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An Exploratory Study Interrelating Emotion, Self-Efficacy and Multiple Intelligence of Prospective Science Teachers

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This research offers a descriptive and inferential analysis of the emotions toward the teaching of science felt by 144 second-year students of a Primary Education bachelor's degree course, identifying their learning styles in accordance with the theory of Multiple Intelligences, studying their perception of self-efficacy concerning the different scientific contents they would need to teach, and establishing correlations between these variables. The investigation is quantitative in character, carried out via a survey, using SPSS and JASP for the data analysis. The results show that these prospective teachers feel greater rejection toward Physics and Chemistry than toward Biology and Geology (they mainly express enthusiasm for the latter). It is possible to establish differences in the emotions that the prospective teachers feel toward science depending on which path they took in their pre-university studies (Arts or Sciences). There are correlations between feeling positive emotions and having greater self-efficacy in teaching those same scientific topics. Those who feel negative emotions, such as fear or rejection, toward Physics and Chemistry have lower self-efficacy. There are correlations between having greater self-efficacy when teaching science and having a predominantly logical-mathematical intelligence. There is also a relationship between having a predominantly logical-mathematical type of intelligence and feeling more positive emotions toward sciences. Predictors of emotional dimension and self-efficacy have been also explored by multiple regression.

Keywords: emotions, multiple intelligences, self-efficacy, affective domain, prospective teachers

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INTRODUCTION

The link between emotions and learning is inescapable: educational processes are replete with affect (Garritz, 2009). There is still much room for progress, however, in analyzing together the affective and cognitive dimensions at whichever educational level (pre-primary, primary, secondary, or higher education). The world we live in, with its constant scientific and technological progress, requires a redesign of how science is taught, and reflection on the kind of science education that society needs–science capable of contributing to social progress and the integral development of society (Mellado et al., 2014; Sanchez-Martin et al., 2018).

What we find, however, is that on many occasions students decide not to continue their higher education in science, often because of the emotional rejection that some scientific subjects generate, generally related to experiences they have lived through in the school classroom (Vázquez and

Manassero, 2008; Mellado et al., 2014). Secondary students' career aspirations in STEM fields have been analyzed, and a gender gap was brought to light. Science subjects at school constitute a major obstacle for young women's aspirations, and the gender stereotype of maths and science persist (Eccles, 2009; Makarova et al., 2019). Pupil's gender differences in science achievement, and in subsequent occupational choices, might be explained by stereotypical teachers beliefs (Tiedemann, 2000).

Pekrun and Stephens (2010) have investigated that the emotional dimension is extremely powerful and affects to other personal aspects as motivation, concentration or the interest that we have on the project what we are working on. Many factors also influence the emotional dimension, as gender or self-efficacy, which they refer to as achievement-related beliefs. This is particularly relevant in prospective teachers, due to the effects that these aspects could have on control perception and tasks development in their future job. Therefore, emotions, self-efficacy and multiple intelligences of a prospective teachers' sample have been described and analyzed in this paper. Prospective teachers use to feel negative emotions toward sciences (as anxiety, boredom or rejection) (Dávila-Acedo et al., 2015) and they also present a low self-efficacy perception, feeling insecure when teaching science contents (Brígido et al., 2012).

For this reason, it is necessary to have scientifically and emotionally competent teachers in order to improve pupils' emotional experiences and the quality of education, which allows science teaching to take pupils' affective dimension into account, and to distance itself from the traditional roles of expository teaching by combining current knowledge of neuroeducation and psychology. This is possible by following Gardner's theory of Multiple Intelligences (Sanchez-Martin et al., 2017). This concern led to the setting of this research study being directly undertaken with prospective primary teachers. Spanish University teaching and all the curricula have been changed due to the Bologna Process and the European Higher Education Area. In Spain, initial primary teacher education is a four-year Bachelor's Degree course of Primary Education Teacher. These students are trained to be teachers at Primary Education level (children aged 6–12 years) and therefore, they will teach sciences at primary school. During their time as primary school pupil themselves, prospective primary teachers were taught science as a single subject (namely, Natural Sciences) during their primary school period. At the compulsory secondary education (12–16 years old) they were taught science also as a single subject of each of the first two years and then, in the third year sciences subject was splitted into two science subjects -Biology and Geology, and Physics and Chemistry-. In the fourth year, science subjects become optional. Finally, during upper secondary education (16–18 years old), the students had a choice of one of two modalities: either Humanities, Social Sciences, and Arts, or Science, Health, and Technology path. Usually, prospective primary teachers choose the first path. This work is characterized as being non-experimental causal or correlation study, an exploratory descriptive analysis of the sample is presented. Information was collected for three variables that were taken into account for the subsequent development of research objectives: emotions, self-efficacy, and multiple intelligences. To carry out this study, we set as a general objective to establish and analyze the possible relationships between emotions, self-efficacy, and the multiple intelligences of the students in the second year of the Primary Education Degree at the University of Extremadura. This general objective can be split into four specific objectives:

Specific Objective 1: To analyze, in a descriptive way, the emotions prospective teachers feel when facing the different scientific contents in their course. Distinguishing according to gender and to upper-secondary education path.

Specific Objective 2: To analyze, in a descriptive way, the self-efficacy of prospective teachers toward the different scientific fields, and to establish relationships between their perception of self-efficacy and the emotions they feel toward the different contents. Distinguishing according to gender and to upper-secondary education path.

Specific Objective 3: To define the profile of the students according to the theory of multiple intelligences.

Specific Objective 4: To establish correlations and looking for the predictor variables between the different intelligence profiles of the prospective teachers and the emotions and perceived self-efficacy they have toward the different scientific fields.

