Variables associated to the self-efficacy perceived by Spanish Secondary School Science Teachers

Variables asociadas a la autoeficacia percibida por el profesorado de ciencias en educación secundaria

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Abstract

Teacher self-efficacy is one of the main factors associated with professional performance of teachers, quality of teaching and learning outcomes achieved by students. In this paper we have analyzed the efficacy of Spanish science teachers and their relation to other features of the teacher and the environment in which they teach. We used data from the 2013 study TALIS (*Teaching and Learning International Survey*) promoted by the Organization for Economic Co-operation and Development (OECD). The Spanish sample amounted to 3422 teachers, of whom 590 teach science subjects. We have described the perceived self-efficacy in this group of science teachers, we compare the means obtained in efficacy variables for teaching science and other subjects, and we have identified the variables that contribute most to explain the sense of efficacy in three domains: classroom management, teaching, and student engagement. To do this we have calculated the correlations between teacher self-efficacy and other variables, and we have applied a regression analysis with more than one dependent variable, by using a multivariate general linear model (GLM). The results show higher levels of self-confidence for teaching and lower levels in self-confidence for student involvement. The most significant variables in explaining self-confidence have proved to be cooperation between teachers, perceived climate of discipline in the classroom, professional development needs in the areas of science and teaching, and constructivist beliefs. However, the predictors behave differently depending on the type of efficacy being explained. From the results, some

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proposals have been made for the improvement of teaching self-efficacy to science teachers.

Key words: secondary school; science education; teacher self-efficacy; school context, TALIS study

Resumen

La autoeficacia docente es uno de los principales factores asociados al desempeño profesional de los profesores, a la calidad de su enseñanza y a los resultados de aprendizaje logrados por los estudiantes. En este trabajo hemos analizado la autoeficacia del profesorado español de ciencias y su relación con otras características del profesor y del contexto en que imparte docencia. Se han utilizado datos obtenidos en el estudio TALIS 2013 (*Teaching and Learning International Survey*) promovido por la OCDE. La muestra española ascendió a 3422 profesores, de los cuales 590 imparten asignaturas de ciencias. Hemos descrito la autoeficacia percibida por este colectivo de docentes de ciencias, comparando las medias obtenidas en las variables de autoeficacia para el profesorado de ciencias y de otras materias, y hemos identificado las variables que en mayor medida contribuyen a explicar el sentido de autoeficacia en tres dominios: el manejo de la clase, la enseñanza y la implicación del alumnado. Para ello, calculamos las correlaciones entre las variables de autoeficacia docente y el resto de las variables, y se ha aplicado un análisis de regresión con más de una variable dependiente, usando un modelo lineal general (MLG) multivariado. Los resultados obtenidos muestran mayores niveles en autoconfianza para la enseñanza y menores en la autoconfianza para la implicación del alumnado. Las variables más relevantes en la explicación de la autoconfianza han resultado ser la cooperación entre el profesorado, la percepción sobre el clima de disciplina en el aula, las necesidades de desarrollo profesional en las materias de ciencias y en su enseñanza, y las concepciones constructivistas. No obstante, los predictores se comportan de diferente modo en función del tipo de autoeficacia que se pretenda explicar. A partir de los resultados obtenidos, se formulan algunas propuestas para la mejora de la autoeficacia docente en el profesorado de ciencias.

Palabras clave: educación secundaria, enseñanza de las ciencias, autoeficacia del profesor, contexto escolar, estudio TALIS

Introduction

The faculty is undoubtedly one of the principal school factors influencing the quality of educational practices and student performance. Research in this field has accumulated evidence on how the teacher's knowledge, skills, professional identity, concepts about teaching and learning, motivation, enthusiasm, efficiency or expectations, among other aspects, all relate to the quality of education (Hattie & Anderman, 2013). In this paper we focus on the study of the perceived effectiveness by the teacher (*self-efficacy*) in their teaching performance.

The concept of self-efficacy arises in the context of social cognitive theory proposed by Bandura (1986). This author believes that to achieve well-being it is necessary to have a positive sense of self-efficacy. Self-efficacy is defined as the belief that the individual has in their ability to act in certain areas of human activity and do it successfully (Bandura, 1997). From this theoretical approach, a high self-efficacy implies greater optimism and motivation, leading to an investment in a greater and more sustained effort to achieve the objectives.

