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# Attitude toward Science Teaching of Spanish and Turkish In-service Elementary Teachers: Multi-group Confirmatory Factor Analysis

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Elementary school teachers' having a positive attitude toward science teaching might encourage students to develop positive attitudes toward science learning. This cross-cultural study aimed to validate the seven-factor structure of the Dimensions of Attitude toward Science (DAS) scale by applying it in two countries. Moreover, it aimed to determine the percentage distributions of in-service elementary school teachers' attitudes on the confirmed seven categories. The DAS scale was translated into Turkish and Spanish and administered to 185 teachers in Burdur and 202 teachers in Almeria. Multi-group confirmatory factor analysis confirmed that the factor structures of the translated scales for the two countries correspond to the same seven-factor structure by fitting the theoretical model. The DAS scale was compatible for both countries at an adequate level. In both samples, most of the teachers were against gender stereotyping in the science teaching/learning process, and they indicated they did not have any anxiety, fear, or stress toward teaching science. The crucial difference between the two samples was seen in the teachers' responses to items measuring "Enjoyment" and "Perceived Dependency Context Factors."

*Keywords*: attitudes toward science teaching, in-service elementary teachers, multi-group confirmatory factor analysis, Turkish attitude scale, Spanish attitude scale

## INTRODUCTION

Attitude is defined as "choosing personal actions based on internal states of understanding and feeling" (Driscoll, 2000, p. 350). To improve the quality of education, it is not sufficient to specify teaching methods with certain activities; it is also necessary to consider teachers' feelings, motivations, and, especially, attitudes. Teachers with negative or less positive attitudes toward science teaching are less likely encourage their students to develop positive attitudes toward science (Jarvis

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& Pell, 2004; Osborne, Simon, & Collins 2003; van Aalderen-Smeets & Walma van der Molen, 2013). Because they usually have low level of self-efficacy (Tosun, 2000) or they could not use time effectively to teach and discuss science in the class (Harlen & Holroyd, 1997; Jarvis & Pell, 2004). On the other hand, teachers with positive attitudes toward science have greater self-efficacy and self-confidence to improve their students' attitudes (Bursal, 2010; Osborne et al., 2003). Therefore, elementary school teachers' attitude toward science teaching should be carefully identified, since the progress in science lesson mostly belong teachers' values and attitudes toward teaching science (Blalock et al., 2008; Haney, Czerniak, & Lumpe, 1996; Osborne et al., 2003; Saad & BouJaoude, 2012; Yilmaz-Tuzun, 2008). The definitions and attributions of subject of attitude toward teaching science were not explicitly analyzed in many studies, as they are far from distinguishing the subject from other measures like motivation (Blalock et al., 2008; van Aalderen-Smeets & Walma van der Molen, 2013; van Aalderen Smeets, Walma van der Molen, & Asma, 2012). For this purpose, Dimensions of Attitude Toward Science (DAS) scale was revised by van Aalderen-Smeets and Walma van der Molen (2013) to measure pre-service and in-service teachers' attitude toward science teaching. In this study, at first the DAS was translated into Spanish and Turkish and structure of translated versions was validated with respect to original structure. Second, the variance in the factor structure across both samples was evaluated. Finally, the data collected to confirm the scale was assessed to determine elementary in-service teachers' perceptions for attitudes toward science teaching in both samples.

***State of the literature***

- Teachers with negative or less positive attitudes toward science teaching are less likely encourages their students to develop positive attitudes toward science.
- It is crucial to examine science teachers' attitudes across various countries to determine whether local needs and demands are the same in the larger population.
- Several scales developed previously included and measured several attitude structures together. It is better to measure them on a single scale. Further, many existing scales designed to measure attitude toward science teaching lack of statistical (e.g., reliability of results) and theoretical standard (e.g., construct validity).

***Contribution of this paper to the literature***

- In both countries, teachers possess high self-efficacy and this could be the reasons for the low rate of anxiety.
- The DAS scale is a new, coherent, and effective in assessing teachers' attitudes toward science teaching since items measuring "attitude toward science" and "science attitude," were removed. The Turkish and Spanish versions of the DAS scale appear to represent valid and reliable measures in both samples.
- The cross-cultural adaptation of the DAS scale might have led the further studies to combine teachers' attitude toward science teaching with the findings of other international studies such as TIMSS and PISA-Science.

## Conceptual framework

In this particular study, the new theoretical framework for primary teachers' attitude toward science, which corresponds personal attitude dimension, and the teaching of science, which corresponds professional attitude dimensions was adopted from the study of van Aalderen-Smeets et al. (2012, pp. 154-172). The general schema of the framework is given in Figure 1.

In general, both dimensions of attitude include the same sub-dimensions as cognition, affect, self-efficacy and behavioral intention. At first, the cognitive beliefs included three cognitive attributes, as: a) 'perceived relevance' that is related to importance and relevance of science and science teaching in primary schools. b) 'perceived difficulty' that is related to general beliefs about difficulty of science relative to other disciplines and difficulty of teaching science. The items correspond to beliefs of a teacher that she/he think 'average' teacher has regarding teaching science (van Aalderen-Smeets & Walma van der Molen, 2013). c) 'gender beliefs' that is related to various abilities of boys and girls in science and potential ability differences between male and female teachers with respect to teaching science and

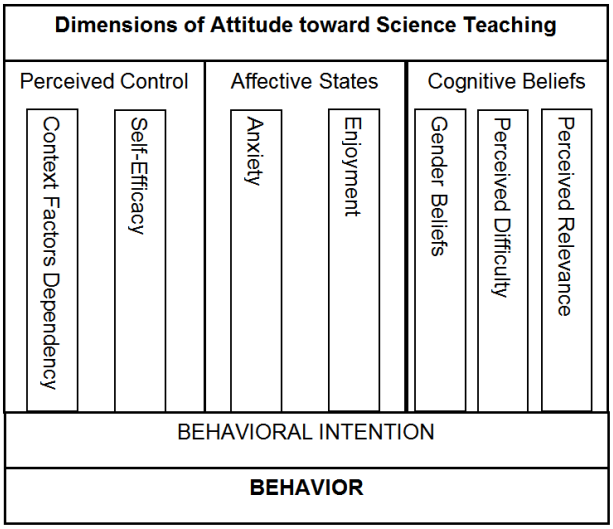


**Figure 1.** Theoretical framework for the seven-factor structure of the DAS Scale (adapted from van Aalderen-Smeets et al., 2012).

their enjoyment in doing so. Indeed, some researchers claimed that developing an attitude is directly related to developing cognitive beliefs (Tosun, 2000; Türkmen, 2013).