Emotions in Teaching and Learning

The emotions and the cognitive part have almost always been considered to be independent, with the cognition part encompassing aspects related to memory, learning, or attention, and the emotional part, motor and physiological responses and sentimental experience (Phelps, 2006). Nowadays, the association between the affective and cognitive dimensions in human beings is undeniable (Pessoa, 2008). Emotions influence pupils' learning results (Carmona-Halty et al., 2019) as they help to direct attention, which is a requirement for learning (Phelps, 2006). Events associated with emotions are easier to recall and last longer in one's memory (Mora, 2016). But the study of emotions, their application in the classroom, and the need for the existence of a good classroom climate for a beneficial, motivating and interesting educational process has not been sufficiently studied (Garritz, 2009), despite the need for teachers to carry out good emotional management and to possess strategies for resolving conflicts (Bonilla et al., 2020). What we know today is that teachers with high levels of stress reported also higher levels of anxiety and depression and that may also influence the student's affective experience in learning (Poon et al., 2019) but also a positive association between teachers and students positive emotions have been found in science lessons (Frenzel et al., 2009).

The key to begin generating changes in the practice of teaching may be to know how to activate emotions in the classroom, and to take advantage of current knowledge about the brain. This is especially important for the science classroom, given the current problem of pupil's alienation from scientific studies (Vázquez and Manassero, 2008). Such changes can be framed within the constructivist paradigm so as to lead to more meaningful learning (Ross, 2006; Krahenbuhl, 2016). In the context of this research, we use the definition of emotion proposed by Bisquerra (2003):

> Emotion is a complex state of an organism characterized by an excitation or perturbation that predisposes to an organized response. Emotions are generated in response to an external or internal event (Bisquerra, 2003, p. 12).

Recognizing and identifying pupils' emotions in the science classroom is the first step to be able to intervene. It is possible to find numerous classifications and taxonomies of emotions in the literature. Paul Ekman (1992) determines six emotions as basic: anger, disgust, fear, happiness, sadness, and surprise. Damásio (1994) classifies them into universal, background, and social. Goleman (1995) and Bisquerra (2003) are other authors who have tried to establish classifications of emotions. However, there is still no established categorization, and the choice of a reduced number of basic emotions on which every author can agree is quite a complex task (Mohammed, 2017). The emotions taken into consideration were classified as in Dávila-Acedo et al. (2015), based on that proposed by Fernández-Abascal et al. (2001).

Emotions impact student's learning and achievement (Frenzel et al., 2007). Differences by gender have been reported previously in achievement emotions in the domain of sciences, where girls reported significantly less enjoyment and pride than boys but more anxiety, hopelessness and shame due to the girls' low competence beliefs (Frenzel et al., 2007). It is necessary that both, in-service and prospective teachers, are aware of their own emotions and of what effects these may generate through their classroom activity, especially in those areas, such as Physics and Chemistry, that provoke negative emotions (Dávila-Acedo et al., 2015). The challenge is to create stronger positive emotions capable of counteracting the negative ones that condition and impede beneficial, motivating, and enthusiastic learning.

Prospective Teachers' Self-Efficacy

Self-efficacy is the term proposed by Bandura (1997) to define the belief in one's own abilities to organize and execute the actions necessary to reach certain achievements. Self-efficacy influences how we feel, think, and act. This is also related to many other dimensions, which include intentionality, self-regulation, and the reflection that allows us to control situations and has a great impact on our actions and decisions (Code, 2020). Eccles and Wigfield (2002) reflect about other psychological aspects, in addition to self-efficacy, as motivational beliefs, values and goals which are inexorable linking to the emotional dimension of prospective teachers. The authors perform a deep reflection about intrinsic motivation theories, and the necessity of pupils to believe that they are academically competent to improve their self-worth.

Self-efficacy is a predictor of the academic success and that is the consequence of the confidence and the students' beliefs that they are skilled of carried out their task (Putwain et al., 2013). Teachers and their behavior have an important impact in the academic goals of their students (Eccles and Wigfield, 2002). Children's perception of their control over results depends on how kindly and helpfully teachers are with them. The investigations of Yeager and Dweck (2012) concluded that students who believe (or are taught) in a growing mindset -what means that intellectual abilities are qualities that can be developed-lean toward showing higher attainment. Their suggestion is not to congratulate students for their own qualities, but to offer them the vision that they can overcome the challenges because they have the potential to change. Children need patience, but they will have help from teachers, family and colleagues, that's the way to prepare students to make them ready to deal with the problems resiliently.

Prospective teachers' self-efficacy has been shown to be a factor that predicts the behavior these teachers will have in their classrooms, and is related to the creation of a good classroom climate and good management of the class (Künsting et al., 2016). Self-efficacy is linked to the interest and performance while a task is being carried out (Nuutila et al., 2020). Those teachers with a greater sense of self-efficacy are less averse to taking risks in methods since they feel more comfortable in teaching the content (Borrachero et al., 2013). The study of prospective teachers' self-efficacy when teaching science is of especial relevance, since teachers tend in general not to feel confident when teaching science, and consider it particularly difficult to learn (Menon and Sadler, 2016). Literature review indicates that prospective teachers have a low self-efficacy for teaching sciences, and that is preceded by high levels of negative emotions (Brígido et al., 2012). Knowledge of the matter and mastery of the topic are necessary to be able to feel effective and to carry out this task. It is impossible for a teacher to be able to teach something they do not know–they need to understand the content and know how to teach it (Mellado et al., 2014). This is essential in science education because teachers should follow active methods in offering the approach to the content and the development of skills, methods distanced from teaching based on textbooks and abuse of theory.

Multiple Intelligences

A possible link between the above variables of our study (emotions and self-efficacy), which combine the two dimensions of affect and cognition, can be found in Gardner's theory of Multiple Intelligences (2011). Gardner suggests that people are not equal, but that each person has a different learning style and way of assimilating information (strongly influenced by their own individual preferences). He creates the model of multiple intelligences which has aroused so much interest and controversy (Shearer and Karanian, 2017). He opposes the way intelligence has traditionally been assessed with the use of the IQ test. In his studies, Gardner concludes that the human mind has a range of skills and abilities, and defines intelligence as a bio-psychological potential that could be induced by experience, culture, and motivational factors and defines the nine basic intelligences: musical, bodily-kinesthetic, logical-mathematical, spatial, linguistic, spiritual, interpersonal, intrapersonal, and naturalist (Mahasneh, 2013). Neuroscientific evidence reinforces the validity if MI theory (Shearer, 2018). It is important to note that people do not have a single intelligence profile, but rather better match one style or another which some authors have spoken of as "prevalent intelligence" (Sanchez-Martin et al., 2017).

