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External assessment of teachers' roles during children's free play and its relation to types of children's play

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Teachers in early childhood education and care (ECEC) assume various roles in children's free play, such as tutor, classroom manager, co-player, and director. Recent research has shown that teacher-related characteristics such as work experience and classroom-related characteristics such as children's age are significant predictors of teachers' roles. However, these roles have mostly been assessed through self-report rather than external observation using standardized scales. Furthermore, it is unclear how teachers' roles depend on the types of children's play, such as construction play and dramatic play. To address these research gaps, we observed 80 teachers during 291 observation cycles in childcare centers and kindergartens in Switzerland. We developed a standardized observation scale to simultaneously assess both teachers' roles during children's free play and the types of children's play. Additional teacher- and classroom-related predictors were assessed with an online questionnaire for teachers. The results of a multilevel regression analysis showed that the roles observed differed in the type of play in which children engaged. However, teacher- and classroom-related predictors were more relevant and explained more variance in teachers' roles than the types of children's play. The findings may stimulate self-reflection by ECEC teachers on the roles they assume during children's free play.

KEYWORDS

play involvement, teachers' roles, free play, childcare center, kindergarten, type of play, early childhood education and care, multilevel regression analysis

1. Introduction

The natural way young children learn is through free play, defined as a voluntary, intrinsically motivated activity that is initiated and directed by the children (Whitebread et al., 2017; Zosh et al., 2018). Free play time in early childhood education and care (ECEC) is characterized by the children's free choice of activities in contrast to structured educational activities led by the teachers, such as circle time (Slot et al., 2015). Currently, teachers' play support is considered as a key competence of teachers in ECEC (Göncü et al., 2000; Jensen et al., 2019). Teachers' play support refers both to the provision of an optimal learning environment and to teachers' involvement in children's play. However, the intensity and intention of teachers' play involvement that is most appropriate remains empirically unclear (Skene et al., 2022). Moreover, the characteristics that affect teachers' play involvement have yet to be identified. Previous research defined various roles that teachers assume during children's free play, such as co-player, director,

tutor, onlooker, and uninvolved (Enz and Christie, 1993; Johnson et al., 2005). The results of recent questionnaire studies on self-reported teachers' roles provide information about the frequency of roles and explained their variation with teacher-related characteristics such as work experience and classroom-related ones such as the age of children (Ivrendi, 2020; Grigoropoulos, 2021; Wustmann Seiler et al., 2022). However, these questionnaire studies do not report on the roles that teachers assume in specific situations during free play. Instead, they indicate the overall subjective preferences of the teachers for the roles they assume during free play according to their perceptions and intentions. Observational studies that focus on teachers' roles in specific situations are currently sparse (Enz and Christie, 1993; Jung, 2013; Gaviria-Loaiza et al., 2017; Tajik and Singer, 2018) but would be crucial in further developing our understanding of teachers' practice during children's free play. Moreover, if situational play-related characteristics such as the types of free play that children engage in are also considered when attempting to explain why and when teachers assume a certain role, we can move beyond the more stable predictors such as teachers' work experience and children's ages to include the specific dynamics of given situations. Therefore, the present study uses a standardized observation scale to describe teachers' roles during free play while considering the types of children's play as predictors.