Secondly, affective states included 'enjoyment' and 'anxiety'. Enjoyment is related to positive emotions regarding science in real life, science related activities, and science teaching. Enjoyment mainly depends on self-efficacy, which is linked with job satisfaction and job stress (Klassen & Chiu, 2010). Anxiety, corresponds to negative and unfavorable feelings regarding not only science related topics and activities but also science teaching. To reduce anxiety in teaching science courses, and to make students develop positive attitudes toward science, teachers should take courses including true science applications, such as activities and experiments (Martin-Dunlop & Fraser, 2008; Lin, Cheng, Chang, Li, Chang & Lin, 2014).

The third component of attitude toward teaching science was perceived control that included 'self-efficacy' and 'context dependency'. Self-efficacy includes both views and feelings of personal capability to exhibit specific behavior (Bandura, 1997). Elementary school teachers have higher levels of self-efficacy because of the contexts in which they work (Klassen & Chiu, 2010). In this study, it is used to express in-service teachers' beliefs in their ability to succeed in science and their capability to teach science. The next attribute, context dependency, is mostly related to context factors of professional attitude toward science (van Aaalderen-Smeets et al., 2012). They indicated four main context factors that are collegial support, lack of resources, time allocated for science in the curriculum, and the time and effort needed to prepare science lessons. The perception of these factors by the in-service teachers reflects their beliefs that several external factors make their science teaching hard or easy. Context factors affect attitudes toward science / science teaching (Ergül, 2009; Martin-Dunlop & Fraser, 2008; van Aalderen-Smeets & Walma van der Molen, 2013).

The final component of attitude toward science is 'behavioral intention' that measures someone's behavior related to science mostly in daily life like reading a science book and watching scientific programs. In terms of attitude toward science teaching, behavioral intention includes teachers' behaviors either finding extra hours to teach science or willing to do science lessons more than other lessons like mathematics (Van Aaalderen-Smeets et al., 2012). The analysis of gender stereotype approaches along with self-efficacy approaches presents "Percevied Difficulty" and "Gender Beliefs" were misevaluated or not sufficiently understood by the participant teachers (van Aalderen-Smeets & Walma van der Molen, 2013). Therefore, they

suggested that in future studies, these two dimensions should be evaluated in greater depth, along with their relationship with other dimensions.

## Teachers' attitudes toward science teaching in Turkey and Spain

In the report of Education, Audiovisual and Culture Executive Agency-EACEA (2011) that revealed how the science education in Europe is organized, average performances of participants from some countries such as Turkey and Spain were found to be below the European Union average. In this report it is recommended that, the reasons for decrease in achievement, interest and attitude toward science should be researched. Moreover, Štefaniková & Prokop (2015) indicated that there is a decreasing interest toward learning science and students usually have negative attitudes toward science from various cultures. It is clear that the attitudes of teachers toward science teaching influence students' attitudes as well as their academic achievement (Bilen & Köse, 2012; Türkmen, 2013; Yakar & Baykara, 2014; Yaşar & Anagün, 2008). In this context, it is crucial to determine perceptions of elementary in-service teachers for attitudes toward science teaching, specific to Spain and Turkey. In this particular study, the Spanish and Turkish versions of the current DAS scale contribute to analyzing elementary school teachers' attitude toward science teaching in detail.

In Turkey, teacher candidates had moderate-level attitude scores and did not perceive themselves as enthusiastic about teaching science subjects (Bursal, 2010; Duban & Gökçakan, 2012; Türkmen, 2013). In Spain, in-service science teachers' held moderate attitudes toward the teaching science profession (Guisasola, Robinson, & Zuza, 2007) and prospective elementary school teachers on the other hand had a rather positive attitude toward teaching science related to which self-efficacy beliefs or attitudes toward science / science teaching (Brígido, Borrachero, Bermejo, & Mellado, 2013).

Effective instruction mostly depends on self-efficacy, and enjoying the job (Azar, 2010; Bursal, 2010; Ergül, 2009; Guisasola et al., 2007; Tekkaya, Çakıroğlu, & Özkan, 2004). Klassen and Chiu (2010) found that teachers with high self-efficacy reported high levels of job satisfaction. Further, teachers reported low job satisfaction because they had high levels of stress. According to The Organization for Economic Co-operation and Development (OECD) report, teachers from a few countries (including Turkey and Spain) reported comparatively weak self-efficacy, and teachers' job satisfaction usually increases with tenure (OECD, 2009).

The two countries have similar elementary school teacher training programs as pre-service teachers must take 60 credits and 25 hours per credit point. Further, both countries participate in the ERASMUS student exchange program. In Turkey and Spain, students begin elementary school in the calendar year of their sixth birthday, and education is free of charge. In Turkey, science lessons start in third or fourth grade (at the age of 10 to 11), which corresponds to the second cycle in Spain. However, in Spain, science lesson start in the first cycle (at the age of 6 to 8).

In both countries, students take Program for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS) exams. More than 80% of the students who took the PISA in Turkey agreed that "Science and Technology teaching is important for society" (International Council for Science [ICSU], 2011, p. 13). In the PISA-Science section, although students in Turkey held more positive attitudes than their counterparts in Spain, their achievement in PISA-2012 was lower. These results raise the query whether the current variance among students' attitudes are similar to the elementary school teachers' attitudes toward science teaching in the two countries. Therefore, it is paramount to admit worldwide standards for effective science teaching (PISA, 2012) and to analyze teachers'

attitudes toward teaching science that is one of the factors affecting students' attitudes toward learning science.

Studies of pre-service elementary school teachers' attitudes and self-efficacy in Turkey and Spain indicated the teachers did not enjoy studying science, but they felt competent to teach it, meaning they had adequate self-efficacy (Brígido et al., 2013; Bursal, 2008; 2010; Ergül, 2009; Tosun, 2000). The review of the studies in Turkey and Spain that measure the attitudes of in-service elementary teachers toward science teaching generally focus on self-efficacy, job satisfaction and enjoyment. The aim of the current study is to analyze the attitudes even for the other sub-dimensions discussed in the framework.

## The scales measuring attitudes toward science

Researchers that measured attitudes toward science teaching used various scales in previous studies. Türkmen (2013), who also conducted some other longitudinal studies of attitudes toward science, adapted The Science Teaching Attitude Scale II from Moore and Foy (1997) with 95 in-service elementary and 38 in-service science teachers. The scale included items measuring general attitude toward science lessons rather than attitude toward science teaching.