The Gardner's theory inclusion in the classroom changes the methodology we teach and evaluate, since intelligence becomes the ability capable to provide solutions for different problems. Moreover, Gardner argued that there is no hierarchy, consequently none of the intelligences is more important than the others (Mahasneh, 2013). According to Yaghoob and Hossein (2016) academic achievement of secondary students is correlated with their multiple intelligences. The key is to provide the information of the topics in the way that students most like, taking advantage of cognition and emotion are interrelated (Immordino-Yang and Damasio, 2011).

The perspective from which this research is undertaken proposes adapting instructional strategies to the different intelligences found in the classroom, so that a response could be given to the heterogeneity of pupils and in order to foster meaningful science learning. This would be sustained by positive changes at an emotional and motivational level, recognizing the different identity of each pupil. The emotional effectiveness of multiple intelligences based teaching strategy in science lessons have been studied (Winarti et al., 2019) and proved that to design the classes according to their interest improve their motivation (Madkour and Mohamed, 2016).

MATERIALS AND METHODS

Participants

Our sample consisted of a total of 144 white Caucasian prospective primary teachers (53 men and 91 women, mean age 20.61, SD = 3.38), all enrolled in a Science Education subject (namely, Didactics of Matter and Energy) in the fourth semester of the Primary Education bachelor's degree (eight semesters in total) in the University of Extremadura's Education Faculty. Regarding their background studies, 75% of the sample (39 men and 69 women) had studied a modality of Humanities, Social Sciences, or Arts in upper secondary education (SS), and 25% of them (14 men and 22 women) a Science, Health, or Technology (SHT) path to access university studies. This sample was chosen conveniently, not randomly, from the population of prospective primary teachers who voluntarily answered a questionnaire about their emotions toward the sciences, self-efficacy, and multiple intelligences. Before being given the questionnaire, the students were informed about the goals of the research, its duration, procedure, and the anonymity of their data. All the participants provided their verbal informed consent prior to data collection. Researchers were always present during the implementation of the survey.

Measures

Design of the Questionnaire

For the data collection, we decided to draft a questionnaire about emotions, self-efficacy, and multiple intelligences (**Supplementary Appendix SA**). The students were asked to complete basic information about demographic aspects such as gender, age, and upper secondary education.

Regarding the prospective teachers' self-efficacy, a ten-point Likert-type questionnaire was used. A list of the most relevant scientific contents related to Physics and Chemistry and Biology and Geology, based on Primary Education curriculum, were included. For each content, prospective teachers were asked to measure their confidence for teaching it by a 1–10 scale, where 1 meant not prepared for teaching, and 10, quite comfortable for teaching.

In order to assess prospective teachers' emotions toward sciences contents, a survey-based study was conducted. For this, a prose-design questionnaire based on previous studies conducted by our research group was considered (Brígido et al., 2012; Borrachero et al., 2014; Dávila-Acedo et al., 2015; Jeong et al., 2019). The emotions were sorted into two groups, namely positive and negative emotions. Positive emotions included joy, confidence, fun, enthusiasm, satisfaction and surprise; while the negative ones were anxiety, boredom, fear, nervousness, rejection and worry. The students indicated which emotions were suggested by the propose science contents. These contents corresponded to those in Part I of the questionnaire in order to establish correlations between emotions and self-efficacy.

With regard to the multiple intelligences, a self-evaluation test extracted from Rosiña et al. (2020) was used, the questionnaire followed a five-point Likert scale (from strongly disagree to strongly agree). The test was consisted in 41 statements (7 for each multiple intelligence) what measure the multiple intelligences proposed by Howard Gardner (2011). The Cronbach's alpha value found out for different intelligences, logical-mathematical $\alpha = 0.719$, verbal-linguistic $\alpha = 0.715$, naturalistic $\alpha = 0.814$, musical $\alpha = 0.818$, bodily-kinesthetic $\alpha = 0.602$ (only 6 statements), visual $\alpha = 0.717$.

Validation of the Questionnaire, Data Collection, and Analysis

The questionnaire was validated by experts in Experimental Sciences Education, who read, modified, and approved it. It was passed to some students who give us the feedback and then final version was constructed. The questionnaire was in Spanish. The value of Cronbach's alpha allowed us to know the internal consistency of the different parts of the questionnaire. The obtained values enabled a grouping of the scientific content blocks into categories: Physics and Chemistry ($\alpha = 0.907$), and Biology and Geology ($\alpha = 0.942$). Regarding to the emotions, the Cronbach's alpha test was again applied, which supported to group the emotions into positive ($\alpha = 0.864$) and negative ($\alpha = 0.942$).

After preparing the questionnaire and selecting the sample, the questionnaire was given to all participants in a paper format in a regular class where they were voluntarily asked to complete them. After data collection, they were processed and transferred to a digital support for being statistically analyzed using the statistical package SPSS (Statistical Package for the Social Science) 22.0 (SPSS, 2017), and graphic descriptively analyzed (the sociodemographic variables frequencies, percentages, means, standard deviations) using Excel (2013) and JASP (V.0.11.1).

