JOURNAL OF EDUCATIONAL RESEARCH & PRACTICE

Journal of Educational Research & Practice
2022, Volume 12, Issue 1, Pages 190–208
DOI: 10.5590/JERAP.2022.12.1.14

Original Research

WALDEN UNIVERSITY

Attitude Toward Physics Teaching of Science Teachers: A Revised Scale and Analysis

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Abstract

The first aim of the study was to apply the revised version of the Dimensions of Attitudes toward Science Scale, namely Dimension of Attitudes toward Physics Teaching Scale (DAPT) with a sample consisting of 207 in-service science teachers in Turkey. The second was to determine the percentage distributions of in-service science teachers' attitudes toward physics teaching in the confirmed seven sub-dimensions. The DAPT is a valid and reliable scale to measure Turkish science teachers' attitudes toward physics teaching. Most of the teachers acknowledge the importance of physics subjects in science lessons and believe that they have self-efficacy in teaching physics subjects. Although a large number of participant teachers were female, they were not against gender stereotyping in their attitude towards physics teaching in science courses.

Keywords: *Attitude scale, confirmatory factor analysis, in-service science teachers, physics teaching*

Date Submitted: February 11, 2022 | **Date Published:** October 18, 2022

Recommended Citation

Korur, F. (2022). Attitude toward physics teaching of science teachers: A revised scale and analysis. *Journal of Educational Research and Practice, 12*, 190–208. https://doi.org/10.5590/JERAP.2022.12.1.14

Introduction

In curricula, generally, middle school science courses include biology, chemistry, and physics. The science curriculum in Turkey is implemented in a structure that integrates physics, biology, and chemistry fields with subject areas such as "physical events," "living things and life," "matter and its nature" and "the Earth and the Universe" (The Turkish Ministry of National Education [TMNE], 2018). Research reports (National Research Council [NRC], 2012) and related studies in the United States that these fields in science teaching should be taught with an interdisciplinary approach and that they are inseparable from each other (Wiyanto et al., 2018). Adopting such an approach requires teachers to have positive abilities and attitudes towards these areas (Wiyanto et al., 2018). It is clear that the teachers' possession of the knowledge at least in these three disciplines and attitudes towards the teaching of physics, chemistry, and biology will play an important role in students' science learning. A literature review analyzing 114 studies related to factors affecting secondary school students' attitudes indicated that students' attitudes are most favorable toward biology and their attitudes towards learning science differ in terms of subjects such as physics or chemistry (Musengimana et al., 2021). Therefore, the teacher's attitude towards science teaching could vary in the context of these three subjects.

Many countries strive to improve the quality of science teaching within the framework of national or international professional standards. One of these standards is the development of science teachers' qualifications, including their attitudes towards science teaching that are desirable for middle school teachers for numerous reasons. One of the important reasons stated in the published reports is that teachers are considered a good motivator for the students and the attitudes of teachers are one of the crucial factors affecting students' attitudes toward science (American Association of Physics Teachers, 2009; Australian Institute for Teaching and School Leadership, 2011; Organisation for Economic Co-operation and Development [OECD], 2013; National Science Teachers Association, 2017; TMNE, 2020). Another reason is that teachers' positive attitudes toward teaching affect students' attitudes and achievement (Brophy, 2010; Korur & Eryılmaz, 2018).

Teachers' attitudes towards teaching are only one of the factors frequently examined in the relevant literature in terms of affecting students' attitudes toward science learning (Korur & Eryılmaz, 2018; Sezer, 2018). The sub-dimensions of attitudes toward teaching science were examined in different studies. In Turkey, the studies reported that science teachers felt competent at teaching science and they have a high positive attitude towards their profession (Camci Erdogan, 2017; Karaalioğlu Çakır & Kadioğlu Akbulut, 2022). They analysed the attitudes of science teachers, focusing mainly on self-efficacy for teachers in science teaching, job satisfaction, teachers' professional and scientific attitudes, and enjoyment. Other studies, however, emphasize a connection between sub-dimensions of teachers' science teaching attitudes (e.g., enjoyment and self-efficacy) and students' attitudes towards science learning (McDonald et al., 2019; van Aalderen-Smeets et al., 2017). van Aalderen-Smeets et al. (2012) first developed a coherent and a comprehensive theoretical framework of the Dimensions of Attitude towards Science (DAS) scale. They indicated that primary teachers' attitudes are examined together as personal attitudes towards science and professional attitudes towards science teaching. Personal attitude includes beliefs about science, society, or daily life, regardless of a person's profession (van Aalderen-Smeets et al., 2012).

In contrast, teachers' professional attitudes towards primary school science teaching include the feelings and beliefs they may have regarding teaching these subjects in the school context. For example, it includes feelings of happiness or anxiety about teaching science subjects. Karaalioğlu Çakır and Kadioğlu Akbulut (2022) stated that studies investigating the professional attitudes of science teachers will contribute to the related literature. Second, van Aalderen-Smeets and Walma van der Molen (2013) revised this scale and confirmed its structure with pre-service and in-service primary teachers from the Netherlands. They specified that the DAS scale focuses on teachers' professional attitudes and there was a need for international validation studies. Then, the DAS was translated into Turkish and Spanish and was applied to in-service teachers from Turkey and Spain (Korur et al., 2016). They found that the DAS was a valid and reliable scale with its invariant seven-factor structure across the samples. Wendt and Rockinson-Szapkiw's (2018) study reviewed the development of the DAS and the English version of the DAS was applied to a sample in the United States. They found that the content, face, and structural validity of the DAS were good and its internal reliability was at an acceptable level. In addition, various qualitative studies utilized the verified theoretical framework of DAS; Australian pre-service primary teachers' attitudes toward teaching science were explored with all dimensions (McDonald et al., 2019) and Swedish teachers' perceptions of attitudes towards teaching technology were examined with selected dimensions (self-efficacy and context dependency; Nordlöf et al., 2019).

