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Development of Science Attitude Scale for Middle School Students with Special Needs Studying in Inclusive Education Program

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Abstract
The attitudes of students with special needs towards science course may not be the same as other students due to their individual differences, and science attitude scales in the literature may not be subjective enough to express their attitudes. It is believed that the development of a customized scale to measure the attitudes of students with special needs towards science course will contribute to both teachers and students and to the literature. This study aimed to develop a valid and reliable science attitude scale for secondary school students with special needs in inclusive education. In addition, the developed science scale was also used to investigate how the variables of duration of support education, gender, grade level and number of siblings of students with special needs affect the science attitudes of secondary school students with special needs in inclusive education. The scale was administered to 310 middle school students receiving inclusive education in 10 different cities in Turkey in the 2021–2022 academic year. A 5-point Likert-type scale was used within the cross-sectional survey model. In the first stage of the scale development process, the theoretical infrastructure of attitudes towards science was formed by examining the relevant national and international literature. After the science attitude scale was checked by the experts, necessary corrections were made for the final form of the scale. During the preparation of the scale, a literature review was conducted, expert opinions were received, and the attitudes scale was created as a result of necessary corrections and analyses of obtained the data. Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were performed to reveal the construct validity of the attitudes scale. According to the results of the analysis of the one-dimensional and 10-item scale, it was seen that the model fitted well with the data set and the reliability coefficients were acceptable values. To examine the "Science Attitude Scale for Inclusion Students" in terms of some variables, it was applied to 95 middle school students with special needs in inclusive education. The effects of gender differences, receiving support education in support rooms, support education duration, and the number of sibling were analyzed via t-test and the analysis of variance (ANOVA). Results showed that the scale had a valid and reliable structure, and

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student's grade level and support education status affected students' attitudes. It can be recommended to carry out similar studies with different sample groups and different variables that may affect the attitudes of students with special needs.

Keywords Attitudes scale · Inclusive education · Middle school · Science education · Students with special needs

Introduction

Learning can be defined as making connections between existing knowledge and newly acquired knowledge as a result of people's lives, making inferences and creating long-term behavioral changes from this knowledge. Based on the idea that each individual is remarkable, the fact that individual differences in learning and perception of events are critical (Khamzina et al., 2024). Students' differences are important because they affect their knowledge and skills, their academic achievement, as well as their feelings, thoughts, approaches and interest in a subject (Cebesoy & Öztekin, 2018). Students with learning difficulties and slow learners are identified by the Guidance Research Centers affiliated to the Ministry of National Education (MNE) in Turkey and are called students with special needs (SWSN) in the MNE system. According to the statistics of the MNE in Turkey, while the number of SWSN was 398,815 in the 2018–2019 academic year, 296,297 of them were students receiving inclusive education. This number increased in the 2019–2020 academic year, and the number of SWSN was 425,774, and 318,300 of them were students receiving inclusive education. These data show that the number of SWSN is significant. These SWSN can continue their regular education as inclusive education students based on their level (Schwab & Arthur-Kelly, 2022; Watkins, 2017). As an indicator of the success of mainstreaming practices, it is thought that individuals with special needs can receive necessary special education and regular education services adequately (Causton-Theoharis et al., 2011; Kırcaali-İftar & Batu, 2007). Although the Turkish education system aims to integrate these students into society, the socialization of individuals with special needs is not the only goal of inclusive education. The fact that these students have individual differences does not mean that they cannot learn. In this context, it is not sufficient to keep these students in schools within the framework of inclusion only for the purpose of socialization and learning to live in society. It is also important for SWSN to reach the highest possible academic level. For this reason, the academic status of the students is crucial, as well as their interests and attitudes towards school subjects. In this context, although SWSN are in inclusive education schools, they have to take exams like their other peers when they move to high schools and universities. Although SWSN are provided with opportunities such as additional time, large print, readers, markers or exemption from English subjects according to their differences (Ministry of National Education [MNE-LGS Guide], 2021), they are responsible

for all other subjects and achievements like their peers. This shows that academic achievement is also critical in inclusive education. SWSN can be successful in academic areas if the necessary care is taken and the appropriate teaching methods and techniques are identified.

Scales serve a crucial purpose in educational research by providing a structured and quantifiable way to measure complex constructs. Rather than relying on single-item measures, which can be susceptible to misinterpretation and lack nuance, scales offer a composite score derived from multiple items designed to capture different facets of a particular concept (DeVellis, 2017; Yusuf & Md Noor, 2023). Bentley et al. (2007) suggest that the attitudinal dimension of science, which includes emotional and value aspects, is a powerful component of learning and serves as a catalyst for learning. This aspect stimulates students' interest and curiosity, which encourages them to learn new things (Bentley et al., 2007; Yalgin et al., 2023). Since the interest and attitudes of students directly affect their academic performance in a course, an increase in their academic achievement can be achieved by increasing the interest and attitudes of these students in a course (Çibik & Boz-Yaman, 2024). Therefore, it is necessary to know the attitudes of SWSN towards courses in inclusive education, as it is for all students. SWSN are sensitive students who expect more attention than their peers (Cengiz, 2019). Therefore, the necessary planning for effective learning should be made based on the individual differences of each student. It is essential to know which courses SWSN enjoy, what they think about the courses, what kind of learning they enjoy, and what their interests and attitudes are.

The interest and attitudes of SWSN are of crucial importance in science courses, as in all other courses. In order to improve the science education of SWSN, it is essential to determine their level of interest and attitude towards science courses. In this context, by increasing the interest and attitudes of these students towards the courses, an increase in their academic achievement can be achieved. In a research study conducted by Köse-Biber (2009), it was indicated that special educational support provided to SWSN through a web-based teaching method improved their academic achievement and performance levels, and positively affected their attitudes towards computers and science.