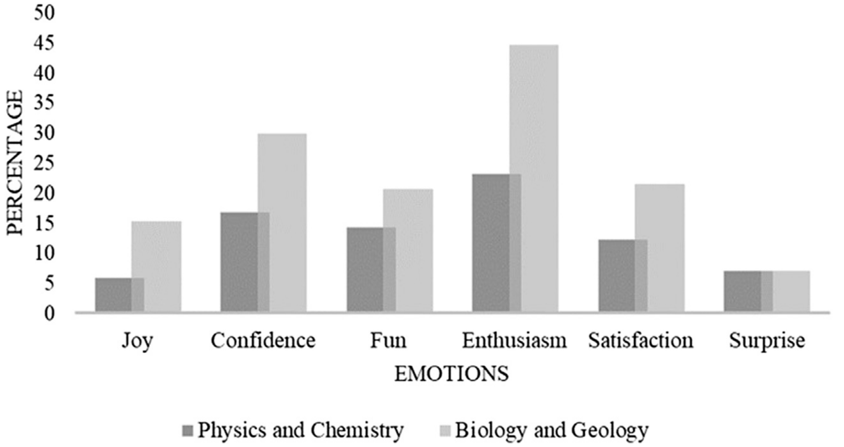

FIGURE 1 | Percentage of positive emotions toward science expressed by the prospective teachers.

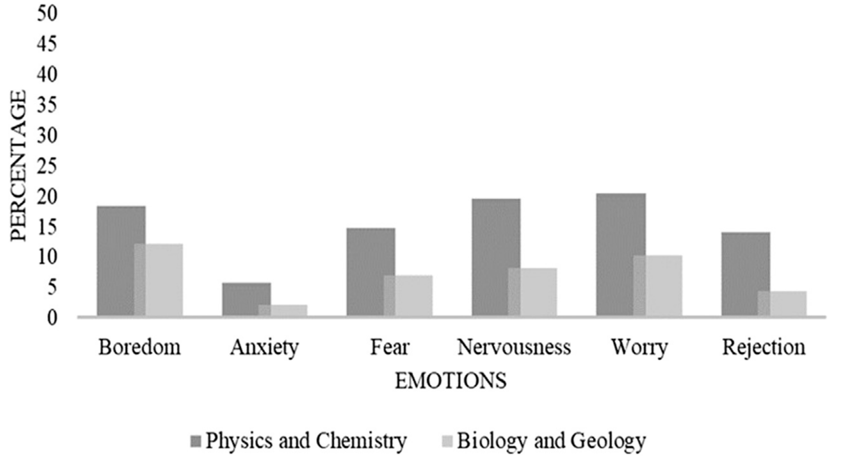

FIGURE 2 | Percentage of negative emotions toward science expressed by the prospective teachers.

The self-efficacy and MI data were averaged, and that data were used to establish differences by gender and by their upper secondary education. Both descriptive and non-parametric statistical test were performed to analyze the data. The use of non-parametric test was considered appropriate after checking normality, skewness and kurtosis of the individual variables. To find if there were significant differences by gender and their upper secondary education, we applied Mann-Whitney *U*-test. To explore relationships between emotions, self-efficacy, and multiple intelligences Spearman's correlations were applied. Bivariate correlations are limited in their usefulness for field studies such as this where many factors may be operating consecutively. Therefore, we also employed multiple regression to describe what variables (gender, secondary school track, intelligence type) best predict prospective teachers' positive and negative emotions toward sciences and their self-efficacy.

RESULTS

Objective 1. Prospective Teachers' Emotions Toward Science

With regard to the first objective of the study (descriptive analysis of the emotions prospective teachers feel when facing the different scientific contents) **Figure 1** shows that for Biology and Geology they indicate a higher percentage of positive (76.05%) than negative (23.95%) emotions. This is not the case for Physics and Chemistry, where they indicate feeling more negative (54%) than positive (46%) emotions.

After a detailed study of emotions, as shown in **Figure 1**, the most indicate emotion by the prospective teachers in both cases was enthusiasm, followed by confidence and satisfaction in the case of Biology and Geology, and fun in the case of Physics and Chemistry.

TABLE 1 | Mann-Whitney *U*-test *p*-values for gender differences in negative and positive emotions toward science.

Scientific field	Positive emotions	Rank-biserial correlation	Negative emotions	Rank-biserial correlation
Physics and Chemistry	<0.001	0.412	<0.001	−0.339
Biology and Geology	0.034	0.212	0.517	−0.065

With regard to negative emotions (**Figure 2**), it can be seen that the percentages indicated are substantially lower in the case of Biology and Geology. The prospective teachers report feeling mostly the negative emotions of worry, nervousness, and boredom.

There were gender differences in emotions, with men having higher percentage of positive emotions in both Physics and Chemistry (mean: 16.7%, SD = 9.1 for men and mean: 11.1%, SD = 10.2 for women) and Biology and Geology (mean: 24.4%, SD = 13.1 for mem and mean: 21.7%, SD = 15.4 for women). Female participants report feeling more negative emotions for Physics and Chemistry (mean: 17.9%, SD:14.4; vs. mean: 11.3%, SD = 9.0) and for Biology and Geology (mean: 7.5%, SD = 5.8 vs. mean: 6.9%, SD = 6.1). To determine whether these differences in positive and negative emotions were significant, Mann-Whitney *U*-test was applied. The *p*-values are given in **Table 1**. The statistical analysis results were contrasted with an $\alpha = 0.5$ (confidence *p*-value of 0.05).

With these results it is possible to conclude that women feel more negative emotions toward Physics/Chemistry (*p*-value = 0.001) and Biology/Geology (*p*-value = 0.034) and less positive emotions toward Physics/Chemistry (*p*-value = 0.001) than men, but that these differences are not significant for negative emotions toward Biology/Geology. Rank-biserial correlation can be considered as effect size and it is interpreted as r of Spearman's correlation, so $r = 0.412$ and $r = -0.339$ are a medium size effect for positive and negative emotions toward Physics and Chemistry.

In terms of the upper-secondary education path, no differences are found neither in the emotions toward Biology/Geology nor toward in Physics/Chemistry.

