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ORIGINAL ARTICLE

# Shaping Teacher Education Through Professional Identities: Enhancing Autism Awareness

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## Abstract

**Purpose** The main aim of this study is to examine autism awareness in relation to different professional identities and to explore its implications for teacher education. Furthermore, the study aims to explore how teacher education can be improved by considering differences in individuals' professional identities, especially regarding autism awareness.

**Methods** A quantitative approach was used with a sample consisting of 745 participants who completed a data collection form that included the Autism Awareness Scale to primarily examine levels of autism awareness, their sources of information about autism spectrum disorder (ASD), and their perceived competence in educating students with ASD. The analysis included group comparisons, structural equation modeling, response surface analysis, and machine learning–based prediction.

**Results** The findings revealed that different professional identities significantly impact the participants' results. Also, this study found that autism awareness was higher when university education was supported by social media and websites (or non-governmental organizations). For in-service teachers, the most effective method was in-service training delivered in partnership with a non-governmental organization.

**Conclusion** In line with the results, the study suggests a framework for designing teacher education programs with a focus on teachers' professional identities to effectively foster autism awareness. Furthermore, the study suggests that focusing on key professional factors such as professional pressure, professional belonging, professional awareness, and cultural pressure could make teacher education more effective, especially when tailored to different professional identities within the framework.

**Keywords** Autism · Awareness · Professional identity · Teacher education · Inclusive education

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition that begins in early childhood and is characterized by difficulties in social communication and interaction, as well as restricted and repetitive patterns of behavior, interests, or activities (American Psychiatric Association [APA], 2013). The number of individuals with ASD has been increasing globally over the years, across all racial, ethnic, and socioeconomic groups (Centers for Disease Control and Prevention, 2025). This increase is also reflected in schools, where the number of students identified with ASD continues to rise (e.g., Cardinal et al., 2021). In line with the global movement toward inclusive education, which aims to educate all students with special needs, including those with ASD, in the same learning environments as their typically developing peers (UNESCO, 2020), more students with ASD are increasingly being educated in general education settings. For instance, in the United States, the proportion of students with special needs, including those with ASD, who spend 80% or more of the school day in general education classrooms has been steadily increasing (National Center for Education Statistics, 2024).

The increasing number of students with ASD in inclusive education makes it essential for teachers across all subjects to be qualified to support these students. To achieve this,

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autism awareness, meaning the understanding, acceptance, and appreciation of individuals with ASD, which greatly impacts their lives (Colbert et al., 2017; Hamilton, 2012), is essential for teachers to provide effective support (Petersson Bloom, 2021). For example, students with ASD often have difficulties making friends because of differences in social skills (Black et al., 2024), and teachers need to support them in this area (Ayasrah et al., 2022). If a teacher incorrectly interprets their ASD students' behavior as antisocial or an unwillingness to make friends, providing necessary support becomes challenging. This can lead to more social problems for the student at school. Even the social differences in students with ASD can be misunderstood as rude behavior in the school environment (Hornok, 2018). To avoid these problems, teachers should have a high level of autism awareness. This is supported by the fact that seven out of ten students with ASD have stated that the most important aspect of their education is having a teacher who understands them (National Autistic Society, 2021). Therefore, developing autism awareness is a key requirement for improving teachers' skills in supporting students with ASD (Ravet, 2018).

Although there are different sources available to raise autism awareness, such as social media, websites, and television nowadays (Jawed et al., 2023), professional training for teachers is especially important and should be given priority (Devi et al., 2024). This is because formal training is usually more accurate and effective than information from less trustworthy sources (e.g., Johnson, & Majewska, 2022). Media content, for example, can sometimes share incorrect or exaggerated views about ASD. It may present ASD as a sign of high intelligence or as a kind of superpower, which can create misunderstandings about what ASD really is (Wright et al.,2020). This is because autism is a complex spectrum, and individuals can exhibit a wide range of characteristics and abilities. For example, they may have variations in IQ, which can be either low or high (Wolff et al., 2022), as well as differences in daily living skills (Bal et al., 2015). Such misunderstandings do not lead to accurate autism awareness. Therefore, teacher training programs should play a more central role in raising awareness of ASD.

Despite the importance of teacher education, both pre-service and in-service training programs worldwide often have limitations in effectively developing autism awareness. For example, in Türkiye, undergraduate teacher education programs have included a two-hour weekly theoretical course related to special education and inclusive education since 2018, where pre-service teachers learn about the characteristics of different groups with special needs. This is the only compulsory course in departments other than special education that provides direct information about ASD and inclusive education, and its content is limited (The Council of Higher Education, 2018). A similar situation is seen in the United Kingdom, where 60% of teachers reported that the initial training they received on teaching students with special needs in inclusive education was insufficient (NASUWT, 2013). These limitations also apply to in-service teacher training. For instance, the limited effectiveness of in-service training on ASD has been reported in several countries, including Croatia, Poland, and North Macedonia (Lessner Listiakova & Preece, 2020). Similarly, in the United States, in-service training is often found to be ineffective in improving teachers' instructional practices and student learning outcomes (Darling-Hammond et al., 2017). Given these challenges, improving pre-service and in-service teacher education by focusing on autism awareness can be seen as a global need to support students with ASD in inclusive classrooms.

While addressing this need, it is not sufficient to treat all individuals in teacher education as a single group. This is because teachers' professional identity refers to how they see themselves and their role in teaching, and this identity can have a significant impact on their development and practice (Hong et al., 2024). Moreover, teachers' professional identity is initially formed through teacher preparation pathways (Flores, 2020) and further shaped by institutional contexts (Beijaard et al., 2004), as well as by the values, beliefs, knowledge, and skills underlying specific positions or schools (Castro et al., 2022). Therefore, the influence of professional identity on individuals' needs and how they understand those needs should be addressed not as a single group, but in a more diverse way. For example, when pre-service teachers begin to build a professional identity as educators, they may evaluate themselves more positively simply because they identify as future teachers. (Marschall, 2022). On the other hand, in-service teachers may believe they are competent simply because they have many years of experience in schools. However, many years in the profession do not always reflect real competence (Kini & Podolsky, 2016). Thus, integrating considerations of professional identity into teacher education programs may be useful for effectively supporting and enhancing autism awareness.

