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Communal and agentic teacher behavior in teacher-child dyads. A new self-report scale based on a circumplex approach

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Introduction: The goal of this study was to develop a self-report scale measuring the teacher's interpersonal behavior in teacher-child dyads in elementary schools and to provide evidence of the scale's validity. Using the framework of interpersonal theory, the *Questionnaire on Dyadic Interpersonal Teacher Behavior (DITeB)* models teacher behavior in an interpersonal circumplex that allows for the simultaneous analysis of teacher behavior along the two orthogonal dimensions of communion (warmth) and agency (guidance, monitoring).

Methods: We analyzed 440 dyadic teacher-child relationships derived from 88 teacher reports. Teachers rated the 20 items (8 scales) of the DITeB to describe their interpersonal behavior towards a child. To test the scale's structural validity, we conducted confirmatory circumplex structural analyses. To test the scale's construct validity, we used teachers 'descriptions of relationship quality (closeness, conflict, dependency), and of their child related emotions (enjoyment, anger, anxiety). In addition, teachers reported on the child's academic performance (numeric grades), as well as their professional beliefs about heterogeneity and self-efficacy for adaptive teaching, data which were used for further construct validation.

Results: We obtained empirical support for both structural and construct validity of the DITeB. Teacher interpersonal behavior correlated significantly with perceived relationship quality and emotions: high relationship quality and positive emotions were associated with high communion and low agency, whereas low relationship quality and negative emotions were associated with low communion and high agency, supporting construct validity. Additionally, as child's academic performance improved, teachers' agency decreased. Towards different groups of children, teachers' interpersonal behaviors varied systematically based on their professional beliefs: teachers with strong heterogeneity beliefs tended to be more communal towards low-performing children compared to high-performing children. Moreover, teachers with strong self-efficacy towards adaptive teaching adjusted their agency more flexibly according to children's performance in school, further supporting the construct validity of our instrument.

Discussion: We discuss how our instrument enriches the spectrum of existing scales on interpersonal teacher behavior. By focusing dyadic specific teacher behavior, the DITeB allows examining the extent to which the teacher adapts their behavior to child characteristics (adaptive teaching), and the effect of teacher behavior on child outcomes.

KEYWORDS

agency, communion, interpersonal teacher behavior, dyads, adaptive teaching

1 Introduction

A large body of research attests to the importance of teacher behavior for student outcomes, such as child learning or social adaptation (e.g., Wentzel, 2023). In previous research, teacher behavior was typically measured on the level of the classroom: both, the Questionnaire on Teacher Interaction (QTI) (Wubbels and Levy, 1991) and the Situations-in-School Questionnaire (SiS) (Aelterman et al., 2019) measure teaching styles, i.e., self-or other-reported behaviors the teacher habitually displays towards the students of their class in particular interactive situations (e.g., when the class period begins; when wanting to motivate students in class; when students complain; when students show signs of anxiety). While there is substantial evidence that some teaching styles are more supportive of student motivation and wellbeing than others (for a review see Aelterman and Vansteenkiste, 2023; Wubbels and Brekelmans, 2005), neither the QTI nor the SIS cannot be used to describe the teacher's behavior towards a particular child. Research in adaptive teaching suggests that students profit from individualized learning support in dyadic interactions: teacher behavior should be adapted to the individual student's learning requirements (adaptive teaching: Corno, 2008; Decristan and Dumont, 2021; Hardy et al., 2019). We therefore considered it important to develop a new scale measuring the teacher's behavior in dyadic interactions with a child, thus allowing us to also measure the extent to which the teacher adapts his or her behavior to the respective child. Teacher adaptivity implies that teachers provide more guidance and support for low-performing students and gradually withdraw it to the extent that the child's performance improves. Therefore, while the QTI and the SIS capture a wide range of teacher behaviors in response to both the child's social and learning behaviors, our questionnaire focuses exclusively on the teacher's steering and support of the child's learning behavior.

In the following we describe the development of a new teacher self-report scale, the *Questionnaire on Dyadic Interpersonal Teacher Behavior (DITeB),* which measures the interpersonal behavior of teachers in a dyadic relationship with a child. We describe teacher behavior on the two fundamental dimensions of interpersonal behaviors which are also referred to as the Big Two: agency and communion (Abele et al., 2016; Fiske, 2018). As was done in the QTI (Wubbels and Levy, 1991) and the SiS (Aelterman et al., 2019), we modeled teacher behavior based on an interpersonal circumplex (Leary, 1957). To examine construct validity of our instrument, we used measures of relationship quality developed within other research traditions, in particular teacher perception of relationship quality and teacher emotions. To provide further evidence of validity, we investigated whether interpersonal teacher behavior as described by our instrument is interdependent with a child's academic performance, as suggested by adaptive teaching theory (Corno, 2008; Decristan and Dumont, 2021; Hardy et al., 2019). As a final step in validating our new scale, we investigated whether personal characteristics of the teacher –particularly his or her beliefs and self-efficacy regarding professional teaching– are systematically related to interpersonal teacher behavior, as measured by our instrument.

1.1 A circumplex approach to modeling interpersonal teacher behavior

The Big Two of interpersonal behaviors (Abele et al., 2016; Fiske, 2018) are *communion* which refers to qualities necessary for establishing and maintaining social relationships (e.g., affection, respectful communication, sensitivity), and *agency* which refers to qualities essential for goal attainment (e.g., power, guidance, control). In interpersonal theory, both dimensions are considered as orthogonal axes within an interpersonal circumplex (for an illustration, see Figure 1), positing that each type of interpersonal behavior can be adequately described by a combination of different levels of communion and agency (Horowitz and Strack, 2011; Leary, 1957).

In utilizing the framework of interpersonal theory and an interpersonal circumplex, we draw upon the foundational work of Wubbels and colleagues (for a comprehensive review see Wubbels and Brekelmans, 2005), who initially introduced them to the domain of educational psychology, with the specific aim of describing teaching styles along the two meta-dimensions of agency and communion. In the circumplex space, by convention communion is represented by the horizontal axis while agency is represented by the vertical axis. Since the two dimensions are orthogonal to each other, they form the basis for the interpersonal circumplex, which comprises octants (comparable to eight scales) that divide the circle into equally spaced sections of 45°. Each octant is characterized by a varying degree or a specific blend of agency and communion, representing interpersonal behaviors that can be seen as prototypical for its position in the circumplex. Hence, the advantage of modelling teacher behavior in an interpersonal circumplex is that it allows to describe communal and agentic dimensions simultaneously. A second advantage is that the circumplex allows to test the structural validity of the underlying scales measuring agency and communion, because associations among octants within the circumplex structure should adhere to a particular pattern, as will be described in more detail below.

1.2 Construct validity of the questionnaire on dyadic interpersonal teacher behavior (DITeB)

A teacher's interpersonal behavior can be considered to be theoretically related to other aspects of dyadic teacher-child relationships, such as perceptions of relationship quality and teacher emotions. However, empirical evidence is still sparse, as scales assessing dyadic relationships typically utilize a conglomerate of items addressing various relationship aspects simultaneously (e.g., Ang, 2005; Brinkworth et al., 2018; Hughes et al., 1999, 2008; Pianta, 2001). To provide evidence of construct validity of the DITeB measuring interpersonal teacher behavior, we used established measures of relationship quality developed within other research traditions, focusing on perceptions of relationship quality and teacher emotions, and examined their correlations.

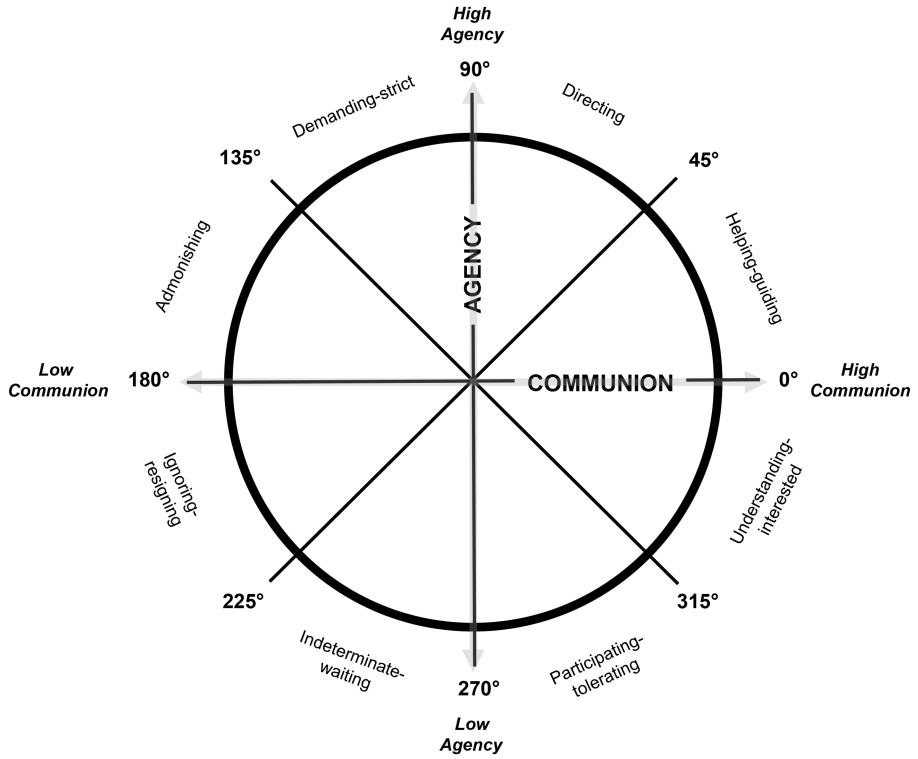

FIGURE 1
Interpersonal circumplex for teacher behavior.

