

The Mechanism Through Which Teacher-Child Interaction Influences Early Childhood Development: The Moderating Effect of Multiple Factors

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Abstract

Rooted in ecological systems theory, existing research has found that the relationship between teacher-child interaction (i.e., classroom interactions between 3-6-year-old children and teachers) and child development outcomes is moderated by factors at four levels—individual, environment, process, and time—and has explained the underlying mechanisms of these moderating effects from three perspectives: developmental risk, environmental continuity, and long-term cumulative effects. Future research should further explore more stable moderating variables, establish more integrated theoretical hypotheses, and attend to the moderating mechanisms through which teacher-child interaction influences child development within the Chinese context.

Full Text

Mechanisms Through Which Teacher-Child Interactions Influence Child Development: The Moderating Role of Multiple Factors

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Abstract

Rooted in ecological systems theory, existing research has found that the relationship between teacher-child interactions (i.e., classroom interactions between teachers and children aged 3-6) and child developmental outcomes is moderated

by factors at four levels: individual, environment, process, and time. The underlying mechanisms of these moderating effects are explained from three perspectives: developmental risk, environmental continuity, and long-term cumulative effects. Future research needs to explore more stable moderating variables, establish more integrated theoretical hypotheses, and examine the moderating mechanisms through which teacher-child interactions influence child development within the Chinese context.

Keywords: early childhood education; teacher-child interactions; child developmental outcomes; moderating effects

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The quality of early childhood education classrooms is typically examined from two dimensions: structural quality (relatively stable framework characteristics such as class size and teacher qualifications) and process quality (the quality of teacher-child classroom interactions and the provision of learning opportunities) (Arya & Pianta, 2018). Process quality is primarily measured through teacher-child interactions (sometimes directly referred to as “classroom quality”) and has been shown to be more predictive of child development than structural quality (e.g., Mashburn et al., 2008; Hamre, Hatfield, Pianta, & Jamil, 2014). Within the “teaching through interactions” framework, Hamre et al. (2014) defined teacher-child interaction quality across three dimensions: emotional support, classroom organization, and instructional support. Emotional support reflects warm and secure relationships between teachers and children and teachers’ sensitivity to children’ s needs. Classroom organization reflects how teachers manage behavior and structure instructional time and daily activities. Instructional support refers to how teachers promote higher-order thinking in the classroom. High-quality teacher-child interactions in practice manifest as supportive relationships between teachers and children, timely responsiveness to children’ s needs, efficient organization of activities aligned with children’ s zones of proximal development, respect for children’ s interests and autonomy, use of diverse teaching methods to promote exploration, intentional cultivation of children’ s advanced cognitive skills, and provision of process-oriented feedback (Pianta, La Paro, & Hamre, 2008).

A substantial body of research has identified two major positive effects of high-quality teacher-child interactions. First, high-quality interactions promote children’ s cognitive development and enhance academic skills (language, mathematics, literacy), learning interest, engagement, and learning approaches, thereby improving comprehensive school readiness (e.g., Hu, Teo, Nie, & Wu, 2017; Hu, Fan, Wu, Locasale-Crouch, & Song, 2018; Trawick-Smith, Swaminathan, & Liu, 2016; Williford, Maier, Downer, Pianta, & Howes, 2013). Second, high-quality interactions contribute to better social-emotional functioning, including improved inhibitory control and executive function, and reduced behavior problems (e.g., Pratt, Lipscomb, & McClelland, 2016; Schmitt, Pratt, Korucu, Napoli, & Schmerold, 2018; Weyns, Colpin, Engels, Doumen, & Verschueren, 2019). These positive effects are crucial for children’ s future school adaptation,

long-term academic success, and the development and maintenance of positive interpersonal relationships.

However, current research has also yielded many inconsistent findings. For example, some studies have found only weak or non-existent effects of teacher-child interactions on improving school readiness and cognitive abilities (e.g., Burchinal et al., 2008; Raver et al., 2011), while others have found that teacher-child interactions do not predict children's social-emotional functioning (e.g., Garbacz, Zychinski, Feuer, Carter, & Budd, 2014; Keys et al., 2013). To explain these contradictory results, some researchers have proposed that potential moderating variables may influence the relationship between teacher-child interactions and child developmental outcomes. For instance, higher-quality teacher-child interactions are associated with fewer behavior problems among rural children, but do not affect behavior problems among urban children (Schmitt et al., 2018).