1.1. Teachers' play involvement in early childhood education and care

Teachers in ECEC take on central and diverse parts in children's play activities by organizing space, materials, and time for children's play, supporting children's learning through play, helping children to engage in play, and participating in children's play (Wood, 2008; Jensen et al., 2019). However, opinions differ on how teachers should be involved in children's free play (Trawick-Smith and Dziurgot, 2011). From a social constructivist perspective stemming from Vygotsky's work (Wood and Bennett, 1998), teachers' proactive play involvement is required to promote children's development and stimulate their play and learning (Yang, 2013; Zosh et al., 2018). However, concerns have been raised about direct adult involvement in children's free play (Trawick-Smith and Dziurgot, 2011): evidence indicates that too much teacher involvement is perceived by children as intrusive, reduces their interest in the activity, and impairs children's play behavior (Gmitrova and Gmitrov, 2003). As a result, teachers should only be involved in a responsive way when children ask for or need support (Trawick-Smith and Dziurgot, 2011). In contrast, the constructive perspective arising from Piaget's theory (Wood and Bennett, 1998) emphasizes the child's active role and the need for the teacher to remain in the background so as to promote children's self-determination and control in play and to strengthen children's motivation to play (Sandberg, 2002; Frost et al., 2005; McInnes et al., 2011). Reflecting this controversial discussion, teacher play involvement is described on a continuum with different levels of control by children and teachers (Sylva et al., 2011; Trawick-Smith and Dziurgot, 2011; Pyle and Danniels, 2016; Zosh et al., 2018).

To more precisely classify teachers' play involvement, previous studies have examined teachers' positioning in children's free play (inside or outside) or according to dimensions of interaction (e.g., behavioral, emotional, or learning support; e.g., Sylva et al., 2011;

Kucharz et al., 2014; Fleer, 2015; Broekhuizen et al., 2017). These studies showed that most teachers were positioned outside of children's play and mainly interacted during non-play activities, such as classroom management tasks to monitor children's behavior (Kucharz et al., 2014; Fleer, 2015). However, it is crucial to consider that teachers' positioning was only assessed during dramatic play (Fleer, 2015). Moreover, dimensions of interaction reflect professional quality more generally and may not be exclusive to teachers' play involvement (Sylva et al., 2011). In addition, Slot et al. (2015) found that the quality of teacher-child interaction was rated more highly in guided activities than in children's free play. The lack of structure in open-ended free-play situations and broad variety of possible play activities may be challenging for teachers trying to respond appropriately to children's needs. In these situations, teachers may also experience difficulties in providing opportunities to promote children's play and learning without following a script as in guided activities (Reyhing et al., 2019). Therefore, describing the roles that teachers intuitively assume in these unplanned free play situations in detail and understanding what predicts these various roles is an essential first step in finally understanding the value of these roles. For this purpose, an assessment of roles should include not only the positioning of teachers in children's play but also their degree of guidance and their intended behavior to reflect the entire continuum of teachers' involvement in children's free play more accurately.

1.2. Teachers' roles during free play

Six roles adopted by teachers involved during free play have been empirically identified and described in various studies (Enz and Christie, 1993; Johnson et al., 2005; Gaviria-Loaiza et al., 2017; Ivrendi, 2020): (1) The *co-player* participates in children's play by taking small and passive roles without dominating the play. (2) The *play tutor*, also called play leader, enriches children's play with suggestions, questions, and demonstrations and supports the children in case of difficulties or if they cannot find their way into play. The teacher can accomplish this either by assisting from within or from outside children's play. (3) The *director* takes control and direction of children's play by making decisions and giving instructions. (4) The *redirector* guides children's attention to promote academic learning by asking didactic questions. (5) The *stage manager* adapts the spatial and material play and learning environment to children's play needs and discusses and supports the implementation of children's play ideas. (6) The *classroom manager* supports children in emotion regulation or conflict resolution and ensures compliance with behavior rules during children's play. In addition, two roles have been described in which teachers do not actively interact with children: The *onlooker* is available and consciously observes children's play activities, and *uninvolved* teachers are busy with other tasks such as administrative and preparatory activities while children are playing. Previous studies have examined these roles through external assessment in small-scale live observations and video analysis (e.g., Jung, 2013; Gaviria-Loaiza et al., 2017; Tajik and Singer, 2018), and via self-assessments with questionnaires and interviews (e.g., Yang, 2013; Ivrendi, 2020; Wustmann Seiler et al., 2022). To date, the roles of onlooker, stage manager, and classroom manager have most frequently been reported and observed, and the roles of play tutor, uninvolved, and redirector have been observed least frequently (Kontos, 1999; Jung, 2013; Aras,

2016; Gaviria-Loaiza et al., 2017; Ivrendi, 2020; Wustmann Seiler et al., 2022). Depending on the situation, teachers change their roles. But it is assumed that role preferences are stable to a certain extent and can be explained with various predictors (Enz and Christie, 1993).

