towards Teaching

Afterwards, possible differences in the participants' emotions towards the teaching of the natural sciences, mathematics, and the social sciences were examined.

In order to analyse the evolution of the participants' emotions, responses were divided into three categories, which were given numerical values to establish possible differences in the means pre- and post-project (Table 3).

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Table 3

Categories of the Emotions Expressed by Participants

Emotion	Category	Valor
Anxiety, Anger, Fear, Rejection, Sadness, Shame	Negative	1
Compassion, Humor, Surprise	Neutral	2
Joy, Love, Hope, Happiness	Positive	3

Figure 1 illustrates the comparison between the emotions predicted by participants towards the teaching of the social sciences content (SS) and the natural sciences and mathematics (SM), before and after the project.

Figure 1

Emotions Experienced Before and After Participating in the Project
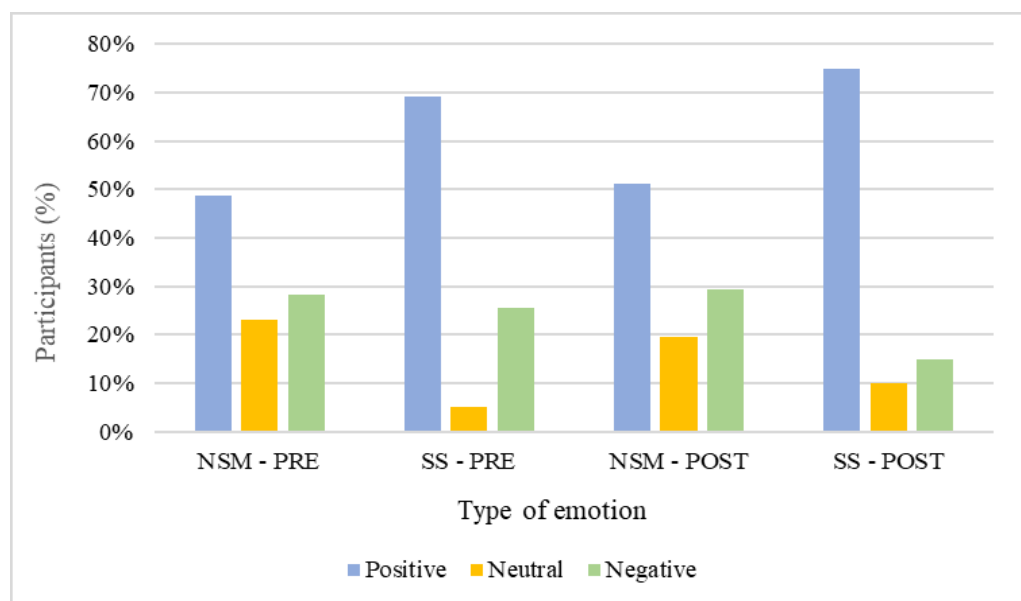
In general, it was observed that teaching the social science produced more positive emotions (joy, love, happiness…), and teaching the natural sciences and mathematics more negative emotions (anxiety, fear, rejection…) among participants, and that after the project there was an increase in positive emotions.

The Wilcoxon test (Table 4) indicated no significant differences between the means. However, the increase in the absolute value of the means suggests that taking part in the project resulted in an increase in positive emotions, especially concerning the teaching of the social sciences.

Table 4

Comparison of Means in Pre- and Post-project Answers according to Wilcoxon's Statistic

Emotions in teaching	Mean Pre-Project	Mean Post-Project	Wilcoxon statistician	*p*-value
[Natural sciences and mathematics content]	2.21	2.22	-.367	.714
[Social science content]	2.44	2.60	-.914	.361

Relationships Between Attitudes, Beliefs, and Emotions in Teaching

The chi-square test of independence was used to detect relationships between the predicted attitudes and beliefs of participants toward teaching in the natural sciences, mathematics, and social sciences.