In the multidisciplinary structure of science, physics is one of the disciplines that is considered to be the most problematic field (Guido, 2013). Only teachers who have a high positive attitude towards their profession can better cope with these difficulties and strive to improve their own teaching approach (Karaalioğlu Çakır & Kadioğlu Akbulut, 2022). Since teachers' attitudes directly affect students' learning outcomes, it would be appropriate to examine attitudes with continuously developed instruments (Ambusaidi & Al-Farei, 2017; Blalock et al., 2008; Pratiwi et al., 2022). A scale to measure the dimensions of attitude and attitudes toward the teaching of physics of science teachers will improve training of future teachers and will bring positive changes in physics teaching attitudes through in-service teacher training programs (Ambusaidi & Al-Farei, 2017; Korur et al., 2016). Since the common scales in the literature focused on students' attitudes or teachers' personal attitudes toward science, a study that measure teachers' science/physics teaching attitudes will contribute to the science education literature (Blalock et al., 2008; Jones & Leagon, 2014; Korur et al., 2016; Wendt & Rockinson-Szapkiw, 2018). When a valid and reliable scale measuring attitude towards teaching physics is introduced, it will be revised to use in measuring the attitudes in the teaching of other disciplines (such as biology and chemistry) in science classes. Instead of developing a new scale, it is planned to revise Turkish version of the DAS because of the strong seven factor structure of the DAS, confirmed in various international samples, its methodological strength, and the good psychometric properties. Therefore, it is important to revise the Turkish DAS to determine the attitudes of science teachers towards physics teaching, since examining teachers' attitudes towards physics teaching will play an important role in improving students' attitudes towards physics lessons. Throughout the article, the word "revise" refers to simply changing the words or sentences in the items of Turkish DAS scale to express science teachers' attitudes towards teaching physics, without adding or removing any items in the scale.

In line with this, this study had two aims. The first one is to apply the revised version of the Dimensions of Attitudes toward Science Scale, namely Dimension of Attitudes toward Physics Teaching Scale (DAPT) with a sample consisting 207 in-service science teachers in Turkey in order to evaluate its psychometric properties. The second aim is to determine the percentage distributions of the teachers' attitudes toward physics teaching in the confirmed seven sub-dimensions.

Literature Review

Driscol (2000, p. 350) defined attitude as "choosing personal actions based on internal states of understanding and feeling." Social psychologists examine attitude in three main components: cognitive, affective, and behavioural (Eagly & Chaiken, 1993; Fishbein & Ajzen, 1975). The senses or feelings associated with an attitude object refer to the affective component. Beliefs and thoughts associated with an attitude object constitute the cognitive component, and past behaviors that occur with respect to an attitude object constitute the behavioral component (Haddock & Maio, 2008). van Aalderen-Smeets et al. (2012) examined the components of attitude from a new perspective within the theoretical framework. Basically, the cognitive and affective components of attitude partially reveal the "behavioral intention" that can be accepted as the stage of the attitude before it turns into behavior. Therefore, behavioral intention is not seen as a direct component of attitude, but as a direct result of two attitude components (van Aalderen-Smeets et al., 2012). In this respect, they took the behaviors and behavioral intentions of primary school teachers, which are conceptually different from their attitudes towards science teaching. Instead, they accepted perceived control as a new third component. Perceived control includes self-efficacy and dependency on context factors. In this context, teachers' attitudes towards science teaching (the dimensions of the DAS) are determined as perceived control, affective states, and cognitive beliefs (van Aalderen-Smeets and Walma van der Molen, 2013).

The same theoretical framework was adopted and confirmed in related studies (Korur et al., 2016; McDonald et al., 2019; Ualesi & Ward, 2018; Wendt & Rockinson-Szapkiw, 2018). Self-efficacy, one of the sub-dimensions under these dimensions, includes both the ideas and thoughts of personal abilities to display a certain behavior (Bandura, 1997). According to the report of the OECD, several countries, including Turkey (OECD, 2009) have relatively weak self-efficacy. The second sub-category, enjoyment, should not be considered independent of self-efficacy (Klassen & Chiu, 2010). It was reported that teachers with high self-efficacy can provide effective teaching because of a high level of enjoyment and job satisfaction (Camci Erdogan, 2017; Karaalioğlu Çakır & Kadioğlu Akbulut, 2022; Klassen & Chiu, 2010). Third, context-factor dependency included factors like peer support, resource needs, and time allotted to science lessons in the curriculum within the teachers' attitudes affecting science teaching (van Aalderen-Smeets et al., 2012; van

Aalderen-Smeets & Walma van der Molen, 2013). Another sub-dimension is anxiety, and teachers' anxiety about science teaching is one of the important reasons that students may approach science learning anxiously (Özbuğutu, 2021). "Perceived difficulty," which is the fifth sub-dimension, indicates the difficulty of science and science education compared to other disciplines. The sixth dimension is "gender stereotyping" which measures teachers "perceptions of male or female students" abilities in science and physics. In this context, teachers who think that learning science, especially physics, is only for one gender (usually male) deliver this message to their students as well (Chen et al., 2020). The last sub-dimension is, "perceived relevance" and this is intended to identify perceptions regarding the importance of science subjects and science teaching in elementary schools (van Aalderen-Smeets & Walma van der Molen, 2013). van Aalderen Smeets et al. (2012) determined that the sub-dimensions of the attitudes stated in their study and the dimensions mentioned for the attitudes towards science/physics teaching were not different from each other. Although a general explanation of the underlying theoretical framework and science students' attitudes towards science teaching is given, for a detailed review see Jones and Leagon (2014) and van Aalderen Smeets et al. (2012).

The Scales Measuring Attitude Toward Science Teaching

Other studies adapt various scales in order to determine attitudes toward science teaching (Moore and Foy, 1998). van Aalderen-Smeets and Walma van der Molen (2013) stated that different dimensions of attitude constituting different concepts should be measured with different subscales. In various scales currently measuring attitudes towards science teaching, statistical and theoretical standards are not the main focus (Blalock et al., 2008). In the DAS, these standards were taken into account and the seven-factor structure with factor loadings between .37 and .90 was confirmed by using confirmatory factor analysis (CFA; van Aalderen-Smeets & Walma van der Molen, 2013). They indicated that, for the seven sub dimensions Cronbach's alpha reliability coefficients varied between .74 and .93, the item-total correlations ranged from .44 to .85, and 69% of the total variance was explained by the seven-factor structure. The DAS could comprehensively measure primary school teachers' attitudes towards science teaching (van Aalderen-Smeets & Walma van der Molen, 2013).