Research on moderating effects in the process through which teacher-child interactions influence child development provides a deeper perspective on underlying mechanisms. To help researchers understand the progress and trends in this area, this review synthesizes studies examining how moderating variables affect the impact of teacher-child interactions, introduces the theoretical foundations of such research, summarizes basic hypotheses, outlines main findings, and proposes future research directions.

2. Theoretical Foundations

According to ecological systems theory, child development is driven and influenced by a series of nested environmental systems. Teacher-child interactions, as one of the proximal processes of individual-environment interaction, constitute an important impetus for child development. These interactions produce complex interactions with multiple factors across the process-person-context-time (PPCT) framework, thereby generating differential impacts on children (Bronfenbrenner & Morris, 2007). First, personal dispositional, resource, and demand characteristics combine in different patterns within individual children, and such characteristic differences may cause different children to benefit differently from the same teacher-child interaction experiences. For example, children who initially exhibit lower inhibitory control show more significant progress after experiencing high-quality teacher-child interactions (Choi et al., 2016). Second, connections between the kindergarten environment and other environments may influence the role that teacher-child interactions play. For instance, teacher-child interactions have more pronounced effects on children from high-risk families (Cadima et al., 2016). Finally, the stability and consistency over time of any element constituting the ecological system are crucial for the effective functioning of the entire system. For example, exposure to poor classroom quality later in development can undermine children's benefits from earlier teacher-child interactions (Broekhuizen, Mokrova, Burchinal, & Garrett-Peters, 2016).

Therefore, although teacher-child interactions exert some independent influence on child development, the magnitude of this influence simultaneously depends on children's characteristics and their immediate or more distal environments. Overall, the interactionist perspective advocated by ecological systems theory provides the foundation for uncovering potential moderating effects.

3. Basic Hypotheses in Moderating Factors Research

Regarding the mechanisms through which moderating variables influence the relationship between teacher-child interactions and child developmental outcomes, current research typically explores three distinct perspectives.

First, from the perspective of developmental risk, the **compensatory hypothesis** proposes that teacher-child interactions may be more strongly positively associated with developmental outcomes for children facing high risks (e.g., poor home environment, difficult temperament, low baseline ability) compared to children without such risks (e.g., Magnuson et al., 2007; Schmitt et al., 2018). High-quality teacher-child interactions may serve as a crucial compensatory factor for these children, helping to reduce developmental disadvantages. Conversely, the **accumulated advantages hypothesis** suggests that children who already possess advantages (e.g., good home learning environment, high socioeconomic status) may be better able to benefit from high-quality teacher-child interactions due to superior learning conditions and foundations, ultimately demonstrating a “rich-get-richer” effect (e.g., Anders et al., 2012; Pinto et al., 2013).

Second, from the perspective of environmental continuity, the **continuities hypothesis** proposes that different environmental systems interact with one another, and that other environmental factors such as family, community, and geographic region may either facilitate or hinder the effectiveness of teacher-child interactions (e.g., Cadima et al., 2016). In contrast, the **discontinuities hypothesis** suggests that the effects of different environmental systems may be relatively separate, with teacher-child interactions exerting independent and relatively consistent influences on child development regardless of other environments (e.g., Keys et al., 2012).

Third, from the perspective of long-term cumulative effects, the **multiplicative hypothesis** implies that teacher-child interaction quality across different developmental stages interacts with itself (e.g., Carr et al., 2019). Later investments in development (e.g., high-quality interactions during kindergarten) can enhance the efficiency of earlier investments (e.g., high-quality interactions in pre-kindergarten child care centers), while early investments without follow-up investments may fail to produce sustained benefits (Ansari & Pianta, 2018). The **additive hypothesis**, however, suggests that teacher-child interaction quality at different stages has relatively independent effects on child development (e.g., Lehl et al., 2016).

It is important to note that these three perspectives are not mutually contradictory; they simply focus on different aspects of how moderating effects operate

and represent research orientations rather than absolute explanations of results. However, the two hypotheses within each perspective are mutually exclusive, and both have received some empirical support, which will be detailed below.

4.1 Moderating Effects of Child Individual Characteristics

Individual characteristics are both direct outcomes of development and factors influencing proximal processes. First, children's gender and ethnicity influence the relationship between teacher-child interactions and developmental outcomes in different ways. Regarding gender, most studies indicate that boys are more sensitive than girls in the development of social-emotional functioning. Higher-quality teacher-child interactions are associated with less social withdrawal and more harmonious peer relationships for boys, while girls remain unaffected (Madill, Gest, & Rodkin, 2014). Low-quality teacher-child interactions are particularly detrimental to boys; when teachers provide inconsistent emotional support, boys exhibit more behavior problems, whereas girls continue to function well (Brock & Curby, 2014).