In those statements in which the test's result is p-value <.10 (shaded in grey), it was concluded that the null hypothesis that the variables are independent can be rejected, with a 90% confidence level, and it was confirmed that some type of association between the emotions experienced by teachers and the teaching of both the natural sciences and mathematics (NSM) and the social sciences (SS) exist. This association is detected in statements [6], [8], [9] and [11] in the case of the natural sciences and mathematics, and in statements [4], [8] and [9] in the social sciences, as presented in Table 5.

Table 5

Post-project Results of Pearson's Chi-square Test

Statements	Natural sciences and mathematics (NSM)		Social sciences (SS)	
	Pearson Chi-Square	*p*-value	Pearson Chi-Square	*p*-value
[1]	7.155	.128	1.551	.956
[2]	5.602	.469	9.468	.149
[3]	3.769	.438	1.632	.950
[4]	8.595	.378	16.641	.055
[5]	10.642	.223	1.928	.926
[6]	12.281	.056	9.481	.394
[7]	7.944	.242	4.485	.877
[8]	14.165	.078	26.468	.009
[9]	12.318	.015	6.358	.095
[10]	9.846	.131	5.301	.506
[11]	10.685	.030	4.412	.882

The analysis of the contingency tables for the statements in which some association between teachers' attitudes and beliefs and their emotions was attested (Table 5) revealed that respondents with more positive attitudes and beliefs in the statements [6], [8], [9] and [11] in the natural sciences and mathematics, and in the statements [4], [8] and [9] in the social sciences, experienced positive emotions more often than expected.

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Discussion

These results emphasize the importance of transversal skills for teachers, as well as the influence of affective and emotional factors on training and teaching. Although this connection has been pointed out in previous studies (Borrachero et al., 2017; Brígido, 2014; Donahue-Keegan et al., 2019), studies on this topic are few and far between, especially in the field of science education (Romero-Rincón et al., 2021), and in general terms, there are still more questions than solid answers. The results highlight the importance of raising awareness of the emotional vulnerability of prospective teachers at different educational stages regarding the teaching of the natural sciences, mathematics, and the social sciences, which was the ultimate target of the study.

Before the project, prospective teachers presented positive attitudes, beliefs, and emotions towards teaching, especially towards the social sciences and less so towards the natural sciences and mathematics; these results are in line with the few previous studies that address these variables and recommend taking tailored approaches to each subject (Bravo et al., 2022; Brígido et al., 2012; Melo et al., 2017). It was noted that participants predicted greater patience and understanding towards their students when teaching the social sciences than when teaching the natural sciences and mathematics. Low teacher self-efficacy may be related to a lack of confidence towards scientific disciplines. In addition, this lack of confidence could foster negative emotions and attitudes towards these subjects (Borrachero et al., 2017; Rohaan et al., 2010). Confidence should be developed at an earlier stage, specifically during the prospective teachers' school years. Later, remedial efforts must be deployed to develop their confidence throughout their university education. It is thus important to think about the influence of emotional factors on teachers, which is rooted in their own experience as science students; several studies indicate that the attitudes, beliefs, and emotions that teachers display in class are strongly related to those felt during their own school years (Borrachero, 2015; Bravo et al., 2022; Brígido et al., 2013; Mellado et al., 2014). As such, it must be broken the "emotional contagion" and the related negative feedback cycle (Houser & Waldbuesser, 2017; Mottet & Beebe, 2002).

The university educational landscape, characterized by the prevalence of traditional teaching methods with excessively theoretical contents and lectures (Jiménez et al., 2020), is reflected in the results, as prospective teachers do not feel that their training prepares them to teach, particularly in connection with the natural sciences and mathematics. The need to develop transversal scientific knowledge is obvious, leading to creative and innovative didactic methods. This idea is reinforced by questionnaire answers that indicate that participants wish to provide their students with more specific examples, diagrams and summaries and to establish relationships between social sciences-related topics, whereas the natural sciences are felt to give less leeway for this type of initiative. The results are in line with new global trends in education, which support the progressive transformation of the teacher's role (Abad et al., 2022), and emphasize the importance of having teachers who not only have solid pedagogical and disciplinary training, but whose emotional stance has a positive impact on teaching, and, it follows, on the quality of the education imparted (Benavidez & Flores, 2019; López-Martínez et al., 2022; Santander et al., 2020; UN, 2015).