1.2.1 Perceptions of relationship quality

Through repeated interactions, teachers develop an internal working model of their relationship with each child in their classroom. These mental representations are automatically activated in social interactions and influence the teacher's interactional behavior towards each child (Pianta et al., 2003). Systematic associations between the teacher's mental representations of the relationship, on the one hand, and certain qualities of teacher interpersonal behavior, on the other, can be hypothesized. In the tradition of attachment theory, secure teacher-child relationships are characterized by the teacher's perceptions of high closeness, low conflict, and low dependency (Pianta, 2001). Closeness has been found to be positively related to the teacher's report of a child's prosocial behavior whereas conflict and dependency have been found to be positively related to the teacher's report of child behavioral problems and aggression (Milatz et al., 2014). Following this, we expected that to the extent a teacher perceives the relationship with a child as close, secure, and predictable, the teacher behaves generally more communal, e.g., by providing understanding, and less agentic, e.g., by guiding the child less constantly and granting more freedom in learning. Hence, positive correlations between perceived closeness and teacher communion as well as negative associations between closeness and teacher agency would support the convergent criterion validity of the DITeB. In contrast, if the teacher perceives the relationship as characterized by conflict or excessive dependency, the teacher will probably interpret the relationship as negative and unpredictable, resulting in emotional detachment and need-thwarting communication (low communion), as well as an increased tendency to control and discipline the child (high agency). Thus, negative correlations between conflict or dependency with communion, as well as positive correlations with agency, would further support convergent validity.

1.2.2 Teacher emotions

It can be further postulated that teachers' emotions are systematically related to their interpersonal behaviors. Within their conceptual framework on the transmission of teacher emotions, Frenzel et al. (2016) found that high quality instruction towards the class (e.g., clarity and variety of instruction), as perceived by students, correlated with teacher's self-reported enjoyment whereas lower-quality instructional behaviors were associated with higher levels of anger and anxiety when teaching the respective class. Similarly, student-centered and creative teaching approaches were found to be associated with more positive teacher emotions, whereas more teacher-centered approaches and techniques that undermine student creativity were found to be associated with negative teacher emotions (Chen, 2019; Trigwell, 2012). Applying these findings to the teacher-child dyad, we expect that communal interactions with the child fulfill the teacher's personal goal of being a good teacher and are therefore experienced as emotionally rewarding, while dyadic interactions characterized by low communion should be perceived as inconsistent with the teachers' personal goals and thus are experienced as emotionally challenging by the teacher. Hence, positive correlations between enjoyment and communal behavior towards the child, and negative correlations between anger or anxiety and communal behavior represent a further indication for the instrument's convergent validity. At the same time, positive teacher emotions should be associated with low agency, as a response to the child cooperating and aligning with the teacher's pedagogical

objectives, resulting in less need to guide the child's actions. In contrast, teacher anxiety or anger towards a child should be accompanied by high agency, as the teacher engages in more directive behavior and adopts a stricter approach in guiding the child's learning process. Thus, positive correlations between anger or anxiety with teacher agency, and negative correlations between enjoyment and agency, can be interpreted as further evidence of convergent validity.

1.3 Interpersonal teacher behavior and child academic performance

In addition to construct-related criteria completed by one actor (the teacher), relationship questionnaires allow for gathering further evidence of construct validity by correlating them with important characteristics of the other actor (the child). This possibility arises from interpersonal theory, which acknowledges the mutual impact of actors on each other (complementarity principle; Horowitz and Strack, 2011; Sadler and Woody, 2017). As our instrument focuses on the teacher's interpersonal behavior in managing the learning process of an individual child, we were interested in whether teacher behavior is systematically influenced by the child's level of academic performance.

Research on adaptive teaching suggests that optimal academic outcomes are achieved when teachers individually adjust their instruction to meet the diverse needs of their students. This approach recognizes that children exhibit varying levels of academic performance, requiring teachers to be sensitive to children's prerequisites and adaptive in their instruction to best support academic accomplishments (Corno, 2008). For example, high agentic teacher behavior, such as guiding and supervising, should support cognitive activation and favorable forms of motivation in a child still performing relatively low academically. Conversely, this behavior may be less beneficial for a child with already high academic performance (e.g., Decristan and Dumont, 2021; Hardy et al., 2019). To provide further evidence on construct validation, we used the idea of adaptive teaching (Corno, 2008) and expected that teacher agency is directly linked to the child's level of academic performance.

1.4 Teacher's interpersonal behavior and other aspects of teacher's professional competence

Teachers' personal characteristics, such as beliefs and self-efficacy, can be understood as aspects of teachers' professional competence (*cf.* Baumert and Kunter, 2006) that are reflected in and guide teaching behaviors. Our final step in construct validation was to explore whether teacher characteristics relevant to professional teaching are systemically related to interpersonal teacher behavior.

1.4.1 Beliefs about teaching in heterogeneous classrooms

Positive beliefs about teaching in heterogeneous classrooms describe the belief that all children, regardless of ability level, can learn from each other and, accordingly, imply a positive attitude towards diverse groups of children (Dignath et al., 2020). Heterogeneity is seen as an asset to the classroom rather than a threat to instructional goals. Previous research has shown that beliefs supporting heterogeneity are correlated with teachers' intentions to adapt their teaching behaviors to a heterogeneous group of students (Hachfeld et al., 2015). We tested the assumption that variations in agency (as measured by the DITeB) toward academically diverse groups of children can be predicted by teachers' beliefs about teaching in heterogeneous classrooms.

1.4.2 Self-efficacy for adaptive teaching

Although teachers may have positive beliefs about heterogeneity, teaching heterogeneous learning groups can still be challenging. Teachers with strong self-efficacy for adaptive teaching in heterogeneous classrooms believe in their competences to meet students' highly diverse needs (Sharma et al., 2011). Adaptive teaching can be achieved, for example, by teachers adjusting learning content, materials, or practice time and providing instruction in the form of contingent verbal support. Meta-analysis findings have shown that teacher self-efficacy beliefs are related to observed teaching performance (Klassen and Tze, 2014). It is therefore reasonable to assume that teachers with strong self-efficacy are more effective in adapting their behaviors to individual differences within a heterogeneous classroom. We predicted that, as compared to teachers with low self-efficacy, teachers with strong self-efficacy more strongly increase their agency towards low-performing children and decrease agency towards high-performing children.

1.5 Goals and research hypotheses of our study

Our study had two aims. First, for a structural validation of the DITeB, we examined the hypothesized circumplex structure through confirmatory analyses. Second, we provided evidence on the questionnaire's construct validity by relating it to the above explained theoretically related constructs.

1.5.1 Structural validation

The appropriateness of a circumplex model can be tested empirically by examining the correlation patterns among the eight scales. Within the circumplex, behaviors from adjacent octants should be positively correlated, opposite behaviors should be negatively correlated, and behaviors in octants arranged at right angles to each other should be uncorrelated (Leary, 1957). The similarities of any two octant scales are expressed by their separating angle (Wiggins, 2003). By convention (Fabrigar et al., 1997; Gurtman, 1991), a perfect circumplex model requires that the observed correlation patterns conform to a cosine curve which is achieved when all scales are equidistant from the center to the circle perimeter ("equal radius") and scales cover a 45-degree angular each ("equal spacing"). Since perfect circularity is unrealistic to achieve, more flexible models were developed to test whether the correlational pattern meets circular properties (Browne, 1992; Nagy et al., 2019). Confirmatory circumplex structural analyses were conducted to assess the structural validity of the DITeB.

1.5.2 Construct validation

Constructs that are presumed to be systematically related to teacher interpersonal behavior were used for construct validation.

In this study, we considered theoretically related constructs that are inherent to the teacher, including the teacher's perception of relationship quality, teacher emotions, and teacher's personal characteristics such as professional beliefs and self-efficacy. Additionally, we included a measure representing the child's academic performance. In the following sections, we present hypotheses regarding the relationships between these constructs and the teacher's behavior as measured by the DITeB.

> *Hypothesis 1a* Positive teacher perception of relationship quality (high closeness) is associated with teacher behavior that is characterized by high communion and low agency.
>
> *Hypothesis 1b* Negative teacher perception of relationship quality (high conflict, high dependency) is associated with teacher behavior that is characterized by low communion and high agency.
>
> *Hypothesis 2a* Positive teacher emotions coincide with teacher behavior characterized by high communion and low agency.
>
> *Hypothesis 2b* Negative teacher emotions coincide with teacher behavior characterized by low communion and high agency.
>
> *Hypothesis 3* Academically high-performing children elicit lower agentic teacher behavior, while children with lower academic performance elicit higher agentic behavior.
>
> *Hypothesis 4a* Teachers with strong heterogeneity beliefs interact in a highly communal manner, irrespective of children's academic performance. In contrast, teachers with weak heterogeneity beliefs show lower communion towards children with lower academic performance compared to children with higher academic performance.
>
> *Hypothesis 4b* The extent of agency displayed towards children with high versus low academic performance differs more strongly in teachers with strong self-efficacy than in teachers with weak self-efficacy.

2 Method

2.1 Questionnaire development

Unlike the QTI (Wubbels and Levy, 1991) and the SiS (Aelterman et al., 2019), which examine teachers' interpersonal behavior towards their classes, our questionnaire aimed to describe teacher's behavior in dyadic interactions with a specific child. In order to fulfill this purpose, we used the theoretical scale descriptions and items of the QTI as a starting point for item development. A sole adaption of the QTI for the dyadic context was not applicable, since the QTI-items are formulated in more general terms (e.g., "This teacher is a good leader."; "If we have something to say, this teacher will listen."), making it challenging to interpret and to relate them to specific behaviors that teachers exhibit towards specific children. Therefore, we additionally referred to the SiS (Aelterman et al., 2019). Here, each item consists of the description of a specific teaching scenario and four answering options describing potential approaches for managing the situation.[1] Thus, we relied on both the QTI and teaching scenarios from the SiS to formulate two to three items for each of the eight scales in our circumplex model (see Figure 1). We concentrated on specific teaching scenarios directly pertinent to students' learning behaviors (e.g., lesson planning, initiation of classes, transitions to new activities, provision of instructional time) and adapted them to the teacher-child dyad.