Teaching is an area in which professional self-efficacy has been extensively researched (Klassen, Tze, Betts, & Gordon, 2011). Teacher self-efficacy refers to the teachers' confidence in adequately addressing their teaching tasks and thereby achieving student learning. Tschannen-Moran, Woolfolk Hoy, and Hoy (1998) have defined a teacher's confidence in their own ability to plan and execute required actions in order to successfully cover the tasks of teaching in a particular context. In the case of teaching sciences, beyond a solid foundation in the discipline subject of education, the concept of self-efficacy leads us to the knowledge of teaching strategies and skills to manage the development of the class, involve students, or establish good relations with them (Blonder, Benny, & Jones, 2014). Thus understood, teacher self-efficacy is a particularly important factor in order to optimize teaching and learning outcomes. With regard to student performance, research has repeatedly stated its relationship with self-efficacy (Caprara, Barbaranelli, Steca, & Malone, 2006; Ross, 2013). A heightened sense of self-efficacy would lead teachers to be more creative in their work, make greater efforts to achieve their goals, and thereby lead to higher levels of motivation and student learning (Scheerens, 2010).

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Teacher self-efficacy may be conditioned by a number of contextual variables, among which are teacher traits, as well as those of the classes and schools where educational work is developed. Among teacher characteristics, the effect of gender has been analysed, assuming that women perceive higher self-efficacy than men, especially in the case of primary education. For Ross, Cousins and Gadalla (1996), this is because education is seen as a profession with a dominant female presence and women are more comfortable working in this area. Another relevant teacher trait is their experience as a teacher. The findings of the research in this aspect reveal that practicing teachers have a greater sense of efficacy than future teachers (De la Torre & Arias, 2007). Among practicing teachers a greater number of years of experience entails greater perceived self-efficacy (Penrose, Perry, & Ball, 2007; Wolters & Daugherty, 2007), although this statement may be qualified in light of work such as Klassen and Chiu (2010), where a nonlinear relationship between the two variables is stated: increased self-efficacy at the beginning and within an average career, falling in the final stages of the teacher's professional life.

Self-efficacy is related to how teachers feel professionally. It is lower in those with low levels of job satisfaction (Caprara, Barbaranelli, Borgogni, & Steca, 2003). In extreme situations, low satisfaction can lead to fatigue, feelings of being overwhelmed emotionally, developing inappropriate attitudes, irritability, and a reduction in the ability to meet labour demands. The relationship of self-efficacy not only to job satisfaction, but also to stress and burnout has also been evaluated, attributing high efficacy with a moderating role of stressors that may affect high school teachers. (Doménech, 2006).

Teaching practices and perceptions about teaching is another issue addressed in the literature. Teachers with high self-confidence show greater levels of planning and organization in their work, and are more open to new ideas and to trying new approaches in order to better respond to the needs of their students (Protheroe, 2008). Science teachers with high levels of confidence are more likely to use student-centred and research-based teaching strategies, while teachers with low self-confidence are more likely to continue with traditional teaching strategies, supported mainly by the use of the textbook (Harlen & Holroyd, 1997). In the work of Lakshmanan, Heath, Perlmutter, and Elder (2011), after conducting continuing professional development activities with science teachers, a positive correlation between the increased levels of

achievement in self-confidence and increased use of research-based instructional strategies is to be found. In a study of mathematics and science teachers, Temiz and Topcu (2013) observed the teaching practices of more than one hundred subjects, concluding that teachers with high self-efficacy tend to employ constructivist approaches in their teaching, while those with low levels of self-efficacy are more likely to use traditional approaches.

Research in teacher self-efficacy in science has paid particular attention to future teachers, checking the effects that certain content or strategy methods in their training have on the perceived teaching self-efficacy (Gunning & Mensah, 2011; Richardson & Lian, 2008; Velthuis, Fisser, & Pieters, 2014). In these works, they identified the direct experiences in teaching as the main factor which enabled those involved to improve their confidence in studying how to become teachers (Brand & Wilkins, 2007) and ensure that these effects persist over time (Palmer, 2007). In the case of practicing teachers, we have explored the relationship between self-efficacy and participation in professional development activities, which would favour increasing the perceived self-efficacy for science teachers (McKinnon & Lamberts, 2014).