Objective 2. Prospective Teachers' Scientific Self-Efficacy

To determine whether there is any correlation between self-efficacy and the emotions, Spearman's correlations were used, and the results showed the existence of significant correlations between feeling positive emotions and having a high perception of self-efficacy (Spearman's rho = 0.339, *p*-value < 0.01). Furthermore, inverse and significant correlations were obtained between negative emotions and self-efficacy, i.e., feeling more negative emotions toward science is related to having a lower perception of self-efficacy (Spearman's rho = −0.255, *p*-value < 0.01).

Mann-Whitney *U*-test was applied to determine whether differences in terms of gender differences by self-efficacy were significant. We obtain that the mean value of self-efficacy is higher in men (mean = 5.2, SD = 1.8) than in women (mean = 5.0, SD = 1.8) teaching contents related to Physics and Chemistry and also teaching Biology and Geology (mean = 5.3, SD = 1.8 for men and mean = 5.1, SD = 1.8 for women). However, the data obtained show that gender does not influence self-efficacy when teaching scientific content.

In terms of the upper-secondary education path, students who had completed SHT upper-secondary education showed greater self-efficacy when teaching any scientific content. The biggest differences were found in self-efficacy shown when teaching contents related to Physics and Chemistry (mean = 6.2, SD = 1.9 for SHT and mean = 4.7, SD = 1.7 for SS). However, it was in Biology and Geology contents teaching where the students, regardless of their upper-secondary education path, showed greater self-efficacy (mean = 6.4, SD = 1.8 for SHT and mean = 4.8 SD = 1.6 for SS).

In order to determine whether there were significant differences in terms of the upper-secondary education path, Mann-Whitney *U*-test was applied. These differences were found to be significant in the case of Physics/Chemistry (*p*-value = 0.043) but not for Biology/Geology. Regardless of their education path and gender, prospective teachers felt equally qualified to teach Biology/Geology, which was also the scientific area toward which they felt the most positive emotions. However, significant differences were found for Physics/Chemistry, being determinant for feeling greater self-efficacy in teaching this content if the student had completed an SHT upper-secondary education path.

Objective 3. Multiple Intelligences

After analyzing the students' multiple intelligences, the distribution in **Table 2** was obtained, showing mean, SD, Cronbach's alpha, skewness, kurtosis and the distribution in percentages of the predominant learning styles indicated by the prospective teachers, some of whom claimed to have more than one. The predominant learning style was selected to develop the analyses.

Based on this, it can be said that the bodily-kinæsthetic intelligence was predominant in 23.1% of the sample. On the other hand, visual-spatial intelligence was the least present in the sample in this study (7.5%). All the intelligence profiles were found to be represented. The negative value of the skewness in all intelligences types, except for linguistic, shows that the mode value is displaced to the right respect to the normal distribution, resulting in a dominant left tail. Kurtosis describes if those tails are pronounced, in our case, all values are negative, showing flattened distribution with short tails.

Since in the classification of Multiple Intelligences there is a differentiation between naturalistic intelligence and logical-mathematical intelligence, we wanted to determine whether this differentiation can be justified with our data. Spearman's correlations were used to see if those prospective teachers with

TABLE 2 | Descriptive statistics and distribution of the students' learning styles.

	Scale range	Mean	SD	α	Skewness	Kurtosis	Distribution (%)
Logical-mathematical	1–5	3.342	0.728	0.719	−0.315	−0.320	18.1
Linguistic	1–5	3.337	0.727	0.715	0.020	−0.622	18.1
Naturalistic	1–5	3.210	0.875	0.814	−0.035	−0.471	16.2
Musical	1–5	3.305	0.875	0.818	−0.023	−0.642	17.5
Kinaesthetic	1–5	3.567	0.766	0.602	−0.471	−0.415	23.1
Visual-spatial	1–5	3.164	0.753	0.717	−0.232	−0.543	7.5

TABLE 3 | Spearman's correlation coefficients between positive and negative emotions toward physics and chemistry and the different multiple intelligence profiles.

		Logical-Mathematical	Naturalistic	Kinæsthetic	Visual-Spatial
Positive emotions	Physics and Chemistry	0.439**		0.242*	0.259**
	Biology and Geology	0.220*	0.272***	0.228**	0.212*
Negative emotions	Physics and Chemistry	−0.329***			−0.212*
	Biology and Geology				−0.211*

Sig.< 0.05; ** Sig.< 0.01; * Sig.< 001.*

naturalistic intelligence also had logical-mathematical intelligence. The results (Spearman's rho = 0.083; p-value = 0.321) suggested that there is no such correlation, and that having certain naturalistic aptitudes does not imply also having logical-mathematical intelligence. Feeling positive emotions toward Biology/Geology does not imply feeling them toward Physics/Chemistry as well, and, in the same way, having a predominantly naturalistic intelligence does not correlate with having a logical-mathematical intelligence profile.

We wanted to determine whether students with an SHT upper-secondary education scored higher on logical-mathematical intelligence items than those with an SS upper-secondary education. Mann-Whitney U-test was used. The data obtained showed that these differences were significant. The students originally from SHT upper-secondary education obtained higher scores than those from SS upper-secondary education (p-value < 0.001).

Objective 4. Correlations Between the Three Variables and the Variable Predictors of the Emotional Dimension and Self-Efficacy

With regard to the last of the proposed objectives, we wanted to determine whether the prospective teachers who express positive nor negative emotions toward Physics/Chemistry have a more logical-mathematical or visual-spatial profile. For this, we used Spearman's correlations (**Table 3**).

These results provide new data that has not been studied previously. A significant correlation was obtained between feeling positive emotions toward Physics/Chemistry and having a logical-mathematical or visual-spatial intelligence profile (p-value < 0.001). This correlation of positive emotions toward Physics/Chemistry was non-existent when talking about naturalistic intelligence. It is necessary to specify and distinguish clearly when talking about the positive emotions that these students feel toward science. However, it can be seen that the correlation was significant when referring to positive emotions in Biology/Geology and naturalistic intelligence (p-value < 0.001). No correlations were found for linguistic and musical intelligences. Inverse and significant correlations were obtained between feeling negative emotions toward Physics/Chemistry and having logical-mathematical (p-value < 0.001) and visual-spatial intelligences (p-value < 0.01).

