The emotions in teaching and learning nature sciences and physics/chemistry in pre-service primary teachers*

María Brígido[1], M. Luisa Bermejo[2], M. Carmen Conde[1], Vicente Mellado[1]

(1. Department of Science and Mathematics Education, Faculty of Education, University of Extremadura, Badajoz 06071, Spain;

2. Department of Psychology and Anthropology, Faculty of Education, University of Extremadura, Badajoz 06071, Spain)

Abstract: A study was made of different emotions that prospective primary school teachers report with respect to science subjects, when they were pupils, and during their practice teaching, taking into account the variables gender and the speciality they studied in the secondary education. The study consisted of a questionnaire completed by 63 primary education students at the University of Extremadura, Spain. The results show a great difference between the emotions related to the subjects of physics/chemistry and the nature sciences (biology/geology). The scientific subject influences the emotions of pre-service primary teachers, both in learning and teaching. In physics and chemistry, the emotions are mostly negative. While in nature sciences they are very positive. In nature sciences, there is a correlation between the emotions felt as secondary school pupils learning science and those they feel as teachers. In physics and chemistry, there is a correlation in the women between the emotions felt as secondary school pupils learning science and those they feel as teachers, but not in the men. The memory of their emotions in learning science at school is more negative than in teaching science during their teaching practice, except in nervousness in physics/chemistry. By gender, men declared a greater predilection for science content than women, with more of them describing such feelings as sympathy or confidence. The results highlight the influential role that emotions play throughout the professional growth of future primary teachers.

Key words: teaching and learning science; emotions; initial teacher education; primary teachers

1. Introduction

The processes of learning and teaching science are not merely cognitive, but are highly charged with feelings. Nevertheless, in schools and universities, science is for the most part portrayed as a rational, analytical and non-emotive area of the curriculum.

Recent results have questioned the independence of the rational and the emotional, since, according to the theory of affective cognitive moulds of Hernandez (2002), the cognitive configures the affective and vice versa.

---

* An earlier version of this article was presented as a paper at ESERA Conference 2009, Istanbul, Turkey, August 31st-September 4th.

This work was financed by Research Project EDU2009-12864 of the Ministry of Education and Science (Spain) and European Regional Development Fund (ERDF).

María Brígido, Ph.D. candidate, Department of Science and Mathematics Education, Faculty of Education, University of Extremadura; research fields: the emotions in teacher education, psychology of education.

M. Luisa Bermejo, Ph.D., associate professor, Department of Psychology and Anthropology, Faculty of Education, University of Extremadura; research fields: the emotions in teacher education, psychology of education.

M. Carmen Conde, Ph.D., Department of Science and Mathematics Education, Faculty of Education, University of Extremadura; research field: science teacher education.

Vicente Mellado, Ph.D., professor, Department of Science and Mathematics Education, Faculty of Education, University of Extremadura; research field: science teacher education.

Research in science education also recognizes the importance of emotions in teaching and learning, and advocates the need to consider the cognitive and affective dimensions (Koballa & Glynn, 2007; Otero, 2006).

Numerous studies have noted that, primary school pupils usually show interest, excitement and generally positive attitudes towards science, but that these decrease with age, especially during secondary education (Beauchamp & Parkinson, 2008; Murphy & Beggs, 2003; Osborne, et al., 2003; Ramsden, 1998; Simpson & Oliver, 1990; Vázquez & Manassero, 2008).

Zembylas (2001; 2002; 2004) reviewed the relationship between science teaching and emotion, and argued that emotions, both positive and negative, play an important role in teachers' construction of pedagogical content knowledge, curriculum planning and relationships with children and colleagues. He suggested that, emotions in science teaching are constructed at a deep level, and may be seen as constitutive of the activity of science teaching. The affective domain is of increasing importance as a regulatory system of learning. Teachers have an "emotional ecology" that exists on 3 levels: individual, relational and socio-political, that are different aspects of their pedagogical content knowledge (Zembylas, 2005). They construct and use emotional knowledge to establish or strengthen their connections with pupils and content, or to perform teaching actions.