In order to provide an appropriate inclusive education for SWSN, teachers should have a good understanding of inclusive education, know their students, recognize their attitudes, and receive a good education (Sebba & Sachdev, 1997). In this context, before preparing an Individualized Education Program (IEP) for SWSN, students' attitudes towards a course should be identified. It can be stated that if teachers gain sufficient understanding of inclusive education and prepare a plan by knowing each student's attitude towards a course, SWSN can increase their academic achievement. In this context, various scales have been used to determine students' feelings, thoughts, interests and attitudes towards topics, courses or methods, techniques and materials used in science courses (Akpınar et al., 2011; Canlas, 2024; Derin et al., 2017; Gelen et al., 2019; Güneş et al., 2013; Keçeci & Kırbağ-Zengin, 2015; Nuhoğlu, 2008; Özcan & Koca, 2019; Şener & Taş, 2016; Taşkın & Aksoy, 2019; Tosun & Genç, 2015; Yılmaz et al., 2017). However, it was noted that these existing scales were designed for regular students, and there is a need for attitude scales specifically designed for each course for SWSN. Although the scales developed in

other studies can be used to measure the attitudes of SWSN towards science courses, it was thought that the development of a customized scale for individuals with special needs could be useful for both teachers and students and could contribute to the related literature. In this study, it was intended to develop a science attitude scale appropriate for SWSN in inclusive education.

Due to their unique characteristics, SWSN may have different attitudes towards science education than regular students, and current attitude assessments may not be subjective enough to capture these differences. For this reason, it is believed that a valid and reliable science attitude scale designed for SWSN will provide convenience in individualized education programs prepared for SWSN, and will be important to teachers, SWSN, and the literature in terms of identifying students and determining the teaching methods to be used. In addition, the Science Attitude Scale was applied to another group of students with special needs to investigate how the variables of support education duration, gender, grade level and number of siblings affect the science attitudes of secondary school SWSNs.

Theories of Science Attitudes

Several theories and frameworks provide insights into the complex nature of science attitudes. Gardner (1995) proposed a model encompassing three dimensions of attitude toward science: interest, enjoyment, and perceived value of science. Weinburgh (1995) similarly conceptualized attitudes toward science as a composite of emotional, cognitive, and behavioral components. These components interact to shape an individual's overall disposition toward science, highlighting the importance of considering these multiple dimensions when developing and evaluating science attitude instruments (Toma & Lederman, 2022). Osborne et al. (2003) focused on the affective dimension, emphasizing students' enjoyment, interest, and motivation in science learning. As highlighted by Mao et al. (2021), different facets of attitude, such as self-efficacy, interest, and perceived societal relevance, can have varying strengths of association with science achievement. This reinforces the need for a nuanced understanding of the specific attitudinal components being measured. Bandura's (1986) social cognitive theory posits that self-efficacy, or the belief in one's ability to succeed, plays a critical role in shaping attitudes and behaviors related to science. This perspective is particularly relevant for students with special needs, as fostering self-efficacy can be essential for their engagement and success in science (Potvin & Hasni, 2014).

Definition and Theoretical Infrastructure

In this study, "science attitude" is defined as the aggregated feelings, beliefs, and values that students with special needs hold towards science as a subject and a field of study. This definition draws upon the multi-dimensional frameworks of Gardner (1995) and Weinburgh (1995), recognizing that science attitudes encompass affective, cognitive, and behavioral components. The theoretical infrastructure prioritizes the affective dimension, emphasizing enjoyment, interest, and motivation (Osborne

et al., 2003). This emphasis stems from the understanding that positive affective experiences are crucial for engaging students with special needs in science learning, particularly given the numerous challenges they may face (Oluwatelure & Oloruntegbe, 2010). Further, the scale development acknowledges the importance of self-efficacy (Bandura, 1986), recognizing that students' beliefs in their ability to succeed in science can significantly impact their attitudes and engagement (Mao et al., 2021). The focus on these affective dimensions aligns with the need for comprehensive assessment of science attitudes, going beyond solely cognitive aspects (Toma, 2020). By considering thzese theoretical foundations, the study aims to develop a valid and reliable instrument for measuring science attitudes in students with special needs, contributing to a more nuanced understanding of their experiences in inclusive science education settings.

Method

Research Design

In this study, the data obtained from students with special needs who received inclusive education in the 2021–2022 academic year regarding their attitudes towards science courses. A cross-sectional survey model based on the descriptive research method was used.

Population and Sample of the Research

The study's sample consisted of 310 middle school students participating in inclusive education programs across the Turkish provinces of Istanbul, Bursa, Erzurum, Konya, Artvin, Trabzon, and Gümüşhane during the 2021–2022 academic year.

As a result of validity and reliability analyses, a 10-item Science Attitudes Scale for Inclusion Students (SASIS) was developed (see Table 7). By applying the developed SASIS to students, it was investigated how the variables of receiving support education, duration of receiving support education, gender, grade level, and the number of siblings affected students' science attitudes. The sample of the research conducted in the 2021–2022 academic year consisted of 95 SWSN from the provinces of Artvin, Trabzon, and Gümüşhane in Turkey.