With respect to self-efficacy, we wanted to determine whether the students who felt greater self-efficacy in Physics/Chemistry had a predominant logical-mathematical intelligence. We used Spearman's correlations, with the p-values being listed in **Table 4**.

This study yielded very interesting data about the students' self-efficacy and their different intelligence profiles. There were also correlations between having a high perception of self-efficacy when teaching Physics and Chemistry contents and the logical-mathematical intelligence (p-value < 0.01) and visual-spatial profiles (p-value < 0.05). It could be surprising that the correlation is even stronger between having a high perception of self-efficacy when teaching Biology and Geology contents, having logical-mathematical (p-value < 0.001), and visual-spatial intelligence (p-value < 0.01).

Our results allow us to state that there is a positive and significant correlation between having logical-mathematical intelligence and feeling positive emotions toward the contents of Physics and Chemistry and Biology and Geology. Regardless of the methods used in their classrooms throughout their previous stages of schooling, these students present positive emotions toward sciences. Likewise, there are inverse and significant correlations between having logical-mathematical intelligence and feeling negative emotions toward the contents in Physics and Chemistry. In this study, it can be seen that having a high perception of self-efficacy when teaching Physics and Chemistry and Biology and Geology correlates with logical-mathematical intelligence but not with naturalistic intelligence. Possessing a naturalistic intelligence is not equivalent to possessing a

TABLE 4 | Spearman's correlation coefficients between self-efficacy in different scientific areas and the students' intelligence profiles.

	Logical-mathematical	Linguistic	Naturalistic	Musical	Kinæsthetic	Visual-spatial
Physics and Chemistry	0.247**	0.089	0.112	0.087	0.091	0.207*
Biology and Geology	0.284***	0.074	0.111	0.087	0.104	0.218**

**Sig.< 0.05; ** Sig.< 0.001.*

TABLE 5 | Multiple regression analyses (stepwise method): the predictor variables.

Dependent variable and step	β	p	R^2
Positive emotions toward Physics and Chemistry			0.366
1. Positive emotions toward Biology/Geology	0.364	<0.001	
2. Logical/Mathematical MI	0.239	<0.001	
3. Self-efficacy	0.164	0.024	
Negative emotions toward physics and Chemistry			0.579
1. Negative emotions toward Biology/Geology	0.412	<0.001	
2. Positive emotions toward Biology/Geology	0.651	<0.001	
3. Positive emotions toward Physics/Chemistry	−0.486	<0.001	
4. Gender	0.170	0.004	
5. Self-efficacy	−0.173	0.004	
Positive emotions toward Biology and Geology			0.557
1. Positive emotions toward Physics/Chemistry	0.599	<0.001	
2. Negative emotions toward Physics/Chemistry	0.652	<0.001	
3. Positive emotions toward Biology/Geology	−0.350	<0.001	
4. Self-efficacy	0.137	0.029	
Negative emotions toward Biology and Geology			0.334
1. Negative emotions toward Physics/Chemistry	0.684	<0.001	
2. Positive emotions toward Biology/Geology	−0.557	<0.001	
3. Positive emotions toward Physics/Chemistry	0.428	<0.001	
4. Upper Secondary Education	0.148	0.039	
Self-efficacy for teaching Physics and Chemistry content			0.224
1. Upper Secondary Education	0.344	<0.001	
2. Positive emotions toward Physics/Chemistry	0.250	0.001	
3. Negative emotions toward Biology/Geology	−0.209	0.005	
Self-efficacy for teaching Biology and Geology content			0.266
1. Upper Secondary Education	0.348	<0.001	
2. Positive emotions toward Physics/Chemistry	0.277	<0.001	
3. Negative emotions toward Biology/Geology	−0.212	0.004	

logical-mathematical intelligence–Gardner already intuited this when he differentiated between these two learning styles.

A regression analysis was performed to examine the predictors of the emotional dimension toward sciences of prospective Primary teachers. Percentage of positive emotions toward Physics and Chemistry was the dependent variable, and predictors were gender, self-efficacy, positive emotions toward Biology and Geology, and the multiple intelligences profiles related. Feeling positive emotions toward Physics and Chemistry was significantly predicted by positive emotions toward Biology and Geology (β = 0.364, see **Table 5**), to possessing logical-mathematical intelligence (β = 0.293) and having a high perception of self-efficacy teaching Physics and Chemistry (β = 0.164). This indicates that prospective teachers with high levels of mentioned variables were more likely to present positive emotions toward contents of Physics and Chemistry. The model explained a substantial proportion of variance 33.6% (R^2 = 0.336).

With regard to the negative emotions, percentage of negative emotions toward Physics and Chemistry was the dependent variable, and predictors were gender, self-efficacy, positive and negative emotions toward Biology and Geology, positive emotions toward Physics and Chemistry and the multiple intelligences profiles related. Feeling negative emotions toward Physics and Chemistry was significantly predicted by the negative (β = 0.412) and positive (β = 0.651) emotions that they feel toward Biology and Geology, and the positive emotions that they feel toward Physics and Chemistry (β = −0.486), gender (β = 0.170) and the self-efficacy toward Physics and Chemistry (β = 0.173). This indicates that the emotions, gender and the self-efficacy are predictors of the negative emotions that prospective teachers feel toward Physics and Chemistry content. The model explained a significant proportion of variance 57.9% (R^2 = 0.579).

With respect to the positive emotions toward Biology and Geology, the predictor variables were gender, secondary school track, self-efficacy, positive and negative emotions toward Physics and Chemistry, negative emotions toward Biology and Geology and the multiple intelligences profiles related. The model shows that the positive (β = 0.599) and negative (β = 0.652) emotions toward Physics and Chemistry, negative emotions toward Biology and Geology (β = −0.350) and the perception of self-efficacy (β = 0.137) are predictors of the positive emotions toward Biology and Geology. The model explained the 55.7% of variance (R^2 = 0.557). This indicates that none of multiple intelligences profiles nor gender serve to predict the positive emotions toward Biology and Geology but emotional dimension and self-efficacy.