Although teachers' conceptions, attitudes, emotions, values and classroom practice are related, depending on the teacher and the context, these aspects are often out of phase with each other, and even plainly in contradiction, and changes in one are not necessarily accompanied by a change in the rest (Mellado, et al., 2006). There is growing evidence that change is more likely to be consolidated if all its aspects are integrated and related (Sanmartí, 2001). As noted by Day (1999), teachers' change is not just a matter of the head, but also of the heart. It will be difficult to put changes into effect unless they are compensated affectively, and contribute to greater personal job satisfaction.

Affective aspects are important during initial teacher education. Prospective teachers have themselves been pupils for many years, and as a result, have beliefs, attitudes, feelings, values, goals and teaching styles which are strongly internalized and difficult to change. Their own experiences at school lead many teachers to take as referents for their science teaching, whether positive or negative, the teachers themselves had when they were pupils, and to use teaching methods that are very close to what they preferred in their teachers when they were at school (Mellado, et al., 1998). Their teaching routines and strategies become most firmly set during their first teaching experiences in their teaching practice, and will subsequently be difficult to modify. Also, during their teaching practice, they are subjected to many dilemmas and stresses that naturally cause them anxiety and insecurity. These negative emotions can cause them to adopt defensive teaching strategies that are centred on the teachers and the contents rather than on the pupils and learning. While this allows them an apparently greater control of the class, and hence, makes them feel safer, it limits their teaching effectiveness. The anxiety that teaching science provokes in prospective primary teachers also has a repercussion on their self-efficacy in science teaching (Czerniak & Scriver, 1994).

For Hugo and Sanmartí (2003), traditional teaching models may be overcome by applying meta-cognitive and meta-affective strategies to control and regulate the emotions that arise when the model is changed. As Efkelides (2009, p. 139) observes, "Metacognitive regulation should be expanded to include not only cognitive but emotional regulation as well". In initial teacher education, Oosterheert and Vermunt (2001) included emotion regulation as a functional component of learning to teach. This dynamic component is generated and evolves from the teachers' own knowledge, beliefs, attitudes and emotions. It requires active personal involvement, reflection on the teaching process and practice in teaching the specific material in particular school contexts. This component is a form of

knowledge in action, and hence, is related to the teachers' pedagogical content knowledge (Garritz, et al., 2008).

2. Purpose

The authors consider it necessary to study the affective and emotional factors in how future primary teachers teach and learn science, since their beliefs and emotions can greatly affect their pupils' achievement, beliefs and attitudes towards learning science.

The aim of the study is to identify the emotions aroused by learning and teaching the subjects of physics/chemistry and nature sciences in a sample of pre-service primary teachers during their period as secondary school pupils and when doing their undergraduate teaching practice.

3. Methods and samples

The subjects participating in the study were 63 students of primary education at the Faculty of Education, University of Extremadura—29 in the second year and 34 in the third year. They were selected by a non-probabilistic sampling procedure of convenience, based on the availability of time and of cases. There were 49 women and 14 men. Data were collected during the 2007-2008 academic year, after their periods of teaching practice. Obviously, the second and third year prospective teachers were different since they were from two distinct courses.

The instrument used was a questionnaire, in which the subjects noted from among the positive and negative emotions offered, which were those that they experienced when learning the different subjects of science as secondary school pupils, and when teaching them in their teaching practice (Blanco, et al., 2008). The questionnaire items were organized in terms of tables of emotions (Brígido, et al., 2009). The resulting data were subjected to the necessary processes of checking, coding and digital storage in order to proceed with their descriptive analysis using SPSS (Statistical Product and Service Solutions) 13.0.

4. Results

4.1 Physics and chemistry

Their recall of the subjects of physics and chemistry at secondary school (see Table 1) suggested fundamentally negative emotions: nervousness, anxiety, tension, worry or despair, and only rarely positive emotions, such as confidence or enthusiasm. During their practice teaching also, they recalled more negative than positive emotions when teaching topics related to physics or chemistry. In each case, the percentages are relative to the sample that answered these questions as pupils or as teachers. The sample as teachers is smaller than that as pupils since many participants did not teach these subjects during their teaching practice, and therefore, did not answer.