Current research proposes two possible explanations for these gender differences in how teacher-child interactions influence social-emotional functioning. First, preschool boys engage more frequently in active, high-conflict play than girls, and high-quality teacher-child interactions provide them with better support and monitoring, helping to ensure that their more aggressive play does not escalate into behavior problems (Votruba-Drzal, Coley, & Chase-Lansdale, 2004). Second, the development of self-regulation skills is generally weaker in boys than girls during early childhood. If teacher-child interaction quality is high, it can provide a rapid and effective form of external control to help boys regulate their emotions and behaviors, serving a compensatory function. For girls, such external controls are relatively less important because they possess stronger self-regulation abilities (Brock & Curby, 2014).

Regarding ethnicity, some studies have found that teacher-child interactions have stronger positive effects for minority children. When teacher-child interaction quality improves, African American and Hispanic children show more significant reductions in behavior problems and greater gains in language skills compared to White American children (Burchinal, Peisner-Feinberg, Bryant, & Clifford, 2000; Magnuson, Ruhm, & Waldfogel, 2007). However, other studies have not detected moderating effects of ethnicity (Dang et al., 2011; Keys et al., 2012; Keys et al., 2013). Keys et al. (2013) caution that there may be confounding between ethnicity and economic status. Research shows that minority children in the United States are more likely to experience disadvantaged developmental environments, including poverty, low parental involvement, immigrant backgrounds, and discrimination (Marks & Coll, 2018). These negative co-occurring factors create stress and challenges for child development, and high-quality teacher-child interactions as a supportive resource may effectively compensate for these disadvantages. For example, a German study found that regardless of ethnicity, only children with immigrant backgrounds showed

reduced behavior problems as classroom organization levels improved, while non-immigrant children did not (Kohl et al., 2020). Therefore, whether the economic conditions and parenting practices underlying ethnicity are more potent moderators than ethnicity itself requires more nuanced investigation.

Second, research has found that children with low baseline ability levels benefit more from teacher-child interactions than those with high baseline levels. Children who initially lag behind in social or behavioral skills typically have greater difficulty adapting to classroom instruction, so their need for high-quality teacher-child interactions is stronger. If interaction quality is low, these children's performance will be more difficult to improve; however, once they receive more positive and personalized support through teacher-child interactions, their developmental gains are compensated and show substantial progress. For example, compared to peers with stronger self-regulation, children with weaker initial self-regulation benefit more from high-quality teacher-child interactions by the end of the school year, showing greater growth in social and learning competence (Connor et al., 2010). Pratt et al. (2016) found that children with lower compliance scores at age three showed significantly improved cooperation after one year of high-quality teacher-child interactions, whereas children with better compliance at age three did not demonstrate this effect.

Furthermore, children's innate temperament and reactivity also play moderating roles. According to biological sensitivity to context theory and the differential susceptibility hypothesis, individuals with "vulnerable" traits show greater environmental sensitivity (Belsky, 2005; Boyce & Ellis, 2005), and thus their development may be more susceptible to teacher-child interaction quality than other children. Children with difficult temperament and high stress reactivity show significant reductions in behavior problems in high-quality teacher-child interactions, and their peer exclusion levels are negatively correlated with interaction quality, whereas children without difficult temperament and with moderate stress reactivity do not show these patterns (Phillips et al., 2012; Roubinov et al., 2019). This may be because children with difficult temperament need more adult support to help them control negative tendencies, and when teacher-child interactions are appropriate, their learning efficiency from the surrounding environment improves, manifesting as progress in social-emotional functioning.

4.2 Environmental Moderating Effects

Most studies have yielded results consistent with the continuity hypothesis, indicating that different family and regional environments can either promote or inhibit the degree to which children benefit from kindergarten instruction. First, the family is children's most immediate developmental environment. On one hand, children from poor home environments often face a lack of resources and cognitive stimulation; their parents provide less attentive care and fewer learning encouragements and instructions. Because they do not receive adequate developmental support at home, these children's development may depend more heavily on compensation from kindergarten instruction, making them more sensitive