Among the variables relating to the working environment, it has been noted that teachers working in classrooms with high performance students tend to perceive higher levels of self-efficacy; especially mathematics and science teachers (Raudenbush, Rowan & Cheong, 1992). The presence of low-performing students in the classroom will often link to discipline problems and conflicts in the relationship between teacher and students. Working with novice teachers, Onafowora (2004) found that teachers with greater confidence in their ability to motivate and involve students spent more time teaching and less time in maintaining discipline. In general, a positive school climate is associated with the perception of a teacher that can achieve positive learning outcomes for students (Hoy & Woolfolk Hoy, 1993).

High levels of perceived self-efficacy are also associated with collaboration between teachers (Duyar, Gumus, & Belibas, 2013; Ross, 1992; Shachar & Smuelvitz, 1997). Schools constitute organizations in which teachers work together and interact socially. In this framework, along with individual teacher self-efficacy, collective teacher efficacy has been defined, which is understood as a feature of schools, and refers to perceptions of the teachers about the extent to which their joint actions as a faculty have positive effects on students (Goddard, Hoy, & Woolfolk Hoy, 2000). This

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perception is due to the interaction dynamics established among faculty members, so that collaboration among teachers is a fundamental factor for generating a high perception of collective teaching effectiveness. In turn, collaborative dynamics among teachers leads to heightened personal confidence, given the connection between the perceptions of individual and collective self-efficacy (Goddard & Goddard, 2001).

The work presented in this article focuses on the study of teacher self-efficacy and contextual factors relating to it. By presenting the study, we took into account several considerations stemming from the review that Klassen et al. (2011) conducted over 218 empirical studies about efficacy, published between 1998 and 2009. Firstly, during this period, research on teacher efficacy had placed particular emphasis on teachers in training (pre-service) or in their first year of teaching, yet still relatively few studies exist that address the perceived self-efficacy by more experienced teachers (in-service). Moreover, only 15% of studies reviewed focus on high school teachers, with most studies focusing on primary education teachers or teachers in training. Secondly, only the most recent works have begun to address the study of teacher self-efficacy in specific areas, such as science, mathematics or reading. For the authors of the above review, one of the key elements that should be especially addressed with the research on self-efficacy, is precisely the attention to specific areas. Thirdly, the study of teacher self-efficacy began in the United States, where most researchers and theorists on the subject are concentrated. Klassen et al. (2011) note that «*teacher efficacy researchers have called for an exploration of teacher efficacy in a wider variety of cultural and national settings*» (p. 25).

Considering these guidelines and taking into account the areas and levels at which previous research is deficient, this work has focused on Spanish secondary school teachers, placing the focus on the specific field of science education. We conducted the study in Spain, where empirical work on self-efficacy of teachers, especially on teachers who teach science in secondary education are scarce. We are especially interested in the teaching of science as it is one of the areas in which teachers feel the lowest self-efficacy (Buss, 2010; Howitt, 2007).

There are two objectives to this study. The first is to describe the efficacy of Spanish science teachers, compared with that perceived by the teachers of other subjects. The studies by Buss (2010) and Howitt (2007) on self-efficacy in science were done at primary education level. We have not found similar studies for secondary education teachers,

which is why we do not suggest any hypotheses on the differences in self-efficacy felt by sciences teachers and those of other subjects. A second objective is aimed at determining which variables contribute most to explaining the perceived self-efficacy of these teachers. We are assuming that the variables being considered are potentially relevant when explaining self-efficacy in science teaching, considering the literature reviewed in the above paragraphs. Furthermore, given that self-efficacy is a multidimensional concept, we aim to assess the relevance of the explanatory variables when considering different domains of self-efficacy. Understanding the factors associated with perceived self-efficacy will help to guide efforts to improve teacher self-efficacy in science, and thus enhance both the quality of teaching and student achievement.

Method

A secondary analysis was conducted using data generated in the 2013 study Teaching and Learning International Survey (TALIS), promoted by the OECD, which involved 33 countries. The purpose of TALIS is to collect information from teachers and headmasters about aspects such as the characteristics of the school environment, educational practices that take place in them, or their attitudes and conceptions about teaching and learning.