Figure 1 compares the emotions as pupils when they were learning physics and chemistry in the secondary education with those experienced as teachers when teaching this content during their practice. One observes that the two are fairly strongly correlated, and, except for nervousness, the negative emotions have decreased more notably when they were teaching these subjects than when they were learning them in secondary school. While this decrease in negative emotions is encouraging, the low percentage of positive emotions is still a cause for concern both for how it will affect the students' learning how to teach these subjects, and for the reflection it makes of the negligible impact that their initial teacher education has had on their positive emotions as teachers.

Table 1 Emotions aroused by topics related to physics and chemistry as pupils at school and when doing practice teaching

	Positive emotions			Negative emotions	
	Teachers (%)	Students (%)		Teachers (%)	Students (%)
Fun	17.5	12.7	Tension	37.5	31.7
Tranquillity	20	3.2	Nervousness	47.5	42.9
Congeniality	10	11.1	Worry	37.5	39.7
Confidence	17.5	7.9	Uncertainty	30	47.6
Capacity	15	14.3	Fear	37.5	47.6
Pride	25	15.9	Anxiety	35	44.4
Gratification	17.5	7.9	Frustration	25	44.4
Satisfaction	10	7.9	Despair	30	42.9
Enthusiasm	17.5	12.7	Pessimism	30	46
Pleasure	7.5	3.2	Hate	25	34.9
Devotion	5	3.2	Anger	25	34.9
Joy	10	1.6	Depression	30	47.6
			Contempt	22.5	33.3
			Sadness	20	25.4

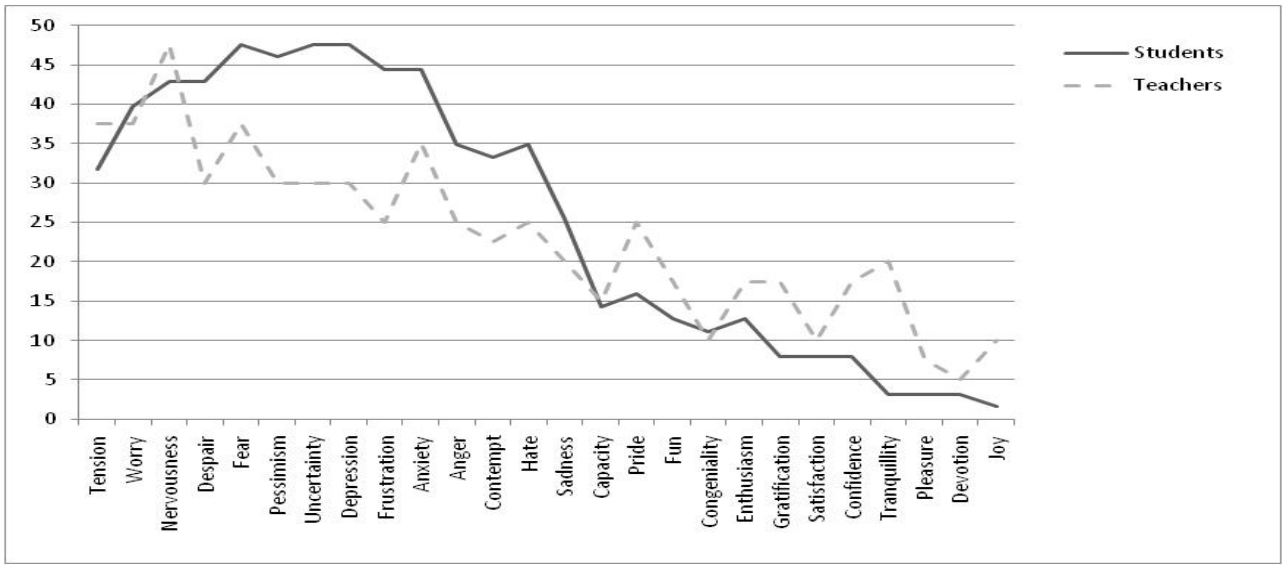

Figure 1 Emotions aroused by topics related to physics and chemistry as pupils at school and when doing practice teaching

There were few differences between men (14 participants) and women (49 participants) in the emotions, when they were learning physics or chemistry at school (see Figure 2), except for the feelings of hate and uncertainty which were more reported by men, or of tension, more reported by women.