Given that it is more time-consuming for the teacher to describe their behavior towards each child of their class than describing their behavior towards the class as a whole, we aimed to capture the eight octant scales with as few items as possible. This resulted in an initial item pool of 20 items, each reflecting a specific combination of strong, moderate, or low agency, paired with strong, moderate, or low communion.

We assessed the content validity of the 20 items through open discussions with other researchers in our study group. This process was refined through a process of expert rating. In further piloting the items, 11 teachers provided feedback on their comprehensiveness of the items and the questionnaire's instruction as well as the feasibility of rating dyadic specific interpersonal behavior towards different children on a 5-point-Likert-scale (ranging from very easy to very difficult). Among them, seven teachers found it rather easy to very easy to assess their behavior towards different children, three found it neither easy nor difficult, and two found it rather difficult to very difficult to assess dyad-specific teacher behavior. Based on this feedback, we made final modifications to the initial item pool.

2.2 Measures assessing construct validity

Below, all measures will be presented in the order in which they were surveyed. Descriptive statistics and consistency measures of validation scales can be found in Table 1.

2.2.1 Teacher behavior in dyadic relationships

Teachers were asked to rate 20 items, each consisting of a unique blend of communion and agency that can be allocated to eight scales reflecting the octants of the interpersonal circumplex for teacher behavior (see Figure 1). These items measure the extent to which a teacher displays affection or sensitivity (communion) in dyadic interactions with a child, as well as the degree of guidance or control (agency) that the teacher provides in order to manage the child's learning process, using 7-point-Likert answering scales (1 = *do not agree at all* to 7 = *completely agree*). The full item set is displayed in the

1 Example of a typical teaching situation and four different ways in which teachers can respond to it, taken from a list of 15 scenarios of the SiS (Aelterman et al., 2019): "At a difficult point in the lesson, students begin to complain. In response you… (a) Show and teach them a helpful strategy for how to break down the problem to solve it step-by-step (resembles a guiding teaching style), (b) Just ignore the whining and complaining. The need to learn to get over the obstacles themselves (abandoning teaching style), (c) Accept their negative feelings as okay. Assure them that you are open to their input and suggestions (attuning teaching style), (d) Insist they pay attention. They must learn this material for their own good (demanding teaching style)."

TABLE 1 Descriptive statistics and internal consistencies (Cronbach's alpha) of teachers communion and agency and validation constructs.

	N	*M*	SD	*α*
Constructs on child level				
Communion[a]	440	0.97	0.95	–
Agency[a]	440	−0.12	1.24	–
Closeness	440	3.48	0.82	0.74
Conflict	440	2.13	1.03	0.84
Dependency	440	1.89	0.91	0.86
Enjoyment	440	3.64	0.96	0.91
Anger	440	2.01	1.05	0.92
Anxiety	440	1.95	0.92	0.82
Child academic performance[a]	416	4.30	1.14	0.85
Constructs on teacher level				
Heterogeneity beliefs	88	3.25	0.68	0.86
Self-efficacy	88	3.61	0.63	0.71

[a]Children's academic performance was assessed using a composite score based on their grades in German and mathematics. Higher values represent better academic performance.

Supplementary Table S1. Based on their teachers' responses, we calculated axis scores for the level of agency and communion each child received. (for details see below).

2.2.2 Perception of relationship quality

The STRS (Pianta, 2001) assesses the teacher's perception of the quality of their relationship with individual students in terms of closeness, conflict, and dependency. We used a German translation of the STRS by Milatz et al. (2014) with a 5-point Likert scale (1 = *not true at all* to 5 = *completely true*). Closeness (4 items) measures a teacher's perception of the extent to which a child seeks contact and shares their own emotions and experiences (e.g., 'This child openly shares his/her thoughts and feelings with me.'). Conflict (5 items) assesses the degree to which a teacher perceives a child's interpersonal behavior as negative or unpredictable and the extent to which they feel emotionally drained by it (e.g., 'This child demands all my energy.'). Dependency (3 items) captures teacher perception of mainly negative child behaviors, for example, excessive demands for attention or possessive behavior (e.g., 'This child mostly feels I am treating him unfairly').

2.2.3 Teacher emotions

The TES (Frenzel et al., 2016) captures the three most relevant emotions in the context of teaching, namely enjoyment, anger, and anxiety. Originally intended to assess emotional experiences of teaching a school class, we adapted the items to address emotional experiences in the dyadic relationship between teacher and individual child (answering scales: 1 = *not true at all* to 5 = *completely true*). Enjoyment (3 items) captures feelings of pleasantness, motivational approach tendencies towards the child, and appraisals of goal congruence (e.g., 'Teaching this child gives me pleasure.'). Feelings of anxiety (3 items) are characterized by unpleasant feelings and motivational avoidance tendencies caused by appraisals of threat and low personal coping skills (e.g., 'When I teach this child, I feel tense and nervous.'). Anger (3 items) is characterized by unpleasant feelings and aversive motivational tendencies, combined with cognitions of goal frustration and other-accountability (e.g.,'When I teach, I occasionally get really mad at this child.').

2.2.4 Child academic performance

Teachers were asked to report school grades in German and mathematics (1 = *very good*, 6 = *deficient*) as an indicator for a child's academic performance. We inverted and averaged the two grades and created a composite measure with higher scores reflecting better performance ($n = 284$; $\rho = 0.73$). In classrooms where children did not get grades yet (especially in grades 1–3) or in rare cases where information on children's grades were unavailable, teachers were asked to provide an estimated grade that best matched the child's performance in the particular subject ($n = 132$ children; $\rho = 0.74$). For 24 children neither grades nor grade estimates were available.

2.2.5 Teacher heterogeneity beliefs

The five-item-scale (Dignath et al., 2020) measures the teacher's general beliefs about school classes that are heterogeneous in terms of performance. Higher values describe that performance heterogeneity in a class is perceived as normal and beneficial for teaching and learning, while lower values indicate that performance heterogeneity is perceived as an obstacle to teaching and learning (e.g., 'Achievement in classes with low-performing children cannot be maintained as high as in classes without low-performing children.'; 1 = *not true at all* to 4 = *completely true*).

2.2.6 Self-efficacy towards adaptive teaching

The five items derived from Meschede and Hardy (2020) capture the teacher's self-efficacy with regard to adaptive teaching in performance heterogeneous learning groups. Specifically, it describes a teacher's confidence to master involving and supporting students of different performance levels in their own teaching, e.g., by providing appropriate individual support and differentiating tasks and learning materials (e.g., 'I am confident in enabling independent learning at different competence levels.'; 1 = *not true at all* to 4 = *completely true*).

2.3 Sample and study procedure

We recruited class teachers who teach children from grade one to six via several online forums, including Facebook groups for teachers, and Twitter (X). The questionnaire was programmed using the Unipark survey tool (Tivian XI GmbH, 2023) and took about 50–70 min to complete. Participating teachers agreed to have their data evaluated for research purposes. After completion, each teacher received 30€ as compensation for their time and effort.

At the questionnaire's beginning, teachers were asked to randomly select five different children from their class. Regarding every individual child, teachers were then asked to describe their teaching behavior, their emotions, and their perceived relationship quality. They also provided information on various attributes of the child and the child's school grades (see below for details).

In total, this resulted in data on 440 children selected from 88 different school classes with a mean class size of 23 students ($M = 22.69$, $SD = 4.12$; *Min/Max*: 8–30). Of them, 305 children (69.3%) attended grades 1 to 3 and 135 children attended grades 4 to 6 (30.7%). For 52 percent of the children, their teacher reported having taught

them since less than one school year, for 26 percent of the children more than one and less than two school years, for 14 percent more than two and less than three school years, and for 8 percent more than three and less than four school years.

Data were derived from a sample of 88 teachers (80% female). Teachers were on average 33 years old ($M = 32.94$, $SD = 10.36$; *Min/Max*: 23–64) and have been working as teachers for about 6 years ($M = 6.52$, $SD = 8.55$; *Min/Max*: 0.2–40). Seventy-nine teachers reported German as their first language, five teachers reported another language than German, and four teachers were bilingual (German and another language). The majority of the sample taught at an elementary school ($N = 80$), three teachers taught at a special needs school, and five teachers taught at inclusive schools that cover grades 1 to 10. Twelve teachers (13.6%) reported having obtained an extra qualification in special education or inclusion.

2.4 Statistical analysis

Data analysis aimed to select items to cover the eight scales of the circumplex measure of teacher behavior and provide evidence for its structural and construct validity. If not stated otherwise, analyses were performed with the open-source software R 4.0.5 (R Core Team, 2021).

2.4.1 Item selection and structural validation

In order to develop a parsimonious self-descriptive inventory of teacher behavior, item selection aimed to capture each of the octant scales with one or two items. Selection procedures for circumplex inventories are mainly based on the items' empirical location (angular location and vector length) in the two-dimensional space. The items coordinates can be derived by orthogonal two-factor principal component analysis (PCA) with the two components representing agency and communion, respectively. Following Jacobs and Scholl (2016), items should sufficiently cover the octant space such that the items' angle should not deviate ±22.5° from the octant's midpoint. Furthermore, item vector lengths should be greater than 0.30, ensuring that items hold sufficient interpersonal content (Gurtman, 1991). Finally, acceptable internal consistency for the octant scales must be achieved (Eisinga et al., 2013). After item selection, we performed confirmatory circumplex structural analyses to examine whether our data fitted the circular model, using the R-package "CircE" (Grassi et al., 2010).