1.3. Predictors of teachers' roles during free play

Predictors of teachers' roles in children's free play have been related in previous studies to the teacher (e.g., work experience), to the classroom (e.g., children's age), and to children's play. To the best of our knowledge, only one study to date has specifically examined teachers' roles during free play considering situational play-related characteristics such as types of children's play. This was done using audio recordings, and results were reported primarily with descriptive statistics (Kontos, 1999). Three studies recently examined teacher- and classroom-related predictors of teachers' roles during free play in more complex analyses of questionnaire data: a Turkish study in public kindergartens in homogenous age groups for children aged 3–4 years, 5 years, and 6 years (Ivrendi, 2020); a Greek study in ECEC settings with young children with a mean of 2.8 years of age (Grigoropoulos, 2021); and a Swiss study in public kindergartens with mixed-age groups from 4 to 7 years (Wustmann Seiler et al., 2022). The results were heterogeneous in the frequency with which the roles were assumed and in which predictors were relevant. This might be due to the heterogeneous educational settings of these studies in children's age, group size, and teachers' educational backgrounds. Moreover, the geographical regions in which the studies were conducted were also likely to play a role in the heterogeneous results, as another comparative study found significant differences in teachers' play involvement among countries (Van der Aalsvoort et al., 2015).

1.3.1. Teacher-related predictors

Previous studies have identified teacher-related characteristics such as work experience, age, educational background, and professional self-efficacy as significant predictors of teachers' roles during free play. Teachers with more work experience were more likely to report taking an uninvolved role by doing something else without interacting with the children (Ivrendi, 2020; Grigoropoulos, 2021). They were also more likely to report that they assume the role of tutor, enriching children's play (Grigoropoulos, 2021). In addition, these experienced teachers were less likely to report being involved in children's play as co-players and as classroom managers (Wustmann Seiler et al., 2022). Older and better educated teachers were both less likely to report assuming a tutor role and more likely to report the uninvolved role (Grigoropoulos, 2021). Teachers who reported higher levels of professional self-efficacy were also more likely to report assuming the roles of onlooker and stage manager (Wustmann Seiler et al., 2022). This is in line with findings that teachers' professional self-efficacy, such as the belief that they can support even children with heterogeneous needs adaptively, has been shown to affect teachers' pedagogical actions (Zee and Koomen, 2016; Perren et al., 2017).

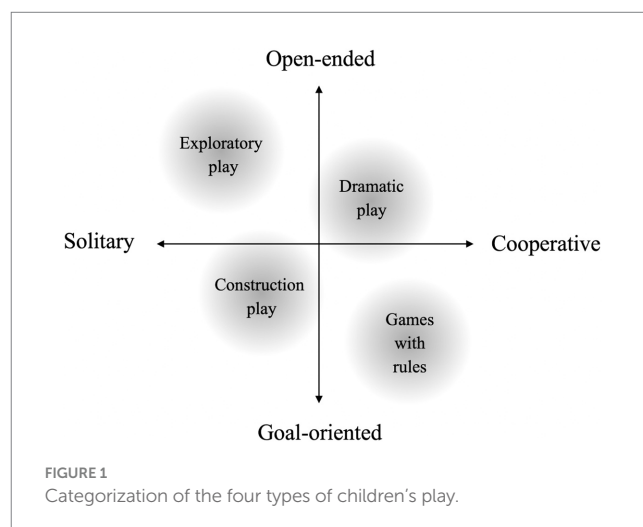
1.3.2. Classroom-related predictors

Several classroom-related characteristics have previously been examined as predictors of teachers' roles during free play, including group composition and play environment. It is generally assumed that the higher the number of children in a classroom, the fewer