Figure 3 shows the emotions reported by men (10 participants) and women (30 participants) when teaching physics or chemistry. One observes that, except for nervousness, the women report more negative and fewer positive emotions than men when they were teaching these subjects. It is noteworthy that men who taught these subjects during their teaching practice showed a noticeable improvement in their emotions relative to what they felt when they were studying these subjects in secondary school.

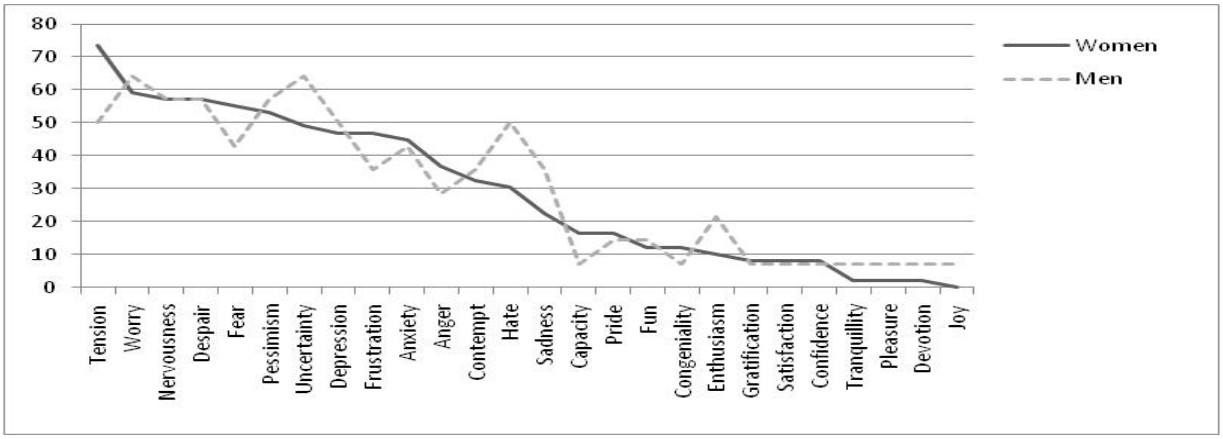

Figure 2 Prospective teachers' emotions when they themselves were pupils learning physics or chemistry by gender