Korur et al.'s (2016) study analysed the data collected from 202 teachers in Spain (Almeria), and 185 teachers in Turkey (Burdur). They attributed the use of the DAS scale in different cultures to a few factors. First, they indicated that attitudes toward science teaching of teachers should be identified in Spain and Turkey, since evaluation of the findings of some global reports (e.g., Program for International Student Assessment [PISA]) related to attitudes toward science is valuable. Second, they also implied that the cross-cultural evaluation of science teachers' teaching attitudes across various countries is paramount to determine whether local indicators are the same in the larger population. Finally, they tried to compare the results of the DAS scale in different languages with the results of the original DAS as suggested by the van Aalderen-Smeets and Walma van der Molen's (2013) study.

They proposed a seven-latent factor structured original model for the CFA. The goodness-of-fit indices from CFA conducted separately on the data for the Almeria and Burdur samples indicated the DAS scale corresponds to the original model and adequately fits the theoretical model (Almeria; $\chi 2$ = 643.984, $\chi 2/df$ = 1.957, df = 329, p < .001, RMR = .053, SRMR = .071, RMSEA = .070, CFI = .917, and GFI = .922; Burdur; $\chi 2$ = 611.143, $\chi 2/df$ = 1.858, df = 329, p < .001, RMR = .047, SRMR = 0.056, RMSEA = .062, CFI = .916, and GFI = .925). They demonstrated that for both groups for the original model the common modification indices indicated the structure was fairly fit within the two samples by operating the multi-group CFA ($\chi 2$=1255.132, $\chi 2/df$ = 1.907, df = 658, p < .001, RMR = .060, SRMR = .070, RMSEA = .049, CFI = .917, and GFI = .923). Korur et al. (2016) indicated that most of the factor loadings for seven latent factors at an adequate level for both samples ranged from .43 to .99. They showed that discriminant validity was confirmed since inter-correlation coefficients were between .04 and .63. Among the sub dimensions, the reliability coefficient of the scale (Cronbach's alpha) ranged between .57 and .96 and for the whole scale it was .80. In addition, Korur et al. (2016) also reported the perceptions of participant teachers' attitudes as a percentage on the basis of the sub-dimensions of their reliable and valid scale. Korur et al. (2016) indicated that (a) in both samples, above 80% of the teachers perceived that they had little to no anxiety or stress in teaching science, (b) In Burdur, 66% and in Almeria 76% of the teachers stated negative opinions about gender stereotypes in science teaching, (c) approximately 60% of the elementary teachers in both samples indicated that they had no difficulty in science teaching, (d) around 80% of the teachers in both samples perceived that their attitudes through the sub-dimensions of self-efficacy and perceived relevance were positive, (e) in the Burdur sample 58% and in the Almeria sample 50% of the teachers associated their attitude with contextual environmental factors, such as collegial support, and (f) almost 90% of the teachers in Burdur and 65% of the teachers in Almeria perceived that they had great enjoyment in science teaching. In Almeria 32% of them said they had neutral feelings on the matter. Korur et al. (2016) attributed this crucial difference on the enjoyment sub-dimension to the job satisfaction of teachers between the two countries based on their perceived job stress. They emphasized that the two countries that constitute the sample in their study and the country where the original scale of the DAS was applied (the Netherlands) had a similar education system, science curriculum, and teacher training program or that teachers' expectations had almost the same effects on teachers' attitudes towards science teaching.

Similarly, Wendt and Rockinson-Szapkiw's study (2018) adapted the DAS into English, with a sample of 300 pre-service and in-service teachers in the United States, and they found that it had good content, face, and construct validity ($\chi 2(329) = 2.65$, $p < .001$, RMSEA = .07, IFI = .93, TLI = .92, CFI = .93, GFI = .83). The items fairly fit on the seven factors having loadings above .50. The reliability coefficient (Cronbach's alpha) for the whole scale was .89 and for the sub dimensions it was between .71 and .98. They indicated that the DAS could be utilized to measure the U.S. teachers' attitudes towards science teaching. Moreover, they indicated that the seven factor structure was compatible with the theoretical background (van Aalderen-Smeets et al., 2012) and the results of the study of Korur et al. (2016). In their descriptive findings, Wendt and Rockinson-Szapkiw (2018) reported that elementary school pre-service and in-service teachers' perceptions were mainly positive for attitudes towards science teaching. The teachers stated that they felt little or no anxiety in teaching science, they found science teaching was enjoyable, they regarded science teaching as important, and the confidence in their competencies to teach science was high (Wendt & Rockinson-Szapkiw, 2018). In addition, they reported that the participant teachers perceived science teaching as moderately difficult and fairly dependent on context factors (such as other instructional materials). Similar to the results of the Korur et al. (2016) study, Wendt and Rockinson-Szapkiw's (2018) study stated that their participant teachers did not have gender stereotypes in science teaching. The results of both studies suggested that their participant teachers' perceptions of attitudes towards science teaching were that they experience "little anxiety, fear or stress" while teaching science, but these results were not compatible with the results of other studies (Jones & Leagon, 2014; Roth, 2014).