Participants

We have considered the data for the Spanish sample of teachers in compulsory secondary education, consisting of 3422 teachers who responded to a questionnaire. From their responses, we selected 590 teachers (41.0% male; 59.0% female) who said they are teaching science classes, such as natural sciences, physics, chemistry, biology or geology. Their average age is 46.0 years (SD=8.4) and their average working experience is 18.3 years (SD=9.5). In order to address the first of the objectives in this study, we also take into account the teachers of other subjects. Among the 3422 teachers who answered the questionnaire, 2791 (40.7% male; 59.3% female) were identified as teaching in areas different from sciences. In this second group, the average age was 45.4 years (SD=8.6) and the average working experience was 18.1 years (SD=9.5).

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Instrument and variables

The data used is based on the Teachers Questionnaire used in the TALIS studies. The information for all the variables considered in our analysis was generated using this questionnaire with the Spanish sample. As for the selected variables, a first group consists of variables that inform about self-efficacy in teaching. The model most frequently used in studies on teacher self-efficacy is the one proposed by Tschannen-Moran et al. (1998), distinguishing three dimensions: self-*efficacy in teaching, self-efficacy in classroom management* and self-*efficacy in student engagement*. These three components correspond to the three self-efficacy variables measured in TALIS and are considered in this work. Along with these variables, we took into account others related to self-efficacy, according to the evidence from the research described in the introduction. Specifically, the variables in question relate to personal, professional or school context characteristics: *gender, number of years of teaching experience, classroom disciplinary climate, constructivist beliefs, inter-teacher collaboration, effective professional development, need for professional development in subject matter and pedagogy*.

With the exception of gender (female=1, male=2) and teaching experience (number of years working as a teacher), each of the variables is found by indices included in the TALIS database. These indices are based on teachers' responses to certain items of the questionnaire. The group of items used in the construction of each index was firstly evaluated by exploratory factorial analysis; a later confirmation by factorial analysis allowed the construction of the scales and the validation of these (for more details see OECD, 2014).

The items on which the three indices of self-efficacy are based measure the extent to which teachers are able to perform certain actions, on a scale which includes the values: nothing (1), to a certain extent (2), significantly (3) and very much (4). The items can be seen in the first table shown in the results (table II). The reliability of the measures of self-efficacy for class management, teaching and implication of the students in the Spanish sample, using values of á by Cronbach, were 0.82, 0.75 and 0.80 respectively. The items used in the other indices appear in table I, where the Likert scale used for the answers and the reliability coefficient is also shown.

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TABLE I. Indices for variables of teacher and school context, along with items used for their calculation

Index (Cronbach α)	Items
Classroom disciplinary climate (α= 0.87)	How strongly do you agree or disagree with the following statements? [1] ▪ When the lesson begins, I have to wait quite a long time for students to quiet down ▪ Students in this class take care to create a pleasant learning atmosphere. ▪ I lose quite a lot of time because of students interrupting the lesson ▪ There is much disruptive noise in this classroom .
Constructivist beliefs (α = 0.74)	How strongly do you agree or disagree with the followi ng statements? [1] ▪ My role as a teacher is to facilitate students' own inquiry ▪ Students learn best by finding solutions to problems on their own ▪ Students should be allowed to think of solutions to practical problems themselves before the teacher shows them h ow they are solved ▪ Thinking and reasoning processes are more important than specific curriculum content
Teacher co-operation (α= 0.70)	On average, how often do you do the following in this school? [2] ▪ Teach jointly as a team in the same class ▪ Observe other teachers' classes and provide feedback ▪ Engage in joint activities across different classes and age groups (e.g. projects) ▪ Exchange teaching materials with colleagues ▪ Engage in discussions about the learning development of specific students ▪ Work with other teachers in my school to ensure common standards in evaluations for assessing student progress ▪ Attend team conferences ▪ Take part in collaborative professional learning
Effective professional development (α = 0.72)	Considering the professional development activities you took part in during the last 12 months, to what extent have they included the following? [3] ▪ A group of colleagues from my school or subject group ▪ Opportunities for active learning methods (no t only listening to a lecturer) ▪ Collaborative learning activities or research with other teachers ▪ An extended time -period (several occasions spread out over several weeks or months)
Needs for professional development in subject matter and pedagogy (α = 0.83)	For each of the areas listed below, please indicate the degree to which you currently need professional development. [4] ▪ Knowledge and understanding of my subject field(s) ▪ Pedagogical competencies in teaching my subject field(s) ▪ Knowledge of the curriculum ▪ Student evaluation and assessment practice ▪ Student behaviour and classroom management

[1] Response scale range: *1 "Strongly disagree"; 2 "Disagree"; 3 "Agree"; 4 "Strongly agree"*. The first, third and fourth items measuring classroom disciplinary climate were reverse coded.