2.4.2 Construct validation

We employed two analytical approaches to validate our questionnaire: the Structural Summary Method (SSM; Zimmermann and Wright, 2017) to examine Hypotheses 1a-3 and linear multilevel regression analyses, which account for nested data structures and control variables, to test Hypotheses 4a-4b.

2.4.2.1 Structural summary method

The SSM (Zimmermann and Wright, 2017) was used to test whether an external variable had an interpersonal relation with the circumplex measure for teacher behavior. SSM can be used to map the interpersonal profile of the external variable onto the circumplex surface and supplies inferential statistics to evaluate the accuracy of the resulting profiles (Zimmermann and Wright, 2017). Hence, SSM-statistics provide crucial information regarding our questionnaire's construct validity. As the circumplex measure in itself should conform to the circular pattern, the correlations of the external variable with the octant scales should also conform to a cosine curve with a clear positive correlation in one octant, zero correlation for orthogonal octants, and a negative correlation in the respective opposite octant of the circumplex. This desired pattern is approximated via a cosine function and can be evaluated against its mathematical properties (Zimmermann and Wright, 2017).

Relevant parameters of this function are their elevation, amplitude, and angular displacement. *Elevation* reflects the relationship between the external variable and general teacher behavior. The cosine curve's *amplitude* indicates the degree of variability within the correlations of the external variable and the octants, thus capturing the content sensitivity of the external variable with the circumplex. In case of high content sensitivity, high values (frequent behavior) in one region of the circumplex and relatively low values (infrequent behavior) in the opposite region would indicate a large differentiation within the correlations. The magnitude of the amplitude indicates the strength of the construct's relationship with the circumplex, by which amplitudes around 0.10, 0.16, and 0.23 are classified as small, medium, or large effects, respectively (Zimmermann and Wright, 2017). The *angular displacement* (0°-360°) represents the area of the circumplex most associated with the external variable. However, the external variable's amplitude and angular displacement are meaningful only if patterns of correlations fit to a perfect cosine curve. The SSM further supplies a value for communion and agency, indicating the average correlation between the external variable and the two core dimensions of interpersonal behavior. Following Zimmermann and Wright (2017), a curve of best fit with a clear maximum in one octant and a clear minimum in the opposite octant is defined by $R^2 \geq 0.70$.

2.4.2.2 Multilevel regression analysis

The SSM-approach does not allow to incorporate control variables or to account for the nested data structure. We therefore additionally calculated regression analyses on the two decomposed dimensions of teacher behavior, agency and communion, while accounting for the nested data structure and control variables. Circumplex octants were decomposed into two axis scores using trigonometric formulas (cf. Gurtman and Pincus, 2003):

$$Communion = \frac{1}{4}\sum_{k=1}^{8}\cos(\theta_k)\cdot S_k$$

$$Agency = \frac{1}{4}\sum_{k=1}^{8}\sin(\theta_k)\cdot S_k$$

To assign each child its individual values on communal teacher behavior (communion, x-axis) and agentic teacher behavior (agency, y-axis,), the scale value (S_k) of each octant scale was weighted by the cosine (or sine respectively) of the scales angular location (θ_k). For better scaling, the sum was multiplied by a constant factor 1/4. Thus, the values for communion and agency determined for each child use the information from the entire circumplex and can be interpreted as the extent of

communion and agency a teacher shows in dyadic interactions with a child.

Due to the nested structure of the data (children within teachers), we used multilevel regression analyses to predict teacher's level of agency and communion by child academic performance (level 1) and teacher's heterogeneity beliefs and self-efficacy (level 2). To test our moderation hypotheses (H4a-H4b) we included the cross-level interactions (Child Academic Performance X Heterogeneity Beliefs; Child Academic Performance X Self-efficacy) in our models. For significant interactions, we followed recommendations by Aiken and West (1991) and tested the simple slopes between heterogeneity beliefs (resp. self-efficacy) and each outcome at higher (+1 *SD*) and lower levels (−1 *SD*) of children's academic performance. The two separated random intercept models were estimated using the software MPLUS 8.9 (Muthén and Muthén, 2023).

3 Results

3.1 Item selection

PCA is recommended and suitable in deriving information about the item's localization in the two-dimensional space because the components' loadings can be treated as descriptive summaries of the items (e.g., Locke, 2019; Trobst, 2000). In a first step, the 20 items on self-reported teacher behaviors were subjected to PCA, in order to extract two orthogonal components representing agency and communion. The obtained factor loadings express the extent of agency and communion within each item and thus can serve as polar coordinates mapping each item onto the two-dimensional circumplex space (Wiggins and Broughton, 1991). The PCA can ensure orthogonality but not axis positioning, leading to potential misalignment with the theoretical structure. Thus, we applied Procrustes rotations (McCrae and Costa, 1989) using the R-package "EFA.dimensions" (O'Connor, 2022). The Tucker-Wrigley-Neuhaus coefficient, a measure of similarity between the target and Procrustes-rotated loadings (Guadagnoli and Velicer, 1991), showed 81% congruence, which can be considered a good fit.

Based on the Procrustes-rotated loadings, we derived information on each item's angular location and vector length (see Supplementary Table S1, pre-selection). Ten items were found to lie within the valid range of ±22.5° of their hypothesized octant scales. In case of two octants (*participating-tolerating, admonishing*) none of the theoretically presumed items were located within the desired range. As a consequence, we had to increase the criterion for item selection to ±45° from an octant's midpoint. For the octant scale *participating-tolerating*, neither of the two proposed items were within the desired range, so we chose the one (pt1) with the lowest deviation from the facet's midpoint to represent this octant. This selection procedure resulted in a smaller set of 13 items which were subjected to a second PCA with Procrustes rotation. As a result of item deletion, the remaining 13 items were "pulled" into the desired location, with angles of 12 items falling within the theoretically expected range and one item (ad2) deviating from it minimally (23.77° from the midpoint of its octant instead of the desired ±22.5). Also, the vector lengths of all items (with the exception of item pt1) were above >0.30, as required by Gurtman (1991), indicating that the selected items contain high interpersonal content. Angular locations and vector lengths after item selection can be found in Supplementary Table S1 (post-selection).

Full information about item statistics (mean, standard deviation, skewness, kurtosis) for the final item set is available in Table 2. Only one item (hg1) was negatively skewed with a value greater than |1| and kurtosis value greater than |2|. Accordingly, our data largely met criteria of normal distribution. While three of eight scales were measured by single items *(ignoring-resigning, participating-tolerating, understanding-interested)* the other five scales were each represented by two items. After reliability analyses showed sufficient to excellent internal consistencies for the five scales, the scale means were calculated (see Table 3). Most teachers predominantly described their behavior in dyadic interactions with a child as *helping-guiding* and *understanding-interested* (behaviors with moderate agency and high communion). Teachers least often described their behavior as *admonishing* (moderate agency, low communion) or *indefinite-waiting* (low agency, moderate communion).

3.2 Structural validation

Intercorrelations of the octant scales are shown in Table 3. In order to compare results from exploratory item selection procedures, we evaluated the confirmatory circular model fit (see Browne, 1992, or Rogoza et al., 2021, for adequate model fit criterions). We started with an unconstrained model with a loose circular arrangement of octant scales (M1) and gradually raised constraints (M2 = equal spacing; M3 = equal radius) to fit a model with equal spacing and equal radius (M4). The unrestricted model demonstrated an excellent fit and confirmed the loose circular structure of the scales (see Supplementary Table S2). An acceptable model fit was maintained even after equal spacing was constrained in M2. By constraining the model to equal radius (M3) a larger decline in model fit was observed. Consequently, model fit was insufficient for M4. The final localization of octant scales within the circumplex is depicted in Figure 2, illustrating a quasi-circumplex structure of the data that supports our instrument's structural validity.

3.3 Construct validation

All relevant parameters for evaluating the correlation profiles between teacher behavior and external criteria arising from Hypotheses 1a-3 are presented in Table 4.

3.3.1 Correlation profiles with perception of relationship quality

Scales on perception of relationship quality (closeness, conflict, dependency) had interpretable correlation profiles with a clear positive correlation in one octant and negative correlation in the opposite octant (amplitudes ≥ 0.22, $R^2 \geq 0.81$; see Figure 3). As expected, closeness had positive correlations with teacher communal behaviors and negative correlations with teacher agentic behaviors (H1a). The summary vectors angle was 323.4° [306.4°, 341.4°], indicating that the area of the circumplex most strongly associated with closeness was located in the *understanding-interested* [315°-360°] octant. In line with predictions, both, the conflict and dependency scales were negatively correlated with communion and

TABLE 2 Means, standard deviations, skewness, and kurtosis for the 13 items of teacher behavior (final item set).

Item	Label	*M*	SD	Skewness	Kurtosis
hg1	If X cannot yet solve a task correctly, I help him/her to identify any misconceptions and thus to find the solution.	5.69	1.21	−1.32	2.19
hg2	If X has difficulties solving a task, I am happy to show him/her step by step how to solve the problem.	5.50	1.31	−0.91	0.54
di1	When I give assignments, I always check that X understands what he/she needs to do.	4.56	1.70	−0.47	−0.66
di2	To X, I very often explain the solution of a problem step by step.	4.08	2.01	−0.05	−1.27
ds1	To X, I often say something like he/she should hurry up to finish an activity in class.	3.62	2.02	0.14	−1.27
ds2	To X, I often directly say something like, now is the time to pay attention.	4.26	2.04	−0.21	−1.26
ad2	I explicitly tell X that the tasks I set must be completed without any ifs or buts.	3.60	2.00	0.20	−1.21
ad3	I make it clear to X that given tasks must be completed, otherwise negative consequences will follow.	3.37	1.92	0.32	−1.13
ir2	To keep the flow of the lesson going, I move from one learning activity to a new learning activity without paying particular attention to how X is coping.	3.75	1.66	0.09	−0.75
iw1	In my lesson preparation, I do not plan specifically for X – he/she will find his/her way into the lesson as it is.	4.07	1.76	−0.10	−0.91
iw2	During class, I just let X work without doing much planning ahead for X or interfering too much.	4.33	1.83	−0.18	−1.08
pt1	When I give tasks, X is always allowed to choose tasks in which he/she learns something new.	4.45	1.45	−0.29	−0.06
ui1	I always listen patiently and with interest especially to X when he/she contributes something in class.	5.58	1.33	−0.95	0.67

Replace X for the alias of the child. $N = 440$.

positively correlated with agency (H1b), with conflict showing a slightly stronger association with agentic behavior than dependency. Thus, their summary vector angles ranged from 116.8° [108.5°, 124.9°] to 131.1° [120.1°, 142.2°], falling into the *demanding-strict* [90°- 135°] octant. We interpreted our findings as supportive of construct validity.