teacher–child interactions take place (Howes et al., 2011). However, previous studies have not produced consistent results on how group size predicts the different roles that teachers assume during children's free play. According to Ivrendi (2020), teachers more often reported taking the uninvolved and the co-player role when there were fewer children in the group. However, Grigoropoulos (2021) found that the uninvolved role was more frequently reported when there were more children in the group. In addition, she reported that the more children were in a classroom, the less likely teachers reported assuming the role of tutor (Grigoropoulos, 2021). Another study found that the tutor role was more frequently reported when the group consisted of more children who spoke a foreign language (Wustmann Seiler et al., 2022). Children's age was also shown to predict teachers' roles during free play. Teachers reported assuming the role of director more frequently for 3- and 4-year-olds than for 5- and 6-year-olds (Ivrendi, 2020). The amount of free play time and the number of learning centers with different play and learning opportunities in the classroom have also been identified as predictors for the role a teacher assumes. Teachers who provided more time for free play also reported playing the role of tutor more frequently and therefore providing more frequent support for children's play activities. Teachers who provided less time for free play were more likely to report acting as classroom managers and therefore instead provided more frequent support for the children's social–emotional and behavioral problems (Wustmann Seiler et al., 2022). The number of learning centers was linked to the self-reported roles of onlooker and stage manager: with higher numbers of learning centers, teachers more frequently reported observing children's play behavior and supporting children in organizing play materials or implementing their ideas on what and how to play (Ivrendi, 2020).

1.3.3. Play-related predictors

During free play, children engage in a variety of play types (Johnson et al., 2005). Four basic types of children's play can be distinguished: exploratory play, dramatic play, construction play, and games with rules (Mogel, 2008; Whitebread et al., 2017). These types of children's play differ in the social setting, for instance in solitary play or cooperative play and the purpose of the play activity, which may be open-ended or goal-oriented. Figure 1 represents an attempt to categorize the four types according to the Revised Peer Play Scale (Howes and Matheson, 1992) and the Social/Cognitive Play



Scale (Johnson et al., 1999). However, the classification does not illustrate distinct categories and should be understood as a continuum between the extreme manifestations with overlaps. For example, when children play alone, at the left on the continuum, they play without other playmates around. But it is also possible for children to play on their own next to each other, as in exploratory or construction play, which would be positioned further to the right on the continuum. The same is true for the other side of the continuum. For example, children can play explicitly cooperatively with the same play objectives or content, which requires social negotiations as in dramatic play and games with rules, or they may play together with simple social interactions in their own flow. The continuum of the purpose of the play activity illustrates similar overlapping. A play activity can have a clearly defined goal such as playing a board game, can be goal-oriented with changing goals during the play process such as building a tower, or can be open-ended with many different options in how the play activity develops, but in a defined direction or framework such as pretending to celebrate a birthday party.

Children in exploratory play are basically exploring the world and themselves in solitary play without pursuing a specific goal. This type of children's play is considered to have low cognitive and social demands and can be detected in infants (Pellegrini, 2009). Dramatic play generally presents itself as social play in which children play with other children, adults, or representatives such as dolls in an open-ended way, developing their play gradually and not following a script as in theatre. In contrast, construction play is defined as a goal-oriented activity in which no playmates need be included. Both dramatic and construction play are considered types of play with higher cognitive demands than exploratory play and have been more frequently observed in children's play from the age of 3 to 4 years onwards (Johnson et al., 1999; Mogel, 2008). Games with rules are generally played in company with playmates by pursuing a defined goal. Most of these games place high demands on cognitive skills involving working memory or developing strategies and on social skills involving taking defeats and respecting play rules. Games with rules have been increasingly observed in children's play from the age of 4 to 5 years onwards (Johnson et al., 1999; Mogel, 2008). Qualitative analyses have shown that teachers are most likely to participate in children's play in concrete and goal-oriented play situations such as construction play and games with rules and least likely to participate in dramatic play (Shin and Spodek, 1991). In addition, quantitative analyses of audio recordings showed that teachers spent more of their time participating in product-oriented constructive play than in open-ended play (Kontos, 1999). Further results demonstrated that teachers' proactive play involvement increased children's complexity in social pretend play for instance by decontextualization and role-taking, whereas only managing children's play had no effect (Perren et al., 2019). Moreover, when teachers participated more actively in children's play, a more complex play was observed: social play such as cooperative pretend play and cognitive demanding play such as games with rules (Vu et al., 2015).