To better understand the role of teacher professional identity in teacher education, one of the important indicators is perceived competence, which is defined as a psychological process based on self-evaluation (Fulmer, 2024). For instance, pre-service primary teachers without experience with students with special needs initially believed they were more competent due to their developing professional identity. However, after ten weeks of classroom experience and increased professional awareness, their perceived competence declined and became more realistic (Yazıcı & Cumalı, 2022). This example clearly illustrates how the gap between actual and perceived competence can have significant

consequences (Bauer et al., 2024). Further supporting this idea, Hatlevik (2017) found that teachers' perceived competence significantly impacts student motivation, achievement, job satisfaction, professional identity, commitment, and even their decision to stay in or leave the profession. Therefore, individuals who believe they are less skilled than they really are, even when they are capable, or those who believe they are more skilled than they really are despite lacking experience, are likely to face difficulties. Specifically, teachers who do not believe in their abilities may lose motivation and quit, whereas those who overrate their skills may avoid learning and improving, ultimately negatively affecting both their professional growth and their students' success. Taken together, all of these indicate that teacher professional identity may be one of the critical factors in the teacher education process, including autism awareness.

**Table 1** Demographic characteristics of the participants

| Variable | Category | Frequency | Percent |
|---|---|---|---|
| Gender | Female | 570 | 76.5% |
| | Male | 175 | 23.5% |
| Age | 18–24 | 547 | 73.4% |
| | 25–34 | 74 | 9.9% |
| | 35–44 | 94 | 12.6% |
| | 45–54 | 30 | 4.0% |
| Participant groups by professional identity | | | |
| Pre-service teachers in education faculties | Year of study | | |
| | First-year pre-service teachers | 185 | 24.8% |
| | Final-year pre-service teachers | 160 | 21.5% |
| Non-education faculty pre-service teachers in pedagogical formation certificate course | Year of study | | |
| | First-year pre-service teachers | 138 | 18.5% |
| | Final-year pre-service teachers | 121 | 16.3% |
| In-service teachers | Duration of experience | | |
| | Less than 1 year | 48 | 6.4% |
| | 1–5 years | 8 | 1.1% |
| | 6–10 years | 37 | 5.0% |
| | 11–15 years | 40 | 5.4% |
| | More than 15 years | 57 | 7.7% |
| | Teacher qualification route | | |
| | Teachers graduated from the faculty of education | 109 | 14.6% |
| | Teachers holding a pedagogical formation certificate | 32 | 4.3% |

## Research Aims and Questions

A review of the existing literature reveals a research gap in examining how teacher professional identity influences inclusive education for students with ASD, as this has not been a primary focus in the literature. Therefore, the main aim of this study is to examine autism awareness in relation to different teacher professional identities and to explore its implications for teacher education. Since the concept of professional identity has a comprehensive scope (Suarez & McGrath, 2022), studies in the literature have approached professional identity from different perspectives, as highlighted in the systematic review conducted by Rushton et al. (2023). In our study, professional identity is specifically examined within the scopes of professional stages, training level, faculty type, professional experience, and teacher qualification route. Furthermore, the study aims to explore how teacher education can be improved by considering differences in teachers' professional identities, especially regarding autism awareness. For these purposes, the research questions of this study are as follows:

(i) Do teachers' professional identities influence their sources of information about ASD, their levels of autism awareness, and their perceived competence in teaching students with ASD?
(ii) How does autism awareness affect the relationship between information sources and individuals' perceived competence in teaching students with ASD?
(iii) How can teacher education be enhanced by considering the different professional identities of teachers?

## Method

To address the research aims, a quantitative research design was adopted. This approach was chosen because it allows for systematic comparisons between groups, supports hypothesis testing, and enables the generation of findings that can be generalized to larger populations (Bryman, 2016; Creswell, 2014).

### Participants

A total of 745 volunteers agreed to participate in the study, as shown in Table 1. In selecting participants, specific professional identities relevant to the study were considered, and invitations were extended accordingly. Therefore, a purposeful sampling strategy was employed, which involves selecting individuals based on predefined characteristics (Patton, 2002). Moreover, an inclusive sampling approach

was adopted to ensure the broad representation of different professional identities (e.g., Beijaard et al., 2004).

In the process of selecting participants for the study, professional stages were initially considered as the basis for professional identity. Accordingly, the study included three groups representing different professional stages: (1) pre-service teachers studying in education faculties, (2) pre-service teachers from non-education faculties enrolled in pedagogical formation certificate programs (designed to provide pedagogical training for graduates of non-education faculties), and (3) in-service teachers working in schools who either graduated from education faculties or hold pedagogical formation certificate.

To further explore the influence of professional identity, subgroups based on training level, faculty type, professional experience (including both the duration of experience and specific experiences such as working with students with ASD), and teacher qualification route were also examined. Firstly, based on training level, both first-year and final-year pre-service teachers were included. The first-year pre-service teachers, who were at the beginning of their pedagogical training, represented only education faculties, whereas the final-year pre-service teachers, coming from both education and non-education faculties, had completed most of their coursework and were approaching graduation. Despite their different academic backgrounds, both groups participated in the same compulsory 14-week course on special and inclusive education, in which only one week focused on ASD and was taught by the same lecturer. In addition, in-service teachers with varying years of professional experience were included to capture diverse dimensions of professional identity related to both the duration of experience and the teacher qualification route. They represented twenty-one subject areas across all school levels, with twenty-two teachers currently teaching students with ASD and thirty-two holding postgraduate degrees (thirty master's and two doctorates).

## Setting

The study was conducted at a state university located in a mid-sized Turkish city with an average level of socioeconomic development (Ministry of Industry and Technology, 2017), as well as in schools situated in the same city. Data from pre-service teachers were obtained from the university's Faculty of Education and from other faculties that offer students the option to participate in a pedagogical formation certificate program, which provides the opportunity to work as teachers in the future. Data from in-service teachers were collected from schools representing all educational levels. All participation was entirely voluntary, and no financial or material compensation was offered to participants in any of the research settings.