The other two studies that use the theoretical basis of the DAS are qualitative in nature. Nordlöf et al. (2019) used the two sub-dimensions (self-efficacy and context-factor dependency) of the DAS to determine the themes in their qualitative analysis in order to measure the attitudes of technology teachers towards technology teaching. The "context-factors dependency" sub-dimension stages are concrete and directly affect daily teaching, such as whether classrooms exist for technology education or whether enough textbooks are available (Nordlöf et al., 2019). In their study, they stated that attitude was not as open as context dependency in terms of self-efficacy and stemmed from experience, education, and interest. Even teachers qualified in technology education may need support because they do not have the knowledge and skills on all aspects of the subject (Nordlöf et al., 2019). McDonald et al. (2019) offered another qualitative study, which aimed to reveal the dimensions of 96 Australian primary school teachers' attitudes towards science teaching as pre-test and post-test and to investigate by interviewing a smaller subset of participants (n = 5) how changes in theoretical attitude structures determined by the DAS applied to students in the science education course. Findings showed that the pre-service primary teachers perceived that (a) the science education lesson was both important and enjoyable, (b) science was a difficult subject to teach, and (c) they did not have gender stereotyping beliefs about teaching science (McDonald et al., 2019). They indicated that the participants' confidence in their science teaching abilities, their pleasure expectations, and especially their self-efficacy increased (McDonald et al., 2019). During the course that the pre-service teachers took, anxiety decreased almost half a point, self-efficacy increased more than one point, and they found the course quite effective in increasing their self-confidence and reducing their stress and anxiety by reinforcing their experiences (McDonald et al., 2019). In van Aalderen-Smeets et al.'s (2017) experimental study conducted with primary school teachers (38 teachers in the experimental group and 24 teachers in the control group), they aimed to explore whether participation in a large-scale study would improve primary school teachers' attitudes towards conducting research and science teaching. Unlike the findings of McDonald et al. (2019), van Aalderen-Smeets et al. (2017) stated that teachers felt less anxious for an attitude towards inquiry and more capable of conducting a research project, although there were no gains in their self-efficacy and relevance beliefs or their science teaching behavior. They reported that anxiety level and dependence of contextual factors of experimental group teachers were less than that of the control group teachers. The inclusion of participants in research projects was not sufficient to change their attitudes towards science teaching; but classroom practices should be through an approach that included inquiry and would put attitude change into the foreground (van Aalderen-Smeets et al., 2017).

In the light of all these findings, the DAS scale was usually implemented to investigate primary school teachers' attitudes towards science teaching. A study was needed that would set an example for the formation of a scale on the attitudes of secondary and high school teachers, in addition to primary school teachers, towards teaching science-related subjects, such as biology, physics, or chemistry. In the Turkish science curriculum, the proportion of time allocated to physics subjects in the middle school science course (average in four grades is 51%) is more than the time allocated to other disciplines (TMNE, 2018). Therefore, it is crucial to start by investigating the attitudes of secondary school teachers towards teaching physics. It is also important to investigate different dimensions of attitudes towards physics teaching such as context dependency and gender stereotyping (van Aalderen-Smeets et al., 2017).

Research Questions

Specifically, this study seeks to answer the following research questions:

1. Do the data obtained through the application of DAPT in the sample of in-service science teachers in Turkey confirm the originally initiated seven-factor structure?
2. What are the percentage distributions of in-service middle school science teachers' attitudes toward physics teaching in the confirmed sub-dimensions?

Methods

In the current study, the DAPT was adapted to determine the perceptions of middle school science teachers' attitudes towards teaching physics subjects. The study has a cross-sectional survey design. The design aims to revise and cross validate the DAPT for in-service teachers' attitudes towards science teaching (Fraenkel et al., 2012).

Validation for Content and Face Validity

The cross cultural equivalence of the items on the Turkish version of the DAS was carried out by Korur et al. (2016). They also included conceptual and experiential equivalence of the DAS. In this study, four physics teaching experts (one professor, two associate professors, and one assistant professor) from different universities of Turkey analysed the content and face validity of the new scale, the DAPT, that is revised from the Turkish DAS. In order to revise the scale, the words "science" were replaced with "physics," the words "primary school" were replaced with "middle school" and in six of the items the words "science teaching" were replaced with "physics teaching" or "teaching of physics subjects." The general structure of the items and their meanings were conserved. For example, under the "Self Efficacy" sub-dimension, Item 1 "I have enough knowledge of the content of science to teach these subjects well in primary school" was transformed into "I have enough knowledge to teach the subjects related to physics content to middle school students."

The expert review process was carried out via e-mail. By using a 5-point Likert-type scale (1 indicating "very poor" and 5 indicating "very good"), it was requested from all of the expert reviewers to evaluate their level of agreement for the 28 items separately, in terms of face validity, openness, shortness, readability, grammar usage, and redundancy. Additionally, expert reviewers provided a brief description about their level of agreement and suggestions for changes. They were asked to answer the whole scale. With respect to their feedbacks, content analysis was performed on a spreadsheet that analysed the responses as a whole. The experts suggested minor changes and they determined that the items could be understood thoroughly and measure science teachers' attitudes toward physics teaching; so they did not remove any items from the scale or add items to the scale. One Turkish language expert also verified the Turkish language usage in the final form of the DAPT. The new format of the DAPT was finalized and prepared on Google Forms®. Online surveys are recommended to researchers because they are more likely to easily reach the participants (especially in today's pandemic environment) and they minimize data entry errors.

Participants and Sampling Procedure

It was hard to find sufficient number of science teachers during SARS-CoV-2 pandemic in Turkey, so in order to enrich the participation of science teachers by using contact networks, a snowball sampling technique was conducted. The online version of the DAPT was hosted on Google Forms and an informative text about the scale was prepared. The link of the form and the text was shared with the science teachers that can be reached directly from WhatsApp® groups of the various science teachers. The same posts were shared with about 10 science teachers, who could possibly contact other science teachers, on the author's personal contact list. The data collection process took about six weeks. A total of 217 middle school science teachers in Turkey voluntarily filled out the online DAPT. Since all of the scale items were coded as mandatory fields, there was no missing information in the data set containing the form answers. However, since the participant science teachers (numbered 9, 25, 103, 118, 139, 140, 182, 199, 213) double sent by pressing the "send" button twice and since the data for participant 49 was an outlier, they were excluded from the analysis. It was confirmed that there were no outliers in the remaining data (p <.001 for Mahalanobis distance; Tabachnick & Fidell, 2007, p. 99). Finally, the data analysis was carried out with 207 (133 females; 64.3%) teachers' data. The number of science teachers aged between 21 and 30 was 98 (47.3%), between 31 and 40 was 62 (30.0%), between 41 and 50 was 40 (19.3%), and between 51 and 60 was 7 (3.4%). Most of the science teachers were graduated from education faculties, 164 (79.6%), but some of them were graduated from science and literature faculties 42 (20.3%), such as chemistry, physics, biology, and became science teachers by having changed their branches, and 1 (0.5%) teacher was graduated from the engineering faculty. Of the participant science teachers, 161 (77.8%) have bachelor degrees, 44 (21.3%) of them have master's degrees, and 2 (1.0%) of them have doctorate degrees.