After participating in the project, differences between the natural sciences/mathematics and the social sciences became less pronounced. However, although, in general, the attitudes, emotions and beliefs improved, the differences in pre- and post-project results were not significant. This could be the result of reflection and metacognition after the sessions, during which the students were made aware of the different problems that could arise in the classroom. Therefore, teacher training programmes based on metacognitive approaches efficiently foster the recognition and regulation of cognitive processes, which are key to improve the teaching

María BRÍGIDO MERO, Ayar RODRÍGUEZ de CASTRO, Ana LEJÁRRAGA GARCÍA, Irene LAVIÑA PÉREZ, Verónica NISTAL ANTA.
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process (Donahue-Keegan, et al., 2019; Duman & Semerci, 2019; Laso et al., 2019; Sepúlveda et al., 2021).

A relationship between beliefs, attitudes, and emotions was attested. Post-project results demonstrated a direct relationship between positive attitudes/beliefs and positive emotions, in line with previous studies, which argue for a relationship between different emotional factors in both teaching and learning (Brígido et al., 2012; Herrera & Vázquez, 2020), as well as for a direct relation between emotions and the professional satisfaction of teachers (Kasalak & Dagyar, 2020). In particular, students who expressed more positive emotions towards the teaching of both NSM and SS are also those willing to support their explanations with examples, diagrams, and summaries, as well as believing that a greater effort in teaching will lead to improved student performance. This is in line with Ritchie et al. (2011), which established a connection between teachers' emotions and students expected results; positive emotions led to higher expectations and negative emotions to lower expectations and the perception that achieving goals was impossible.

Conclusions and Implications

This research highlights the importance of considering affective and emotional factors in the training and teaching of prospective teachers as a way to improve the teaching-learning process, particularly in subjects related to the natural sciences and mathematics.

The improvement in post-project attitudes, beliefs, and emotions, specially towards the natural sciences and mathematics, demonstrates the relevance of self-awareness of emotional vulnerability among trainee teachers. This is a key tool to improve teaching practice, for teachers with or without previous teaching experience. These results not only have implications for individual teachers but also call for institutional changes. Adapting university teacher training curricula, which are predominantly rooted in theoretical didactic methods, seems fully justified, and the need to design programmes to improve professional development based on emotional teaching is also clear.

The relatively small size of the sample and the specific characteristics of the participants are regarded as the main limitations of this study. However, it is common for participants in this type of research to lack prior teaching experience, which recommends future studies to consider this variable with larger samples, allowing for the extrapolation of results. Additionally, the online education factor is a novelty of this study. In the frame of online education, the challenge posed by emotional aspects in teacher training programmes can be turned into an opportunity with the design of transversal initiatives, such as the one put forth by the BetterTeachers project. The potential for interaction afforded by online environments creates ideal conditions for collaborative learning environments, which are particularly suitable to develop emotional skills.

Finally, it is deemed necessary to recognize and enhance the value of emotional education as a fundamental factor in teacher training programmes. Emotions should take centre stage, considering the part that teachers play in current education, more as guides than lecturers, who must engage in the emotional and social experience of their students. To achieve this, it is crucial to continue investigating the formative needs of teachers in this regard. Although significant progress has been made in many areas, research focused on the influence of metacognitive training on affective and emotional aspects in teacher education is scarce. The results are in line with previous studies, which emphasize the positive impact of emotional training programmes on the beliefs, attitudes, and emotions of teachers and prospective teachers, especially in subjects that pose greater cognitive and emotional challenges, such as the natural sciences and mathematics.

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Authors declare no competing interest.

References

Abad, E., Luque, A., Hervás-Gómez, C., & Carmona, N. (2022). *Enseñar y aprender en ámbitos formativos* [Teaching and learning in educational settings]. Dykinson.