The mostly used instrument was the Attitude Scale Toward Science Teaching, which was adapted into Turkish by Özkan, Çakıroğlu, and Tekkaya (2002) based on Thompson and Shrigley (1986). Thompson and Shrigley's original scale includes 22 items and it divides attitude into four sub-dimensions. It is adapted into various cultures and used in many studies. However, it was prepared for pre-service teachers and lacks items that directly measure elementary school teachers' attitudes toward science teaching (Tosa, 2009). In addition, van Aalderen-Smeets and Walma van der Molen (2013) indicated that it included several attitude structures like self-efficacy related to science, feeling toward science, and self-efficacy of science teaching components. They recommended that it is better to measure them with different subscales than to represent them on a single scale. Osborne et al. (2003), Blalock et al. (2008) and Gardner (1995) emphasized that many existing scales designed to measure attitude toward science teaching lack of statistical (e.g., reliability of results) and theoretical standard (e.g., construct validity). In this sense, as the result of need for a new and up-to-date scale that would measure the attitude toward science teaching, van Aalderen-Smeets and Walma van der Molen (2013) revised the DAS scale, which was first developed by van Aalderen-Smeets et al. (2012). They offered to adapt the scale to the other cultures. Thus, this particular study provides Spanish and Turkish adapted versions of the DAS scale.

In their study, van Aalderen-Smeets and Walma van der Molen (2013) gave the Dutch version of the DAS scale to 158 in-service and 398 pre-service teachers and found inter-item correlations from .39 to .59. Their explanatory factor analysis with direct oblimin rotation revealed that the items were loaded on seven factors with loadings between .37 and .90.

Van Aalderen-Smeets and Walma van der Molen (2013) also applied a multifaceted and atypical confirmatory factor analysis (CFA) including various steps beginning with principal axis factoring to confirm the seven-factor structure. The reliability coefficients (Cronbach's alpha) for the seven categories ranged from .74 to .93. The inter-item correlation coefficients among the sub-categories ranged from .44 to .85. Sixty nine percent of total variance was explained with the seven-factor structure. Van Aalderen-Smeets and Walma van der Molen also validated the scale's construct and face validity. They proposed that with 28 items and its seven-factor structure, the DAS scale can thoroughly measure elementary school teachers' attitudes toward science teaching.

Based on the findings of the detailed review, in-service teachers' attitudes toward science teaching should be identified in Spain and Turkey, since the comparison is valuable to support various related findings in global reports (e.g., PISA, ICSU). Moreover, cross-cultural studies, such as Campbell, Medina-Jerez, Erdogan, and Zhang (2010), suggest that it is crucial to examine science teachers' attitudes across various countries to determine whether local needs and demands are the same in the larger population. Further, van Aalderen-Smeets and Walma van der Molen (2013) recommended comparing the findings of applications of the DAS scale in different languages and countries with the results of their study. Therefore, this study adapted the scales into Turkish and Spanish. The multi-group CFA is applied in order to validate the DAS scale with proposed seven-factor structures for two countries and to confirm that the model is invariant across groups. Bryne (2010) stated that, this purpose was one of the five purposes defined in several studies that aimed to seek evidence of multi-group equivalence. The two main research questions of this study are as follows:

1) Do the adapted scales confirm the originally implemented seven-factor structure of the DAS scale through their application in two groups, Burdur, Turkey and Almeria, Spain? More specifically, the answer to this question was analyzed through two hypotheses:
   Hypothesis 1: The multi-dimensional structure of the DAS comprising self-efficacy (SE), perceived relevance (PR), gender stereotyping (GS), anxiety (A), difficulty of science teaching (DST), perceived dependency on context factors (PDC), and enjoyment (E) is valid across both groups.
   Hypothesis 2: This seven-factor structure of the DAS is invariant across the two groups.
2) What are the percentage distributions of in-service elementary school teachers' attitudes on the confirmed seven categories for both groups?

## METHOD

This investigation is a comparative survey that uses a questionnaire implemented in two countries (as discussed by Klandermans & Smith, 2002) to identify and compare the interests, abilities, attitudes, or competencies of respondents (Fraenkel, Wallen, & Hyun, 2012). The findings are mostly analyzed descriptively.

### Participants and sampling procedure

The study population is about 1000 in-service elementary school teachers in Burdur, Turkey and approximately 2900 in-service elementary school teachers in Almeria, Spain. The sample consisted of 185 (83 female) teachers in Burdur and 202 (94 female) teachers in Almeria who voluntarily filled out the scale. The data collection process took 4 weeks in Burdur and 8 weeks in Almeria. In Burdur, the largest cohort of teachers had 21–30 years of teaching experience (117 teachers; 63.2 %); it was 1–10 years in Almeria (121 teachers; 59.9 %). In Burdur 11% and in Almeria 12 % of the teachers had an MS degree. Moreover, 62% and 71% of the Burdur and Almeria teachers, respectively, had graduated from the university in their city.

### Data collection instrument

The DAS scale is based on the theoretical framework of van Aalderen-Smeets et al. (2012). The reliability and validity analyses were carried out by van Aalderen-Smeets and Walma van der Molen (2013).

Given the DAS scale's development procedure and unique structure, the researchers of this particular study decided to translate it for the Turkish and Spanish

contexts after gathering written permission from the developers. It is a challenging task to translate and to ask questions about attitudes (Behling & Law, 2000). Therefore, the process was carried out thoroughly by analyzing the studies related to translation of scales (Beaton, Bombardier, Guillemin, & Ferraz, 2000; Byrne, 2008; Gierl, 2000; Küçüközer, Kırtak-Ad, Ayverdi, & Eğdir, 2012). In these studies, mostly a five-step guideline including translation, review, back translation, pretesting, and documentation was used. Therefore in this study a) the DAS scale was translated into target languages by two independent bilingual translators. b) A third bilingual language experts checked the translated scales and obtained one form scale. c) The scales were subjected to a blind back translation. d) The back translated version was analyzed and compared with the source scale. There was not any critical ambiguity in terms of both understanding the language and methodology of the items for both languages. In the original form of the scale two items include examples given in parenthesis "Techniektorens" and "Natuiek, Leefwereld" were particular to the source language and they were cultural terms. The experts concluded that the item could be understood clearly without these terms, so they were removed from both translations. Each version of the DAS scale also included 28 items. Specific to this study, there were seven demographic questions about the participants' age, gender, and teaching experience. e) Then the scale in the source language was administered to bilingual samples twice and almost one month apart. The correlation coefficients among total scores of the source and target language applications was $r$=.817 and $r$=.784, for Burdur and Almeria samples respectively. All of this five-step procedure was used to verify language (semantic and conceptual) equivalence of the translated scales. Two language experts—academicians and one MS student supported the final scale's face validity. All of the procedures to answer the first research questions of this study including both reliability analysis and the CFA to evaluate the model fit can also be an evidence to validate construct equivalence of the translated versions. The Turkish and Spanish versions of the DAS scale are shown in Appendix a and b, respectively.