3.3.2 Correlation profiles with teacher emotions

The correlation profiles with teacher emotions were meaningful with amplitudes ≥ 0.42 and $R^2 \geq 0.83$ (see Figure 4). The teacher's feelings of enjoyment when interacting with a child correlated positively with the teacher's communal behavior and (to a greater extent) negatively with the teacher's agentic behavior, as hypothesized (H2a). The angle of the summary vector was 297.6° [290.0°, 305.0°], stating that the teacher behaved more communal and less agentic towards a child to the extent that they enjoyed interacting with the child (*understanding-interested*). Teacher experience of anxiety and anger was negatively related to communion (H2b), with slightly stronger associations being found for anger compared to anxiety. Positive correlations were found between anger/anxiety and agency. The corresponding angles ranged from 125.7° [118.2°, 133.3°] to 109.8° [101.6°, 118.4], revealing that teachers behaved less communal and more agentic to the extent that they felt anger or fear towards a child (*Demanding-strict*), which was in line with our predictions and confirmed construct validity.

3.3.3 Correlation profiles with child academic performance

A child's academic performance level showed a clear pattern of correlations with the teacher's behavior in dyadic interactions (amplitude = 0.49; $R^2 = 0.90$; see Figure 5). A moderate negative correlation was found with agency, indicating less agentic forms of teacher behavior towards high-performing children, as predicted (H3). No correlation was found between academic performance and communal teacher behavior; thus, the summary vector's angle was placed orthogonally to the x-axis (269° [261.0°, 277.0°]). The profile plot was placed in the facets of the circumplex with moderate communion and low agency, namely on the boundary of the two octants *indeterminate-waiting* [225°- 270°] and *participating-tolerating* [270°- 315°]. In conclusion, systematic correlations observed between measures inherent in the teacher and academic characteristics of the child strengthen the construct validity of our questionnaire.

3.3.4 Predicting teacher's interpersonal behavior from teacher's professional beliefs

The ICC for communion was about 0.37 for children nested within teachers, indicating the proportion of variance in communal teacher behavior explained by teachers was 37 percent. For agency the ICC indicated that 0.7 percent of variance in agentic teacher behavior could be explained by teacher level. Table 5 summarizes the results of multilevel regression analyses predicting agency and communion of teacher behavior from children's academic performance (level 1), teacher heterogeneity beliefs and self-efficacy (level 2), representing the final stage in assessing construct validity. The independent variable on level 1 was centered around its group mean, independent variables on level 2 were centered around their grand mean. Consequently, the intercept in each model is the level of agency (or communion) averagely performing children experienced from teachers with average heterogeneity beliefs and self-efficacy.

3.3.4.1 Communion

We found a main effect of teacher heterogeneity beliefs ($B = 0.246$, $SE = 0.113$, $p = 0.030$): teachers who viewed heterogeneity in the classroom as valuable interacted more communal with children than teachers who saw heterogeneity in a less positive manner. Also, we obtained a main effect for self-efficacy ($B = 0.391$, $SE = 0.125$, $p = 0.002$): teachers with strong self-efficacy behaved more communal than teachers with weak self-efficacy.

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TABLE 3 Descriptive statistics, internal consistencies (Spearman-Brown), and intercorrelations for the octant scales of teacher behavior with confidence intervals.

	M	*SD*	*ρ*	1	2	3	4	5	6	7
1. Helping-guiding	5.60	1.09	0.65							
2. Directing	4.32	1.67	0.77	0.29** [0.21, 0.38]						
3. Demanding-strict	3.94	1.82	0.76	0.07 [−0.03, 0.16]	0.52** [0.44, 0.58]					
4. Admonishing	3.49	1.85	0.87	−0.05 [−0.14, 0.04]	0.33** [0.24, 0.41]	0.70** [0.65, 0.74]				
5. Ignoring-resigning[a]	3.75	1.66	-	−0.13** [−0.22, −0.03]	−0.34** [−0.42, −0.25]	−0.15** [−0.24, −0.05]	0.02 [−0.07, 0.12]			
6. Indeterminate-waiting	4.20	1.52	0.60	−0.12* [−0.21, −0.02]	−0.62** [−0.67, −0.56]	−0.37** [−0.45, −0.29]	−0.15** [−0.24, −0.06]	0.49** [0.41, 0.56]		
7. Participating-tolerating[a]	4.45	1.45	-	−0.01 [−0.10, 0.09]	−0.06 [−0.15, 0.04]	−0.13** [−0.22, −0.03]	−0.04 [−0.14, 0.05]	0.02 [−0.08, 0.11]	0.08 [−0.02, 0.17]	
8. Understanding-interested[a]	5.58	1.33	-	0.30** [0.21, 0.38]	0.00 [−0.09, 0.10]	−0.19** [−0.28, −0.10]	−0.23** [−0.32, −0.14]	−0.07 [−0.16, 0.02]	0.06 [−0.04, 0.15]	0.16** [0.07, 0.25]

Octant scales ranges from 1 = do not agree at all to 7 = completely agree.
[a]Single-item scale.

A significant cross-level interaction between teacher heterogeneity beliefs and communion suggested that the relationship between the two variables varied according to the child's academic performance ($B = -0.145$, $SE = 0.059$, $p = 0.014$). Contrary to predictions (H4a), post-hoc tests revealed that teachers with strong heterogeneity beliefs were more communal with low-performing children than with high-performing children ($B = -0.111$, $SE = 0.054$, $p = 0.038$), whereas teachers with weak heterogeneity beliefs did not differ in their communion depending on the level of the child's academic performance ($B = 0.083$, $SE = 0.059$, $p = 0.159$). Further *post hoc* testing of the interaction showed that the positive effect of teacher heterogeneity beliefs on communion was significant only for children with relatively low performance ($B = 0.392$, $SE = 0.135$, $p = 0.004$), while high-performing children received the same communion level regardless of their teacher's heterogeneity beliefs ($B = 0.099$, $SE = 0.121$, $p = 0.412$). The plots of the obtained cross-level effects can be found in Figure 6.

3.3.4.2 Agency

With agency as the outcome, we found a negative effect of children's academic performance ($B = -0.805$, $SE = 0.049$, $p < 0.001$), indicating that teachers showed less agency towards children whose academic performance was already advanced than towards children with lower performance. Neither teachers' heterogeneity beliefs ($B = 0.051$, $SE = 0.090$, $p = 0.568$) nor their self-efficacy ($B = -0.025$, $SE = 0.105$, $p = 0.809$) had a direct effect on their agency. While we did not find a cross-level interaction for teacher heterogeneity beliefs ($B = -0.102$, $SE = 0.085$, $p = 0.229$), the interaction between teachers' self-efficacy and children's academic performance was significant ($B = -0.206$, $SE = 0.059$, $p = 0.002$). Post-hoc tests showed that the interaction effect was due to the two groups of teachers differing in their behaviors towards high-performing children but not towards low-performing children: children with advanced performance levels received less agency from teachers with strong than from teachers with weak self-efficacy ($B = -0.233$, $SE = 0.118$, $p = 0.048$) while children performing relatively low obtained similar degrees of agency from both groups of teachers ($B = 0.183$, $SE = 0.129$, $p = 0.158$). In summary, our results supported H4b in that as compared to teachers with weak self-efficacy, teachers with strong self-efficacy showed more complementarity in their teaching, especially by more strongly lowering their agency towards high-performing children (but not by more strongly increasing their agency towards low-performing children).

4 Discussion

We developed the *Questionnaire on Dyadic Interpersonal Teacher Behavior*, which captures different forms of behavior a teacher displays in the dyadic relationship with a child. Based on the framework of interpersonal theory (Horowitz and Strack, 2011), the DITeB uses a circumplex structure, to describe a teacher's interpersonal behavior along two orthogonal dimensions: communion and agency. Since circumplex models allow for the simultaneous description and analysis of both dimensions, this approach offers a major advantage over unidimensional scales that assess teacher agency and teacher communion separately. In addition, while other research implies that the teacher's behavior is similar towards all children within a class and can consequently be subsumed into his or her teaching style

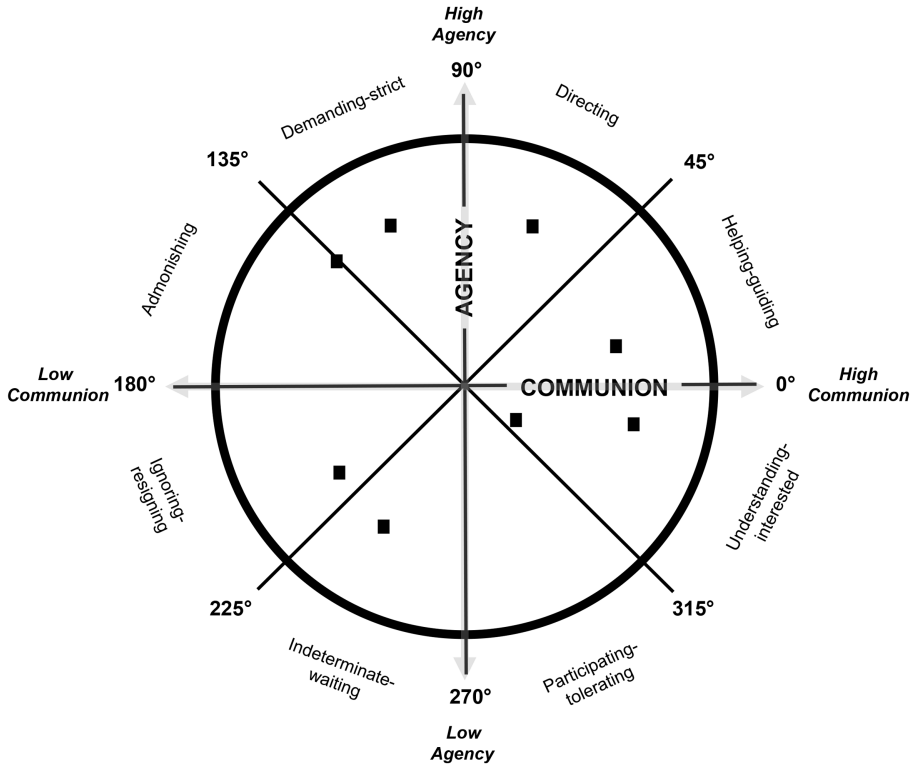

FIGURE 2
The octant scales' final localization within the circumplex of teacher behavior.