## Measures

In this study, a data collection form consisting of three sections was developed by the researchers to be administered to all participants. The first section included seven demographic questions directed at the participants. The second section contained two main questions. The first asked participants to rate their perceived competence in educating students with ASD using a five-point Likert scale (1: Very Low, 2: Low, 3: Undecided, 4: High, 5: Very High). The second question was a multiple-response item asking about the sources from which participants obtained information about ASD. Based on the literature (e.g., Genovesi et al., 2024), nine information sources were provided, along with an "Other" option allowing participants to specify additional sources.

The final section of the data collection form included the Autism Awareness Scale, a 32-item, seven-dimensional measure developed by Yazıcı and Karsantık (2023) using a five-point Likert format. In this study, the scale demonstrated high internal consistency ($\alpha = 0.86$), with subscale reliabilities ranging from 0.69 (SS5) to 0.87 (SS6), indicating acceptable to excellent reliability (McNeish, 2018; Taber, 2018). Confirmatory factor analysis further supported its factorial structure, yielding acceptable fit indices ($\chi^2/df = 2.1$, RMSEA = 0.058, SRMR = 0.06, CFI = 0.93, NNFI = 0.92, NFI = 0.87, GFI = 0.85, AGFI = 0.82).

After the survey instrument, comprising the sections outlined above, was developed by the researchers, it was examined by three experts: a special education specialist, an assessment and evaluation scholar, and a language expert. All sections and items of the form were examined by the experts to ensure overall coherence, content validity, and linguistic clarity. The specialists assessed whether the questions appropriately measured the intended constructs, were clearly worded, and culturally suitable for the target population. Based on their reviews, the form was deemed appropriate for implementation. In addition, a pilot study was conducted with nine individuals (three from each participant group) who did not take part in the study, and the form was found to be appropriate for use.

## Data Collection and Analyses

Following ethical approval from the university and permission from the relevant institutions, data collection was planned to be carried out through direct visits to the university. Faculty secretaries and lecturers were consulted to coordinate the process, and classroom visits were scheduled

at the end of lectures to avoid disrupting class time. During these visits, pre-service teachers who voluntarily agreed to participate remained in the classroom, while those who did not wish to participate were allowed to leave. Voluntary participants received an information sheet and were briefly informed about the aim of the study; any questions they had were also addressed by the researchers. Subsequently, the data collection form, along with the consent form, was distributed, and participants were given approximately fifteen minutes to complete it. For pre-service teachers, data collection took place at different times depending on their academic standing: it was conducted at the beginning of the fall semester for first-year pre-service teachers and at the end of the spring semester for final-year pre-service teachers, in order to capture participants at both the entry and completion stages of their teacher education.

A similar procedure was followed for in-service teachers, whereby schools were visited, and both school administrators and teachers were informed about the study. Consent and data collection forms were then distributed and later collected according to a schedule that did not interfere with class hours. While data collection at each institution lasted approximately one week, the overall process was conducted in Türkiye during the 2024–2025 academic year.

The analyses proceeded in four stages to address the research questions. For the first research question, independent samples t-tests and one-way ANOVAs were performed in IBM SPSS 26.0 to test group differences (e.g., academic years, professional experience, pre- vs. in-service teachers), highlighting the role of professional identity. For the second research question, Structural Equation Modeling (SEM) was conducted in R using the lavaan package (Rosseel, 2012), with assumptions of normality (George & Mallery, 2010) and multicollinearity (Neter et al., 1996) confirmed. Model fit was evaluated with CFI, TLI, RMSEA, and SRMR (Byrne, 2012; Kline, 2016), mediation tested via bootstrapping (Preacher & Hayes, 2008), missing data handled with FIML (Enders & Bandalos, 2001), and residual covariances added as theoretically justified (MacCallum, 1986). For the third research question, Response Surface Analysis (RSA) examined the joint effects of information sources and autism awareness on perceived competence, testing congruence, incongruence, and asymmetry models (Edwards & Parry, 1993; Humberg et al., 2019; Schönbrodt & Humberg, 2016; Shanock et al., 2010). Finally, to complement RSA, a Random Forest model (Breiman, 2001; Liaw & Wiener, 2002) was applied to predict perceived competence, with interpretation supported by variable importance (Molnar, 2022), Partial Dependence Plots (Friedman, 2001), SHAP values (Coulston et al., 2016), and prediction intervals (Ramosaj, 2021) (see Supplementary Materials 2 for more details about the analyses).

## Results

This section presents the findings with regard to the research questions, organized under relevant headings and subheadings based on the analyses.

### Group Differences in ASD Information Sources, Perceived Competence, and Awareness

This section presents the findings related to the first research question, examining whether there are differences between participant groups in their sources of information about ASD (ISA), their perceived competence in educating students with ASD (PCA), and their levels of autism awareness (AAL), considering their professional identity.

#### ASD Information Sources (ISA) Across Participant Groups

This section first presents Table 2 (see Supplementary Material 1), which compares and ranks the ISA used by different participant groups to learn about ASD. The table shows that social media is the most widely used source of information across all participants. Among the groups, it is used the most by final-year pre-service teachers in the certificate program, and the least by final-year pre-service teachers from education faculties. On the other hand, learning from individuals with ASD in one's family or social environment is the least used source overall. Another important point is that in-service training is rarely mentioned by in-service teachers as a way of learning about ASD, suggesting a lack of ongoing training opportunities in this area.