Concerning negative emotions toward Biology and Geology, the predictor variables were gender, secondary school track, self-efficacy, positive and negative emotions toward Physics and Chemistry positive emotions toward Biology and Geology, and the multiple intelligences profiles related. The model shows that negative (β = 0.684) and positive (β = 0.428) emotions toward Physics and Chemistry, and positive emotions toward Biology and Geology (β = −0.557) and the upper secondary school are predictors of the negative emotions toward Biology and Geology. The model explained the 33.4% of the variance (R^2 = 0.334). This indicates that neither the multiple intelligences profiles, nor gender, nor self-efficacy serve to predict the negative emotions toward Biology and Geology. However, emotions toward sciences and the upper secondary education can predict the negative emotions toward Biology and Geology.

Finally, regarding to perception of the self-efficacy toward Physics and Chemistry and Biology and Geology (both represented at **Table 5**), the predictor variables were gender, secondary school track, positive and negative emotions toward sciences, and multiple intelligences profiles related. Having a high perception of self-efficacy was significantly predicted by the upper secondary education (β = 0.344 for Physics and Chemistry and β = 0.348 for Biology and Geology), the positive emotions toward Physics and Chemistry (β = 0.250/β = 0.277) and the negative emotions toward Biology and Geology (β = −0.209/β = −212). Both models explained a moderate proportion of variance 24.4% (R^2 = 0.244) and 26.6% (R^2 = 0.266) respectively. That means that neither the gender, nor the multiple intelligences profiles can predict the perception of self-efficacy of prospective Primary teachers when they teach sciences. However, both upper secondary education and emotional performance toward sciences can predict the self-efficacy perception of prospective Primary teachers.

DISCUSSION

In this study, authors aimed to describe the emotional dimension of a Spanish prospective teachers' sample toward different sciences fields, intending to establish correlations with their self-efficacy and with their multiple intelligences.

Work by Dweck and colleagues indicates that people's implicit beliefs (particularly about their own emotions) may predispose them toward emotion regulation approaches that have significant consequences for well-being and psychological distress (De Castella et al., 2013). Science educators should provide a cooperative and supportive classroom climate, for those students who remain affected by negative emotions such as anxiety or fear (Britner, 2008). The emotions that prospective teachers experience toward science contents predetermine the emotions that they will transfer to their upcoming students (Borrachero et al., 2013). Emotions greatly influence cognition, motivation, interest, and science learning, so it is necessary for teachers to be aware of the potential of emotions and how they influence the development of the classroom. This would help them to carry out their tasks by applying different methods and making decisions to foster positive emotions during the learning of science (Tomas et al., 2016).

Teacher training process should contemplate the emotional dimension in order to improve the emotions that they feel, providing them with experiences that provoke changes on them turning negative emotions into positives ones. Differences by gender have been explored and our results agree with numerous studies which have found these gender differences toward the sciences in students, differentiating between Physics/Chemistry and Biology/Geology, with women mainly choosing topics related to Biology (Steegh et al., 2019). In other research with prospective teachers, was reported that men tend to express positive emotions more frequently than women (Borrachero et al., 2014). Many studies warn of a significant gender gap in STEM education (Steegh et al., 2019). Primary and early childhood teachers are potentially involved in the development of vocational interests among children, and gender stereotypical beliefs should be also tackled for the purpose of rise in gender equity in education (Makarova et al., 2019). Depending on the upper secondary education path, biology is the favorite science for the prospective teachers to teach, uninfluenced by gender or the upper-secondary education path. In all cases, it generates very few negative emotions, as also has been shown by other studies (Ochoa-De Alda et al., 2019) which note the low intensity of the presence of negative emotions toward Biology.

With regard to prospective teachers' scientific self-efficacy, previous studies have already shown the correlation existing between the emotional component and self-efficacy (van Aalderen-Smeets et al., 2012; Putwain et al., 2013) which also functions as a predictor of academic success in the study of the sciences (Britner, 2008; Oloo et al., 2019), and helps to establish learning strategies (Wu et al., 2019). Possessing a high perception of self-efficacy has a great influence on the emotions that prospective teachers feel when they teach science (Brígido et al., 2012), and is in a modest but significant way also related to the academic success of their pupils (Klassen and Tze, 2014). Depending on gender, our results are in agreement with those obtained in the study by Britner (2008) who reported no significant differences regarding self-efficacy depending on gender in sciences classes. Regarding to the upper secondary education path, our findings are in accordance with the study by Martín-Díaz (2006), which concluded that teachers' original secondary education path influences them decisively when teaching science.

Both educational curricula and IQ tests have traditionally been based on associating intelligence with mathematical or linguistic competencies. Gardner argues, however, that human intelligence cannot be simplified to a single number. The perspective provided by this theory allows each student to be valued individually, making them participants in their teaching-learning process with the use of the contributions of neuroscience (Fischer et al., 2007). Studies carried out with secondary education pupils have shown the potential cognitive and emotional benefits of teaching science through multiple intelligences (Sanchez-Martin et al., 2017). Theoretical and practical implications can be extracted from this section.

Curriculum and academic practice should be reedited and modified in order to adapt teaching including multiple intelligences, what is supported by neuroscience foundations (Shearer, 2018). That could help to improve their self-efficacy, which is extremely related with the emotional dimension and the learning process (Putwain et al., 2013). Eccles and Wigfield (2002) concluded that self-efficacy are the major determinant of goal settings and disposition to effort and persist. Self-efficacy and multiple intelligences correlation has been studied previously and correlation with the academic performance of undergraduate students was shown (Dragoshi and Samuel, 2016). Our results agree with studies of Mahasneh (2013) and Aghajani (2018) who analyzed multiple intelligences of students at higher education and concluded that self-confident and self-efficacy are influenced by the multiple intelligence.