[2] Response scale range: *1 "Never"; 2, "Once a year or less"; 3, "2 -4 times a year"; 4, "5 -10 times a year"; 5, "1 -3 times a month"; 6. "Once a week or more".*

[3] Response scale range: *1 "Not in any activities"; 2, "Yes, in some activities"; 3, "Yes, in most activities"; 4, "Yes, in all activities".*

[4] Response scale range: *1 "No need at present"; 2, "Low level of need"; 3, "Moderate level of need"; 4, "High level of need".*

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In TALIS, the factorial scores for each of the prepared indices are converted to a convenient measurement with standard deviation 2; with value 10 coinciding with the central value on the answer scale for the items used. For example, the index of disciplinary climate in the classroom is constructed from items answered on a Likert scale with four degrees of agreement, where the values 1 and 2 indicate disagreement and values 3 and 4 agreement. Consequently, the value 10 in disciplinary climate coincides with the central value 2.5 of the scale used to respond to the items, and a value above 10 means that on average there is a degree of agreement with the items on the scale. The minimum and maximum values that can be achieved in the indexes created vary for each index in question. As a guideline, the values 1 and 4 on the Likert scale with four degrees correspond with scores close to 6 and 14 respectively.

Data analysis

To answer the first of the objectives in this study, a descriptive analysis of the variables of teacher self-efficacy, using the frequency distribution (percentages) and the calculation of basic descriptive statistics (mean and standard deviation) is performed. The 't' test was used, comparing the averages obtained in self-efficacy variables for science and other subject teachers. In applying this test, we took into account the sample design adopted in TALIS, representing a stratified selection of centers, from which teachers are selected in a second stage sampling. Because the sampling units do not have equal probability of being selected, we performed a weighting of individuals that allows for unbiased estimates. In addition, the estimated standard errors for statistical sampling was performed using re-sampling procedures characteristic of OECD studies, based on the method of balanced repeated replications (*BRR*), with 100 replicates (OECD, 2014). In this analysis, we used the IDB Analyzer program, created by the Data Processing and Research Center of the IEA to analyse assessment data and large-scale international studies. This software generates executable macros with SPSS®, considering the applicable sampling weights and the BRR re-sampling procedure.

In response to the second objective, we have worked with the sample of 590 science teachers. We calculate the Pearson correlations between

teacher self-efficacy and the other variables, with the exception of gender, in which case we calculate the biserial point correlation coefficient. Following this, we have applied regression analysis with more than one dependent variable, by using a multivariate general linear model (GLM). The three indices of teacher self-efficacy were taken as dependent variables, and as independent variables the characteristics of teachers and school context. The gender variable was considered in the model as a dummy variable. The relationship of the independent variables with the perceived self-efficacy was tested, and the role of these variables in explaining each of the domains of teacher self-efficacy was analysed by univariate multiple regression analysis.

Results

Confidence of Science Teachers in their Skills

According to the results shown in table II, among the items related to self-efficacy for classroom management, we can see the high level of confidence of teachers in making their expectations clear about the behaviour of the students (91.2% consider themselves quite or very able) and in getting them to follow classroom rules (84.9% consider themselves quite or very capable). The science teaching staff has a high level of confidence in their ability to perform teaching tasks. More than half of science teachers (54.7%) consider themselves to be very capable of providing an alternative explanation when students do not understand something, and over 80% believe they are quite capable or very capable of asking good questions to their students (88.8 %), use diverse assessment procedures (85.7%) and different educational strategies in the classroom (82.1%). In contrast, relatively lower levels of self-efficacy are recorded in achieving student involvement. One in two teachers (49.9%) considered themselves incapable or only capable to some extent, of being able to motivate students who show little interest. Just over 70% believe to be quite or very able to convince students that they can do well in class (70.3%) or help them to value learning (71.7%).