Development of Data Collection Tool

During the scale development process, examining related literature formed the theoretical background of attitudes towards science. In addition, previous scale development studies within the field of science education (Coulson, 1992; Derin et al., 2017; Keçeci & Kırbağ-Zengin, 2015; Özcan & Koca, 2019; Shah & Mahmood, 2011; Taşkın & Aksoy, 2019; Yiğit et al., 2022; Yılmaz et al., 2017) and the objectives of students' attitudes towards science in the curriculum published by the MNE were reviewed. While creating the scale items, certain sub-headings of Hattie's

(2009) book "Visible Learning: A Synthesis of over 800 Meta-Analysis Relating to Achievement" such as family, family's attitudes, school opportunities, curriculum situation, technology, peers, and teachers' approaches which affect the success of students were taken into consideration. In addition, individual interviews were held with 11 SWSN in inclusive education in Artvin to hear firsthand the thoughts of SWSN about science. The feelings and thoughts of the students were also a guide when creating items. As a result, a five-point Likert-type item pool consisting of 65 items was created. The 3-point Likert-type scales were deemed to be brief, and a 5-point Likert-type scale was chosen, taking into account the possibility of a chance factor. The 7-point Likert-type measures were considered to be lengthy and unsuitable for inclusive students. Two experts working from science education field, two experts from special education, and two experts in the field of Turkish language reviewed the developed items. Long items in the scale were shortened and some items were removed or changed, as they might be difficult to understand by SWSN. For example, words such as "offend" and "encourage" were changed because they were difficult to understand by SWSN. 26 out of 65 items were removed and a draft scale with 39 items was created. The obtained attitudes scale was administered to 11 students in Artvin as a pilot application. Again, two experts from science education, two experts from special education, and two experts from Turkish language provided expert opinions. Since the word "motivation" was not understood, the word "interest" was used instead, and the expression "does not affect my success" was corrected as "decreases my success" or "increases my success" because participating students had difficulty in understanding. In the pilot study, it was noticed that some students could not mark the last items and had difficulty reading them within the given time. Therefore, 4 more items from the scale were removed and an attitudes scale with 35 items was prepared. There were 28 positive and 7 negative items in the scale, and positive items were scored in the range of 1–5 and negative items are scored in the range of 5–1.

Rationale for Variable Selection

The variables selected for this study, namely duration of support education, gender, grade level, and number of siblings, were chosen based on their potential influence on the science attitudes of students with special needs, drawing from established theoretical frameworks and empirical observations within the field of special education. Duration of support education is a critical factor as it reflects the extent of individualized instruction and specialized services received by students, which can potentially impact their academic self-efficacy and, consequently, their attitudes towards science. Longer durations may foster greater comfort and confidence in learning, while shorter durations might indicate unmet needs or transitional challenges that could negatively influence attitudes. Gender is included due to the persistent recognition of gender disparities in science engagement and achievement, highlighting the importance of investigating potential differences in science attitudes between boys and girls with special needs within inclusive settings. Studies have shown varying results, with some indicating boys possess more positive attitudes

(Weinburgh, 1995), while others reveal nuanced differences depending on the specific science type or context (Acar & Ordu, 2022; Mallow et al., 2010; Oon & Subramaniam, 2023; Wan & Lee, 2017). Moreover, gender differences in science anxiety, which can indirectly impact attitudes, have been observed (Bryant et al., 2013; Mallow et al., 2010). Grade level is incorporated as a variable to explore developmental trends in science attitudes, acknowledging that students' cognitive abilities, academic experiences, and social-emotional development evolve throughout middle school, potentially shaping their perspectives on science learning. Research indicates a frequent decline in positive science attitudes as students progress through school (Acar & Ordu, 2022; Aini et al., 2019; Sagir, 2012; Toma et al., 2019), emphasizing the need to understand this trend within the context of special needs and inclusive education. Finally, the number of siblings was selected due to its potential influence on family dynamics and the availability of resources, both of which can indirectly affect students' academic engagement and attitudes. Larger families may have limited individual attention and support available for each child, potentially impacting academic performance and motivation (Porter-Stransky et al., 2024) while smaller families may offer more concentrated support. Examining the number of siblings allows for an exploration of potential correlations between family structure and science attitudes in students with special needs. By considering these variables, the study aims to provide a nuanced understanding of the multifaceted factors that contribute to the development of science attitudes in this specific student population.

Relevance to Science Attitudes

The selected variables – duration of support education, gender, grade level, and number of siblings – have varying degrees of established relevance to science attitudes, particularly for students with special needs in inclusive settings. Research consistently identifies gender as a factor influencing science attitudes, although its impact can be complex and intertwined with other variables. Some studies, such as Weinburgh's (1995) meta-analysis, suggest boys tend to have more positive attitudes overall, while others find this difference is not universally consistent or may vary based on the specific aspect of science being considered (e.g. Acar & Ordu, 2022; Mallow et al., 2010; Oon & Subramaniam, 2023; Wan & Lee, 2017). Gender disparities in science anxiety have also been noted (Bryant et al., 2013; Mallow et al., 2010), which can indirectly affect attitudes. The influence of grade level on science attitudes is also observed, often demonstrating a decline in positive attitudes as students progress through middle and high school (Acar & Ordu, 2022; Aini et al., 2019; Sagir, 2012; Toma et al., 2019). However, the reasons for this decline, and the extent to which it applies to students with special needs, requires further investigation. Research on the impact of support education duration and number of siblings on science attitudes, particularly within inclusive settings, is more limited. Studies like Porter-Stransky et al. (2024) highlight the influence of socioeconomic factors, which can be related to family structure and resources, but direct connections to sibling number are less clear. The duration of support education is likely a crucial variable for students with special needs, as the amount of specialized instruction and individualized attention could significantly impact their academic self-efficacy

and, consequently, their attitudes towards science. However, empirical research specifically addressing this relationship is scarce. A key gap in the current literature is the intersectional examination of these variables and their combined influence on science attitudes for students with special needs in inclusive settings. Most research focuses on individual factors in isolation, failing to capture the complex interplay of gender, grade level, family dynamics, and special education services that shape these students' experiences and attitudes. Furthermore, many studies do not specifically focus on students with special needs or inclusive education environments, limiting the generalizability of findings to this unique population.