#### Perceived Competency in Educating Students With ASD (PCA) Across Participant Groups

A significant discrepancy was found among participant groups in their PCA [$\chi^2(25, N=745)=852.316$, $p<.001$]. As shown in Table 3 (see Supplementary Material 1), most first-year pre-service teachers from education faculties rated their PCA as "Very Low" ($n=75$) or "Low" ($n=54$), while fourth-year pre-service teachers from education faculties most frequently chose "Undecided" ($n=75$) and "Low" ($n=55$), indicating a slight increase in confidence over time. Among graduate teachers from education faculties, "Low" ($n=43$) and "Undecided" ($n=23$) were the most common responses, though a few selected "High" ($n=13$) or "Very High" ($n=3$). Teachers holding a pedagogical formation certificate mostly reported "Very Low" PCA ($n=13$), and all first-year ($n=138$) and fourth-year ($n=121$) pre-service teachers in the certificate course reported themselves as "Inadequate," which is equivalent to "Very Low." The "Very High" level of PCA appeared only in small numbers

among first-year pre-service teachers from education faculties ($n=7$) and graduate teachers from education faculties ($n=3$), with no responses at this level from any other group, including fourth-year pre-service teachers from education faculties. The "Undecided" category was also notably frequent among first-year ($n=39$), fourth-year ($n=75$), and graduate teachers ($n=23$) from education faculties. These findings suggest that PCA varies systematically by educational background and is unlikely to be due to chance alone.

### Autism Awareness Levels (AAL) Across Participant Groups

The study investigated whether statistically significant differences existed in the overall scores on the Autism Awareness Scale across participant groups. The analysis revealed statistically significant differences between the groups [$F(5, 739)=3.41$, $p=.005$]. Table 4 (see Supplementary Material 1) presents the AAL of the participant groups.

LSD multiple comparison tests were conducted to identify which group pairs showed significant differences, and some statistically significant differences were found in autism awareness scores. Notably, teachers graduated from the faculty of education demonstrated significantly higher AAL compared to both first-year and fourth-year pre-service teachers studying in education faculties ($p=.016$; mean difference = 4.12 and $p=.000$; mean difference = 6.53, respectively). Additionally, teachers graduated from the faculty of education scored significantly higher than first-year pre-service teachers in the certificate program ($p=.001$; mean difference = 5.87). Another important finding was that fourth-year pre-service teachers in the certificate program had significantly greater AAL than those in the education faculty. ($p=.038$; mean difference = 3.56).

## AAL as a Mediator Between ISA and PCA

This section focuses on the second research question, which examines how AAL affects the relationship between different ISA and the PCA of participant groups. To investigate this, a conceptual model was designed, with AAL modelled as a latent construct representing participants' multidimensional understanding of autism. It was operationalized through seven observed indicators (SS1–SS7), with factor loadings ranging from 0.68 to 0.88, corresponding to the subscales of the Autism Awareness Scale (Yazıcı & Karsantık, 2023). Furthermore, PCA was incorporated as an observed endogenous variable, serving to reflect participants' self-assessed efficacy in teaching students with ASD. At the same time, the nine ISA were entered as exogenous observed predictors, representing distinct channels through which participants reported acquiring autism-related knowledge. Accordingly, a regression analysis within the structural equation modeling (SEM) framework was conducted to examine the structural paths specified in the research model, as shown in Fig. 1 (see Supplementary Material 3). The analyses explored how various ISA for learning about ASD, along with AAL, predicted participant groups' PCA in teaching students with ASD. The regression results and related diagnostics are presented in Table 5 (see Supplementary Material 1).

The standardized regression weights and significance levels for both direct and indirect paths are presented in Table 5 (see Supplementary Material 1). The model shows that AAL has a statistically significant negative effect on PCA ($\beta = -0.338$, $p=.007$). This suggests that as individuals' awareness of autism increases, their PCA in this area decreases. Turning to ISA, printed sources significantly enhance PCA ($\beta=0.111$, $p=.001$). In-service training also shows a significant positive effect ($\beta=0.119$, $p<.001$), while university education has a smaller but still positive effect ($\beta=0.060$, $p=.05$).

On the other hand, social media shows no significant effect on PCA ($\beta = -0.008$, $p=.828$). Television ($\beta = -0.051$, $p=.121$) and websites ($\beta = -0.005$, $p=.883$) also do not significantly influence PCA. In addition, non-governmental organizations ($\beta=0.052$, $p=.098$), the nuclear family ($\beta=0.056$, $p=.064$), and the social environment ($\beta = -0.026$, $p=.387$) show no significant effect either.

Additionally, as reported in Table 6 (see Supplementary Material 1), the model met the conventional thresholds for model fit. The goodness of fit was evaluated with a chi-square value of $\chi^2(68)=294.209$. The CFI value was 0.864, which exceeds the 0.85 threshold suggested by Hu and Bentler (1999) for models with large samples and multiple variables, indicating an acceptable fit. Furthermore, the Root Mean Square Error of Approximation (RMSEA) was 0.067 and the Standardized Root Mean Square Residual (SRMR) was 0.049, both below the recommended threshold of 0.08 (Brown, 2015; Schermelleh-Engel et al., 2003), thereby supporting the model's reasonable fit. The 90% confidence interval for the RMSEA ranged from 0.059 to 0.075, indicating the precision of this estimate.

In the established model, as shown in Fig. 1 (see Supplementary Material 3), AAL was conceptualized as a unidimensional construct measured through seven subdimensions (SS1-SS7). This construct was incorporated into the model as a latent factor directly predicting PCA. Additionally, various ISA were included as exogenous variables influencing both AAL and PCA. The results revealed that AAL significantly mediated the relationship between several predictor variables and PCA. In particular, ISA from printed materials and in-service training showed both significant direct effects ($\beta=0.328$, $p=.001$; $\beta=0.578$, $p<.001$, respectively) and significant indirect effects via AAL

(β = 0.056, $p$ = .014; β = 0.244, $p$ = .001, respectively), supporting the presence of partial mediation whereby predictors influence PCA both directly and through the mediator (Baron & Kenny, 1986). For social media and university education, direct effects on PCA were not significant ($p$ > .05), whereas indirect effects through AAL were significant (β = –0.134, $p$ = .001; β = 0.136, $p$ < .001), indicating full mediation whereby the influence of these predictors on PCA occurs entirely through the mediating variable (Preacher & Hayes, 2008). These findings were further supported by the results of the bootstrapping analysis, which provided a more robust examination of the direct and indirect effects in the model. The detailed results are presented in Table 7 (see Supplementary Material 1).