Aneas-Novo, C., Sánchez-Rodríguez, J., & Sánchez-Rivas, E. (2019). Valoración de la formación del profesorado: Comparativa entre autoformación y formación presencial [Assessment of teacher training: Comparison between self-training and face-to-face instruction]. *Gestión y Análisis de Políticas Públicas*, *21*, 94–108. https://doi.org/10.24965/gapp.v0i21.10569

Bachler, R., Segovia-Lagos, P., & Porras, C. (2023). The role of emotions in educational processes: The conceptions of teacher educators. *Frontiers in Psychology*, *14*. https://doi.org/10.3389/fpsyg.2023.1145294

Barrios, M., & Cosculluela, A. (2013). Fiabilidad [reliability]. In J. Meneses (Ed.), *Psicometría* (pp. 75–140). UOC.

Benavidez V., & Flores, R. (2019). The importance of emotions for the neurodidactics. *Wimb Lu*, *14*(1), 25–53. https://doi.org/10.15517/wl.v14i1.35935

Borrachero, A. B. (2015). The emotions in the teaching and learning of science in secondary education. *Enseñanza de las Ciencias*, *33*(3), 199–200.

Borrachero, A. B., Dávila, M. A., Costillo, E., & Mellado, V. (2017). The emotions of future secondary teachers of science and mathematics, after an intervention program. *Ápice*, *1*(1), 17–39. https://doi.org/10.17979/arec.2017.1.1.2008

Bravo, E., Brígido, M., Hernández, M. A., & Mellado, V. (2022). Emotions in science during the initial training of Early Childhood and Primary Education teachers. *Revista Interuniversitaria de Formación del Profesorado*, *97*, 57–74. https://doi.org/10.47553/rifop.v97i36.1.92426

Brígido, M., Borrachero, A. B., Bermejo, M. L., & Mellado, V. (2012). Prospective primary teachers' self-efficacy and emotions in science teaching. *European Journal of Teacher Education*, *36*(2), 200–217. https://doi.org/10.1080/02619768.2012.686993

Brígido, M., Couso, D., Gutiérrez, C., & Mellado, V. (2013). The emotions about teaching and learning science: A study of prospective primary teachers in three Spanish universities. *Journal of Baltic Science Education*, *12*(3), 299–311. http://dx.doi.org/10.33225/jbse/13.12.299

Brígido, M. (2014). Programa metacognitivo de intervención emocional en la enseñanza de las ciencias experimentales para maestros de primaria en formación inicial [Doctoral dissertation, University of Extremadura]. Spanish Ministry of Education Collections. https://www.educacion.gob.es/teseo/mostrarRef.do?ref=1067205

Cejudo, J., & López-Delgado, M. L. (2017). Importance of emotional intelligence in the teaching practice: A study with primary education teachers. *Educational Psychology*, *23*(1), 29–36. http://dx.doi.org/10.1016/j.pse.2016.11.001

Cobo, C., Abril, A. M., & Romero, M. (2019). Didactical approach in the teacher training to work with nature of science and critical thinking. *Ápice. Revista de Educación Científica*, *3*(1), 15–28. https://doi.org/10.17979/arec.2019.3.1.4630

Damasio, A. (2010). *Y el cerebro creó al hombre* [And the brain created man]. Destino.

De la Barrera, M., & Rigo, D. (2019). Executive functions and metacognition: A dialogue between neuropsychology and educational psychology. *Revista de Investigación CRONÍA*, *15*(19), 38–49. http://hdl.handle.net/11336/126362

Domínguez, M. (2019). Neuroeducation: Elements to enhance learning in the classrooms of the 21st century. *Educación y Ciencia*, *8*(52), 66–76. https://dialnet.unirioja.es/servlet/articulo?codigo=9119603

Donahue-Keegan, D., Villegas-Reimers, E., & Cressey, J. M. (2019). Integrating social-emotional learning and culturally responsive teaching in teacher education preparation programs. *Teacher Education Quarterly*, *46*(4), 150–168. https://www.jstor.org/stable/26841580

Duman, B., & Semerci, C. (2019). The effect of a metacognition-based instructional practice on the metacognitive awareness of the prospective teachers. *Universal Journal of Educational Research, 7*(3), 720–728. http://dx.doi.org/10.13189/ujer.2019.070311