Data Analysis

For the validity analysis in this study, it was determined that the data from the 35-item attitude scale administered to 310 SWSN were suitable for the Kaiser–Meyer–Olkin (KMO) sampling and Bartlett's Sphericity tests. The data were found to be sufficient and appropriate for the factor analysis; therefore, Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were conducted. To evaluate whether the data obtained in DFA fit, the ratio of the $\chi 2/sd$, SRMR, RMSEA, and GFI values were checked for the goodness of fit indices. As acceptable critical values in this goodness of fit was determined as $\chi 2/sd < 5$; SRMR, RMSEA < 0.08; GFI ≥ 0.90 (Bollen, 1989; Hooper et al., 2008; Hu & Bentler, 1999). In the EFA and CFA analyses, the data of 310 SWSN from the provinces of Istanbul, Bursa, Erzurum, Konya, Artvin, Trabzon, and Gümüşhane were used since the sample group of the research consisted of SWSN. Since the number of SWSN within the scope of inclusion was smaller, a different data group could not be created. Therefore, EFA and CFA were applied to the same dataset. Likewise, in the literature, in the development of an attitude scale toward coding for middle school students by Akkuş et al. (2019), both EFA and CFA were performed on the same data set due to the limited number of schools offering coding education.

To assess the reliability of the attitude scale developed for SWSN, multiple reliability methods were employed. In this context, Cronbach Alpha (α), McDonald Omega (ω), and Guttmann λ6 analyses were performed. According to the related literature, (a) if the reliability coefficient is between 0.00 and 0.40, the scale is not reliable, (b) if it is between 0.40 and 0.60, the reliability is low, (c) between 0.60 and 0.80, it is quite reliable and its internal consistency is acceptable, and (d) between 0.80 and 1.00 has high reliability (Kline, 2015; Pallant, 2020).

The SASIS obtained as a result of validity and reliability analysis was applied to 95 students and the effects of gender, grade level, receiving support education status, duration of support education, and number of siblings on science attitudes of middle school SWSN within the scope of inclusion were examined. To determine the appropriate analyses for assessing the effect of these variables on science attitudes, we examined the distribution of the students' scale scores and the homogeneity of variances. The results indicated that the assumption of homogeneity of variance was satisfied ($p > 0.05$), and the distribution of the students' scale scores was acceptably close to normal. In addition, in cases where the normal distribution is not provided,

it can be stated that the sample size is sufficient (30+) to be acceptable for applying parametric tests (Pallant, 2020).

The effect of students' gender and the effect of receiving academic support in support rooms at schools were analyzed via t-test, and the effect of receiving support education in support rooms, grade level, and the number of siblings were analyzed via the analysis of variance (ANOVA). For the ANOVA, according to the duration of the support training for SWSN, the participants were divided into 4 groups (1st Group [those who did not receive support training], 2nd Group [those who received support training for 1 year], 3rd Group [those who received support training for 2 years], 4th Group [those who receive support education for 3 years or more]). Based on grade levels of SWSN, they were divided into 4 groups (1st Group [5th Grade], 2nd Group [6th Grade], 3rd Group [7th Grade], 4th Group [8th Grade]). According to the number of siblings of SWSN, they were divided into 3 groups (1st Group [having 1 sibling], 2nd Group [having 2 siblings], 3rd Group [having 3 or more siblings]). While determining the number of sibling variables, 4 SWSN who did not have siblings were not included in ANOVA.

Results

Validity Results

When the discrimination indices of the scale items were examined, it was identified that the discrimination validity of 18 items in the scale was high, 7 items needed to be improved, and 10 items had to be removed from the scale by looking at the item discriminations seen in Fig. 1.

KMO sample fit and Barlett Sphericity tests were considered in the EFA, which was used to see the factor structure of the scale. As a result of the analysis, the KMO sample fit coefficient was calculated as 0.83, the Barlett Sphericity

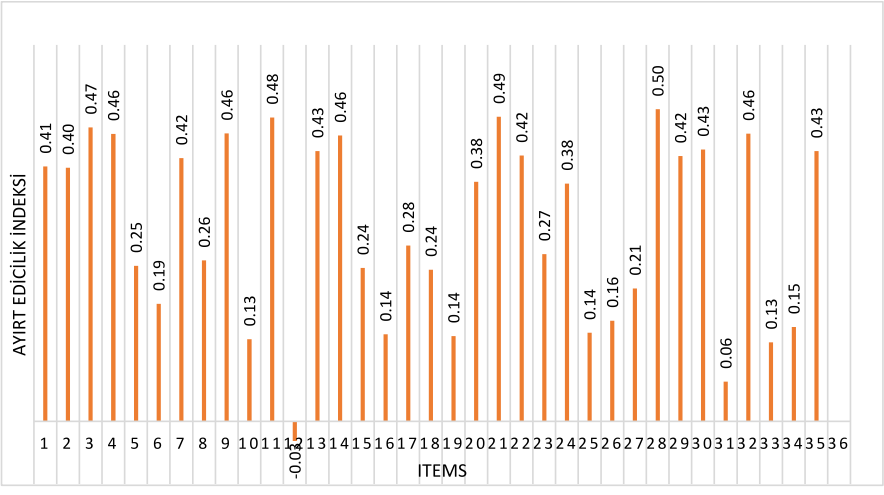


Fig. 1 Discrimination indices of science attitudes scale items developed for SWSN

test $\chi 2$ value was determined as 519.49 ($p < 0.001$, sd = 45), and it was decided that the data were sufficient and appropriate for factor analysis. Items with factor loadings above 0.40 were taken into account, while items with factor loadings below 0.40 and grouped into two factors were excluded from the analysis. In this direction, a 16-item and two-dimensional form was obtained. Reliability analysis was performed and as a result of the reliability analysis, the alpha (α) coefficient for the first dimension was calculated as 0.79 and for the second dimension as 0.57. When the items of the second dimension were examined in detail, it was observed that the corrected item-total correlation coefficients were low (i.e. 0.24 and 0.39) and it was not found to be distinctive. Therefore, the second dimension was removed and EFA was performed again. As a result, the finalized one-dimensional scale with 10 items accounted for 32% of the total variance, and the factor loadings of the items ranged from 0.50 to 0.68. Descriptive statistics for these items obtained from the EFA are presented in Table 1.