Data Analysis

Science teachers' attitude scores towards physics teaching were coded as 1 "I Strongly disagree," 2 "I Disagree," 3 "I am Neutral," 4 "I Agree," and 5 "I Strongly agree." In the 5-point Likert-type scale, 12 items between 10–21 were reverse-coded. After reverse coding, the frequencies of the responses to the items of each sub-category in the 5-point scale were found. In order to obtain percentage scores with respect to frequencies;

the frequency values were divided by both the number of items in that category and the number of participants, and the result was multiplied by 100. Furthermore, at first with respect to sub-dimensions and then with respect to the whole scale, an attitude mean score towards physics teaching (out of 5) was obtained by averaging the score of all participants' respective average scores from 28 items of the 5-point scale. Higher mean scores obtained from the scale indicate a more positive attitude towards physics teaching. The threshold values of the mean scores of interpreting the perceptions of science teachers from the 5-point Likert-type scale were interpreted using the formula of the highest score minus the lowest divided by five levels (5-1/5). The new intervals "I strongly disagree" for 1.00–1.80; "I disagree" for 1.81–2.60; "I am neutral" for 2.61–3.40; "I agree" for 3.41–4.20; "I strongly agree" for 4.21–5.00 (see Table 3). The compatibility of the DAPT with the original seven-factor structure was tested using Confirmatory Factor Analysis (CFA) through the AMOS program. Before performing the CFA, no violations were found in the hypothesis testing for the suitability of the data for analysis. The linear regression curve estimation and linearity assumption were confirmed. The homoscedasticity assumption was validated from the similar shape of the scatter plot diagrams. For univariate normality (skewness and kurtosis values between -1.5 and +1.5) was confirmed, as Byrne (2010) initially suggested. Whether the CFA results supported the theoretical structure was checked using multiple fit indices. The required value ranges of fit indices for a good and acceptable fit proposed by Schermelleh-Engel et al. (2003) are shown in Table 1.

Table 1. *The Required Value Ranges for the Fit Indexes of CFA**

Fit indexes **	Good fit	Acceptable fit
χ^2/df	$0 \leq \chi^2/df \leq 2$	$2 < \chi^2/df \leq 3$
RMSEA	0 ≤ RMSEA ≤ .05	.05 < RMSEA ≤ .08
SRMR	0 ≤ SRMR ≤ .05	.05 < SRMR ≤ .10
NFI	.95 ≤ NFI ≤ 1.00	.90≤ NFI < .95
CFI	.97 ≤ CFI ≤ 1.00	.95 CFI < .97

Note: *The table was revised from the study of Schermelleh-Engel et al. (2003).

**$\chi2/df$: Chi-square/degrees of freedom, RMSEA: Root mean square error of approximation, SRMR: Standardized root mean square residual, NFI: Normed fit index, CFI: Comparative fit index

A different rule combination has been proposed to obtain a good fit and to keep Type I and Type II error rates at minimum (Hu & Bentler, 1999). In this context, it is recommended that SRMR values are close to or below .08, RMSEA values are close to or below .06, and CFI and TLI values close to .95 or higher. Since the value of $\chi2$ in Table 1, which is sensitive to the sample size, and its statistical significance might not suggest a poor model fit (Brown, 2012; Tabachnick & Fidell, 2007). Hair et al. (2010) indicated that composite reliability (CR) should be CR > .7 in terms of reliability. Construct validity was checked as convergent and discriminant validity. Convergent validity was used for the degree of relationship of the items coming from the structure in the theoretical framework. Discriminant validity was used for measures of constructs that should not be related to each other theoretically (Ullman, 2007). For convergent validity threshold values average variance extracted (AVE) should be more than .5 while CR > .7 (Fornell & Larcker, 1981); for discriminant validity threshold values maximum shared variance (MSV) should be less than AVE and inter-construct correlations (IC) should be smaller than square root of AVE (Brown, 2012).

Results

Results for the Confirmatory Factor Analysis

The evaluation of the first research question of the study was examined by CFA in order to verify the baseline model developed with the data obtained from the science teachers. It was found that all fit indices, except for NFI, which is a little below the criteria, were within the acceptable range, revealing that the theoretical seven-factor structure was confirmed [$\chi2(327, N=207) = 557.912$, $\chi2/df = 1.706$, NFI = .857, CFI = .935, RMR= .068, SRMR = .058, RMSEA = .059 (90% CI = .050, .067)]. It was concluded that the model provides an adequate fit of the data (Byrne, 2010). The representation of the CFA results as a path diagram is given in the Appendix. Within the seven-factor structure, the factor loadings, except for Item 9 (.33), are all above the critical value of .50 for CFA (see Appendix), ranging from .33 to .96. The validity and internal reliability values with respect to the whole scale and the sub-dimensions are given in Table 2.

Table 2. *Validity (CR, AVE, MSV, and IC) and Reliability (Cronbach's Alpha) Coefficients With Respect to the Seven Sub-Dimensions of the DAPT*

Sub-dimensions	Item No.	CR	AVE	MSV	IC	α	Sample Item
Self-Efficacy	1-4	.790	.487	.339	.698	.786	1. I have enough knowledge to teach the subjects related to physics content to middle school students.
Perceived relevance	5-9	.811	.481	.339	.694	.781	6. I believe that teaching physics subjects in science is essential for the development of the secondary school students.
Gender stereotype	10-14	.887	.613	.037	.783	.892	13. I believe that boys in secondary schools are more enthusiastic about experimenting than girls.
Anxiety	15-18	.900	.693	.389	.833	.904	15. I feel nervous while teaching physics.
Perceived difficulty	19-21	.910	.773	.256	.879	.881	19. I think that most secondary school science teachers find physics content to be a difficult subject to teach.
Dependence on Context	22-24	.639	.373	.256	.611	.626	24. For me, the support of my colleagues is decisive for whether or not I will teach science in class.
Enjoyment	25-28	.943	.806	.389	.898	.942	26. Teaching physics makes me cheerful.
Whole scale	--	.976	.601	--	--	.726	