Egloff, F., & Souvignier, E. (2020). Effects of emotion on teaching-related beliefs, attitudes, and intentions of preservice teachers. *Psychology Learning & Teaching, 19*, 161–183. https://doi.org/10.1177/1475725719868841

Escolar, M. C., De la Torre, T., Huelmo, J., & Palmero, C. (2017). Educación emocional en los profesores de infantil: Aspecto clave en el desempeño docente [Emotional education in early childhood education teachers: A key aspect in teaching performance.]. *Contextos Educativos*, *20*, 113–125. https://doi.org/10.18172/con.2994

Fernández, E. (2020). La metodología docente adecuada para la formación inicial de profesionales de la educación críticos y reflexivos en sus prácticas externas: Un estudio al alumnado de pedagogía [Appropriate teaching methodology for the initial training of critical and reflective education professionals in their external placements: A study of student teachers.]. In E.J. Díez & J.R. Rodríguez (Eds.)*, Educación para el Bien Común: Hacia una práctica crítica, inclusiva y comprometida socialmente* (pp. 357–365). Octaedro.

García-Vila, E., Sepúlveda-Ruiz, M. P., & Mayorga-Fernández, M. J. (2022). The emotional competences of the students of the teacher's degrees in Early Childhood and Primary Education: An essential dimension in initial teacher training. *Revista Complutense de Educación*, *33*(1), 119–130. http://dx.doi.org/10.5209/rced.73819

Goleman, D. (1996). *Emotional intelligence.* Bantam.

Hargreaves, A. (2000). Mixed emotions: Teachers' perceptions of their interactions with students. *Teaching and Teacher Education*, *16*(7), 811–826. https://doi.org/10.1016/S0742-051X(00)00028-7

Herrera, A. D., & Vázquez, B. (2020). Beliefs, attitudes and emotions of a group of primary school teachers in the teaching of environmental education topics. *Investigación en la Escuela*, *102*, 1–15. https://doi.org/10.12795/IE.2020.i102.01

Houser, M. L., & Waldbuesser, C. (2017). Emotional contagion in the classroom: The impact of teacher satisfaction and confirmation on perceptions of student nonverbal classroom behavior. *College Teaching*, *65*(1), 1–8. https://doi.org/10.1080/87567555.2016.1189390

Hugo, D. (2005). *Desafiar la formación de profesores de ciencias trabajando con metas y emociones* [Challenging science teacher education by working with goals and emotions] [Conference]. VII International Congress on Research in Science Didactics, Granada, Spain.

Imbernón, F. (2019). Secondary education teachers' training: The eternal nightmare. *Revista de Currículum y Formación de Profesorado*, *23*(3), 151–163. http://doi.org/10.30827/profesorado.v23i3.9302

Imbernón, F. (2020). Personal, professional and institutional development and teacher training: Some trends for the 21st century. *Revista Qurriculum*, *33*, 49–67. https://doi.org/10.25145/j.qurricul.2020.33.04

Jiménez, D., González, J. J., & Tornel, M. (2020). Active methodologies in the university and their relationship with teaching approaches, *Revista de Currículum y Formación del Profesorado*, *24*(1), 76–94. https://doi.org/10.30827/profesorado.v24i1.8173

Kasalak, G., & Dagyar, M. (2020). The relationship between teacher self-efficacy and teacher job satisfaction: A meta-analysis of the teaching and learning international survey (TALIS). *Educational Sciences: Theory and Practice*, *20*(3), 16–33. http://dx.doi.org/10.12738/jestp.2020.3.002

Laso, S., Ruiz, M., & Marbán, J. M. (2019). Impact of a metacognitive program on the environmental awareness of the students of the primary education degree. *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias*, *16*(2). https://doi.org/10.25267/Rev_Eureka_ensen_divulg_cienc.2019.v16.i2.2501

Li, L., Gow, A. D. I., & Zhou, J. (2020). The role of positive emotions in education: A neuroscience perspective. *Mind, Brain and Education*, *14*(3), 220–234. https://doi.org/10.1111/mbe.12244