The bootstrapping analysis revealed significant direct and indirect effects of various ISA on participants' PCA. University education and printed materials had both significant direct (β = 0.29; β = 0.40) and indirect effects through AAL (β = 0.11; β = 0.05). Additionally, social media, websites, nuclear family, social environment, and in-service training showed significant indirect effects on PCA via AAL, with social media having a negative indirect effect (β = −0.12) and the others positive effects ranging from β = 0.17 to 0.35. AAL itself exerted a strong negative direct effect on PCA (β = −1.03), highlighting its key mediating role, while in-service training also influenced PCA directly (β = 0.68). These findings suggest that the influence of different ISA on PCA largely operates through their impact on AAL, emphasizing the mediating function of AAL in this relationship.

## Combined Effects of ISA on AAL

This section presents the analyses conducted to address the final research question, which focuses on the development of autism awareness in teacher education. In this regard, advanced statistical techniques were used to identify the most effective combinations of ISA that contribute to increased AAL. Specifically, Response Surface Analysis (RSA) and machine learning methods were applied to explore how different sources—and their interactions—affect AAL.

### Response Surface Analysis (RSA)

The results showed clear patterns regarding how different combinations of ISA influence AAL. The analysis supported the Interaction-Based Model, indicating that AAL improves mainly when two sources are used together, rather than individually. In other words, the effect of each source increases when used in combination with the other, and relying on a single source is not sufficient to significantly enhance awareness.

The three-dimensional surface analysis revealed an upward trend along the line of congruence (LOC), where balanced use of both sources led to higher awareness. By contrast, along the line of incongruence (LOIC), where one source dominated, effects were weaker or no significant, indicating limited benefits of unbalanced use. Moreover, the first principal axis (FPA) closely aligned with the LOC, and the surface curvature confirmed that awareness was primarily driven by the combined increase of both sources rather than by a single dominant source.

As shown in Table 8 (see Supplementary Material 1), among all combinations tested, two pairs of ISA demonstrated the strongest statistical effects, clearly indicating that using different ISA together is more effective than using them separately. The table presents both the regression coefficients and the RSA-specific surface parameters. These findings emphasize the importance of an integrated approach to information access, where both the amount and the balance of source use play a key role in shaping AAL.

The analysis revealed significant interaction patterns for the two strongest source combinations: *Television* + *Nuclear Family* and *Printed Materials* + *In-Service Training*. In both cases, the significant negative value of the $b_4$ coefficient ($p$ < .05) suggests that when these sources are used together but in an imbalanced manner, their combined impact on AAL tends to decrease. Conversely, the positive and significant $a_1$ coefficient ($p$ < .05) indicates that using both sources at similar levels contributes to a linear increase in awareness, as illustrated in Fig. 2 (see Supplementary Material 3).

Other model parameters—such as the curvature terms ($a_2$, $a_4$), mismatch slope ($a_3$), and the coordinates of the principal axes ($p_{10}$, $p_{20}$)—were not statistically significant, suggesting only partial support for a full congruence or reverse congruence model. Based on the criteria outlined by Humberg et al. (2019), the Printed Materials + In-Service Training combination showed subtle indications of a weak reverse congruence pattern. Specifically, the second principal axis had an intercept near zero ($p_{20} \approx 0$) and a slope close to one ($p_{21} \approx 1$), while the surface showed relatively high $a_4$ and low $a_3$ values—resulting in a subtle "valley" formation on the response surface, as shown in Fig. 2 (see Supplementary Material 3). In other words, the findings suggest that the interaction between printed materials and in-service training may influence AAL, although the statistical evidence does not strongly support either main effects or a clearly defined congruence structure.

### Machine Learning Analysis

Building on the RSA, the study examined how the simultaneous use of three different ISA affects AAL. The analysis identified specific triadic combinations of the ISA that are

associated with higher average autism awareness scores. Table 9 (see Supplementary Material 1) presents the top ten three-way combinations linked to the greatest increases in awareness. These findings suggest that exposure to multiple, diverse ISA at the same time may have an additive or synergistic effect on improving AAL.

The analysis of three-way ISA combinations expands on earlier two-source findings. Table 9 (see Supplementary Material 1) shows that combinations including IS1 (social media) and IS5 (university education) consistently rank highest, highlighting their important role in increasing AAL. The highest average score was found for IS3 + IS1 + IS5 (websites + social media + university education; M = 106.82). A very close value was recorded for IS1 + IS5 + IS6 (social media + university education + non-governmental organizations; M = 106.81).

To support the findings mentioned above, variable importance scores calculated using the Random Forest algorithm reveal the relative contributions of different ISA in predicting AAL. Social Media (IS1) ranks highest with a score of 0.268, followed by University Education (IS5) at 0.198, and Non-Governmental Organizations (IS6) at 0.151. The Nuclear Family (IS7) also plays a notable role with a score of 0.138. Moderate importance is observed for In-service Education (IS9) and Websites (IS3), with scores of 0.088 and 0.072, respectively. In contrast, Television (IS2), Printed Materials (IS4), and Social Environment (IS8) show lower contributions, with scores of 0.048, 0.029, and 0.008, respectively.

Additionally, to evaluate the relative contribution of each information source to AAL, variable importance scores were computed using the Random Forest algorithm. As the results indicate, IS1 (Social Media), IS5 (University Education), and IS6 (Non-Governmental Organizations) emerged as the top three-way combination. To further explore how each predictor individually affects AAL across its range of values, Partial Dependence Plots (PDPs) were examined. The PDP trends revealed that Social Media (IS1) shows a strong, consistent positive linear increase in awareness. University Education (IS5) has a moderately positive effect that rises to a certain threshold before leveling off. Non-Governmental Organizations (IS6) exhibits a positive, curvilinear (concave) effect. The Nuclear Family (IS7) contributes a mildly increasing positive effect. In contrast, In-service Education (IS9), Printed Materials (IS4), and Social Environment (IS8) show neutral effects, indicating no significant change in AAL. Websites (IS3) also demonstrates a positive, linear increasing effect, while Television (IS2) shows a curvilinear (convex) effect with mixed outcomes, meaning it can have positive, neutral, or negative influences depending on the context.