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TABLE II. Frequency distribution (percentages) for the extent that science teachers consider themselves capable of performing different actions

		Not at all	To some extent	Quite a bit	A lot
Classroom management	Control disruptive behaviour in the classroom	0.8	17.8	49.3	32.0
	Make my expectations about student behaviour clear	1.0	7.9	51.9	39.3
	Get students to follow classroom rules	0.5	14.6	59.6	25.3
	Calm a student who is disruptive or noisy	0.9	26.0	54.0	19.1
Instruction	Craft good questions for my students	0.5	10.7	61.7	27.1
	Use a variety of assessment strategies	0.3	14.0	56.8	28.9
	Provide an alternative explanation for example when students are confused	0.3	2.9	42.0	54.7
	Implement alternative instructional strategies in my classroom	0.5	17.4	48.2	33.9
Student engagement	Get students to believe they can do well in school work	0.7	29.1	52.5	17.8
	Help my students value learning	1.1	27.2	47.8	23.9
	Motivate students who show low interest in school work	2.2	47.7	36.5	13.6
	Help students think critically	0.6	22.0	53.3	24.1

Table III shows the mean scores achieved in all three self-efficacy indices constructed from each item, all of them being above 10. Since scoring 10 corresponds to a central value (between options «to some extent» and «quite a bit») of the scale used to respond to items, a score over 10 means showing a degree of self-efficacy. Differentiating between the three components of self-efficacy, the maximum and minimum values among the science teaching staff correspond to the efficacy for teaching (12.58) and efficacy of student involvement (11.04) respectively. Table III also includes the averages corresponding to teachers of other subjects.

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Although mean values are slightly lower among science teachers, the differences did not reach statistical significance (t<1.96; p >0.05 in all three variables).

TABLE III. The 't' test comparing the averages for the indices of self-efficacy of teachers in the subjects taught.

	Sciences (n=590)		Other subjects (n=2791)		t
	Mean (E.T.)	Std. Dev. (E.T.)	Mean (E.T.)	Std. Dev. (E.T.)	
Self-efficacy in classroom management	11.96 (0.08)	1.91 (0.06)	12.09 (0.05)	1.99 (0.02)	1.44
Self-efficacy in instruction	12.58 (0.07)	1.62 (0.06)	12.59 (0.04)	1.63 (0.02)	0.12
Self-efficacy in student engagement	11.04 (0.08)	1.87 (0.05)	11.18 (0.05)	1.87 (0.03)	1.54

S.E.: standard error

Variables Associated with Science Teachers' Self-Efficacy

Bivariate correlations between teacher self-efficacy and the remaining variables measured are presented in table IV. The climate of classroom discipline, and cooperation among teachers positively correlated with self-efficacy, recording coefficients between 0.188 and 0.365 (p<0.01). The correlation with the constructivist conceptions of teachers or effective professional development, is slightly lower, having values between 0.115 and 0.155. In the case of professional development needs in the subject, the correlations with the three areas of self-efficacy are negative, indicating a tendency for those who feel a greater need for knowledge about science and pedagogical competence consider themselves less effective, especially in terms of self-efficacy in teaching (correlation -0.175; p<0.01). The number of years of teaching experience does not

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correlate with the perceived self-efficacy. Concerning the gender variable, a weak relationship becomes significant in the case of self-efficacy for classroom management (correlation -0.083, $p<0.05$); the negative sign indicates slight superiority of the female over the male teachers.

TABLE IV. Correlations between self-efficacy and variables of teacher and school context

	Gender	Number of years working as a teacher	Classroom disciplinary climate	Constructivist beliefs	Teacher cooperation	Effective profesional development	Need for PD in subject matter and pedagogy
Classroom management	-0.083*	0.050	0.365**	0.130**	0.188**	0.115*	-0.169**
Instruction	-0.044	-0.017	0.210**	0.155**	0.300**	0.139**	-0.175**
Student engagement	-0.058	-0.026	0.287**	0.130**	0.316**	0.137**	-0.099*

* P<0.05; ** p<0.01

The variables that have a significant correlation with the self-efficacy variables were included in a multivariate regression model MLG (see table V), using the three indexes of perceived self-efficacy as dependent variables. The results reveal significant relationships ($p<0.001$) between the set of variables for teacher self-efficacy and the variables for disciplinary climate, teacher collaboration and professional development needs in the field and in their teaching. The effect of the constructivist conception of education variable is significant at the 0.05 level.