LOMLOE (2020). Ley Orgánica 3/2020, de 29 de diciembre, por la que se modifica la Ley Orgánica 2/2006, de 3 de mayo, de Educación, (2020). Boletín Oficial del Estado, 340, sección I, de 30 de diciembre de 2020, 122868 a 122953. https://www.boe.es/eli/es/lo/2020/12/29/3

López-Martínez, O., García-Jiménez, E., & Cuesta-Sáez-de-Tejada, J.-D. (2022). El bienestar emocional de los docentes como factor determinante en los procesos de enseñanza/aprendizaje en el aula [Teachers' emotional well-being as a determining factor in classroom teaching/learning processes]. *Estudios Sobre Educación*, *44*, 155–177. https://doi.org/10.15581/004.44.007

Martins, J., & Borges, O. (2005). *Emoções de professores do ensino médio em procedimentos de ensino [Emotions of secondary school teachers in teaching procedures]* [congress communication]. Encontro Nacional de Pesquisa em Educação em Ciências, Bauru, Brasil.

Mcleod, D. B., & Adams, V. M. (1989). *Affect and mathematical problem solving: A new perspective.* Springer-Verlag.

Mellado, V., Borrachero, B., Brígido, M., Melo, L., Dávila, M., Cañada, F., Conde, C., Costillo, E., Cubero, J. Esteban, R., Martínez, G., Ruíz, C., Sánchez, J., Garritz, A., Mellado, L., Vázquez, R., & Bermejo, M. (2014). Emotions in science teaching. *Enseñanza de las Ciencias*, *32*(3), 11–36. http://dx.doi.org/10.5565/rev/ensciencias.1478

Melo, L., Cañada, F., & Mellado, V. (2017). Exploring the emotions in pedagogical content knowledge about the electric field. *International Journal of Science Education*, *39*(8), 1025–1044. https://doi.org/10.1080/09500693.2017.1313467

Mora, N., Martínez-Otero, V., Santander, S., & Gaeta, M.L. (2022). Emotional intelligence in the training of pre-school and primary education teachers. *Perspectiva Educacional*, *61*(1), 53–77. http://dx.doi.org/10.4151/07189729-vol.61-iss.1-art.1234

Mottet, T. P., & Beebe, S. A. (2002). Relationships between teacher nonverbal immediacy, student emotional response, and perceived student learning. *Communication Research Reports*, *19*(1), 77–88. http://dx.doi.org/10.1080/08824090209384834

Mustafina, R., Ilina, M., & Shcherbakova, I. (2020). Emotions and their effect on learning. *Utopía y Praxis Latinoamericana, 25*(7), 318–324. https://doi.org/10.5281/zenodo.4009736

Naylor, D., & Nyanjom, J. (2021). Educators' emotions involved in the transition to online teaching in higher education. *Higher Education Research & Development*, *40*(6), 1236–1250. https://doi.org/10.1080/07294360.2020.1811645

OECD (2019). *TALIS 2018 Results (Volume I): Teachers and school leaders as lifelong learners.* OECD Publishing. https://doi.org/10.1787/1d0bc92a-en

Park, M., & Flores, R. (2021). Developing a questionnaire to measure preservice elementary teachers' emotions for teaching science and mathematics. *International Journal of Science Education, 43*(18), 2911–2935. https://doi.org/10.1080/09500693.2021.2001072

Porras, S., Pérez, C., Checa, P., & Luque, B. (2020). Emotional competence among future teachers: A study on emotional intelligence and empathy levels. *Revista Educación*, *44*(2), 76–90. https://doi.org/10.15517/revedu.v44i2.38438

Puertas, P., Ubago, J. L., Moreno, R., Padial, R., Martínez, A., & González, G. (2018). Emotional intelligence in training and teaching labor performance: A systematic review. *Revista Española de Orientación y Psicopedagogía, 29*(2), 128–142. https://doi.org/10.5944/reop.vol.29.num.2.2018.23157

Ritchie, S. M., Tobin, K., Hudson, P., Roth, W. M., & Mergard, V. (2011). Reproducing successful rituals in bad times: Exploring emotional interactions of a new science teacher. *Science Education*, *95*(4), 745–765. https://doi.org/10.1002/sce.20440