## Data analysis

The score for teachers' attitudes toward science teaching were assigned the following codes: 1 "Totally disagree," 2 "Disagree," 3 "Neutral," 4 "Agree," 5 "Totally agree." On the five-point Likert type scale, higher scores are interpreted as more a positive attitude. The first research question of this study was analyzed with the CFA and multi-group CFA with AMOS to determine the model fit of the scales. Before conducting analysis, it is checked (measure for outliers is Mahalanobis distance at $p<.001$, Tabachnick and Fidell, 2007, p.99) and validated that there is no outlier. The linear regression-curve estimation was conducted for all relationships of the model and determined that they were seems to be linear. The shape of the scatter-plot diagrams was also analyzed for homoscedasticity and this assumption was also validated. For the normality, as Byrne (2010) suggested at first univariate normality (skewness and kurtosis values are within the range of -3 and +3) was validated. For the multivariate normality, all of the critical ratio values for both samples were analyzed and they are below 5.00, indicating that the data normally distributed. The CFA process is a theory-testing statistical technique that begins with the hypothesis that a relationship exists between the observed variables and their underlying latent constructs (Child, 1990).

The model fit was tested for the theoretical structure included seven factors; as Figure 1 presents. At first, the CFA was conducted to the answer to test the first hypothesis by running the original seven-factor structure model namely Model7

**Table 1.** Fit indices with suitable thresholds used in this study

| Fit Index | Critical Values | Resource(s) |
|---|---|---|
| **$\chi^2$ (CMIN)** | Low $\chi^2$ value and<br>$p > .05$<br><br>If $p < .05$ | Brown (2012)<br>Tabachnick and Fidell (2007)<br>Bryne (1989)<br>Hu and Bentler (1999) |
| **$\chi^2$/df** | Good Fit $\chi^2/df < 1$<br>Acceptable Fit $\chi^2/df < 2$ | Byrne (1989) |
| **RMSEA** | RMSEA < .05<br>(good fit)<br>RMSEA < .08<br>(fair fit) | Brown (2012)<br>Hu and Bentler (1999)<br>Jöreskog and Sörbom (1993)<br>Tabachnick and Fidell (2007) |
| **RMR** | RMR≤.05<br>(good fit) | Jöreskog and Sörbom (1993) |
| **SRMR** | SRMR≤.08<br>(reasonably good fit) | Hu and Bentler (1999) |
| **GFI** | .95 ≤ GFI ≤ 1 | Tabachnick and Fidell (2007) |
| **AGFI** | .85 ≤ AGFI ≤ 1 | Tabachnick and Fidell (2007) |
| **CFI** | .90 ≤ CFI ≤ .95<br>(adequate fit) | Brown (2012) |
| **IFI** | .90 ≤ CFI ≤ .95<br>(adequate fit) | Brown (2012) |

*Note: $\chi^2$ = chi-square, RMSEA = root mean square error of approximation, RMR = the root mean square residual, SRMR = the standardized root mean square residual, GFI = goodness of fit, AGFI = adjusted goodness of fit, CFI = comparative fit index, and IFI = incremental fit index.*

(default model in AMOS) only the factor loadings are constrained equal to the data of each group separately. Secondly, by satisfying the conditions of measurement invariance a multi-group CFA was conducted by including factor-loading parameters remained constrained and equality constraints were then placed on the factor variances and covariance for both groups simultaneously to test the second hypothesis. This process is specifically named as "the manual multiple-group approach" (Byrne, 2010, p.214). The common fit indices are given in Table 1 with their critical value ranges. In this particular study, the similarity between two groups was controlled by ensuing a similar analysis procedure carried out by Sanchez, Gallego, Soria, and Aborg (2008) was closely followed.

In addition to the critical values in Table 1, Hu and Bentler (1999), for example, suggested a combination of rules for a reasonably good fit between the baseline model and the source data. a) SRMR values are close to or below .08; b) RMSEA values are close to or below .06; and c) CFI and TLI values are close to or greater .95. Hu and Bentler indicated that these are necessary to improve the acceptability of Type I and Type II error rates. There is no strict difference between their combined values and the critical limits of this study, given in Table 1. In Table 1, $\chi^2$ (CMIN) value is not a unique index of good model fit, and it is sensitive to sample size (Brown, 2012; Tabachnick & Fidell, 2007). Statistically significant $\chi^2$ is not enough to imply a poor-data-to-model fit. In such a case, the model fit could be evaluated by comparing the value of $\chi^2$ with two times of degrees of freedom (Byrne, 1989), by analyzing the critical limits for $\chi^2$/df value, and by analyzing the other fit indexes. Further, analysis was conducted for the comparisons of the original seven-factor structure model (Model7) with the model in which only the factor loadings are constrained equal among groups ($Model7_{MW}$); all factor loadings, variances and covariance are constrained equal among groups ($Model7_{SC}$); and all factor loadings, variances, covariance and error variances are constrained equal among groups ($Model7_{MR}$). As Byrne (2010, p.221) indicated, evidence of invariance between Model7 and the other

**Table 2**. Goodness-of-fit indices from cfa conducted separately on the data for the Almeria and Burdur samples

| Sample | Model | $\chi^2$ | df | *p* | $\chi^2$/df | SRMR | GFI | AGFI | RMSEA | RMR | IFI | CFI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **202 Spanish** | Model7 | 643.984 | 329 | <.001 | 1.957 | 0,071 | .922 | .880 | .070 | .053 | .919 | .917 |
| **185 Turkish** | Model7 | 611.143 | 329 | <.001 | 1.858 | 0,056 | .925 | .884 | .062 | .047 | .917 | .916 |

*Note: $\chi^2$: chi square; df: degrees of freedom.*

three models were based on the differences in CFI values presenting a probability <.001. The second research question was evaluated through a detailed descriptive analysis for both samples.

## RESULTS

### Findings for the first research question

#### *Confirmatory factor analysis*

The evaluation of the first research question is analyzed under two main hypothesis first of which was assessed by CFA to validate the original Model7 separately for the Almeria and Burdur participants. Table 2 presents the Model7 fit indices for both groups.