CFA was performed on the same data to evaluate whether the structure obtained after EFA was compatible. Considering these criteria, in the CFA Goodness of fit indices of the scale (i.e., $\chi^2_{(35,\ N=310)} = 89.507$, $\chi 2/sd = 2.55$; SRMR = 0.057; GFI = 0.941; RMSEA = 0.071) were found. In addition, factor loadings of all items were found to be significant. Thus, it can be stated that this obtained scale was well-fitted and validated (see Table 2). The scale revealed as a result of CFA is presented in Fig. 2.

No analysis was performed for convergent validity and concurrent validity since a similar scale was not created with inclusive students and the scale obtained had a single-factor structure.

Reliability Results

To determine the reliability of the Science Attitudes Scale for Middle School Students in Inclusive Education (SASIS), multiple reliability methods were employed. In this context, Cronbach Alpha (α), McDonald Omega (ω), and

Table 1 Factor loadings and descriptive statistics of items

Items	Factor loadings	Average	Standard deviation	Distortion	Kurtosis
Item 35	0.678	4.37	1.01	−1.835	2.954
Item 30	0.635	3.98	1.17	−1.094	0.438
Item 28	0.626	4.04	1.10	−1.206	0.884
Item 29	0.588	4.00	1.06	−1.077	0.754
Item 3	0.544	3.76	1.26	−0.894	−0.142
Item 22	0.537	3.87	1.22	−0.998	0.080
Item 32	0.529	3.78	1.20	−0.848	−0.096
Item 9	0.502	4.12	1.03	−1.415	1.819
Item 14	0.501	3.95	1.22	−1.161	0.459
Item 24	0.497	3.25	1.25	−0.362	−0.798

Table 2 Measurement model fit measures

Compliance Metrics	Good Compatibility	Acceptable Match	Measurement Value	Compliance
χ^2	$0 \leq \chi 2 \leq 2df$	$2df \leq \chi 2 \leq 3df$	89,507	Acceptable
χ^2/sd	$0 \leq \chi 2 /sd \leq 2$	$2 \leq \chi 2 /df \leq 3$	2.55	Acceptable
SRMR	$0 \leq SRMR \leq 0{,}05$	$0{,}05 \leq SRMR \leq 0$	0.057	Acceptable
GFI	$0{,}95 \leq GFI \leq 1{,}00$	$0{,}90 \leq GFI \leq 0{,}95$	0.941	Acceptable
RMSEA	$0 \leq RMSEA \leq 0{,}05$	$0{,}05 \leq RMSEA \leq 0$	0.071	Acceptable

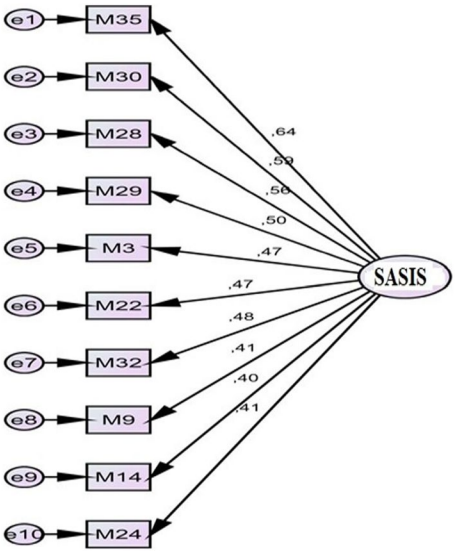


Fig. 2 CFA Results on the science attitudes scale for middle school students in inclusive education

Guttmann λ6 analyses were performed. It was confirmed that the Cronbach alpha coefficient of the scale was 0.789, the McDonald omega coefficient was 0.794, and the Guttmann λ6 coefficient was 0.803. It is stated that the reliability coefficient should be 0.60 and above in order to accept the reliability of the scales used in scientific studies (Büyüköztürk, 2012). Accordingly, it can be stated that the reliability coefficients of the SASIS were reliable and acceptable.

Results Regarding the Variables Affecting the SASIS

After the validity and reliability analysis, the SASIS with 10 items was applied to 95 middle school students who received inclusive education. The effect of students' gender and the effect of receiving academic support in support rooms at schools were analyzed via t-test, and the effect of receiving support education in support rooms, grade level, and the number of siblings were analyzed via ANOVA. Related results are explained below.

Results Related to the Effect of Gender Variable on Students' Attitudes Towards Science Course

The t-test results ($t(93) = 1.00$, $p > 0.05$) indicate that there is no significant difference between genders. This suggests that male and female students have similar attitudes toward science courses (see Table 3).

Results Related to the Effect of the Variable of Support Education Duration on Students' Attitudes towards Science Course

Statistically significant differences were observed in these students' attitudes toward science courses among the four groups categorized by the number of years they received support education ($F_{3-91} = 12.359$, $p < 0.05$, $\eta 2 = 0.289$). While equality of variances ($p = 0.088$) was provided, Post-hoc comparisons based on Scheffe test showed that the average score obtained for 2nd Group ($M = 46.44$, $sd = 2.42$) was higher than 1st Group ($M = 40.98$, $sd = 4.15$), the difference was statistically significant favoring 2nd Group. The mean score obtained for 3rd Group ($M = 47.25$, $sd = 3.02$) was higher than the mean score for 1st Group ($M = 40.98$, $sd = 4.15$), the difference was statistically significant favoring 3rd Group. The mean score obtained for 4th Group ($M = 44.55$, $sd = 5.21$) was higher than the mean score for 1st Group ($M = 40.98$, $sd = 4.15$), the difference was statistically significant favoring 4th Group. When the mean scores of the 2nd, 3rd, and 4th groups were analyzed, no statistically significant differences were found among them. According to the results we obtained, it can be said that SWSN who received support education within the scope of inclusion had higher attitudes towards science than those who did not receive support education. No statistically significant differences were found in the durations of support education received (see Table 4).