Rohaan, E., Taconis, R. & Jochems, W. (2010). Reviewing the relations between teachers' knowledge and pupils' attitude in the field of primary technology education. *International Journal of Technology and Design Education*, *20,* 15–26. https://doi.org/10.1007/s10798-008-9055-7

Romero-Rincón, Y. N., Tuay-Sigua, R. N., & Pérez-Mesa, M. R. (2021). Relation between emotions and education in science: State of the art reported in academic events. *Praxis & Saber*, *12*(28), 182–197. https://doi.org/10.19053/22160159.v12.n28.2021.11173

Salovey, P., & Mayer, J.D. (1990). Emotional intelligence. *Imagination, Cognition and Personality*, *9*(3), 185–211. https://doi.org/10.1016/S0962-1849(05)80058-7

Santander, S., Gaeta, M.L., & Martínez-Otero, V. (2020). Impacto de la regulación emocional en el aula: Un estudio con profesores españoles [The impact of emotional regulation in the classroom: A study with Spanish teachers]. *Revista Interuniversitaria de Formación del Profesorado*, *34*(2), 225–246. https://doi.org/10.47553/rifop.v34i2.77695

Sepúlveda, M. P., Guillén, F. D., García, E., & Mayorga, M. J. (2021). Emotional competence of prospective early childhood and primary education teachers: Analyses of significant predictors. *Formación Universitaria, 14*(3), 105–114. http://dx.doi.org/10.4067/S0718-50062021000300105

UN (2015). *Transforming our world: The 2030 agenda for sustainable development.* United Nations. https://sdgs.un.org/2030agenda

Van Veen, K., Sleegers, P., & Van de Ven, P. (2005). One teacher's identity, emotions, and commitment to change: A case study into the cognitive-affective processes of a secondary school teacher in the context of reforms. *Teaching and Teacher Education*, *21*, 917–934. https://doi.org/10.1016/j.tate.2005.06.004

Vázquez, A., & Manassero, M. A (2007). En defensa de las actitudes y emociones en la educación científica (I): Evidencias y argumentos generales [In defence of attitudes and emotions in science education (I): General evidence and arguments]. *Revista Eureka de Enseñanza y Divulgación de las Ciencias*, *4*(2), 247–271. http://dx.doi.org/10.25267/Rev_Eureka_ensen_divulg_cienc.2007.v4.i2.03

Zembylas, M. C. (2018). Rethinking the demands for 'preferred' teacher professional identities: Ethical and political implications. *Teaching and Teacher Education*, *76*, 78–85. https://doi.org/10.1016/j.tate.2018.08.011

María Brígido Mero *(Corresponding author)*	PhD, Associate Professor, Faculty of Psychology and Education, UDIMA University, 28400, Collado Villalba, Madrid, Spain. E-mail: maria.brigido@udima.es ORCID: https://orcid.org/0000-0001-8410-1754
Ayar Rodríguez de Castro	PhD, Associate Professor, Faculty of Sciences, University of Alcalá, 28802, Alcalá de Henares, Madrid, Spain. E-mail: ayar.rodriguez@uah.es ORCID: https://orcid.org/0000-0003-3196-9765
Ana Lejárraga García	PhD, Associate Professor, Faculty of Psychology and Education, UDIMA University, 28400, Collado Villalba, Madrid, Spain. E-mail: anamaria.lejarraga@udima.es ORCID: https://orcid.org/0000-0003-2342-6373
Irene Laviña Pérez	PhD. Student, Associate Professor, Faculty of Psychology and Education, UDIMA University, 28400, Collado Villalba, Madrid, Spain. E-mail: irene.lavina@udima.es ORCID: https://orcid.org/0000-0001-7014-8519
Verónica Nistal Anta	PhD, Associate Professor, Faculty of Psychology and Education, UDIMA University, 28400, Collado Villalba, Madrid, Spain. E-mail: veronica.nistal@udima.es ORCID: https://orcid.org/0000-0001-7012-7769