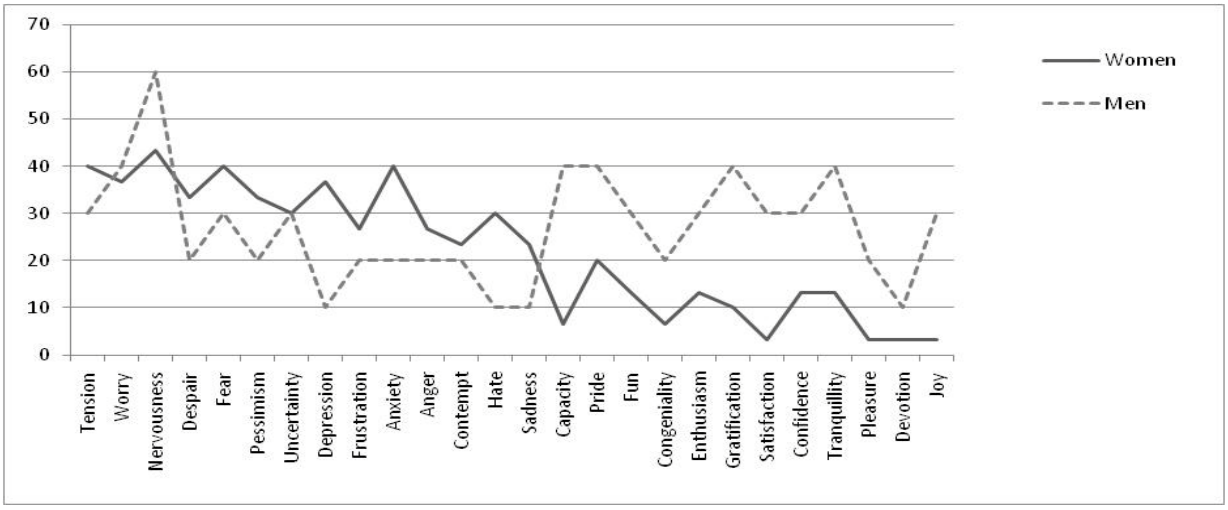

Figure 3 Prospective teachers' emotions when they were teaching physics or chemistry in their practicum by gender

4.2 Nature sciences (biology/geology)

Their recall of the subjects of nature sciences during their time in secondary school suggested to them fundamentally positive emotions: fun, tranquillity, joy, satisfaction, congeniality, capacity, etc. On teaching topics related to nature sciences during their teaching practice, they also experienced positive feelings, even to a greater extent than when they were at school (see Table 2).

The results show a great difference between the emotions related to the subjects of physics/chemistry and the nature sciences. For the nature sciences, there was a strong correlation between their emotions when learning at school and as teachers during their practice teaching (see Figure 4).

Figure 5 shows the results of differentiating the emotions reported in learning nature sciences between men and women (sample: 14 men and 49 women). Both groups had many positive and few negative emotions. For men, there stood out feelings of capacity, pride, congeniality, satisfaction, confidence, tranquillity and pleasure.

Various studies of pupils' attitudes towards science in general which have included studies of their emotions have found that males tend to show more positive attitudes than females (Caleon & Subramaniam, 2008; Koballa & Glynn, 2007; Vázquez & Manassero, 2007).

Table 2 Emotions aroused by topics related to nature sciences as pupils at school and when doing practice teaching

Positive emotions			Negative emotions		
	Teachers (%)	Students (%)		Teachers (%)	Students (%)
Fun	76.6	42.9	Tension	6.4	17.5
Tranquillity	76.6	49.2	Nervousness	10.6	11.1
Congeniality	59.6	47.6	Worry	4.3	12.7
Confidence	59.6	38.1	Uncertainty	4.3	6.3
Capacity	68.1	44.4	Fear	4.3	9.5
Pride	44.7	31.7	Anxiety	2.1	9.5
Gratification	53.2	30.2	Frustration	2.1	6.3
Satisfaction	57.4	41.3	Despair	2.1	14.3
Enthusiasm	51	39.7	Pessimism	4.3	14.3
Pleasure	53.2	38.1	Hate	0	3.2
Devotion	31.9	23.8	Anger	2.1	3.2
Joy	55.3	38.1	Depression	2.1	6.3
			Contempt	0	7.9
			Sadness	0	6.3