Results Related to the Effect of Grade Level Variable on Students' Attitudes Towards Science Course

Statistically significant differences were found in the attitudes of SWSN towards the science course for the four groups formed based on grade levels of special needs middle school students receiving inclusive education ($F_{3-91} = 4.856$, $p < 0.05$, $\eta 2 = 0.138$). While equality of variances ($p = 0.185$) was achieved, Post-hoc comparisons based on Scheffe test indicated that the mean score obtained for 1st Group ($M = 45.22$, $sd = 3.08$) was higher than 4th Group ($M = 41.20$, $sd = 4.58$), the difference was statistically significant favoring 1st Group. A statistically significant difference was

Table 3 Results Related to the Effect of Gender Variable on Students' Attitudes Towards Science Course

Variable	Gender	*n*	$\overline{X}$	*ss*	*t*	*sd (Indipendint Degrees)*	*p*
SASIS	Kız	47	43.02	4.88	1.00	93	0.32
	Erkek	48	44.00	4.64			

Table 4 Variance analysis results related to the effect of the variable of support education duration on students' attitudes towards science course

Variable	Year of Support	*n*	$\overline{X}$	ss	Source	Mean of Squares	sd	Mean of Squares	F
SASIS	1. Group	45	40.98	4.15	**Between Groups**	617.106	3	205.702	12.359**
	2. Group	16	46.44	2.42					
	3. Group	12	47.25	3.02					
	4. Group	22	44.55	5.21	**In-group**	1514.620	91	16.644	

** $p < 0.05$

observed between the mean score of the 2nd Group (M = 45.94, SD = 3.70) and that of the 4th Group (M = 41.20, SD = 4.58), favoring the 2nd Group. When the average score obtained for the 1st Group (M = 45.22, sd = 3.08) was examined for the 2nd Group (M = 45.94, sd = 3.70) and the 3rd Group (M = 43.32, sd) = 4,58), there was no statistically significant difference between them. Likewise, when the average score obtained for 3rd Group (M = 43.32, sd = 4.58) was compared to 2nd Group (M = 45.94, sd = 3.70) and 4th Group (M = 41, 20, sd = 4.58), there was no statistically significant difference between them. Based on the results, SWSN in the 5th and 6th grades who received inclusive education exhibited more positive attitudes toward science than 8th-grade students. Additionally, there were no statistically significant differences in the science attitudes of SWSN when comparing the 5th and 6th grades, 5th and 7th grades, 6th and 7th grades, or 7th and 8th grades (see Table 5).

Results Related to the Effect of the Number of Siblings Variable on Students' Attitudes Towards Science Course

No statistically significant differences were observed in the attitudes toward the science course among the three groups of middle school SWSN receiving inclusive education, when classified by the number of siblings ($F_{2-88} = 0.513$, $p > 0.05$). According to the results, the findings indicate that the number of siblings among SWSN participating in inclusive education had no effect on their attitudes toward science classes. In other words, there were no statistically significant differences in students' attitudes based on whether they had one sibling, two siblings, or three or more siblings (see Table 6).

Table 5 Variance analysis results related to the effect of grade level variable on students' attitudes towards science course

Variable	Grade Level	*n*	$\overline{X}$	ss	Source	Mean of Squares	sd	Mean of Squares	F
SASIS	1. Grup	18	45.22	3.08	**Between Groups**	294.162	3	98.054	4.856**
	2. Grup	16	45.94	3.70					
	3. Grup	34	43.32	5.30					
	4. Grup	27	41.20	4.58	**In-group**	1837.564	91	20.193	

** $p < 0.05$

Table 6 Analysis of variance results on the effect of number of siblings variable on students' attitudes towards science course

Variable	Number of Siblings	*n*	$\overline{X}$	ss	Source	Mean of Squares	sd	Mean of Squares	F
SASIS	1. Group	28	43.50	5.30	**Between Groups**	23.727	2	11.863	0.513
	2. Gorup	27	43.96	4.87					
	3. Group	36	42.75	4.35	**In-group**	2036.713	88	23.144	

Discussion and Conclusion

Science Attitude Scale Developed for Students with Special Needs

In this study, an attitude scale was developed with factor loads varying between 0.50 and 0.68, with a final form of one-dimensional and 10-item scale, which can be utilized to determine the attitudes of SWSN who receive inclusive education towards science course. When the results were examined, it was considered appropriate to remove 25 items from the 35-item scale. SWSN might have problems in understanding these items, as the focus time is shorter than for regular students. When creating the scale items in the pilot application, it was observed that some students felt uncomfortable because of the length of the items and had problems with time management. The fact that this situation observed in the pilot application continued and that there were more than 35 items could affect the students' responses to the items. Therefore, it can be assumed that it was more appropriate to remove more items so that SWSN could concentrate more easily. Similarly, it can be assumed that some students who answered the scale items could not give clear answers because they could not concentrate fully, and some students could not understand more complex or difficult items due to different reading comprehension levels. The 25 removed items also included 7 negative items. SWSN may have problems perceiving negative sentences because they have difficulty understanding and thinking about these sentences. In fact, in the pilot application, it was found that SWSN had difficulties in making sense of negative items. Therefore, some items were removed and the rest were reduced to a level that SWSN could understand. It is noted in the literature that students with intellectual disabilities have difficulties in reading and they struggle to make sense of them because they read by spelling (Tokta & Avcıoğlu, 2012). Considering this situation, it can be stated that SWSN cannot understand or have difficulty in understanding negative items. It was found that Cronbach alpha coefficient of the scale was calculated as 0.789, McDonald omega coefficient as 0.794, and Guttmann λ6 coefficient as 0.803. Considering the factors and reliability coefficients of the scale, the scale can be asserted to have an acceptable ratio of reliability and can be utilized. By examining related studies on attitude scales towards science courses in the literature, it can be indicated that there are studies that have values close to this study with regards to the number of items and factor loads of this scale (Demirbaş & Yağbasan, 2006; Şimşek & Nuhoğlu, 2013; Aykış & Kılıç-Öztürk, 2024). Attitudes scales for the science course in the literature are generally aimed at middle school students or teacher candidates studying in

science education. Hereby, this study can be regarded as a valid and reliable science attitude scale for middle school students who receive inclusive education and can be utilized to identify the attitudes of SWSN towards science course. As a consequence, it can be affirmed that the obtained attitude scale is a valid, reliable, single-factor, and 10-item scale that does not contain negative items. Thus, SWSN can understand more easily and students can answer these items more clearly.