Table 2 presents the related fit indexes (CFI, GFI, AGFI, and IFI) that are all within the accepted thresholds given in Table 1. The RMSEA values are smaller than .08, which corresponds to a fair fit. Moreover, the rejection criteria for the fit formed by various combinations of SRMR, RMR, RMSEA, and CFI values were also discarded with respect to the values in Table 2, especially given SRMR <.08. Therefore, in both countries, the DAS scale corresponds to the same seven-factor structure model (Model7) as it adequately fits the theoretical model. The path diagram of the original seven-factor structure (Model7) is presented in Figure 2. The respective factor loadings and variance estimation values derived from both Almeria and Burdur samples were combined on the same figure.

#### *Multi-group analysis*

After satisfying the conditions of group equivalence, the Model 7 was performed through both groups simultaneously through multi-group CFA to test the second hypothesis. At first, as suggested by Byrne (2010) multi group analysis was performed by including both groups simultaneously and running Model7 (unconstrained model in AMOS) in which the factor-loadings are constrained equal. The Model7 tested the factorial structure through two groups and the fit indices for the Model7 were $\chi^2$=1255.132, $\chi^2$/df = 1.907, df=658, $p$ < .001, RMSEA = .049, CFI = .917, SRMR=0.070, RMR = .060, IFI = .918, GFI = .923, and AGFI = .882. The common modification indices for the two groups with respect to the original Model7 imply that the model fairly fit the data with all parameters freely estimated in the two groups. The results of the multi-group CFA indicated that in terms of factor loadings seven latent factors of attitude toward teaching, the adapted DAS scale was compatible for both countries at an adequate level.

For further analysis, the baseline comparisons of the original Model7 with the other models, $Model7_{MW}$, $Model7_{SC}$, and $Model7_{MR}$ is investigated. The related fit indices for the multi-group CFA are presented in Table 3.

The differences between CFI values for the Model7 and the second and third models met the cutoff criteria of below .01 indicating that it is an evidence of invariance across models. The model in which only the factor loadings are constrained equal among groups ($Model7_{MW}$) as well as the model in which all factor

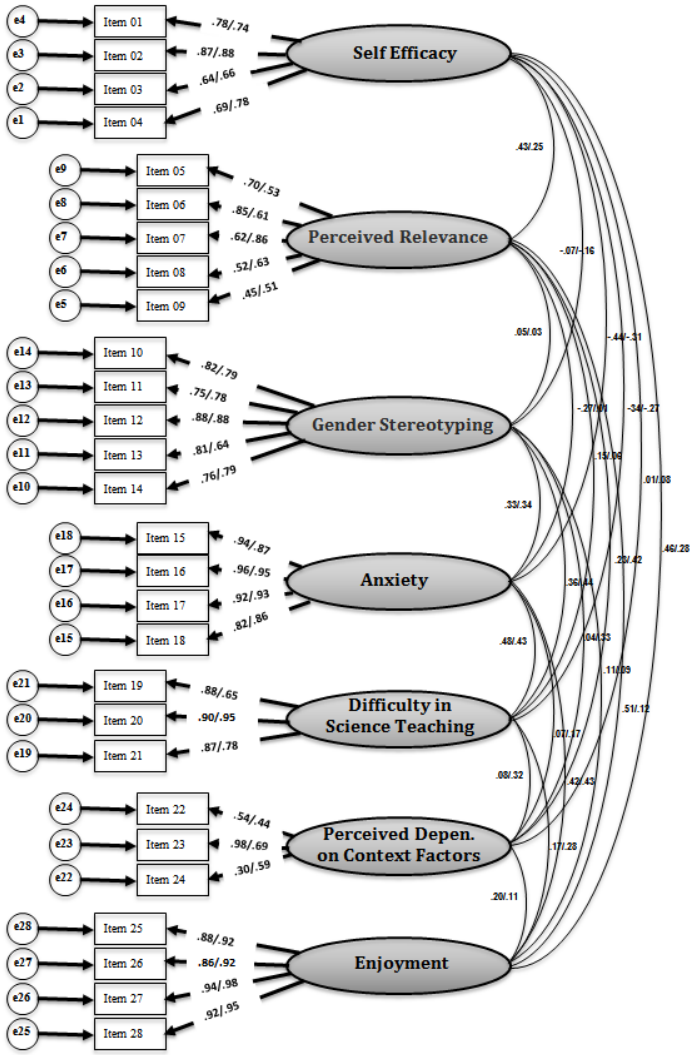


**Figure 2.** The path diagram of the original seven-factor structure and respective factor loadings derived from the two sample (Almeria, N=202/ Burdur, N=185)

**Table 3.** Multi-group CFA conducted simultaneously for both groups

| Model | $\chi^2$ | df | *p* | SRMR | GFI | RMSEA | IFI | CFI | $\Delta\chi^2$ |
|---|---|---|---|---|---|---|---|---|---|
| **Model 7** | 1255.132 | 658 | <.001 | .070 | .923 | .049 | .918 | .917 | |
| **Model 7$_{MW}$** | 1313.757 | 679 | <.001 | .071 | .916 | .049 | .912 | .911 | Model 7$_{MW}$-Model7=58.625 |
| **Model 7$_{SC}$** | 1348.270 | 707 | <.001 | .074 | .912 | .049 | .911 | .910 | Model 7$_{SC}$-Model 7=93.138 |
| **Model 7$_{MR}$** | 1623.382 | 735 | <.001 | .081 | .878 | .056 | .876 | .876 | Model 7$_{MR}$-Model 7=368.25 |

*Note: $\chi^2$:chi square; df=degrees of freedom.*

loadings, variances and covariance are constrained equal among groups (Model7$_{SC}$) were successfully fitted to the data of two groups. Therefore, it can be concluded that all factor loadings constrained to be equal across two groups, Spanish and Turkish in-service elementary school teachers. The confirmed factors correspond to categories of attitude toward science teaching. The category names given by van Aalderen-Smeets and Walma van der Molen (2013) were also used in this study.