To further interpret the machine learning results, another analysis was conducted to provide more nuanced and interpretable insights into the individual contributions of each variable by calculating SHAP (SHapley Additive exPlanations) values. The SHAP summary plot illustrated not only the relative magnitude of influence but also the direction of each variable's effect on the predicted outcome. Specifically, Social Media (IS1) showed the highest contribution with a mean SHAP value of 0.162, followed closely by University Education (IS5) at 0.141, and Non-Governmental Organizations (IS6) at 0.116. The Nuclear Family (IS7) also played a significant role with a value of 0.104. Moderate positive contributions were observed for In-service Education (IS9) and Websites (IS3), with values of 0.073 and 0.069, respectively. In contrast, Television (IS2) demonstrated a mixed effect, with a lower mean value of 0.031, indicating variable influence depending on the context. Printed Materials (IS4) and Social Environment (IS8) showed neutral effects with relatively low values of 0.020 and 0.006, suggesting minimal impact on AAL.

Finally, in this section, to assess the model's reliability across different input combinations, prediction intervals were calculated for the top three-way combinations of ISA, as presented in Table 9 (see Supplementary Material 1). The narrow confidence intervals observed for the highest-ranked combinations—especially for IS1 + IS3 + IS5 (Social Media + Websites + University Education)—indicate a high level of predictive accuracy. This suggests that the model is reliable in estimating autism awareness scores when these sources are used together. Moreover, these tight intervals imply low variability in participant responses within these groups, supporting the consistency of the findings (Alakuş et al., 2022; Ramosaj, 2021).

## Discussion

This study found that participants' autism awareness levels (AAL) were generally moderate, while their perceived competence in teaching students with ASD (PCA) was low. This may be related to the information sources (ISA) that participants used to learn about ASD. The results show that most participants learned about ASD through social media and websites rather than formal education. However, these information sources can sometimes provide incorrect or misleading information (e.g., Brown et al., 2024), which may explain the moderate AAL and low PCA levels found in this study. In addition to the overall perspective outlined above, it is important to consider the results in relation to the participants' professional identities to gain a clearer understanding of teacher education.

When examining the findings in relation to professional identity, autism awareness can be addressed first. This is because this study showed that AAL plays an important role in improving participants' PCA during the process of learning about ASD. The connection between awareness and perceived competence is supported by existing research (e.g., Nestorowich et al., 2022). At this point, a notable aspect related to professional identity is the similarity in AAL between first- and final-year pre-service teachers in faculties of education, which suggests that current undergraduate teacher education has no significant effect on increasing autism awareness. This may be due to the fact that in Türkiye, there is only a compulsory course about special education and inclusive education, which includes ASD as one of its topics (The Council of Higher Education, 2018). Similar limitations are also observed in developed countries such as the United Kingdom (Ravet, 2018), the USA (Al Jaffal, 2022), and Germany (Wittwer et al., 2024), indicating that this is a global problem. Therefore, the lack of significant improvement in AAL during the four-year program is considered a serious weakness of the current teacher education systems and highlights the need for more focused and identity-based approaches to inclusive education.

Another important aspect of autism awareness is the finding that final-year pre-service teachers in the certificate program, have higher AAL scores than final-year pre-service teachers from education faculties, even though there is no significant difference between first-year pre-service teachers in the two groups. This is notable, because both groups completed the same course on special education and inclusive education (including ASD), taught by the same lecturer. Moreover, education faculties are specifically designed to offer professional training focused on preparing future teachers, while the faculties where pre-service teachers enrolled in the certificate program do not aim for direct teacher training. However, those in the certificate program may have shown greater progress in AAL over time. Therefore, understanding why education faculty pre-service teachers demonstrate a lack of significant improvement in AAL compared to their peers in certificate program is essential for evaluating and improving teacher education policies.

Examining the ISA used by final-year pre-service teachers in education faculties and those in the certification program may help explain the difference in AAL scores. While pre-service teachers in education faculties primarily learned about ASD through university courses, pre-service teachers in the certification program mostly relied on social media, with university education as a secondary source. Interestingly, social media was the least used source among education faculty pre-service teachers. This suggests that, despite the risk of misinformation (Brown et al., 2024), social media may still play a significant role in increasing autism awareness. Supporting this, Jawed et al. (2023) highlighted several benefits of social media, including accessibility, wide reach, and its potential to promote awareness and neurodiversity in the context of ASD. Therefore, the observed difference between the two groups may be linked to greater exposure to ASD content on social media among pre-service teachers in the certification program. This also raises concerns about the effectiveness of university-based teacher education in addressing ASD. This limitation is further supported by several other studies (e.g., Ravet, 2018; Yazıcı & Karsantık, 2025). Therefore, it becomes clear that teacher education programs need further development to better prepare future teachers to support students with ASD.

In improving teacher education, teachers' PCA in educating students should also be considered (Bannister-Tyrrell et al., 2018), as such perceptions significantly influence their professional experiences, particularly when educating students with ASD. In other words, these perceptions can directly or indirectly impact various outcomes, including student learning, the effort teachers invest in teaching, job satisfaction, professional commitment, burnout, and turnover (Hatlevik, 2017). Therefore, designing teacher education programs that acknowledge and strengthen PCA may be beneficial. This study also emphasizes the importance of examining competence perceptions in relation to teachers' professional identities, as participants' professional identities were found to influence their PCA. A notable finding in this context is that, despite no significant difference in AAL, first-year pre-service teachers in education faculties reported significantly lower PCA, whereas PCA increased among final-year students, likely due to more exposure to the field or professional pressures (e.g., Gray & Seiki, 2020). However, this increase may lead to overconfident self-assessments that do not accurately reflect actual competence. Further supporting this, although teachers with education faculty degrees and those with a pedagogical certificate had similar AAL scores, PCA was much higher among education faculty graduates. These findings suggest that unrealistic perceptions of competence represent a challenge in ASD education, as they may lead to reduced motivation, limited professional growth, and an inability to effectively meet students' needs (Dassa & Nichols, 2019).