The CR calculated for the seven factors ranged between .640 and .943 and for the whole scale the CR was .976 (see Table 2). With respect to the seven factors, the computed AVE ranged between .373 and .806. For the whole scale the AVE value was calculated as .601, which is higher than 0.5 and is acceptable when the CR is higher than .700 (Fornell & Larcker, 1981). Therefore, the convergent validity of the construct can be accepted as adequate. Furthermore, the sub-dimensions measured different concepts from each other and the inter-construct correlation coefficients (IC) between them varied between .611 and .898, which were smaller than square-root of AVEs supporting the discriminant validity (Brown, 2012). For this reason, it has been confirmed that the indicators of one construct are dissimilar from other constructs. Cronbach's alpha reliability coefficient for the whole scale was α = .726. The value indicates that reliability of the test results are at an acceptable level (Fraenkel et al., 2012). Based on all these factors, the results collected from the sample of this study with the DAPT scale are reliable and valid.

Percentage Distribution of Science Teachers' Attitude Toward Physics Teaching

The latent structure of the DAPT contained seven factors, which are indicative of the number of sub-dimensions. The data gathered from the sample of this study were converted to the frequency tables. The science teachers' percentages and the mean scores in terms of seven sub-dimensions and their denotations are given in Table 3.

Table 3. *Percentages, Mean Scores, and Their Denotation With Respect to the Seven Sub-Dimensions*

	Positive		Neutral	Negative		Mean score	(Denotation)
Sub-dimensions	5 %	4 %	3 %	2 %	1 %	out of 5	"higher mean scores denote stronger belief…
Self-Efficacy	45.8	36.7	14.7	2.4	0.4	4.25	about teachers' high confidence for physics teaching."
Perceived relevance	60.2	24.4	11.9	2.4	1.1	4.40	about importance of science. "
Gender stereotype	29.3	17.9	19.6	17.2	16.0	3.27	against gender stereotyping. "
Anxiety	61.4	24.4	6.8	4.8	2.6	4.37	about teachers' less anxiety in science teaching. "
Perceived difficulty	11.6	18.2	31.2	26.6	12.4	2.90	that teaching physics is not difficult. "
Dependence on Context	28.2	29.3	24.8	12.6	5.1	3.63	that teaching science did not depend on context-factors."
Enjoyment	48.7	28.6	15.0	5.9	1.8	4.16	about enjoyment in teaching physics. "

The mean attitude score of science teachers for whole scale towards teaching physics was found to be 3.90 out of 5. This score corresponding to the level of "I agree" reveals that science teachers generally have a positive attitude towards physics teaching. The participant teachers have perceptions about the importance of physics subjects (with the highest mean score of 4.40) in their career choices and their future success at the level of strongly agree (with 84.6% positive response) in the perceived relevance sub-dimension. In the self-efficacy sub-dimension, the mean score was 4.25 and it was found that participant teachers had strong perceptions (with 82.5% positive response) at the strongly agree level. For gender stereotyping, the mean score was 3.27 corresponding with the participant science teachers' perceptions, which were at a neutral level. Less than half of teachers (47.2%) opposed gender stereotyping in physics teaching. Specific to gender stereotyping sub-dimension, the differentiation status was examined by independent sample *t*-test analysis (after validation of normality and equality of variance). The average attitude scores of male participant teachers (M = 2.75, SD = 1.11; neutral level) was significantly different [$X_{difference}$= .81; t (205) = 4.955, p <.05] with respect to that of female teachers (M = 3.56, SD = 1.14; disagree). The effect size was medium (Cohen's d = .69) and the statistical power was high (.99).

According to Table 3, more than 85% of teachers answered positively (with the mean score of 4.37) at the level of strongly agree for the Anxiety sub-dimension, indicating the science teachers have little or no anxiety, fear, or stress about teaching physics. In the perceived difficulty in physics teaching sub-dimension, the mean score was 2.90 corresponding that science teachers perceived the difficulty of physics teaching at a neutral level. Almost 29.8% of the participant science teachers gave a positive response indicating that teaching physics is not difficult, 39.0% of them gave a negative response indicating that teaching physics is difficult, and 31.2% of the teachers remained neutral.

The other two sub-dimensions that the participant science teachers perceived positively in their attitude towards physics teaching are perceived dependency on context factors (the mean score of 3.63 corresponding to agree level) with 57.5% positive response and Enjoyment (with the mean score of 4.16 corresponding to agree level) with 77.3%. Specific to the items in the Enjoyment, there were ($X_{difference}$ = .37) significant difference (t (205) = -3.054, p = .003) between the average scores of male participant teachers (M = 4.40, SD = .73; strongly agree level) and female teachers (M = 4.03, SD = 1.00; agree level). The effect size was small (Cohen's d = .44) and the statistical power was high (.93).

Discussion

The DAPT was analysed with in-service science teachers in Turkey and it was found that its face, content, and construct validity were good. Experts in this study confirmed the face and content validity. By using the results of the CFA applied in this study, the seven-factor structure recommended by van Aalderen-Smeets and Walma van der Molen (2013) was verified. The items measured a specific sub-dimension loaded without cross-loadings indicating that the model fit of 28 items to theoretical seven-factor model was fully confirmed. In this study, the results supported the conceptual and theoretical model that attitudes towards physics teaching are multi-dimensional in structure that consists of cognitive, affective, and perceived control dimensions. As reported by Ambusaidi and Al-Farei (2017), it is stated that attitudes towards physics education should be examined in the context of different cultures and curriculums in order to yield positive results for teaching competencies. Therefore, the classification of seven sub-dimensions of attitude towards physics teaching of science teachers in the Turkey sample is consistent with the results of the various studies to determine attitudes toward science teaching of elementary school teachers (Korur et al., 2016; McDonald et al., 2019; van Aalderen-Smeets & Walma van der Molen, 2013; Wendt & Rockinson-Szapkiw, 2018). Some of the main reasons for this consistent seven-factor structure in many cultures and practices in many countries may be that the DAS was prepared in a quite systematic approach by van Aalderen-Smeets and Walma van der Molen (2013) and its theoretical structure is very strong and effective in evaluating attitudes toward science teaching of elementary teachers. Internal consistency coefficients were found to be good for the whole scale and for each of the sub-dimensions. Attitudes of middle school science teachers towards physics teaching were positive. It can be stated that science teachers have a very positive attitude toward the effect of physics subjects on students' career preferences and future success. Science teachers' self-efficacy attitudes towards the teaching of physics subjects were quite positive and they had little or no anxiety during teaching. Their attitudes towards enjoying the teaching of physics subjects is positive. They have positive attitudes toward the fact that the teaching of physics subjects depends on contextual factors (such as collegial support). The gender role is a factor affecting their attitudes towards teaching. They have neither positive nor negative attitudes towards the difficulty of teaching physics subjects in science class at the middle-school level. Researchers who use the DAPT to measure attitudes of science teachers towards teaching physics should expect a similar consistent structure with this study.