The construct validity was also controlled by convergent and discriminant validity. The convergent validity, which estimates the degree to which items of a theoretical construct relate to each other, was tested. If the items of a construct load strongly together, this is an indicator of high convergent validity (Ullman, 2007). The factor loadings, most of which are above the critical value of .50, found at the end of the multi-group CFA, ranged from .43 to .99 within the seven-factor structure. Moreover,

**Table 4.** The Cronbach's Alpha values with respect to the seven sub-dimensions of the DAS scale

| | Item Numbers | α (Almeria data) | α (Burdur data) | α (Both) |
|---|---|---|---|---|
| **SE** | 1-4 | .83 | .85 | .84 |
| **PR** | 5-9 | .76 | .71 | .74 |
| **GS** | 10-14 | .90 | .84 | .87 |
| **A** | 15-18 | .95 | .95 | .95 |
| **DST** | 19-21 | .91 | .83 | .87 |
| **PDC** | 22-24 | .56 | .60 | .57 |
| **E** | 25-28 | .95 | .97 | .96 |
| **OVERALL** | -- | .82 | .76 | .80 |

*Note. SE: self-efficacy; PR: perceived relevance; GS: gender stereotyping; A: anxiety; DST: difficulty of science teaching; PDC: perceived dependency on context factors; E: enjoyment.*

**Table 5.** Percentages for the seven sub-categories by country

| | Almeria/Spain | | | | | Burdur/Turkey | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Positive Responses | | Neutral | Negative Response | | Positive Response | | Neutral | Negative Response | |
| | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 |
| | % | | | | | % | | | | |
| **1. SE** | 43.7 | 37.0 | 16.5 | 2.5 | 0.4 | 44.1 | 41.4 | 11.0 | 3.5 | 0.0 |
| **2. PR** | 42.4 | 36.4 | 17.9 | 2.7 | 0.6 | 41.7 | 39.8 | 13.1 | 4.7 | 0.7 |
| **3. GS** | 2.9 | 6.5 | 15.7 | 27.8 | 47.0 | 8.0 | 9.5 | 16.2 | 44.5 | 21.8 |
| **4. A** | 0.7 | 2.7 | 10.8 | 35.4 | 50.4 | 0.6 | 4.5 | 5.0 | 45.7 | 44.2 |
| **5. DST** | 1.8 | 13.5 | 27.1 | 33.0 | 24.6 | 3.3 | 19.8 | 17.1 | 33.3 | 26.5 |
| **6. PDC** | 16.0 | 33.2 | 35.8 | 12.4 | 2.6 | 15.0 | 43.2 | 16.0 | 17.8 | 8.0 |
| **7. E** | 26.6 | 38.2 | 31.7 | 3.0 | 0.5 | 37.0 | 52.7 | 6.8 | 2.2 | 1.3 |

the factors measured distinctly different concepts, supporting discriminant validity with inter-correlation coefficients that ranged from .04 to .63. They were all below the critical limit of .80 (Brown, 2012).

The reliability coefficient (Cronbach's alpha) of the scale with respect to the whole was calculated as $\alpha$ = .80. It was .82 and .76 in the Almeria and Burdur samples, respectively. Table 4 shows the reliability coefficients corresponding to seven factors for both the Almeria and Burdur data. The values indicate high reliability of the test results (Fraenkel et al., 2012). Therefore, the results collected from both samples with the DAS scale were reliable and valid.

## Findings for the second research question

The latent structure of the DAS is multifactorial (i.e., seven factors) and since the factor loadings are supported by CFA, the subscales might also be scored, since the number of factors is indicative of the number of subscales, and the pattern of items loading on factors reveals how the subscales should be scored (Brown, 2012). For this reason, the participant teachers' frequencies in the items of a sub-category (see Figure 2) were added up, and its percentages was calculated. The same calculation was performed for seven-subcategories of both samples. The percentage distribution of teachers' responses to the items with respect to confirmed categories of the DAS scale is presented in Table 5.

In both samples, teachers' negative responses constituted more than 80% in the "Anxiety" dimension. This indicates that they had little to no anxiety, fear, or stress in science teaching. In Burdur sample around 66% of teachers and in Almeria sample almost 76% of teachers (shown by their negative responses; Table 5) were against gender-stereotyping in the science teaching/learning process. In both samples, agreement was strongly in the sub-dimensions (shown by their positive responses; Table 5) of "Self-efficacy" and "Perceived Relevance" as the percentages was above 80 for each of them. The other two common positive categories are "Perceived Dependency Context Factors" and "Enjoyment." The teachers in Burdur perceived that their attitudes toward science teaching were affected by contextual environmental factors, e.g diversity of students more than teachers in Almeria. In Burdur, almost 90% of the teachers indicated that they enjoyed science teaching and liked their jobs. In Almeria, 65% of the teachers said the same, whereas 32% of them said they had neutral feelings on the matter.

## DISCUSSION

The DAS scale was developed by van Aalderen-Smeets and Walma van der Molen (2013) was translated into Spanish and Turkish. The validity and reliability of the results of both versions were also examined. The results confirmed that the seven-factor structure of the translated scales is valid for the two samples. Further, the multi-group CFA verifies the theoretical model proposed by van Aalderen-Smeets et al. (2012). The items intended to measure a specific sub-dimension loaded onto that specific factor without cross-loadings. Therefore, the seven factor structure of DAS is invariant across the samples.

With respect to two sub-dimensions of cognitive states, "Gender Stereotyping" and "Difficulty of Science Teaching", van Aalderen-Smeets and Walma van der Molen (2013) recommended that they should be analyzed thoroughly. The two sub-dimensions, as they have crucial factor loadings, were analyzed in both samples. It was found that the teachers were against gender stereotyping in science teaching. Further, almost 60% of the teachers in the sample of this study perceived that 'average' elementary teacher did not find difficult to teach science. The other sub-dimension is 'perceived relevance' which has high percentage scores related to teachers' perceptions indicating their strong cognitive beliefs. It is possibly explained by the teachers' understanding the importance of science teaching and knowing how to adapt science to technological and social developments. The results of this study (almost 80 % of the teachers) and related studies (Harlen & Holroyd, 1997; van Aalderen-Smeets & Walma van der Molen, 2013) indicate that elementary teachers identified that science teaching is important and they expressed it is relevant to primary school level.

The percentage score for self-efficacy that is a sub-dimension of perceived control is high in both countries. The reason might be the teachers' high self-confidence as well as their low rate of anxiety. Around 70% of the teachers graduated from the university in the city where they lived, so they knew the culture, level of education, and socio-economic status in these cities, which allowed them to develop self-confidence. Further, the teachers in this study were mostly experienced and tended to lack anxiety. For example, in Burdur the large percentage (70%) of participants had more than 21 years of teaching experience. This result contradicts the report (OECD, 2009) indicating teachers' self-efficacy beliefs in both countries are weak. However, the results of this study are consistent with corresponding findings in related literature (Brígido et al., 2013; Bursal, 2008, 2010; Ergül, 2009; Osborne et al., 2003; Tekkaya et al., 2004; Tosun, 2000; Türkmen, 2013).