As mentioned above, a different form of the unrealistic perception that caused various problems was observed among pre-service teachers in the certificate program. While the AAL of these individuals in their fourth year was higher than that of first-year pre-service teachers, both groups reported very low levels of PCA. In other words, regardless of their awareness-based competencies, these individuals may not consider educating students with ASD as part of their professional role and may experience limitations in their professional sense of belonging. At this point,

during teacher training, their sense of belonging should be examined through professional identities, and appropriate support efforts should be implemented (e.g., McKay & Manning, 2019).

Another element that needs to be addressed in this research is the role of experience in the context of AAL and PCA. Despite applying similar ISA, teachers demonstrated the highest AAL compared to all pre-service teacher groups in the study. This suggests the potentially positive impact of experience with ASD on AAL (Gillespie-Lynch et al., 2022). However, consistent with the general finding that PCA decreases as AAL increases, the teachers' PCAs were very low. Furthermore, when examining the teacher groups, it was observed that as teachers gained experience, they tended to perceive themselves as less competent (i.e., exhibited lower PCA). In this context, they may have a more realistic perspective on their PCA as their AAL improves (e.g., Danijela, 2018; Eryılmaz & Dikilitaş, 2023).

Despite the positive aspects of experience, it should be emphasized that experience alone is not sufficient (Kini & Podolsky, 2016). Similarly, the study found that teachers with 6–10 years of experience who had received a course related to ASD during their undergraduate education demonstrated the highest levels of autism awareness, compared to newly qualified teachers with limited experience but more formal education on ASD, and teachers with over 15 years of experience but no direct course on the topic. This finding suggests that the combination of experience and theoretical knowledge is more effective than either alone (Resch & Schrittesser, 2023). Similarly, teachers who had received in-service training showed higher AAL and PCA scores than those who had not, which can also be interpreted as evidence of the added value of integrating theoretical knowledge with practical experience.

Within the context outlined above, teachers who work with students with ASD should be specifically addressed. While the AAL levels of teachers with and without such students were similar and at a moderate level, those teaching students with ASD had higher PCA. This situation may create a perception among these teachers that they have learned through experience, which, as previously mentioned, is not adequate on its own. Furthermore, this situation may also be influenced by cultural pressure, as teachers may be reluctant to express their limitations while actively working with students with ASD. This is because in societies where people care a lot about others' opinions, known as collectivist cultures, such as the one where the research took place, individuals may find it difficult to express their limitations or weaknesses and may choose to conceal them (Cha et al., 2021; Hofstede, 1980; Markus & Kitayama, 1991). Therefore, teacher training should include content designed to help teachers recognize and express their professional limitations.

## A Practical Framework: Recommendations for Implementation

This study demonstrates that professional identities play an important role in enhancing autism awareness within teacher education for students with ASD. Building on this, a framework has been developed to support more effective teacher education practices. As shown in Fig. 1, the proposed framework is grounded in the findings of this research and offers practical guidance for teacher training programs.

As shown in the framework, this study suggests that improving pre-service teacher education can be done by adding social media and website (or NGO) resources to university courses on ASD. Using these three learning sources together may increase the effectiveness of autism awareness training. Although there is limited research on this exact approach, some studies have pointed out the benefits of using social media in teacher education (e.g., Kilis et al., 2014). Therefore, including this framework in university programs could be an important step toward increasing autism awareness among future teachers. For example, to support this, a social media account could be created within current courses, and pre-service teachers could be encouraged to follow it. On this platform, in addition to theoretical knowledge, content from people directly related to ASD, such as diagnosed individuals, their families, teachers, and therapists, could be shared. In addition, reliable web resources about ASD could be posted there.

Regarding in-service teacher training, while the study found that using printed resources during training was initially effective, this benefit decreased as the training period was extended. Incorporating NGO into in-service training, in addition to the undergraduate education mentioned earlier, appears to be the most effective way to improve autism awareness among in-service teachers. Given that NGO are actively involved in ASD-related initiatives and are known to raise awareness (Parsons, 2018), it is believed that integrating these sources of information with targeted ASD training can enhance the overall effectiveness of in-service education in developing teachers' awareness of ASD. To achieve this, it could be beneficial for schools to establish formal collaborations with NGOs. For example, individuals diagnosed with ASD, their families, and experts from NGOs could visit schools to share their experiences and participate in activities together.

In addition to the elements mentioned above, the research revealed that all pre-service teachers should be supported through experiential learning opportunities. At this point,