Variables Affecting the Attitudes of Secondary School Students with Special Needs towards Science Course

The Science Attitude Scale (Table 7) obtained in this study was applied to middle school SWSN and the effects of such variables as duration of support education, gender, grade level, and number of siblings on the students' attitudes towards science were also investigated and the results are discussed below.

Effect of Gender on the Attitudes of Secondary School Students with Special Needs towards Science Course

When the results regarding the attitudes of SWSN towards science course were analyzed with regards to gender, it can be stated that the attitudes of female and male SWSN towards science course were close to each other. When the literature was examined, the researchers came to the conclusion that the attitudes of female and male students towards science were not very different from each other (Ilgaz, 2006; Külçe, 2005; Turhan et al., 2008). In addition, different results are seen in the literature (İnci & Çubukçu, 2022; Uyanık, 2017). In general, when the literature is reviewed, it was identified that there are studies in which similar results were obtained and gender did not affect science attitudes, while in some studies male students and in some other studies female students were found to have higher science attitudes (İnci & Çubukçu, 2022; Liou et al., 2023; Uyanık, 2017). It can be considered that students' grade level, family structure, socioeconomic status, teacher factor, or used teaching methods may affect the gender variable.

Effect of the Support Education Period on the Attitudes of Secondary School Students with Special Needs towards Science Course

When analyzing students' attitudes toward science courses in relation to the duration of support education, ANOVA results indicated statistically significant differences among the four groups of middle school SWSN categorized by how long they received support education. When the origin of the statistically significant difference was investigated, it was found that the students who received support for 1 year, 2 years, or 3 years or more had higher attitudes towards science courses than the students who did not receive support. However, when the duration of support education students received was examined, it was indicated that there was no difference between students who received support education for 1 year and those who received support education for 2 years, or 3 years or more. When the support education status of SWSN was

analyzed through t-test, a result supporting the obtained result emerged. It can be concluded that support education positively influenced students' attitudes toward science courses, irrespective of how long they received it (Langlois et al., 2024). The reason for the more positive development of attitudes towards the science course could be due to (a) providing opportunities for individual study with a teacher in special education rooms, (b) choosing appropriate methods and techniques according to individual differences of students, and (c) finding opportunities to conduct experiments themselves in special education rooms where SWSN in the science course cannot be active when they are with their peers. It is noted in the literature that when learning is provided for SWSN by using necessary individualized plans and books appropriate to their level, it has a positive influence on their academic achievement and attitudes (Filippatou & Kaldi, 2010; Karasu & Şimşek, 2018). It can be asserted that these studies in the literature support the results obtained in this study. As a consequence of this study, it can be identified that providing special education with individualized plans for SWSN can enhance academic achievement and attitudes.

Effect of Grade Level on the Attitudes of Secondary School Students with Special Needs towards Science Course

The attitudes of the students towards the science course were analyzed in relation to their grade levels and it was identified that there were statistically significant differences in attitudes towards the science course among the four groups formed based on the grade levels of the SWSN as a result of the ANOVA data obtained. To investigate the origin of the significant difference, it was indicated that significant differences were determined in the attitudes towards science course between 5 and 6th grade and between 5 and 7th grade students. However, no significant difference was found between 6 and 7th grade and between 7 and 8th grade. It was observed that 5th and 6th graders had higher attitudes towards science courses than 8th graders. It was stated that as the age and grade of middle school students increased, their attitudes towards science decreased. (Uyanık, 2017). It is noted that the motivation levels of 6th grade students towards science course are higher than 8th graders (Yaman & Dede, 2007). The reason for the low motivation of 8th grade students was thought to be the stress of the High School Entrance Exam (HSE) and the difficulty of the subjects. The reason for the more positive development of 5th and 6th grade students' attitudes towards science course may be due to the learning outcomes at this grade level. Teachers may do more activities and experiments in these grades because the topics are shorter in grades 5 and 6 and students do not have to worry about preparing for the exams. The fact that more entertaining or easy-to-understand topics may affect their attitudes. In the literature, it was noted that the difficulty of topics, the stress of exams and the anxiety level of students increase in 7th and 8th grade (Zengin & Akçöltekin, 2022). It can be stated that the increase in students' anxiety levels has a negative impact on students' attitudes. In addition, the ineffective teaching and preferred teaching methods of teachers may lead to a decrease in the science attitudes of students in higher grades (Uyanık, 2017). The reason for 8th grade students' moderate level of emotional interest towards science course may be due to the fact that topics are not associated with daily life (İnci & Çubukçu, 2022). Although the students in the sample group of this study were SWSN,

they were required to take an exam to enter a high school. If they aim to go to a high school with their peers, there was no different road map for these students for transition to a high school. The stress and intensity of studying for LGS, which 8th grade students take at the end of the year, the difficulties of subjects and the fact that the subjects remained abstract because students could not relate the subjects to daily life might cause negative changes in students' science attitudes. As a result, it can be concluded that as the grade level of SWSN increases, their attitudes toward science decrease, as do those of their typical peers. Activities and teaching methods can be chosen to attract more attention from SWSN. If students' attitudes and thoughts about science courses are determined before the IEPs are prepared, planning can be based on the individual differences of the students. In this case, it can be expected to have a positive influence on the students' attitudes in their educational process.