"Anxiety" together with "Enjoyment" are the sub-dimensions of affective states. In both samples most of the teachers were tenured, and therefore, they may have felt

more relaxed and confident, as indicated by the OECD report (OECD, 2009). In terms of "Enjoyment", on the other hand, teachers in Burdur had higher scores. One might expect the scores to be similar since both cities are in the Mediterranean region of respective countries and Mediterranean people are known for their warm and moderate job-related attitudes. However, there may be differences in job satisfaction between the two countries, because of the perceived job stress (Bursal, 2010; Klassen & Chiu, 2010). There was also a crucial difference between the two countries in terms of "Perceived Dependency Context Factors". The teachers, in Burdur, thought that they might feel relax when they had more support, such as collegial support and time allocation for science in the curriculum, as these factors decrease anxiety (Ergül, 2009; Martin-Dunlop & Fraser, 2008; van Aalderen-Smeets & Walma van der Molen, 2013). The behavioral intention of the teachers is not directly measured as the results were limited how elementary teachers perceived the items in the DAS scale. However, as indicated in related literature teachers' perceptions of attitudes may affect their behavioral intention and cause a change in their behaviors (Haney et al., 1996; van Aalderen-Smeets et al., 2012; Yilmaz-Tuzun, 2008).

## CONCLUSION AND RECOMMENDATIONS

This study presents Spanish and Turkish translated versions of the new and the current DAS scale that provide broader perspective than previous scales' in terms of teachers' attitude toward science teaching. In the translation and adaptation process, highly suggested approaches reviewed and a well-planned five-step guideline was conducted. The guideline includes some structural, semantic and conceptual equivalence of the translations. Translation equivalence procedures were rigorously explained, as they might lead up future studies aimed to adapt it into other languages. The model fit, examined with CFA, of seven-factor structure of the DAS scale for both versions also supports construct equivalence of the translated scales. Therefore, this study in general contained clear directions for further studies aimed to adapt and validate the DAS scale that can be adapted to other cultures.

The multi-group CFA confirmed that the factor structures of the adapted scales are invariant across the Spanish and Turkish samples. The two versions of the DAS scale appear to represent valid and reliable measures of attitudes toward science teaching of in-service elementary teachers in both samples. The reason for this fit is likely that the original scale was applied again in a European country (Netherlands), where the education system, science curriculum, teacher training program, or expectations of teachers may yield almost the same effects on teachers' attitudes toward science teaching. As stated by van Aalderen-Smeets and Walma van der Molen (2013), the DAS scale is coherent and effective in assessing elementary teachers' attitudes toward science teaching because items measuring "attitude toward science" and "science attitude," which could be confused, were removed. The most crucial products of this study are not only the Turkish and Spanish versions of the scale but also confirmation of the cross-cultural structure of the DAS scale that would be useful in further studies on attitudes toward science teaching. In fact the cross-cultural adaptation of the DAS scale might have led the further studies to combine teachers' attitude toward science teaching with the findings of other international cross-cultural comparison studies such as TIMSS and PISA-Science. The confirmed seven factors of the DAS are the sub-categories of the attitude toward science teaching.

Future studies could analyze how in-service elementary school teachers' attitudes toward science teaching in each country affect students' achievement related to the seven categories confirmed in this study. Moreover, the model fit of the DAS scale can be investigated in other cultural contexts as well. Finally, a subsequent investigation could be organized with the teachers in the Almeria sample to explore the reasons behind their moderate level of enjoyment in science teaching.

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**APPENDIX**

**a. Turkish form of the DAS scale**

FEN ÖĞRETİMİNE YÖNELİK TUTUM ÖLÇEĞİ

AÇIKLAMA: Bu çalışma İspanya ve Türkiye'deki örneklemlerinde sınıf öğretmenlerinin fen öğretimine karşı tutumuna yönelik genel eğilimi belirlemeyi amaçlamaktadır. Araştırma sonuçları tek bir kişi ile ilgili değil, istatistiksel olarak var olan durumu ortaya koymak adına olduğu için isim yazmak zorunda değilsiniz. Lütfen uygun kutulara X koyarak cevaplayınız. İşbirliğiniz için çok teşekkür ederiz.

Yrd. Doç. Dr. Fikret KORUR
Noemí Torres Serrano
Rocío Vargas Vargas

ÖLÇEK

| No | Maddeler | Uygun Bölüme 'X' Koyunuz. | | | | |
|---|---|---|---|---|---|---|
| | | Kesinlikle Katılıyorum | Katılıyorum | Kararsızım | Katılmıyorum | Hiç Katılmıyorum |
| 1 | Öğrencilerden gelen fenle ilgili soruların rahatlıkla üstesinden gelebiliyorum. | | | | | |
| 2 | Fen içeriği ile ilgili konuları ilkokul öğrencilerine anlatabilecek düzeyde yeterli bilgiye sahibim. | | | | | |
| 3 | Öğrencilerin sınıfta araştırma ve tasarım yapmalarını destekleyebilecek düzeyde iyi malzeme bilgisine sahibim. | | | | | |
| 4 | Eğer ilkokul öğrencileri fen ile ilgili ödevlerinde bir çözüm üretemezse, bu ödevlerinde ilerleme göstermeleri konusunda onlara yardım edebileceğimi düşünüyorum. | | | | | |
| 5 | İlköğretimde fen bilimlerine mümkün olduğunca erken başlanması gerektiğini düşünüyorum. | | | | | |
| 6 | Fen bilimleri eğitiminin ilkokul öğrencilerinin gelişimi için gerekli olduğunu düşünüyorum. | | | | | |
| 7 | Fen bilimleri eğitiminin ilkokul öğrencilerinin toplumdaki teknolojik problemlerle ilgilenmelerini sağlaması için gerekli olduğunu düşünüyorum. | | | | | |
| 8 | İlkokulda fen bilimleri eğitimi öğrencilerin çalışmaları ile ilgili doğru tercihler (kariyer seçimi ve ders seçimi gibi) yapabilmeleri için gerekli olduğunu düşünüyorum. | | | | | |
| 9 | İlkokulda fen bilimleri eğitimi o kadar önemlidir ki deneyimsiz öğretmenler bu alanda fazladan eğitimler almalıdır. | | | | | |
| 10 | Erkek ilkokul öğretmenlerinin, bayan ilkokul öğretmenlerine göre fen bilimlerini öğretmekten daha fazla hoşlandıklarını düşünüyorum. | | | | | |
| 11 | İlkokuldaki erkek öğrencilerin kız öğrencilere göre daha büyük olasılıkla fen ile ilgili ödev seçeceklerini düşünüyorum. | | | | | |
| 12 | Öğrencilerle bir araştırma veya teknik ödevi erkek ilkokul öğretmenlerinin, bayan ilkokul öğretmenlerine göre daha rahat yapabileceklerini düşünüyorum. | | | | | |
| 13 | İlkokuldaki erkek öğrencilerin, kız öğrencilere göre malzemelerle ve kimyasal maddelerle deney yapma konusunda daha fazla hevesli olduklarını düşünüyorum. | | | | | |
| 14 | Bir fen gösterisi için bilinçli olmayarak bir kız öğrenciden daha çok erkek öğrenci seçeceğimi düşünüyorum. | | | | | |
| 15 | Sınıfta fen öğretirken gergin hissederim. | | | | | |
| 16 | Fen öğretirken sinirli hissederim. | | | | | |
| 17 | Fen öğretmek beni sinirli yapıyor. | | | | | |
| 18 | Sınıfımda fen öğretmem gerektiğinde stresli oluyorum. | | | | | |
| 19 | Çoğu ilkokul öğretmeninin, fen ile ilgili konuları öğretmeyi zor bulduğunu düşünüyorum. | | | | | |
| 20 | Çoğu ilkokul öğretmeninin, fen bilimleri dersinin içeriği açısından konuları öğretmeyi zor bulduğunu düşünüyorum. | | | | | |
| 21 | Öğretmenlerin fen bilimleri dersinde karşılaşılan konuları karışık bulduklarını düşünüyorum. | | | | | |
| 22 | Bana göre, uygun kullanıma hazır paket malzemelerin kullanılması sınıfta fen öğretimi için gereklidir. | | | | | |
| 23 | Bana göre, uygun bir fen öğretim yönteminin olması sınıfta fen öğretmek veya öğretmemek için belirleyicidir. | | | | | |
| 24 | Bana göre, meslektaşlarımın ve okulun desteği sınıfta fen öğretmek veya öğretmemek için belirleyicidir. | | | | | |
| 25 | Fen öğretirken kendimi mutlu hissediyorum. | | | | | |
| 26 | Fen öğretmek beni neşeli yapıyor. | | | | | |
| 27 | Fen öğretmekten çok zevk alıyorum. | | | | | |
| 28 | Fen öğretmek beni heyecanlandırıyor. | | | | | |