to teacher-child interaction quality. For example, some studies have found that teacher-child interaction quality is only positively associated with self-regulation and executive function among children from high-risk families (Cadima et al., 2016; Duval, Bouchard, Pagé, & Hamel, 2016) and shows stronger positive correlations with mathematics and reading skills among children whose parents have lower educational attainment (Peisner-Feinberg & Burchinal, 1997; Peisner-Feinberg et al., 2001). On the other hand, some studies have reached opposite conclusions, finding stronger positive correlations between teacher-child interaction quality and academic skills among children from high socioeconomic status families (Anders et al., 2012; Pinto, Pessanha, & Aguiar, 2013) and stronger positive correlations with cognitive development among children whose mothers have higher educational levels (Dang et al., 2011). This may be because children from advantaged home environments often have more economic and educational capital; their parents can provide rich cognitive stimulation and invest more actively and responsibly in parenting practices, allowing these children to accumulate learning advantages and thereby benefit more from teacher-child interactions. Additionally, some studies have yielded results consistent with the discontinuities hypothesis, finding no moderating effects of family factors (Burchinal et al., 2000; Keys et al., 2012; Li et al., 2016). Overall, current research findings on family factors' moderating effects are inconsistent and require further investigation.

Second, the geographic region where children live influences their experiences by permeating the microsystem. Urban and rural areas differ significantly in resource availability, economic characteristics, and community structure, creating interactions between teacher-child interactions and geographic location. Schmitt et al. (2018) found that high-quality teacher-child interactions helped reduce behavior problems among rural children but did not affect behavior problems among urban children. Li et al. (2019) also found that teacher-child interactions were positively associated with language and early mathematics development among rural (but not urban) Chinese children. This may be because rural children's parents are more likely to adopt negative parenting styles, educational resources are more scarce, and kindergarten education plays a more guiding role in developing children's behavioral and cognitive skills. Urban children, by contrast, often receive adequate resources and support, making them potentially less sensitive to teacher-child interaction quality. These findings suggest that high-quality teacher-child interactions may be an effective measure for narrowing the developmental gap between rural and urban children.

4.3 Moderating Effects of Other Factors in Classroom Processes

Previous research typically evaluated teacher-child interaction quality in a given classroom through holistic observation, often overlooking children's individual experiences during classroom processes. Jeon et al. (2010) found that only about one-third of children in high-quality classrooms actually had high-quality personal experiences, and that personal experience positively moderated the

relationship between teacher-child interactions and children' s social-emotional functioning. Therefore, although good teacher-child interaction quality provides overall support, it cannot ensure that all children receive adequate attention and engage in the classroom; each child' s differential personal experiences influence their degree of benefit.

Another moderating factor implicit in classroom processes is the teacher-child relationship, which refers to the accumulated, ongoing unique interpersonal relationship between a teacher and a specific child (Pianta & Ryan, 2002). Teacher-child interactions (at the group level) and teacher-child relationships (at the individual level) both independently influence children and interact with each other. For example, one study found that children with conflictual teacher-child relationships (i.e., oppositional, disharmonious relationships) received less attention outside the classroom, and their positive behavior development was more compensated by high-quality teacher-child interactions within the classroom. However, children with close teacher-child relationships (i.e., warm, open relationships) showed fewer behavior problems regardless of classroom interaction quality because they already received sufficient guidance and support outside the classroom (Lippard, La Paro, Rouse, & Crosby, 2018). Thus, underlying positive or negative relationships between children and teachers may influence the effects of teacher-child interactions.

4.4 Moderating Effects of Temporal Factors

The chronosystem in ecological systems theory uses temporal factors as a frame of reference for studying individual development, emphasizing changes in environments, events, and elements over time (Bronfenbrenner & Morris, 2007). This dynamic process is also reflected in how teacher-child interactions influence child developmental outcomes. First, some originally observed effects may change as children develop. Peisner-Feinberg' s (2001) study tracked children from kindergarten through second grade and found that the positive correlation between teacher-child interactions and children' s cognitive abilities decreased annually. In another longitudinal study, while the home learning environment did not show a moderating effect during early childhood, it was found during middle childhood that teacher-child interaction quality was positively correlated with children' s mathematics achievement only under conditions of high-quality home learning environments (Lehrl, Kluczniok, & Rossbach, 2016).

Second, proximal processes promoting child development also produce complex cumulative effects over time. Although a few studies support the additive hypothesis and have not found interactions between later and earlier teacher-child interaction quality in long-term child outcomes (Lehrl et al., 2016), more research supports the multiplicative hypothesis. For example, the relationship between pre-kindergarten child care center interaction quality and children' s mathematics skills one year after kindergarten entry was positively moderated by kindergarten classroom quality (Carr, Mokra, Vernon-Feagans, & Burchinal, 2019). A study of low-income rural children found that only when children ex-

experienced high-quality teacher-child interactions in both pre-kindergarten child care centers and kindergarten did they demonstrate better social skills and fewer problem behaviors in their final kindergarten year; experiencing high-quality interactions in only one stage did not produce this effect (Broekhuizen et al., 2016). These results suggest that without subsequent consistent high-quality instructional support, the positive effects of high-quality early childhood programs are prone to decay and may not have strong predictive power.