(Aelterman et al., 2019; Wubbels and Levy, 1991), our results suggest that teachers display different kinds of interpersonal behaviors towards different children, underscoring the benefit of examining teacher behavior at the level of dyadic relationships. Thus, our new measure is the first self-report questionnaire that allows for the assessment of dyad-specific teacher behaviors and the analysis of reciprocal effects of teacher and child behaviors, making it a useful tool for drawing inferences about adaptive teaching that is attuned to the child's characteristics, such as his or her learning behaviors and academic performance. In the present study, we tested the questionnaire's structural and construct validity.

4.1 Structural and construct validity of the DITeB

Item selection procedures resulted in a smaller set of 13 items representing the octant scales. Five octants were measured by two items with sufficient to excellent internal consistency while the remaining three octants (*ignoring-resigning, participating-tolerating, understanding-interested*) were represented by single items. Confirmatory circumplex structural analyses indicated that the data conformed to a quasi-circumplex structure, with octant scales equally spaced at 45-degree intervals around the circle, yet without reaching equal radius (equal distance from the circle's midpoint). The difference in scale radius may have been due to the *participating-tolerating* scale having a shorter vector length: it was very challenging to create items that convey moderately strong communion and weak agency simultaneously, i.e., behaviors that reflect an affectively moderately positive teacher-child relationship in which the teacher provides much autonomy. To fully assess the circumplex of interpersonal teacher behavior, future studies should generate additional items for this region of the circumplex.

To test the construct validity of the new instrument, we used several well-established measures that previous research used to assess relationship quality, including teacher perception of relationship quality (Pianta, 2001) and teacher emotions (Frenzel et al., 2016).

Results supported our research hypothesis that the more the teacher saw the relationship with a child as close, the more the teacher behaved communal and with weak agency in dyadic interactions with the child. By the same token, we found evidence supporting our assumption that teachers interacted with weak communion and strong agency with a child they perceived as high in conflict and high in dependency. These findings suggest that strong communion and weak agency are beneficial for the child, consistent with other research that linked teacher relationship perceptions to student outcomes and found that children felt emotionally supported and recognized in relationships that teachers described as close, and that children expressed a lack of support and recognition from their teachers when the relationship was perceived as conflictual by the teacher (Milatz et al., 2014).

In the tradition of attachment theory, teacher's perceptions of child closeness, conflict, and dependency are considered valid measures of relationship quality (Pianta, 2001). Against this background, we interpret the systematic interrelations we found between teacher-reported communion and agency on the one hand, and teacher-reported relationship quality on the other as evidence that our instrument measures different qualities of teacher behavior. None of the correlations between communion and agency with the subscales for relationship quality perception were weaker than $r = -0.22$ or

TABLE 4 Correlations and structural summary parameters for relations between the circumplex of teacher behavior and perception of relationship quality, teacher emotions, and children's academic performance.

	Correlations with octant scales [CI]								Structural summary parameters					
	Helping-guiding	Directing	Demanding-strict	Admonishing	Ignoring-resigning	Indeterminate-waiting	Participating-tolerating	Understanding-interested	Elevation [CI]	Communion [CI]	Agency [CI]	Angle in degree [CI]	Amplitude [CI]	R^2
Perception of relationship quality														
Closeness	0.12*	−0.03	−0.21**	−0.28**	0.03	0.02	0.11*	0.27**	0.01	0.17	−0.13	323.4	0.22	0.846
	[0.03, 0.22]	[−0.12, 0.06]	[−0.29, −0.11]	[−0.36, −0.19]	[−0.07, 0.12]	[−0.07, 0.12]	[0.02, 0.21]	[0.18, 0.35]	[−0.03, 0.04]	[0.11, 0.23]	[−0.20, −0.06]	[306.4, 341.4]	[0.16, 0.28]	
Conflict	−0.08	0.33**	0.60**	0.57**	−0.08	−0.32**	−0.08	−0.26**	0.09	−0.19	0.39	116.8	0.43	0.810
	[−0.17, 0.01]	[0.24, 0.41]	[0.53, 0.65]	[0.51, 0.63]	[−0.17, 0.01]	[−0.40, −0.23]	[−0.17, 0.01]	[−0.34, −0.17]	[0.05, 0.12]	[−0.25, −0.13]	[0.33, 0.44]	[108.5, 124.9]	[0.38, 0.48]	
Dependency	−0.13**	0.19**	0.45**	0.51**	0.03	−0.17**	−0.05	−0.25**	0.07	−0.22	0.26	131.1	0.34	0.816
	[−0.22, −0.03]	[0.10, 0.28]	[0.37, 0.52]	[0.44, 0.58]	[−0.07, 0.12]	[−0.26, −0.08]	[−0.14, 0.05]	[−0.33, −0.16]	[0.04, 0.11]	[−0.28, −0.17]	[0.20, 0.32]	[120.1, 142.2]	[0.29, 0.39]	
Teacher emotions														
Enjoyment	0.06	−0.36**	−0.59**	−0.51**	0.06	0.31**	0.22**	0.40**	−0.05	0.22	−0.43	297.6	0.48	0.910
	[−0.03, 0.16]	[−0.44, −0.28]	[−0.65, −0.53]	[−0.58, −0.44]	[−0.03, 0.16]	[0.22, 0.39]	[0.13, 0.31]	[0.32, 0.47]	[−0.09, −0.02]	[0.16, 0.28]	[−0.48, −0.38]	[290.0, 305.0]	[0.43, 0.53]	
Anger	−0.12*	0.30**	0.62**	0.61**	−0.03	−0.22**	−0.11*	−0.38**	0.08	−0.27	0.37	125.7	0.46	0.846
	[−0.21, −0.02]	[0.21, 0.38]	[0.55, 0.67]	[0.55, 0.66]	[−0.12, 0.07]	[−0.31, −0.13]	[−0.20, −0.02]	[−0.45, −0.29]	[0.05, 0.12]	[−0.32, −0.22]	[0.32, 0.43]	[118.2, 133.3]	[0.41, 0.51]	
Anxiety	−0.04	0.38**	0.52**	0.46**	−0.10	−0.39**	−0.09*	−0.27**	0.06	−0.14	0.39	109.8	0.42	0.833
	[−0.14, 0.05]	[0.30, 0.46]	[0.45, 0.59]	[0.38, 0.53]	[−0.19, −0.00]	[−0.47, −0.31]	[−0.19, −0.00]	[−0.36, −0.19]	[0.02, 0.09]	[−0.20, −0.08]	[0.34, 0.45]	[101.6, 118.4]	[0.37, 0.47]	
Child academic performance[a]														
Child academic performance[a]	−0.12*	−0.61**	−0.44**	−0.32**	0.21**	0.54**	0.20**	0.18**	−0.04	−0.01	−0.49	269.0	0.49	0.903
	[−0.21, −0.02]	[−0.67, −0.54]	[−0.51, −0.35]	[−0.40, −0.23]	[0.11, 0.30]	[0.47, 0.61]	[0.11, 0.29]	[0.08, 0.27]	[−0.08, −0.00]	[−0.08, −0.06]	[−0.54, −0.44]	[261.0, 277.0]	[0.44, 0.54]	

*$p < 0.05$, **$p < 0.01$. $N = 440$. R^2 = goodness-of-fit to ideal curve. CI = Confidence intervals computed using resampling procedures implemented by the circumplex package for R (Girard et al., 2023).

[a]Higher values represent better academic performance.

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exceeded $r = 0.39$. Hence, the two dimensions of teacher behavior explained a considerable amount of unique variance, suggesting that teacher perceptions of relationship quality and teacher interpersonal behavior were related but distinct aspects of dyadic teacher-child relationships.

Building on the findings from emotion transfer in teachers (Frenzel et al., 2016), we used teachers' self-reports of enjoyment, anger, and anxiety experienced in a dyadic relationship with a child as another measure to investigate our instrument's construct validity. As expected, we found that teachers displayed more communal and less agentic behaviors the more they reported enjoying teaching a particular child. Consistent with this, our results confirmed that the more anger or anxiety a teacher reported when teaching the child, the less communal and the more agentic the teacher behaved towards the child. Thus, our results show that the different qualities of the teacher's emotions corresponded to different behavioral patterns the teacher displayed towards the child. This resonates with the findings from Frenzel et al. (2016) at the classroom level, where students reported receiving more support from their teachers the more the teacher reported enjoying teaching the particular class, and where children experienced more disrespect from the teacher when their teacher felt anger and (to a lesser extent) anxiety in the particular class. Given that in our study all correlations between communion or agency with the three subscales of emotions were above $r = -0.43$ and below $r = 0.39$, we considered teacher emotions and interpersonal behaviors to be related but distinct indicators of relationships between teacher and child.