TABLE V. Multivariate Analysis MLG for explaining self-efficacy in science from variables about the teacher and the school context

	F	Sig.
Gender	0.128	0.943
Classroom disciplinary climate	18.575	0.000
Constructivist beliefs	3.325	0.020
Teacher co-operation	9.535	0.000
Effective profesional development	1.326	0.266
Needs for professional development in subject matter and pedagogy	6.962	0.000

Excluding the effective professional development variable from the analysis, whose effect has not proven to be relevant in the above analysis, the coefficients were estimated for three models of univariate regression, using as a dependent variable each of the self-efficacy variables (see table VI). Thus, we aim to clarify the relationship of the explanatory variables depending on the type of self-efficacy. The first model explains 18.4% of the variance of self-efficacy in classroom management (adjusted R^2=0.184). The largest effects ($p<0.001$) relate to the disciplinary climate in the classroom (B=0.297), the need for professional development in the subject and in its teaching (B=-0.211), and to the cooperation between teachers (B=0.213). To a lesser extent, the effects of constructivist beliefs of education are significant ($p<0.05$). Therefore, the increase in score for disciplinary climate, teacher co-operation or constructivist beliefs increases the perceived self-efficacy in classroom management, while a greater need for professional development is associated with a decrease in self-efficacy. In model II (adjusted R^2=0.170), the variables that contribute most ($p<0.001$) in explaining self-efficacy in teaching are the cooperation between teachers (B=0.326), the need for professional development (B=-0.216) and the disciplinary climate in the classroom (B=0.129). The contribution of constructivist beliefs is slightly lower ($p<0.01$). According to model III (adjusted R^2=0.176), the self-efficacy in student engagement is explained ($p<0.001$) to a large extent by cooperation between teachers (B=0.386), and the classroom disciplinary

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climate (B=0.224), and to a lesser extent by constructivist beliefs ($p<0.01$) and the need for professional development ($p<0.05$).

TABLE VI. Estimated coefficients for regression of the variables in self-efficacy about variables on the teacher and school context

	MODEL I [1]				MODEL II [2]				MODEL III [3]			
	B	Std. Error	t	Sig.	B	Std. Error	t	Sig.	B	Std. Error	t	Sig.
Intercept	7.528	0.974	7.727	0.000	8.812	0.813	10.834	0.000	4.769	0.937	5.092	0.000
Classroom disciplinary climate	0.297	0.036	8.204	0.000	0.129	0.030	4.251	0.000	0.224	0.035	6.430	0.000
Constructivist beliefs	0.087	0.036	2.376	0.018	0.093	0.030	3.059	0.002	0.095	0.035	2.711	0.007
Teacher co-operation	0.213	0.062	3.459	0.001	0.326	0.051	6.334	0.000	0.386	0.059	6.513	0.000
Need for professional development in subject matter and pedagogy	-0.211	0.055	-3.869	0.000	-0.216	0.046	-4.738	0.000	-0.115	0.052	-2.188	0.029

1 Dependent variable: Self-efficacy in classroom management
2 Dependent variable: Self-efficacy in instruction
3 Dependent variable: Self-efficacy in student engagement

Discussion and Conclusions

Confidence levels of Spanish science teachers in the knowledge and skills they possess to fulfill their role are above the average value of the measurement scale used in the TALIS study. The Spanish science teachers especially trust in their ability to ask questions to students, to provide alternative explanations for easy understanding of the content and implement teaching strategies and diverse assessment procedures. The results of this study also show that self-efficacy did not differ between science teachers and teachers imparting other materials. Previous work focused on intra-subject comparison, have indicated that the self-efficacy of teachers varies depending on the subject taught (Tschannen-Moran & Woolfolk Hoy, 2001). It is generally accepted that science is an area in which teachers feel less effective than in other subjects, especially in primary education (Howitt, 2007) and when analysing teachers in training, before they join a teaching faculty (Buss, 2010). In the case of

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secondary education, Spanish science teachers have a university degree in one of the scientific disciplines, complementing their training with postgraduate studies of pedagogical content. These teachers therefore have specialized training in a given field, and they generally teach only in scientific matters. Therefore, the comparison made here is not an intra-professor comparison but rather one between teachers of different subjects. The evidence obtained note the absence of significant differences between perceived ability of Spanish science teachers and teachers of other subjects.