1.4. Summary and aims of the study

The roles defined above describe teachers' pedagogical practice in play involvement on a continuum of control by the teacher and the child. Heterogenous findings have been found on

teacher- and classroom-related predictors of these roles. However, previous studies were conducted in diverse countries and ECEC settings (Ivrendi, 2020; Grigoropoulos, 2021; Wustmann Seiler et al., 2022). In addition, most of these studies used questionnaires and do not capture the roles teachers actually assume during free play. To date, situational play-related characteristics have rarely been examined as a predictor, although Johnson et al. (2005) have referred to the variety of play contexts in which children engage during free play and how this complex dynamic may place high demands on teachers and affect teachers' play involvement.

The aim of the present study was to extend previous research by (1) developing an observation scale to capture the range of roles teachers assume during free play in a standardized way, (2) describing the frequency of the roles observed without evaluating the roles' value for children's development, and (3) analyzing how teacher-, classroom-, and play-related characteristics predict these roles. Two different ECEC settings, childcare centers and kindergartens, were included to test for potential setting-specific differences regardless of geographical region. The two settings differ in children's ages, group sizes and teachers' educational backgrounds. Teacher-related predictors included teachers' work experience and teachers' professional self-efficacy. Time for free play and ECEC setting were used as classroom-related predictors. Finally, the four types of children's play constituted the play-related predictors. Due to the heterogeneous findings in previous studies, no hypotheses were formulated to predict the specific roles that teachers assume during free play. However, we assume according to Perren et al. (2019) and Vu et al. (2015) that children need more active play support as the complexity of their play increases. In addition, many of the variables used as teacher- and classroom-related predictors differ between the two ECEC settings. As a result, we expect the distribution of frequency with which teachers assume the various roles to differ between the two settings.

2. Materials and methods

2.1. Procedure

This study was conducted in spring 2021. The recruitment of the participants was part of the "Playfulness in Early Childhood (Playful)" project, funded by the Swiss National Science Foundation. The study involved 80 live observations in childcare centers and kindergartens in Switzerland. We developed a standardized observation scale to externally assess teachers' situational roles during free play in a nonparticipatory observation. In addition, we observed and recorded children's types of play as teachers interacted with children. Data from several observation cycles were collected per teacher, and additional variables were assessed with an online questionnaire.

The study was reviewed and approved by the Ethics Committee of Faculty of Philosophy at the University of Zurich, Switzerland, in January 2021 (Ethics approval number 20.12.13). Teachers were informed about the aims and procedures of the study with a written study description. In addition, they were informed about their right to terminate their participation at any time without stating any reason and were assured that their data would be collected anonymously and

evaluated exclusively for scientific research purposes. All participants provided informed consent before participation.

2.2. The context of ECEC in Switzerland

In Switzerland, two ECEC institutions are distinguished: childcare centers and kindergartens. Childcare centers are private institutions for children from infancy onwards, mostly until entry of kindergarten, and are attended by around 33% of children aged 0 to 3 years (Bundesamt für Statistik, 2021). Kindergartens are part of the public school system and compulsory for children approximately from the age of 4 to 6 years. Both settings also differ in teachers' education. Teachers in kindergarten hold a bachelor level degree whereas teachers in childcare centers have completed vocational training. However, in both settings a distinction is made between activities in child-centered free play and activities that are led by teachers (Stamm, 2009).