We also predicted that there would be a systematic relationship between teacher agency and a child's academic performance in the language of instruction and mathematics. In line with interpersonal theory (Horowitz and Strack, 2011) and research on adaptive teaching (Decristan and Dumont, 2021; Hardy et al., 2019), we found that children with higher academic performance encouraged teachers to be less directive and to provide more degrees of freedom in learning (see also Hannover et al., 2022). In summary, our findings suggest that the DITeB is sensitive to measure variations in teacher behavior depending on child performance and thus is a promising tool for studying adaptivity in teaching (e.g., Corno, 2008), i.e., the degree to which the teacher adapts behavior to the individual child's performance or other factors that characterize child agency.

As another piece of evidence for construct validity, we used teachers' professional beliefs and self-efficacy regarding adaptive teaching (Dignath et al., 2020; Meschede and Hardy, 2020) to predict their interpersonal behaviors towards children with different performance levels. We hypothesized that positive heterogeneity beliefs would support teachers in exhibiting equally strong communion, irrespective of the child's performance level. Other than expected, our results revealed that teachers with strong heterogeneity beliefs showed more communion towards low-performing children compared to high-performing children, while no such difference was observed for teachers with weak heterogeneity beliefs. Complementing findings from other research (Dignath et al., 2020; Hachfeld et al., 2015), this result suggests that teachers who see heterogeneity as an asset to the classroom rather than a threat tend to compensate for the perceived disadvantages of low-achieving children by interacting with them in a particularly strong communal manner.

While this behavioral tendency is certainly due to good intentions on the part of the teacher, it probably does not have the intended supportive effect on lower-performing children. There is a risk that they feel treated in a paternalistic manner if they notice that they are treated with more communion than other children (see paternalistic stereotype, Cuddy et al., 2007). As a result, they might infer that the teacher feels pity for them or ascribes them a weaker developmental potential, ultimately undermining their academic progress and growth. Teachers should be sensitized to the fact that all children profit from high communion (Roorda et al., 2011, 2017), regardless of their academic performance, and should take care not to treat different groups of children with different levels of communion.

Our final hypothesis suggested that teachers with strong self-efficacy regarding adaptive teaching would more strongly adapt their behavior according to child performance than teachers with weak self-efficacy. The results supported our hypothesis, in that teachers with strong self-efficacy granted more autonomy to high-performing children than teachers with weak self-efficacy did. However, we did not find the two groups of teachers to differ in the strength of their agency towards low-performing children.

Taken together, a picture emerges in which positive attitudes towards heterogeneity fostered more communal teacher behaviors towards low achieving children while teachers' expectation that they can successfully engage in adaptive teaching gave them the security to withdraw guidance and control from high-performing children and provide them more autonomy. Hence, while the pattern of interrelations we found between indicators of teachers' professional competence (Baumert and Kunter, 2006) and teachers' interpersonal behaviors only partly supported our research hypotheses, it can be interpreted in a meaningful manner ex post and thus does provide evidence for the validity of our measurement tool.

4.2 Assessment of dyadic-specific relationship quality through interpersonal teacher behavior

Overall, our findings show that teachers in our sample described their behavior in dyadic relationships with a child on average as high in communion and moderately strong in agency: the highest scale means fell into the octant *understanding-interested* and *helping-guiding* and the lowest scale means fell into the octants *admonishing* and *indeterminate-waiting*. Although the effects of teacher interpersonal behavior on child outcomes were not directly tested in this study, existing research suggests that this pattern of teacher behavior can be considered to be of high quality.

For instance, meta-analyses by Roorda et al. (2011, 2017) show that the warmth and extent to which the teacher responds to the child's emotional needs within the dyad are decisive for how motivated and engaged the child is and how the child performs academically. Additionally, research by Frühauf et al. (2024) demonstrates that the effect of dyadic teacher communion on child motivation is mediated by the higher satisfaction and lower frustration of the child's need for relatedness to the teacher. Regarding the agency dimension of teacher interpersonal behavior, research suggests that students gain better self-regulated learning skills and autonomous forms of motivation when teachers describe their teaching style towards the class as high in communion and low to moderate in agency (e.g., attuning, guiding, clarifying) (Aelterman et al., 2019; for an overview see Aelterman & Vansteenkiste, 2023).

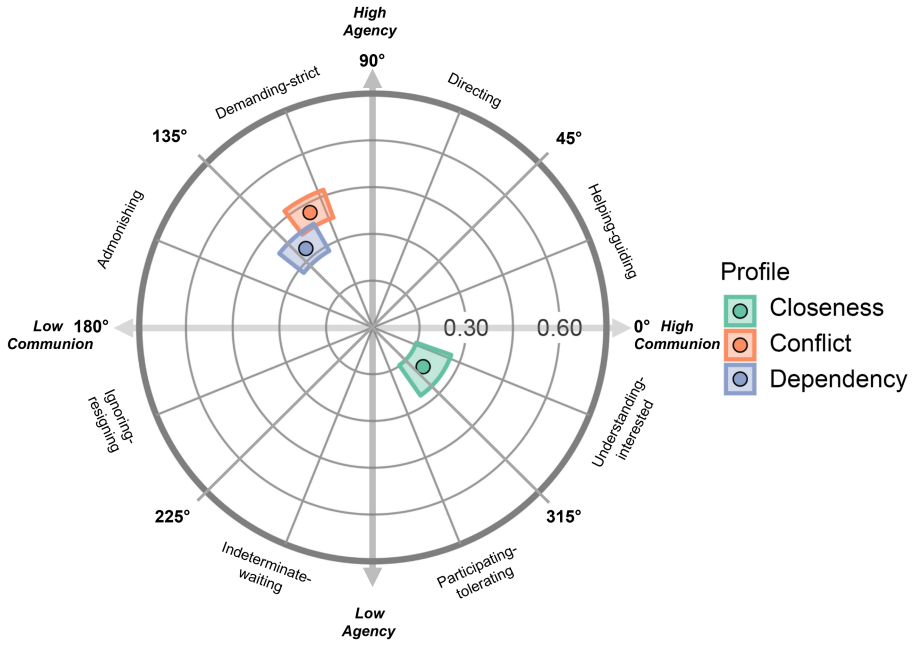

FIGURE 3
Projecting teachers' perceptions on relationship quality on the circumplex of teacher behavior.

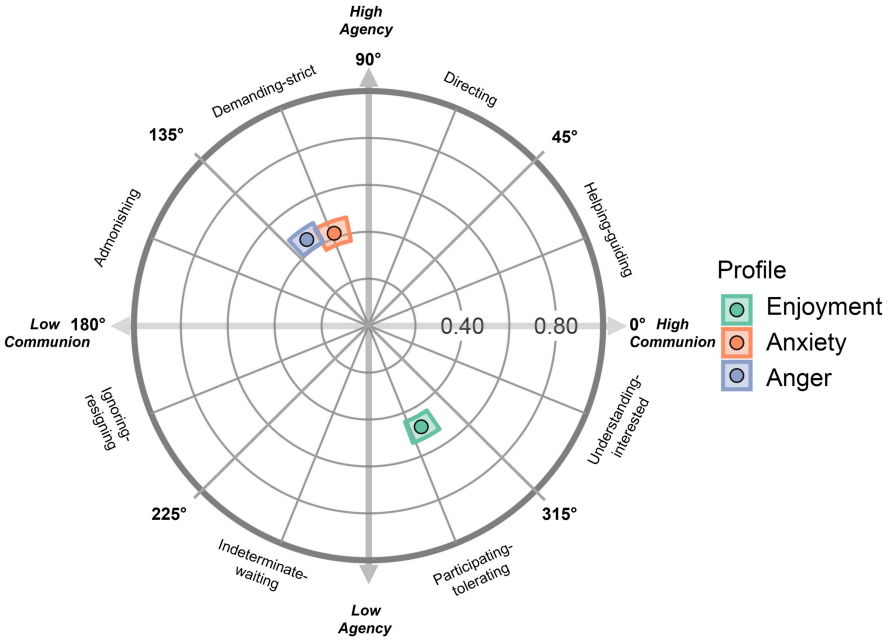

FIGURE 4
Projecting teachers' emotions in dyadic relationships on the circumplex of teacher behavior.

Koeppen et al. (2024) found that strong teacher communion and weak teacher agency strengthened a child's self-determined motivation through satisfaction and non-frustration of their need for competence. These findings suggest that the interpersonal behavior the teachers in our sample displayed in dyadic interactions with their children can be described as being of high quality on average.