Answering the second objective of the study, we have analysed variables that could be linked to self-efficacy and contribute to its explanation. Teacher characteristics such as gender, teaching experience or participation in recent months in effective professional development activities have been shown irrelevant. Cooperation between teachers and the climate of discipline in the classroom show a significant relationship with self-efficacy, in line with the results found in previous studies (Duyar et al, 2013; Onafowora, 2004). A good climate of discipline in the classroom, that is, a slightly noisy classroom, without interruption and with a good learning environment, is the aspect that further explains the perception of Spanish science teachers about their self-efficacy in classroom management. Cooperation among science teachers turns out to be the best predictor of self-efficacy in teaching and student engagement. Both types of self-efficacy tend to be higher where there is greater participation in educational activities and group meetings, exchange of materials, sharing of teaching activities, or the adoption of common standards for student assessment.

Although with less intensity, the constructivist belief in teaching, which is associated with higher self-efficacy, has also been relevant, confirming the results obtained in previous studies (Lakshmanan, Heath, Perlmutter, & Elder, 2011; Temiz & Topcu, 2013). In the case of the need for professional development in the subject and pedagogy, a great need is associated with lower perceived self-efficacy. Yet even though the connection of the need for professional development with the three types of self-efficacy is relevant, it is less so in regard to the self-efficacy in student engagement. These results underline the fact that self-efficacy is not a one-dimensional construct but consists of different components (Tschannen-Moran et al., 1998), associated differently to teacher characteristics and the teaching and learning environment.

Assuming the confidence of teachers in their ability to accomplish student learning is one of the few individual teacher characteristics that reliably predict the achieved results in students (Ross, 2013), educational policies should effectively promote a sense of self-efficacy in teachers as a way to achieve faculty motivation, promote teacher commitment to the school and teaching, and ultimately contribute to improve students' learning. The results obtained in this study allow us to point out some lines of action. One is to promote the development of collaboration among teachers, promoting the dynamics of joint work of science teachers in education centres and achieving a positive environment that facilitates coordination and mutual aid. Another suggested action aims to optimize teacher training. In particular, to enhance the self-efficacy of the future science teacher, quality practical experience is fundamental. According to Petersen and Treagust (2014), trainee teachers should begin by observing how science is taught, and when teaching should have a professional tutor that encourages them to reflect on practice. In the case of in-service teaching staff, involvement in professional development activities usually finds an obstacle in the shortage of time left after attending daily teaching duties. Collaborative professional development activities, involving teachers from the same school, have proven to be one of the best accepted and most successful modalities (Watson, Steele, Vozzo, & Aubusson, 2007). Finally, we suggest the need for a positive disciplinary climate in the classroom, providing teachers and schools with the strategies and guidelines for reducing disruptive behaviours, conflict resolution and improved coexistence. The usual answers based on punishment or sanctions are a treatment to a problem with much room for improvement (Osher, Bear, Sprague, & Doyle, 2010). For this, it is important to involve the students in developing classroom rules, getting their acceptance thereof, improving both inter-student and teacher-student relationships, and achieving the cooperation of families, especially in the case of pupils with disruptive behavior in class.

This study was based on a secondary analysis from the data obtained in the TALIS study. This has allowed work with a large sample of teaching staff, with rigorously measured variables. However, this has involved analysing only the available variables without the possibility of adding others that may be relevant in explaining teacher self-efficacy. Another limitation of this study is inherent in the correlational approach, which allows us to detect variables connected with teaching self-efficacy, but

not establish causal relationships that support the possibility of intervening upon them, as a valid strategy to increase teacher self-efficacy. However, the study has allowed us to explore teaching self-efficacy and its relationship to other characteristics of teachers and schools in the field of Spanish science teachers, responding to shortages of previous research in this context. To overcome some of these limitations, future work could focus on implementing strategies such as those suggested in the previous paragraph, in order to assess their potential impact in terms of improving teaching self-efficacy.

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