Concerning Multiple intelligences, analysis carried out show the necessity to establish differences between the naturalistic and logical-mathematical intelligence profiles. These results have already been found in the research study of Rosiña et al. (2020) who did not find these correlations in a sample of primary and secondary education pupils. The present data confirm that this lack of correlation is plausible at all educational stages. That research also highlights the importance of knowing the learning styles of the pupils. This is necessary so as to know how to handle emotions. Pupils who had a logical-mathematical intelligence also reported having more positive attitudes and emotions toward scientific subjects.

With the analysis in our sample of intelligence profiles, and taking into account the high representation of the kinæsthetic learning style, it would be interesting to work with pupils of this type. Contents promoting physical and sports activities in the classes should be included, taking advantage also of the relevance that this has on learning and how it promotes neurogenesis (Hillman et al., 2008; Kempermann, 2012) and the improvement of memory (Erickson et al., 2011), in addition to obviously contributing significantly to improve the pupils' health (Hernández et al., 2015).

According to Shearer (2018) the use and application of multiple intelligences' theory in the classroom is supported by neuroscience and it would provokes numerous changes when conducting a class. We think that it is appealing that our sample, as prospective teachers, learn about different learning styles. It would be interesting that in their future work as teachers, they should know what the learning styles of their pupils are, and stimulate meaningful learning by adapting and facilitating the access to information in the most appropriate way according to those profiles. They can not forget that it is necessary to develop all the intelligence profiles in their pupils. Even when a pupil might prefer just one, the teacher must ensure that the pupil manages to improve and enhance skills related to other learning styles (Yaghoob and Hossein, 2016).

CONCLUSION AND FINAL CONSIDERATIONS

In this research, the emotional dimension of a Spanish prospective teachers' sample toward different sciences fields has been described, and correlations between affective dimension with self-efficacy are reported. Relationship between these factors with their multiple intelligences have been also studied applying multiple regression. Next, a summary of the results obtained, according to the objectives initially proposed, is given.

With regard to the first objective, relative to the emotions prospective teachers feel toward science, the results show that Physics and Chemistry constitute an area that arouses more negative than positive emotions, a fact that is not the case for Biology and Geology. Depending on their pre-university education path, the students with a background in science experience more positive emotions toward the contents of Physics and Chemistry. The linear regression analyses showed that possessing logical-mathematical intelligence and having a high perception of self-efficacy are factors that can predict the positive emotions toward Physics and Chemistry. Gender and self-efficacy are variables that can predict the negative emotions toward Physics and Chemistry. Self-efficacy can also predict the positive emotions toward Biology and Geology. Upper secondary education can predict the negative emotions toward Biology and Geology.

With regard to self-efficacy, there are strong correlations between feeling positive emotions and having a greater perception of self-efficacy, and between feeling negative emotions and having a low perception of self-efficacy, and there are no differences depending on gender. Biology and Geology are the science subjects that the prospective teachers prefer to teach. Upper secondary education and the emotions that prospective Primary teachers feel, can predict the perception of self-efficacy of when they teach sciences, this is not the case for the gender, nor the multiple intelligences profiles.

Finally, about the third and fourth objectives, relative to the profiles of multiple intelligences, we find correlations between having a predominantly logical-mathematical style of intelligence and feeling more positive emotions toward Physics and Chemistry. In addition, students who have a greater self-efficacy when teaching science are those who have a logical-mathematical intelligence. The logical-mathematical intelligence profile of prospective teachers may serve as a predictor of the emotions they will feel toward science. From the results obtained in this study, our future line guides will include the use of Project Based Learning as methodology for teaching sciences at the Degree in Primary Education, the PBL design will be based on this preliminary study. Methodological and practical changes will be implemented to improve the prospective teacher self-efficacy and emotional dimension provided during in their training using Gardner's theory.

This study is relevant principally for three reasons. Firstly, the implications that it has for the initial scientific training of prospective teachers are invaluable since the aim is to address the problem of the decrease in scientific attitudes at its root. In the initial training of teachers, this can be approached through the different science subjects in their degree course, and taking advantage of neurodidactics to provide a solution. Secondly, this first study can serve as the basis for interventions with prospective teachers (at cognitive and emotional levels) with the aim of reversing the negative emotions they feel. And thirdly, it constitutes a new contribution to the field of the didactics of experimental sciences, suggesting new lines of research that will promote the growth of this area, our study contributes to improve the quality of science lessons, supporting that teaching and learning process should be oriented not only to enhance cognitive functions but also other skills and potentials.

LIMITATIONS OF THE STUDY

The questionnaire is self-administered, and the veracity of the data depends on the degree of honesty with which each student has answered. For this reason, future research intends to include additional methods to help eliminate this bias. Despite using a validated questionnaire, alpha Cronbach's value for kinæsthetic learning style obtained was quite low. Also, the sample belongs to a single university, and the results cannot be extrapolated other than to what they represent–a sample of prospective teachers from one university in one Spanish region. However, this is an appropriate approach since it is an exploratory study of the sample with whom we intend to continue working, although with the intention to improve the approach in the future.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Since this piece of research involves data collection from individuals, all procedures performed were in accordance with the ethical standards of the 1964 Helsinki Declaration. Informed consent was obtained from all individuals, and the study was validated by the corresponding Ethical Committee (Comisión de Bioética y Bioseguridad, Universidad de Extremadura). All information about the bioethics and ethics in research activity at the University of Extremadura can be retrieved from http://investigalia.unex.es/#!/page36.do?acond12=es&rcond3.att2=197&kcond92.att3=229. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FC-C, JS-M, and IC-C designed the study. All the authors designed the questionnaire, collected the data, and wrote sections detailing the sample of students and data collection. MH-B performed the data analyses and wrote the first draft of the manuscript. FC-C, JS-M, and IC-C reviewed, edited, and supervised the article. All the authors have made a substantial, direct and intellectual contribution to the work, all them have agreed to the published final manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2021.604791/full#supplementary-material.

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