2.3. Sample

The sample was recruited through a broad call for applications in German-speaking cantons of Switzerland via different channels such as newsletters, school administrations, and organizations of ECEC. When selecting the sample, we stratified by urban and rural areas, cantons, and different pedagogical settings. Eighty teachers in the German-speaking part of Switzerland participated in the study. Of these, 93.8% were female, and 88.8% were Swiss citizens. They were between 20 and 63 years of age ($M = 37.85$, $SD = 12.1$) and had between 1 and 38 years of work experience ($M = 14.1$, $SD = 10.6$). They worked in two ECEC settings: kindergartens ($n = 47$, including 4 kindergartens for children with special needs) and childcare centers ($n = 33$). All the participating teachers were observed, and 97.5% completed the online questionnaire.

2.4. Study measures

2.4.1. Observation scale to assess teachers' roles during free play

An external observation scale was developed to assess teachers' situational roles during children's free play [Teacher Roles during Free Play – Observation scale (TRFP-O)] in standardized live observations. The scale was developed from the items of the Teacher Roles in Free Play (TRFP) questionnaire (Ivrendi, 2020) and its German translation and extension (Wustmann Seiler et al., 2022). First, a conceptual framework was developed to describe the various roles of the teachers that were observed in specific situations during free play (see Table 1).

TABLE 1 Conceptual framework of teachers' roles during free play.

	Proactive		Reactive
With reference to children's play	Co-player	Director	Tutor & stage manager
Without reference to children's play	Redirector		Classroom manager

These roles are classified by whether teachers' behavior refers to children's play. The roles are also differentiated according to teachers' activity level, whether the teacher acted proactively or reacted to the immediate needs of the children during their play. Because the focus of the observation was on the teachers and the type of children's play while interacting with the children, the two passive roles without clear interaction, uninvolved and onlooker, were excluded for this purpose. Second, roles that did not differ from each other when classified by activity level and reference to children's play were combined. This was the case for the roles of tutor and stage manager, which are therefore referred to below as *tutor and stage manager*. Similarly, co-player and director were both classified the same way in the two dimensions. However, we decided to keep the two roles separate, because the teachers' positioning is inside the play as co-player and outside the play as director. We adapted the description of the director role to the Swiss context, because the literature describes the director as taking the leadership of the play situation and making decisions about the theme, material, or group composition (Gaviria-Loaiza et al., 2017; Ivrendi, 2020). However, pilot tests using video observations revealed that in Swiss ECEC settings, this does not correspond to the understanding of child-centered free play and was therefore seldomly observed. As a result, we included teachers' efforts to affect children's play without direct instruction, for example, by proactively giving hints or comments about children's play without the children asking for it, as an additional characteristic of the director role. The description of each role and coding examples can be found in Table 2.

Roles were rated by trained researchers on a five-point scale (1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always) by how much of the time the teacher spent in one of the roles for free-play situations in each observation cycle of between 15 and 20 min. In this study, each teacher was observed for 3 to 5 observation cycles ($M = 3.7$, $SD = 0.82$; $N = 291$) during three to four hours. A total of five trained researcher were involved in the data assessment. Ratings were usually done by one trained researcher. For this study, 19% of the sample were rated by a second rater for quality control. Interrater reliability for teachers' roles was satisfactory ($ICC = 0.72-0.93$). The training for the researchers consisted of a one-day session including various inputs covering the procedure and theoretical framework of the observation scale. The training also involved coaching, exercises with videos of teachers' play involvement, and comparing the ratings of these video-based exercises.