In this particular study, the positive attitudes of the teachers towards teaching physics subjects, which have a crucial proportion in science, may be assumed to have a positive effect on students' attitudes towards science learning. However, especially at the middle-school level, the "medium" average score for the science section in national exams such as Entrance Exam to High Schools (TMNE, 2020), and "very low" average score for physics in exams such as Undergraduate Placement Exam and Higher Education Institutions Exam (The

Measuring, Selection and Placement Center, 2017, 2019); are interesting in that they reveal that factors affecting students' achievement other than teachers' attitudes can be found and these should be investigated seriously.

Descriptive statistics were analysed specifically for sub-dimensions under three main dimensions. There are context-factor dependency and self efficacy under perceived control dimension. The self-efficacy covers many situations, from answering their physics questions to helping them progress on a given assignment from physics subjects. The science teachers perceived that they have high self-efficacy towards physics teaching at the level of "strongly agree." Furthermore, the science teachers perceived context-factor dependency was at the level of "agree" for the attitudes towards physics teaching. One of the reasons for this is that while teaching physics subjects, the science teachers may think that they may need technician support (for online teaching materials), collegial support (to choose the appropriate teaching method), and the support of the school administration (to fulfill the laboratory equipment requirements). These findings reveal the perception that the science teachers feel a need for support within various context factors, despite the high self-efficacy they have in teaching physics subjects in science. These findings are consistent with the results reporting that the attitudes of primary school teachers for the teaching of science in Turkey are influenced by contextual factors such as preparation time for the lesson and collegial support (Korur et al., 2016). They are also coherent with the findings that teachers and pre-service teachers in the U.S. sample reported that science teaching as moderately difficult and they perceived that it depended on context factors such as preparation time and pre-structured materials (Wendt & Rockinson-Szapkiw, 2018). It was stated that the specified context factors like collegial support, supply of resources, and time allocated in the curriculum also affect science teachers' general attitudes towards teaching (van Aalderen-Smeets & Walma van der Molen, 2013).

It was stated that the effect of the enjoyment and anxiety sub-dimensions of affective states dimension on attitudes towards physics education was perceived at the level of "strongly agree." The science teachers mostly enjoy teaching physics subjects. These findings coincide with the results of the study conducted with U.S. teachers (Wendt & Rockinson-Szapkiw, 2018); however, it conflicts with the results of the related studies (Jones & Leagon, 2014; Roth, 2014). The results of this study are consistent with results of the report indicating that students in Turkey perceived 70% of their teachers enjoy teaching (PISA, 2018). Korur et al. (2016) stated that most of them were tenured so they felt less anxious and more comfortable, which may be one of the reasons for the results of this study. Another reason may be the science teachers' high self-efficacy in this sample, as teachers with high self-efficacy reported high levels of job satisfaction (Camci Erdogan, 2017; Karaalioğlu Çakır & Kadioğlu Akbulut, 2022; Klassen & Chiu, 2010). Furthermore, the difference between the genders in the enjoyment sub-dimension is in favor of the average scores of the male participant teachers.

The third dimension, cognitive beliefs, includes three sub-dimensions. One of the interesting findings among these belongs to the gender stereotyping sub-dimension. More than half of the teachers, despite the fact that large number of participants were female, were not against gender stereotyping in their attitudes towards physics teaching in science courses. In further analysis, male teachers' item total scores average is significantly higher than female teachers' item total scores average (t (205) = 4.955, $p < .05$). While female participant teachers stated negative opinions at the "disagree level," stating that there is no place for gender stereotyping in attitudes towards physics teaching, it was determined that male participant teachers remained "neutral" towards gender role in physics teaching. The percentage of the participants in the study group was 52.8% (staying "neutral" or giving "negative response") who possibly perceived that there was gender discrimination on completing the physics concepts in the science course with success and that the gender of the teacher who teaches the lesson plays a role in their attitudes towards the teaching of science. The results are not consistent with the results of various studies indicating that the teachers' (whether pre-service or in-service) perceptions were strongly against gender stereotyping in science teaching (Korur et al., 2016; McDonald et al., 2019; Wendt & Rockinson-Szapkiw; 2018). It is consistent with studies stating that gender role (especially the historical acceptance that men are more successful in science than women) may affect teachers' attitudes in science teaching (Jones & Leagon, 2014; Shepardson & Pizzini, 1992). One of the reasons for this result, which includes the acceptance of the gender role, may be that the study is on the teaching of physics subjects within middle-school science, not primary-school science. Although it is emphasized that it should not be so, it could be assumed that traditional gender discrimination in physics subjects is more than science subjects (as gender roles might be considered as equal in science disciplines such as biology and chemistry; Sekuła et al., 2018).

In terms of perceived relevance, the participant teachers have a high level of perception about the importance of physics subjects for students and their necessity for career choices and success in their future lives. These findings were consistent with the findings of the related studies (Korur et al., 2016; van Aalderen-Smeets & Walma van der Molen, 2013). There may be several reasons for this perception. First, the teachers know that science/physics topics are important in technology and scientific developments. Second, they may think that students need the science/physics knowledge in their future career. The other sub-dimension was perceived difficulty in physics teaching, which is perhaps one of the key sub-dimensions of this study, forcing a science teacher to teach physics. It was found that 39% of the participant teachers perceived the effect of having difficulty in teaching physics on their attitudes toward teaching. The science teachers thought that the content of the physics course is not complex but the teaching of the subjects is not very easy. One of the reasons may be the prejudice that physics in general consists of difficult and abstract issues (Oon & Subramaniam, 2011). Another possible reason that causes problems in science teaching courses at universities may be the standard curricula focusing on methods rather than direct courses and the lecturers generally prioritize teaching based on traditional lectures for pre-service science/physics teachers (Larsson & Airey, 2021) Because of this situation, in-service science teachers might require continuous and coherent support for their professional development (Kohnen & Whitacre, 2017).