5. Summary and Future Directions

The literature review reveals that moderating effects in the process through which teacher-child interactions influence child development represent an important theme in this field, with many aspects requiring deeper exploration in future research. First, in terms of selecting moderating variables, future research could further expand based on the PPCT model. Personal-level factors such as children's goal orientation and learning motivation, other environmental-level factors such as parenting styles, kindergarten structural quality, and peer relationships, as well as more distal sociocultural and educational values, could all be considered as potential moderators. For example, in cultures with different levels of uncertainty avoidance and power distance, expectations differ regarding the degree to which educators should provide clear goals and maintain authority (Hofstede, 1986). Influenced by such expectations, the effects on children when teachers adopt teacher-child interactions characterized by high openness and autonomy may also differ. For some known moderating variables such as family socioeconomic status and ethnicity, whose moderating directions and effects remain inconsistent, future researchers could consider using meta-analysis to identify more stable moderators. Simultaneously, multilevel, more systematic research models should be established to examine whether more complex multiple interactions exist among factors at different PPCT levels, which may reveal interesting patterns of differential child responsiveness to teacher-child interactions under various factor combinations and yield more valuable conclusions for the field.

Second, regarding mechanisms of action, more integrated basic hypotheses and more adequate verification are needed for how moderating variables interact with teacher-child interactions. The explanatory power of existing hypotheses is relatively limited; for example, they cannot adequately explain why some moderating effects change over time. Future research adopting more global hypotheses would be more illuminating. For instance, when revealing the moderating effects of family and regional environments, researchers could explore connections between different environments from a continuity perspective, explain the direction of moderating effects based on developmental risk, and use longitudinal designs to investigate cumulative environmental influences across different stages from a temporal dimension. Additionally, besides moderating effects, another possible explanation for inconsistent findings regarding teacher-child interaction effects is the threshold effect—that teacher-child interaction

quality may only be effective when it exceeds a certain threshold level (Burchinal, Vandergrift, Pianta, & Mashburn, 2010). Future research could combine threshold effects with moderating effects to identify the most critical mechanisms of action.

Third, most current research on teacher-child interactions has been conducted in Western contexts. Future research should pay greater attention to moderating mechanisms in the Chinese context. The Ministry of Education's "Guidelines for Kindergarten Education (Trial)" (referred to as the New Guidelines) proposes specific requirements for kindergarten instructional models, including using play as the basic activity, promoting individualized development and autonomy, and expanding children's experiences and perspectives (Ministry of Education of the People's Republic of China, 2001). These pedagogical characteristics align with features of high-quality teacher-child interactions. However, research has found that the actual process quality of Chinese kindergarten instruction still has some gaps with the New Guidelines' expectations. First, surveys show that large class sizes, low teacher-child ratios, and whole-group instruction remain very common in Chinese kindergartens (e.g., Hu, Fan, Wu, & Yang, 2017). Second, influenced by collectivist culture and Confucian values, Chinese kindergarten teachers tend to be teacher-centered, emphasizing discipline and obedience, and focusing more on group needs than individual needs (e.g., Hu, Fan, Li, & Jeong, 2015; Hu, Fan, Gu, & Yang, 2016). Third, kindergarten teachers often lack skills in scaffolding, providing feedback loops, and extending learning (e.g., Hu et al., 2018). This reality makes research on teacher-child interactions in the Chinese context uniquely valuable. Although some pioneering studies have explored the patterns, influencing factors, and effects of teacher-child interactions in China (e.g., Hu et al., 2017; Hu et al., 2018; Li et al., 2016), research on teacher-child interactions in China started relatively late, and many aspects remain to be explored, including complex mechanisms such as moderating effects. Indeed, exploring moderating factors that influence the positive effects of teacher-child interactions will not only help clarify the patterns and characteristics of how teacher-child interactions function within Chinese kindergarten instructional models but also contribute to developing targeted intervention programs and providing recommendations for developmentally appropriate teacher-child interactions, thereby promoting the full utilization of educational resources.

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Note: Figure translations are in progress. See original paper for figures.

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