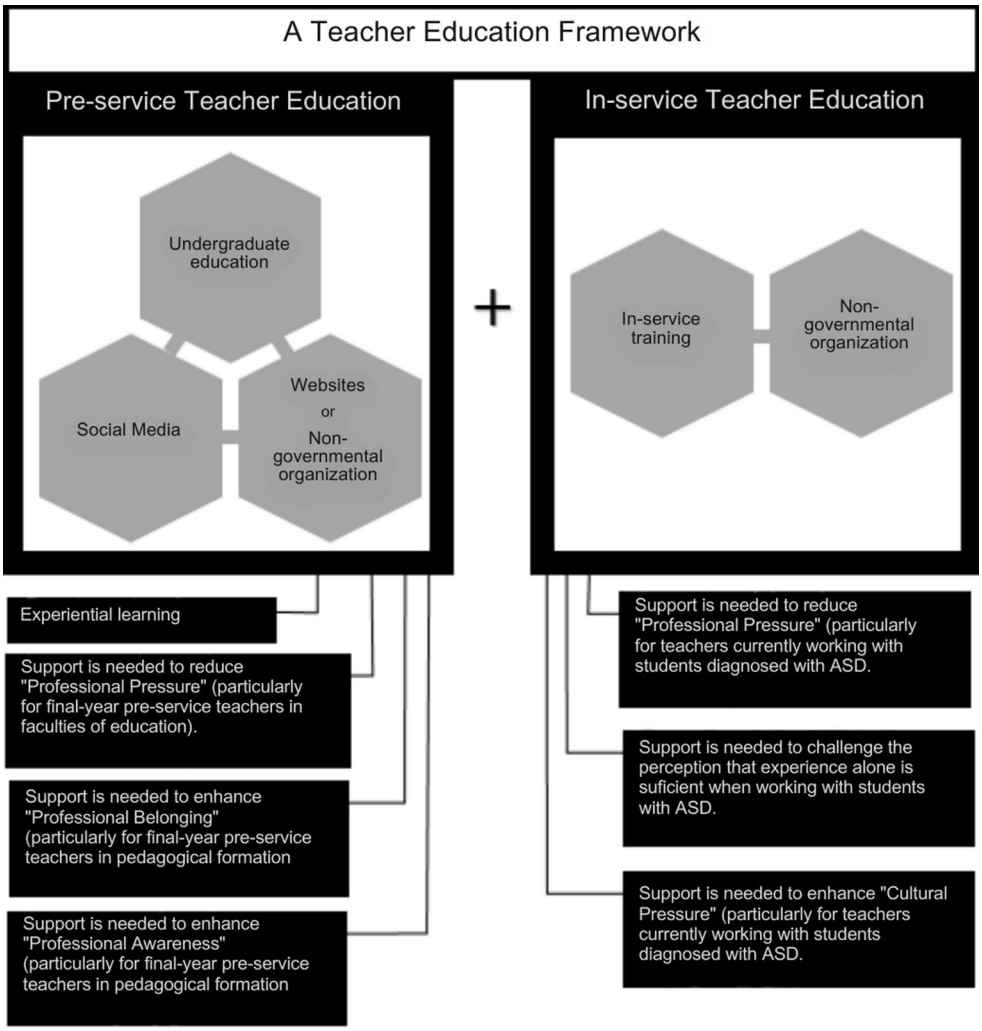


**Fig. 1** A teacher education framework for pre-service and in-service teachers to improve autism awareness

for example, school-based inclusive mentoring within the scope of an experiential learning model (IEM) can be used to support this approach (Yazıcı & Uzuner, 2024). Furthermore, training on professional pressure (e.g., Liu et al., 2022), professional belonging (e.g., Allen et al., 2025), professional awareness (e.g., Sciuchetti et al., 2018) and cultural pressure (Wang et al.,2023) is recommended for both pre-service and in-service teachers and should be included in teacher education as shown in Fig. 1.

## Integrating the Framework Into Current Teacher Education

The proposed framework could be integrated into current teacher education programs with a few adjustments. First, course content at the university level could be developed by experts in the field for special education and inclusion courses, with technical support from institutions' IT departments. Within the scope of these courses, pre-service teachers could be guided to use designated social media platforms or websites. This strategy could encourage participation not only from pre-service teachers but also from the wider community. Such engagement may foster collaboration among various stakeholders, including current and future teachers involved with ASD.

Alternatively, partnerships between universities and ASD-focused NGO could strengthen interaction between pre-service teachers and these organizations. Similar collaborations could also be established for in-service teachers. Since technological tools (such as social media platforms or simple websites) and existing institutions (e.g., universities, schools, NGO) already provide a foundation for collaboration, policymakers would not face a significant financial burden when implementing this approach to enhance teacher training effectiveness.

Regarding experiential learning, all pre-service teachers participate in teaching practice in schools during their final year (The Council of Higher Education, 2018). Although this experience varies, it is also common in different countries (e.g., National Center on Education and the Economy,

2015; OECD, 2022). However, many pre-service teachers graduate without the opportunity to work with students with special needs, including ASD (Yazıcı & Baş, 2023). Therefore, when selecting schools for teaching practice, priority should be given to institutions that have students with ASD. This calls for a dedicated study focused on classroom and school selection for the current practice.

Finally, although the framework highlights the elements of professional pressure, professional belonging, professional awareness, and cultural pressure, these concepts require clearer integration into teacher training. An examination of various teacher training programs (e.g., The Council of Higher Education, 2018) shows that many courses, such as those related to educational psychology, professional ethics, and teaching practicum, already cover or are able to adapt these concepts. Therefore, the next step should be to increase the emphasis on these concepts in course content to make their importance clearer and more effective.

## Limitations and Suggestions for Future Research

This study examined professional identity in terms of professional stages, training level, faculty type, professional experience, and teacher qualification route within the context of teacher education. However, professional identity is a diverse concept that can take many forms. For example, this study did not consider teachers' subject specializations. This represents a key limitation, as the study focused only on a limited set of professional identity categories. To address this, future research could expand the proposed framework by including a broader range of professional identities, which would lead to a more comprehensive understanding of how professional identity shapes teacher education. To support a more comprehensive understanding, preliminary studies focusing on sample representativeness could also be conducted. This would enhance the generalizability of the findings. Moreover, the study relied on self-report measures to assess participants' perceptions of competence. In this context, to reduce the potential risk of bias, future research is encouraged to use diverse data collection tools to obtain more reliable information.

Additionally, cultural factors are known to influence teacher training for inclusive education involving students with ASD (Beyer & Zeichner, 2018). Therefore, future studies could explore how these cultural elements interact with the framework in different educational settings and propose culturally responsive adaptations. Future research would also benefit from examining the main reasons why social media plays an important role in raising autism awareness. One possible explanation is the influence of first-person voices related to ASD, including individuals with ASD, their families, educators, and therapists, on social media platforms (Courchesne et al., 2022). Furthermore, future studies should include a detailed analysis of the role that social media plays and the types of content shared, as this could offer valuable insights with implications for improving autism awareness. Finally, the use of qualitative research methods could provide deeper, more nuanced understanding of these dynamics.

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## Declarations

**Conflict of interest** All authors declare that they have no conflicts of interest.



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