Effect of Number of Siblings on the Attitudes of Secondary School Students with Special Needs towards Science Course

When the attitudes of the students towards the science course were investigated in relation to the number of siblings of the students, it was identified that there was no statistically significant difference in their attitudes towards the science course for the three groups formed according to the number of siblings of the middle school SWSN as a result of the obtained ANOVA data. It was found that the number of siblings of the SWSN who were educated within the scope of inclusion did not affect the students' attitudes towards science course. It can be asserted that the number of siblings does not affect the attitudes of SWSN towards science courses. It has been noted in the literature that the number of siblings does not affect the success of students, as does their attitudes (Güvendir, 2014). Parents of SWSN may have to take more care of their children and spend more time with them because of their special circumstances. In this case, this may be the reason why the sibling factor is not effective in the attitude of SWSN towards the science course. SWSN often get help from their families in doing their homework. While families do not help each other individually for their normal children, they do homework and repetition together for their children with special needs. For this reason, having a sibling or not having a large number of siblings may not affect the attitudes of SWSN. It has been observed that the academic achievement of regular students decreases as the number of siblings increases, and this is thought to be due to the parents' inability to provide sufficient support to the students (Pala & Başıbüyük, 2020). In the literature, it is stated that as the number of siblings of regular students increases, their bullying increases and school attitude is negatively affected (Açıkgöz, 2017). The reason for this situation has been shown as the fact that families cannot take care of their children enough and do not allocate sufficient time to each child. Parents may not be able to take care of their normal children as the number of children increases, but regardless of the number of children, parents may take care of their special needs children by creating a separate time. This can ensure that the number of siblings does not affect SWSN. It can be asserted that the lack of adequate support and care for students affects their attitudes as well as their academic success. It can be thought that SWSN are not affected much by the number of siblings they have due to their special circumstances and families' interest in them.

Limitation

One of the limitations of this study lies in the methodological approach used for validating the SWSN. Specifically, we employed Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) instead of Item Response Theory (IRT). Factor analysis is a widely used method for determining and confirming the structure of a scale; however, IRT allows for a more detailed analysis of each item's contribution to the measured construct and the participants' responses at the item level. IRT calculates parameters such as item difficulty and discrimination, thereby enhancing the measurement precision of the scale and providing more in-depth psychometric information. The application of IRT generally requires larger and more homogeneous samples (Embretson & Reise, 2000). In this study, factor analysis was preferred because the sample size was insufficient for the application of IRT and the data did not fully meet the assumptions of IRT. Additionally, since the study is at the scale development stage and the primary aim was to reveal the basic structure of the scale, the use of factor analysis was deemed more appropriate. Future research could apply IRT with larger and more diverse samples to contribute to a more comprehensive examination of the scale's psychometric properties.

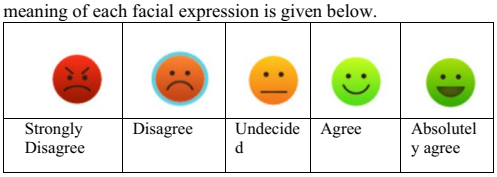
Another concern relates to the use of the same sample (N = 310) for both EFA and CFA. While this approach was necessitated by the limited number of students with special needs participating in inclusive education programs within the accessible geographical area, it introduces the risk of overfitting the model to the specific characteristics of this sample. This overfitting may inflate the apparent goodness-of-fit indices and limit the generalizability of the findings to other populations of students with special needs. Further, the relatively small sample size (N = 95) used for examining the effects of variables like gender, grade level, and support education status on science attitudes raises concerns about statistical power. This smaller sample size, drawn from the original 310, may have limited the ability to detect subtle but potentially important relationships between these variables and science attitudes. Future research should prioritize larger and more diverse samples to enhance generalizability and statistical power, allowing for more robust and nuanced conclusions.

Conclusion

In conclusion, this scale can be utilized to determine the attitudes of SWSN towards science. In addition, this scale can be applied to regular students and comparisons can be made. It can be suggested that different studies can be conducted by applying the scale in different regions or different countries. Furthermore, it has been observed that different variables affect the attitudes of SWSN towards science, therefore this scale can be applied to regular students to investigate whether there is a difference in terms of different variables. Finally, it can be recommended to carry out new research by diversifying these variables or to carry out quantitative studies to determine how different variables such as the number of siblings and the status of receiving support education affect attitudes or why they do not affect attitudes.

Appendix

Table 7 Science Attitudes Scale for Inclusion Students (SASIS)

	Dear Students In this study, we would like you to answer this scale consisting of 10 items in order to determine the situations that are effective in learning the science course. The statements in the scale are graded in 5 ways with facial expressions. We ask you to mark your thoughts about the items on these expressions. The meaning of each facial expression is given below.  Strongly Disagree | Disagree | Undecided | Agree | Absolutely agree Grade Level: How many years has he/she been receiving support? Gender: Number of siblings:	Strongly Disagree	Disagree	Undecided	Agree	Absolutely Agree
1	My teacher's behavior towards us during the lesson increases my interest in science lesson.					
2	I learn science better when my teacher supports me.					
3	Using videos in science lessons makes it easier for me to learn the lesson.					
4	I like to share tasks while doing experiments and activities in science class.					
5	The fact that my friends are successful in science makes me enthusiastic about the course.					
6	When my teacher gives fun assignments related to the science lesson, it increases my success in the lesson.					
7	I learn the subject better when we make animations about the subject in science lesson.					
8	When my teacher takes us to science activities (such as science fairs), it increases my enthusiasm for the lesson.					
9	My teacher's use of tools and equipment in the science lesson increases my willingness for the lesson.					
10	If my teacher makes fun applications in science lessons, the lesson becomes enjoyable.					

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Data Availability The data that support the findings of this study are available from the corresponding author upon request.

Declarations

Competing Interest No potential conflict of interest was reported by the author(s).

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