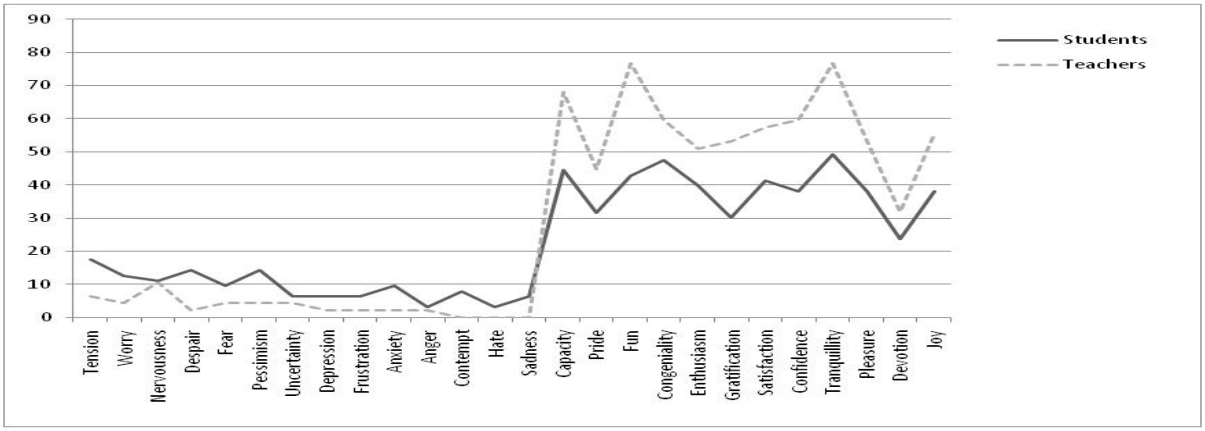

Figure 4 Emotions aroused by topics related to nature sciences as pupils at school and when doing practice teaching

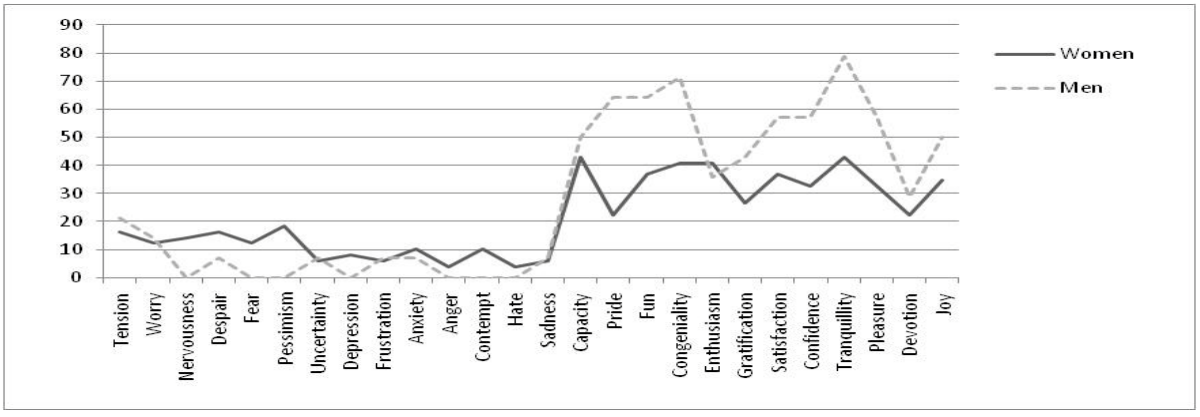

Figure 5 Prospective teachers' emotions when they themselves were pupils learning nature sciences by gender

Figure 6 shows the results for the emotions of the men and women reported when they were teaching nature sciences (sample: 12 men and 35 women). Again both groups report few negative emotions in teaching these subjects, and present very high values for the positive emotions. Although the percentages are slightly higher for

men than for women, there is a notable coincidence in the pattern between the two groups.

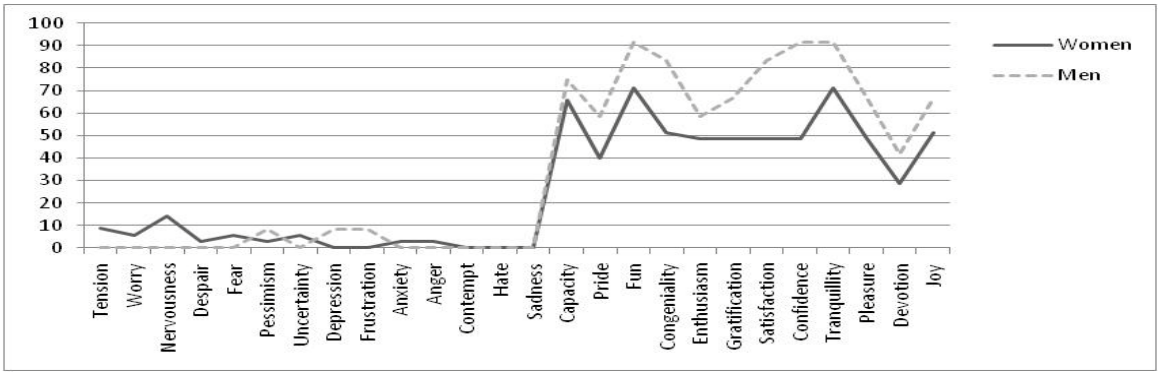

Figure 6 Prospective teachers' emotions when they were teaching nature sciences in their practicum by gender