**b. Spanish form of the DAS scale**

ESCALA DE ACTITUDES EN LA ENSEÑANZA DE LAS CIENCIAS

Estimado,

Este estudio tiene como objetivo identificar la tendencia o actitud general de los maestros de educación primaria "hacia la enseñanza de la ciencia en España y en Turquía''. Usted no tiene que escribir su nombre ya que el estudio no está relacionado con una persona concreta, sino que se trata de un estudio donde los resultados se analizarán estadísticamente con el fin de aclarar la situación actual.

Por favor, responde poniendo una X en las casillas correspondientes. Muchas gracias por su colaboración.

Asst. Prof. Dr. Fikret KORUR
Noemí Torres Serrano
Rocío Vargas Vargas

Escala

| No. | Artículos | **pon una "X" en las casillas correspondientes** | | | | |
|---|---|---|---|---|---|---|
| | | Totalmente de acuerdo | De acuerdo | Neutral | En desacuerdo | Totalmente desacuerdo |
| 1 | Soy perfectamente capaz de resolver las preguntas de mis alumnos/as sobre ciencias. | | | | | |
| 2 | Tengo suficiente conocimiento sobre los contenidos de ciencias para enseñar adecuadamente dichas asignaturas en la educación primaria. | | | | | |
| 3 | Tengo un dominio suficiente del material para ayudar a mi alumnado en la investigación y diseño de clase. | | | | | |
| 4 | Si los niños/as de educación primaria no alcanzan una solución durante las tareas de ciencias, considero que podré tener éxito ayudándolos a solucionar dichas tareas. | | | | | |
| 5 | Pienso que las ciencias deben enseñarse en la educación primaria tan pronto como sea posible. | | | | | |
| 6 | Pienso que la enseñanza de las ciencias es esencial en educación primaria para el desarrollo del/a niño/a. | | | | | |
| 7 | Pienso que la enseñanza de las ciencias es esencial para hacer que los/as niños/as de educación primaria se involucren más en los problemas tecnológicos de la sociedad. | | | | | |
| 8 | Pienso que la enseñanza de las ciencias en la educación primaria es esencial para que los/as alumnos/as sean capaces de tomar buenas decisiones acerca de sus estudios (por ejemplo, elección de una carrera y elección de un curso) | | | | | |
| 9 | La enseñanza de las ciencias es tan importante en la educación primaria que maestros/as inexpertos/as deberían recibir una formación adicional en este área. | | | | | |
| 10 | Pienso que la enseñanza de las ciencias sociales es más divertida para los maestros que para las maestras. | | | | | |
| 11 | Pienso que en educación primaria los niños son más propensos que las niñas a elegir tareas que tienen que ver con la ciencia. | | | | | |
| 12 | Pienso que los maestros de educación primaria pueden hacer una investigación técnica con mayor facilidad que las maestras. | | | | | |
| 13 | Pienso que los niños de educación primaria son más entusiastas acerca de lo experimentado con materiales y sustancias químicas que las niñas. | | | | | |
| 14 | Pienso que yo inconscientemente sería más propenso a elegir para una demostración científica a un niño que a una niña. | | | | | |
| 15 | Me siento tenso/a mientras enseño ciencias en clase. | | | | | |
| 16 | Me siento nervioso/a mientras enseño ciencias en clase. | | | | | |
| 17 | La enseñanza de las ciencias me pone nervioso/a. | | | | | |
| 18 | Me siento estresado/a cuando tengo que enseñar ciencias en mi clase. | | | | | |
| 19 | Pienso que la mayoría de los/as maestros/as de educación primaria tienen dificultades para enseñar temas relacionados con la ciencia. | | | | | |
| 20 | Pienso que la mayoria de los/as maestros/as de educación primaria encuentran la ciencia una materia difícil de enseñar en términos de contenido. | | | | | |
| 21 | Pienso que los/as profesores/as encuentran complicados los temas que surgen en la ciencia. | | | | | |
| 22 | Para mí, la disponibilidad de un paquete de materiales listo para su uso es esencial para la enseñanza de la ciencia en el aula. | | | | | |
| 23 | Para mí, la disponibilidad de un método de enseñanza de las ciencias es decisivo independientemente de si voy a enseñar o no ciencias en clase. | | | | | |
| 24 | Para mi, el apoyo de mis compañeros/as y de la escuela es decisivo independientemente de si voy a enseñar o no ciencias en clase. | | | | | |
| 25 | Me siento feliz mientras enseño ciencias. | | | | | |
| 26 | Enseñar ciencias me hace estar alegre. | | | | | |
| 27 | Me divierto mucho enseñando ciencias. | | | | | |
| 28 | La enseñanza de las ciencias me entusiasma. | | | | | |