Limitations

First, participation in the DAPT is on a voluntary basis. There may have been a situation where volunteers had a positive attitude toward teaching of physics subjects in science classes, while non-volunteers had a negative attitude. Therefore, voluntary participation in the study is a limitation that cannot be ignored. Second, the snowball sampling is one of the limitations of the study. Because of COVID-19 pandemic, an online form was prepared and its link was announced through social media groups and personal emails. This type of sampling made it impossible to determine sampling error or make inferences about populations based on the sample obtained. However, the sample used in this study is similar to the demographics of teachers in Turkey (Ceylan et al., 2020). Third, the evaluations on the scale were based on the perceptions of the in-service teachers. Therefore, as with all self-assessment scales, the assumption is made that participants answered honestly and precisely.

Conclusion

This study presents the revised DAPT and its psychometric analysis. The results indicate that its content, face, and structure validity were good and reliability of the scale was at an acceptable level. The DAPT may be used as a scale to determine middle school science teachers' attitudes towards teaching physics subjects in order to shape the curriculum of science teacher training institutions and professional development program contents of in-service teachers. Furthermore, the DAPT could be used to investigate the compliance of different countries or cultures with similar goals. When it is aimed to increase students' positive attitudes and achievements; in order to determine and develop teachers' attitudes in pre-service and in-service trainings, it is recommended to be translated into different languages and applied in other cultures as a valid and reliable scale whose theoretical framework is quite strong. Besides this, it might also be possible to compare the findings of the preliminary reports of The Trends in International Mathematics and Science Study (2020) and

PISA (2015 and 2018) on science teachers' attitudes towards physics teaching for different countries by using cross-cultural adapted version of the DAPT.

The DAPT also provides an opportunity to assist middle school science teachers in measuring their attitudes towards physics teaching by lecturers and in-service planning administrators in teacher training institutions. These administrators and lecturers may find the DAPT useful to determine the general attitudes of in-service teachers and prospective teachers towards science teaching as well as their attitude levels within the sub-dimensions. While this study supports the very strong theoretical framework on which the DAPT is based, the analyses of the sub-dimensions and the relationships between the dimensions are discussed in this study. This information can be used by in-service planning administrators to measure the success of the courses conducted for the professional development of teachers. The DAPT can be used as a self-assessment tool to reveal personal development. The DAPT could also be a potential source of understanding the relationship between teacher attitudes and student performance in evaluations at international standards and could allow science teachers' attitudes to be compared across different cultures.

Future studies can analyze science teachers' attitudes toward teaching Earth science, biology, or chemistry subjects in science and correlate the findings in terms of sub-dimensions of attitude. Finally, with respect to the interesting results for gender stereotyping in this study, more longitudinal studies on gender roles with a group of more male participants than female can be carried out in order to differentiate the existence of gender discrimination effects on attitudes toward physics teaching.

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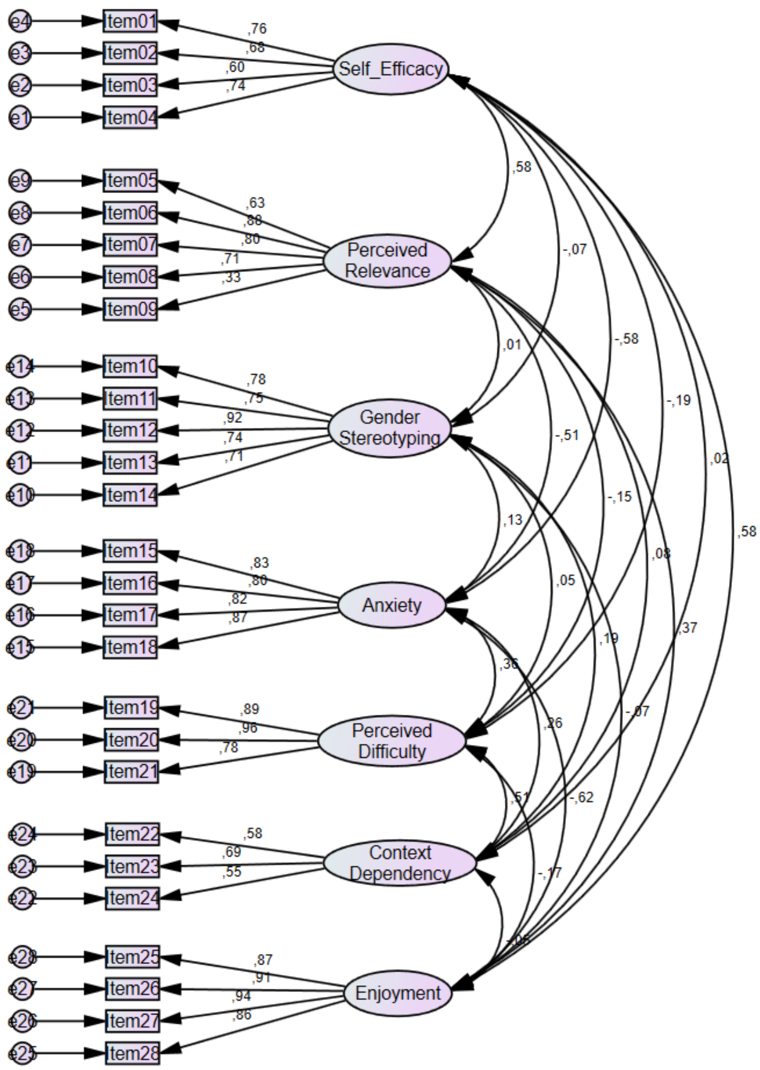
Appendix

The Path Diagram of the Original Seven-Factor Structure and Respective Factor Loadings.



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