5. Conclusion and implications

The present results reflect a great difference in the emotions aroused in pre-service primary teachers by the subjects of physics/chemistry and nature sciences (biology/geology). In physics and chemistry, the emotions are mostly negative in women, both in learning and teaching, while men recall negative emotions in learning, but positive in teaching. In nature sciences, the emotions of both men and women are very positive, both in learning and teaching.

Overall, their memory of their emotions in learning science at school is more negative than in teaching science during their teaching practice, except in nervousness in physics/chemistry. In nature sciences, the emotions felt as secondary school pupils learning science are strongly correlated with those they feel as teachers. In physics and chemistry, there is a correlation in women between the emotions felt as secondary school pupils learning science and those they feel as teachers, but not in men. Except for nervousness, men report positive emotions when they were teaching physics/chemistry, but negative emotions when they were learning these subjects in secondary school.

Comparing by gender, men declared more positive emotions for teaching science content than women. In learning science, men declared more positive emotions than women in nature sciences, and both of them reported negative emotions in learning physics/chemistry.

The present study is subject to two types of limitation. The first is because of the questionnaire may not have captured all the nuances of the emotions. For this, it would have to be supplemented with other more qualitative methods, such as interviews. And the second is because of the small size of the sample of prospective teachers enrolled in the year of the study. This was especially so for men, particularly when one considers that in their practice teaching, not all the participants taught science subjects.

With respect to the implications, the authors believe that the study of emotions is important in the context of initial teacher education (Shoffner, 2009). This is to help them, on the one hand, become aware of their own possible emotional vulnerability, of their time at school and of how emotions affect teaching and learning the different science subjects, and on the other hand, to enable them to develop the capacity to act to change and self-regulate those emotions. Younger teachers are more likely to incorporate educational changes into their practice and to consider the emotional dimension of those changes (Hargreaves, 2005). It is, therefore, necessary to develop programs of intervention and emotional support for prospective teachers (Appleton, 2008; Blanco, et al., 2008; Koballa, et al., 2008) in order for them to gain in emotional competence—an aspect on which the authors are currently working.

References:

Appleton, K. (2008). Developing science pedagogical content knowledge through mentoring elementary teachers. *Journal of Science Teacher Education, 19*(6), 523-545.

Beauchamp, G. & Parkinson, J. (2008). Pupils' attitudes towards school science as they transfer from an ICT-rich primary school to a secondary school with fewer ICT resources: Does ICT matter? *Education and Information Technologies, 13*(2), 103-118.

Blanco, L. J., Caballero, A. & Guerrero, E. (2008). Training program of general problem solving, mathematics problem solving, and emotional control. In: González-Pienda, J. A. & Núñez, J. C. (Eds.). *Psicología y educación: Un lugar de encuentro*. Oviedo: Universidad de Oviedo, 2027-2033.

Brígido, M., Caballero, A., Bermejo, M. L., Conde, C. & Mellado, V. (2009). Emotions in science of primary education teaching students during their practice teaching. *Campo Abierto, 28*(2), en prensa.

Caleon, I. S. & Subramaniam, R. (2008). Attitudes towards science of intellectually gifted and mainstream upper primary students in Singapore. *Journal of Research in Science Teaching, 45*(8), 940-954.

Czerniak, C. & Scriver, M. (1994). An examination of preservice science teachers' beliefs and behaviors as related to self-efficacy. *Journal of Science Teacher Education, 5*(1), 77-86.

Day, C. (1999). *Developing teachers, the challenges of lifelong learning*. London: Falmer Press.