2.4.2. Observation scale to assess the type of children's play

During the same observation cycles, the trained researchers noted the type of play children were engaged in while interacting with the teacher. When several types of play occurred during a single cycle, the one that was most prevalent during that time was noted dichotomously (1 = yes, 0 = no). The types of play were derived from the four categories of the Social/Cognitive Play Scale (Johnson et al., 1999): (1) Exploratory play is characterized by a sensomotor process with or without objects or using objects in a stereotypical way (e.g., rough and tumble play, playing with water, sand, or other objects without pursuing a specific goal, dancing without choreography). (2) Dramatic play is characterized by dramaturgical elements or acting as-if (e.g., imitating everyday actions by dress up or playing at the doll's house). (3) Construction play is characterized by a goal-oriented and constructive process of building with play materials (e.g., building a

TABLE 2 Operationalization of the five active roles of teachers during free play.

Roles	Role description	Coding examples
Co-player	As <i>co-players</i> , teachers participate in children's play in minor functions or roles, at children's request or on their own initiative. They leave the leadership of the play to the children and join in as a play partner at the children's level, without directing children's play. Parallel play, when teachers play for themselves next to the children, is also considered co-play.	The teacher proactively participates in children's play (at the children's request or on his/her own initiative): <ul style="list-style-type: none"> • Takes on a role in pretend play. • Plays a rule game with the children. • Dances or sings along.
Director	In the role of <i>director</i> , teachers give hints, comments, and instructions about the children's play on their own initiative - without prompting, demand, or identifiable need for assistance. They take over the control and guidance of the children's play and try to influence it by making decisions (about the topic, material or group composition).	The teacher proactively supports children's play (on his/her own initiative): <ul style="list-style-type: none"> • Determines group compositions or assigns children to different play corners/offers or roles. • Makes comments or asks questions about children's play. • Suggests other play strategies or new play opportunities.
Tutor and stage Manager	In the role of <i>tutor and stage manager</i> , the teachers support the children's play when it gets bogged down, when the children cannot find their way into a play, or when they send out signals of support (with questions or gestures). The teachers then react with hints, suggestions, or questions. The teachers support and advise the children during play and adapt the physical play and learning environment to the children's interests and needs.	The teacher reacts to the request or needs of the children regarding their play: <ul style="list-style-type: none"> • Provides assistance when children ask for it or when play cannot continue. • Provided additional play materials or creating space. • Is eager to integrate children who are not playing.
Redirector	In the role of <i>redirector</i> , the teachers implement activities with individual children to promote specific skills during the free play time. Didactic questions from the teachers (with a focus on specific learning content) and general conversations with the children during play time are also evaluated as redirectors.	The teacher proactively interacts with the children without reference to their play (on his/her own initiative): <ul style="list-style-type: none"> • Chats with individual children about their daily routines without reference to their current play. • Directs an activity of the children specifically (e.g., a handicraft, telling a book). • Asks didactic questions or talks to children about specific learning content (e.g., letters, numbers, and colors).
Classroom manager	In their role as <i>classroom managers</i> , the teachers react to the children's needs, which are not related to their current play, but to their immediate behavior. They intervene in a regulating manner in the event of conflicts, rule violations or behavioral problems. When teachers gain an overview of the group's activities, this is also seen as a classroom manager.	The teacher reacts to the request or needs of the children without reference to their play: <ul style="list-style-type: none"> • Accompanies children in conflict situations and supports them in emotion regulation. • Intervenes in the event of inappropriate or dangerous behavior. • Gives children practical everyday support, e.g., undoing a trouser button, putting on shoes, blowing their nose.

tower or a hut, painting a picture, laying patterns, modeling with playdough). (4) Lastly, games with rules are characterized by clear game procedures and objectives (e.g., board games, puzzles, hide-and-seek games).