4.3 Limitations and future directions

Measurement instruments based on a circumplex structure must meet high methodological requirements: Although conformation analyses confirmed the circular arrangement of the octant scales of the DITeB with equal spacing, we did not achieve perfect circularity with equal radius. However, finding such a perfect circular structure is

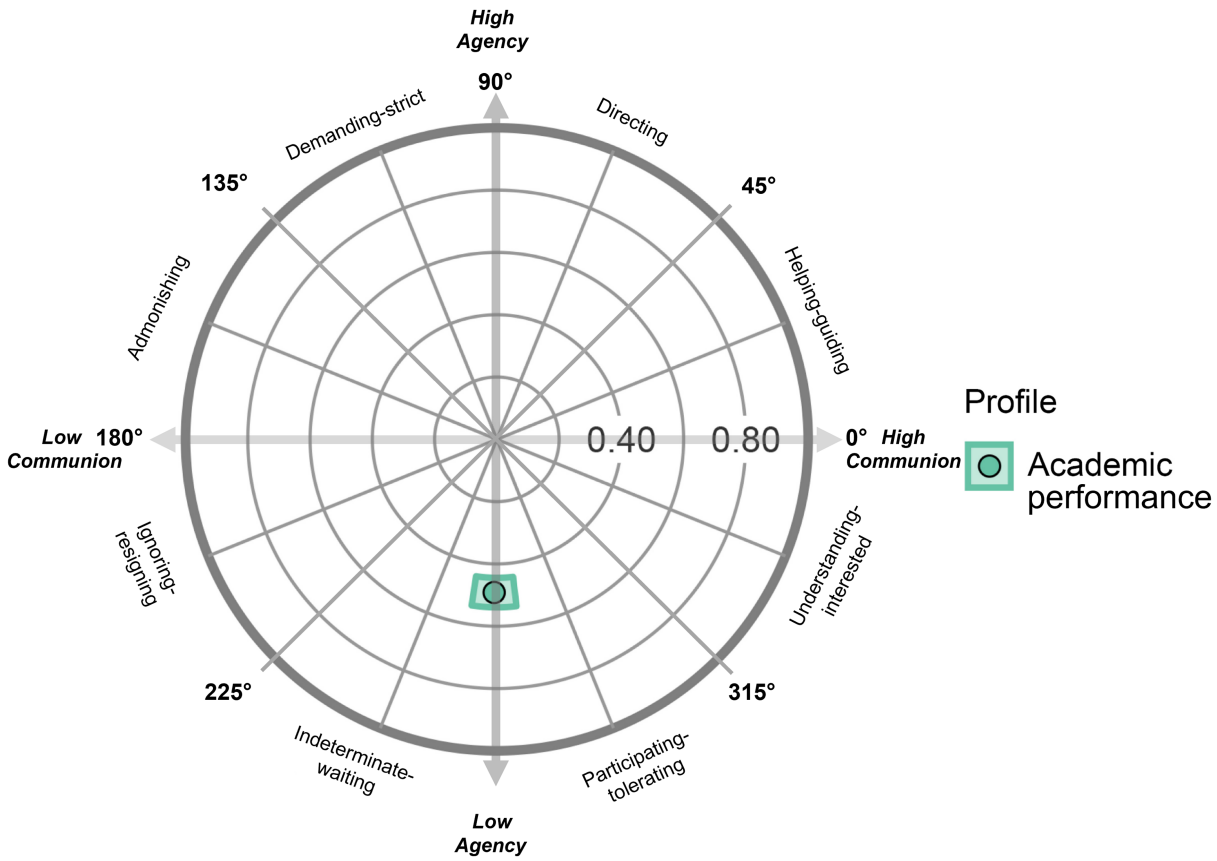

FIGURE 5
Projecting children's academic performance on the circumplex of teacher behavior.

extremely unlikely and it can be assumed that our instrument sufficiently meets the methodological criteria for a valid measurement of teacher behavior (*cf.* Browne, 1992; Nagy et al., 2019).

Although we attempted to include the most relevant measures from other relationship quality research to assess construct validity of the DITeB, all of our external variables were measured via self-report which may be subjectively biased. Future studies should consider examining how teacher self-reports using the DITeB relate to independent observer ratings on the same dimensions of teacher interpersonal behavior. An observer rating scale is available in the research by Frühauf et al. (2024).

Another limitation of our study is that we did not objectively measure children's academic performance with standardized tests, but instead used teachers' reports of children's grades as a proxy. Since student grades were primarily assigned by those teachers who reported on their behavior towards a child, it is conceivable that teachers described their behavior in consistency with the valence of the child's grades. In addition, the strong correlations between teacher agency and grades may be due to a third factor: teacher's expectation. For this reason, our findings should be replicated using children's performance data rather than their grades.

4.4 Practical implications

The DITeB enables teachers to assess and reflect on their own interpersonal behavior in dyadic relationships with a child. By calculating the mean values for each octant scale, a behavioral profile can be created which provides feedback on the teacher's interpersonal behavior along the circumplex. This feedback can assist teachers in recognizing patterns in their dyadic interactions with specific students. For example, they may find out that they tend to treat certain children or groups of children with too much agency or less communion. Consequently, utilizing the DITeB may encourage teachers to modify their behaviors within dyads, thereby fostering high-quality relationships with students.

Moreover, the DITeB could be particularly valuable in teacher education programs. Teacher educators could use DITeB profiles to help prospective teachers learn what constitutes high-quality relationships. Also, in working with DITeB profiles in teacher education, it can be conveyed in what kind of situations the teacher is particularly challenged to ensure a high quality of relationship – for example, when a child behaves noncommunal and thus (following the principle of complementarity, Sadler and Woody, 2017) triggers noncommunal behavior in the teacher or when a child with little initiative causes the teacher to guide the child very strongly and closely.

Additionally, our instrument is recommended for use by school psychologists, as a fine-grained analysis of teacher interactions towards a child could be a promising approach in helping to explain a child's disengagement or a motivation and to derive interventions for improving problematic teacher-child relationships. However, the successful use of the DITeB may depend on the teacher's openness to feedback, as some may view the evaluation of their relationship with a child as a challenge to their competence or authority. Finally,

TABLE 5 Multilevel regression results for the relations of children's academic performance (Level 1), teacher heterogeneity beliefs, self-efficacy (Level 2) and cross-level interactions on communion and agency.

	Communion			Agency		
	B (SE)	*β*	*p*	*B (SE)*	*β*	*p*
Intercept	0.984 (0.063)	1.667	<0.001	−0.098 (0.056)	−0.292	0.078
Child characteristics (Level 1)						
Academic performance[a]	−0.015 (0.040)	−0.020	0.705	−0.805 (0.049)	−0.676	<0.001
Teacher characteristics (Level 2)						
Heterogeneity beliefs	0.246 (0.113)	0.280	0.030	0.051 (0.090)	0.103	0.568
Self-efficacy	0.391 (0.125)	0.424	0.002	−0.025 (0.105)	−0.048	0.809
Cross-level interaction						
Academic performance X heterogeneity beliefs	−0.145 (0.059)	−0.137	0.014	−0.102 (0.085)	−0.060	0.229
Academic performance X self-efficacy	0.073 (0.064)	0.059	0.251	−0.206 (0.059)	−0.102	0.002
R^2 Within	0.015		0.200	0.491		<0.001
R^2 Between	0.361		0.003	0.009		0.766

[a]Higher values represent better academic performance.

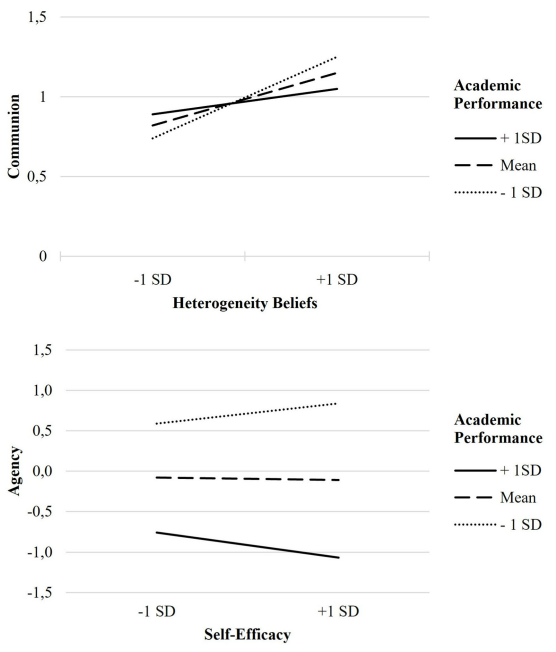

FIGURE 6
Cross-level interaction effects between teacher characteristics (heterogeneity beliefs, self-efficacy) and children's academic performance.

educational researchers may find the DITeB useful for investigating how teacher behaviors relate to child outcomes, such as motivation.

Although our instrument was primarily designed to shed light on how teachers can support their students in their individual learning processes, it also allows for an examination of what teachers themselves can do to improve the quality of their relationships with a child - and thus their own wellbeing. Existing research has demonstrated that teachers' emotions significantly impact job satisfaction, self-efficacy, and the risk of burnout (e.g., Frenzel et al., 2016; Taxer et al., 2019). Our findings indicate that more positive teacher emotions, such as enjoyment, and fewer negative teacher emotions, such as anger and anxiety, are associated with high-quality interpersonal behavior characterized by high communion. Our results thus suggest that teachers can regulate their emotional states through their interpersonal behaviors in dyadic interactions with the children. High demands are placed on teachers in terms of their emotion regulation skills, e.g., because they often have to navigate conflictual relationships. Hence, it is essential for teacher wellbeing that they actively engage in positive relationship-building. Teachers might use the knowledge of the complementarity principle in dyadic interactions (Sadler and Woody, 2017) to their own advantage. For instance, particularly in conflictual relationships, teachers can disrupt the vicious circle of negative interactions with a child by exhibiting communal behaviors, even when faced with socially inappropriate or oppositional defiant behaviors from the child. Communal teacher behavior not only increases the likelihood that the child will learn to engage in communal behaviors themselves but also promotes positive emotions in the teacher, which, consistent with other research, can help reduce emotional exhaustion and enhance job satisfaction (Frenzel et al., 2016; Taxer et al., 2019).

Data availability statement

Original datasets are available in a publicly accessible repository: The original contributions presented in the study are publicly available. This data can be found here: https://osf.io/3tupf/.

Ethics statement

The studies involving human participants were reviewed and approved by Freie Universität Berlin, Berlin, Germany. The participants provided their written informed consent to participate in this study.

Author contributions

MK: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Writing – original draft. MF: Formal analysis, Methodology, Writing – review & editing. BH: Conceptualization, Funding acquisition, Supervision, Writing – original draft. KK: Conceptualization, Funding acquisition, Investigation, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2024.1397936/full#supplementary-material

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