Efklides, A. (2009). The new look in metacognition: From individual to social, from cognitive to affective. In: Clayton, B. L. (Ed.). *Metacognition: New research developments*. New York: Nova Science Publishers, 137-151.

Garritz, A., Nieto, E., Padilla, K., Reyes, F. & Trinidad, R. (2008). Pedagogical content knowledge in chemistry: What every teacher should possess. *Campo Abierto, 27*(1), 153-177.

Hargreaves, A. (2005). Educational change takes ages: Life, career and generational factors in teachers' emotional responses to educational change. *Teaching and Teacher Education, 21*(8), 967-983.

Hernández, P. (2002). *The moulds of the mind: Beyond emotional intelligence*. La Laguna: Tafor publicaciones.

Hugo, D. V. & Sanmartí, N. (2003). Trying to reach a consensus with prospective science teachers on the objects and criteria of evaluation. *Enseñanza de las Ciencias, 21*(3), 445-462.

Koballa, T. R., Bradbury, L. U., Glynn, S. M. & Deaton, C. M. (2008). Conceptions of science teacher mentoring and mentoring practice in an alternative certification program. *Journal of Science Teacher Education, 19*(4), 391-411.

Koballa, T. R. & Glynn, S. M. (2007). Attitudinal and motivational constructs in science learning. In: Abell, S. K. & Lederman, N. G. (Eds.). *Handbook of research on science education*. Mahwah, NJ: Erlbaum, 75-102.

Mellado, V., Blanco, L. J. & Ruiz, C. (1998). A framework for learning to teach sciences in initial teacher education. *Journal of Science Teacher Education, 9*(3), 195-219.

Mellado, V., Ruiz, C., Bermejo, M. L. & Jiménez, R. (2006). Contributions from the philosophy of science to the education of science teachers. *Science & Education, 15*(5), 419-445.

Murphy, C. & Beggs, J. (2003). Children perceptions of school science. *School Science Review, 84*(308), 109-116.

Oosterheert, I. E. & Vermunt, J. D. (2001). Individual differences in learning to teach: relating cognition, regulation an affect. *Learning and Instruction, 11*, 133-156.

Osborne, J., Simon, S. & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049-1079.

Otero, M. R. (2006). Emotions, feelings, and reasoning in science education. *Revista electrónica de investigación en educación de las ciencias, 1*(1), 24-53.

Ramsden, P. (1998). *Learning to lead in higher education*. London: Routledge.

Sanmartí, N. (2001). Teaching to teach secondary education science: A comprehensive challenge. *Revista Interuniversitaria de Formación del Profesorado, 40*, 31-48.

Shoffner, M. (2009). The place of the personal: Exploring the affective domain through reflection in teacher preparation. *Teaching and Teacher Education, 25*(8), 783-789.

Simpson, R. & Oliver, S. (1990). A summary of mayor influences on attitude toward and achievement in science among adolescent students. *Science Education, 74*(1), 1-18.

Vázquez, A. & Manassero, M. A. (2007). In defence of attitudes and emotions in science education (II): Empirical evidence from research. *Revista Eureka, 4*(3), 417-441.

Vázquez, A. & Manassero, M. A. (2008). The decline in students' attitudes towards science: A troubling indicator for science education. *Revista Eureka, 5*(3), 274-292.

Zembylas, M. (2001). A paralogical affirmation of emotion's discourse in science teaching. In: Barton, A. & Osborne, M. (Eds.). *Teaching science in diverse setting: Marginalized discourses and classroom practice*. New York: Peter Lang, 99-128.

Zembylas, M. (2002). Constructing genealogies of teachers' emotions in science teaching. *Journal of Research in Science Teaching, 39*(1), 79-103.

Zembylas, M. (2004). Emotional issues in teaching science: A case study of a teacher's views. *Research in Science Education, 34*(4), 343-364.

Zembylas, M. (2005). Discursive practices, genealogies, and emotional rules: A poststructuralist view on emotion and identity in teaching. *Teaching and Teacher Education, 21*(8), 355-367.

(Edited by Nicole and Sunny)