2.4.3. Questionnaire to assess teacher-related and classroom-related characteristics

The teacher-related characteristics of work experience and professional self-efficacy and the classroom-related characteristics of ECEC setting and duration of free play time were assessed with an online questionnaire via the Survalyzer program. Professional self-efficacy was evaluated with the German version of the Professional Self-Efficacy Scale (Perren et al., 2017). The scale consists of nine items, which are assessed on a five-point scale (1 = not at all true, 5 = completely true, e.g., "I can structure the learning environment in such a way that all children in the group find suitable challenges, even when their needs are very different"). A confirmatory factor analysis

confirmed a one-dimensional scale with a good model fit with two error correlations [$X^2(36) = 137.06$, $p < 0.001$, CFI = 1.00, RMSEA = 0.014, SRMR = 0.058] and satisfactory reliability (Cronbach's $\alpha = 0.76$). ECEC setting and amount of free play time were recorded as dummy variables. Free play time was divided into less or more than 2 h per morning (0 = less than 2 h; 1 = more than 2 h). Settings included childcare center or kindergarten (0 = childcare center, 1 = kindergarten).

2.5. Analytic plan

First, we computed simple descriptive statistics and bivariate correlations to describe the prevalence of the variation in teachers' roles during free play as well as the predictors (see Table 3). Second, we estimated multivariate regression models in which we predicted teachers' roles in free play by the type of children's play and by

teacher-related and classroom-related characteristics. Because the observation cycles (level 1) were nested within teachers and groups (level 2), we calculated intraclass correlation coefficients (ICCs) to explore outcome variation across level 2 units before finally estimating multivariate regression models in a multilevel framework (see Table 4). All externally assessed predictors from each observation cycle (level 1) and self-reported predictors (level 2) were modeled as manifest independent variables. Teachers' roles in free play measured at level 1 entered the model as a manifest dependent variable. The analyses were conducted using MPLUS version 8.8 (Muthén and Muthén, 1998-2018).

3. Results

3.1. Descriptive statistics

There were differences in the frequency of the observed roles and the types of children's play across the overall 291 observation cycles (see Table 3). The reactive roles of tutor and stage manager ($M=2.66$; $SD=1.00$) and classroom manager ($M=2.22$; $SD=0.97$) were the most frequently observed roles, followed by the proactive roles of the director ($M=1.83$; $SD=0.99$) and the redirector ($M=1.82$; $SD=1.00$). The co-player ($M=1.69$; $SD=0.94$) was the least frequently observed role. The mean values are rather low for a five-point scale because the 5 (always) was only rated if no other role could be observed in this cycle, which was very rarely the case. Exploratory play ($M=0.31$; $SD=0.46$) occurred most in interaction with teachers, followed by construction play ($M=0.29$; $SD=0.45$) and dramatic play ($M=0.11$; $SD=0.32$). Games with rules ($M=0.08$; $SD=0.28$) were rarely observed as the most prevalent type of play.

3.2. Bivariate correlations

3.2.1. Intercorrelations of the roles

As the correlation matrix in Table 3 shows, the intercorrelations of the roles demonstrated that the role of classroom manager was significant negatively correlated at a low level with the three roles with reference to children's play of co-player ($r=-0.13$, $p<0.05$), director ($r=-0.12$, $p<0.05$), and tutor and stage manager ($r=-0.13$, $p<0.05$). In addition, the role of redirector correlated significantly negatively with those of co-player ($r=-0.16$, $p<0.01$) and tutor and stage manager ($r=-0.38$, $p<0.001$) at a low to moderate level. No other roles correlated significantly with each other.

3.2.2. Teacher-related characteristics

The correlations between work experience and the roles of co-player ($r=-0.12$, $p<0.05$) and classroom manager ($r=-0.18$, $p<0.01$) were significantly negative, whereas the correlations with the role of director ($r=0.14$, $p<0.05$) and redirector ($r=0.12$, $p<0.05$) were significantly positive. All these significant correlations between teachers' roles and work experience were at a low level. There was no significant correlation between teachers' work experience and the role of tutor and stage manager. Professional self-efficacy was negatively correlated with the tutor and stage manager ($r=-0.25$, $p<0.001$) and positively correlated with the redirector ($r=0.24$, $p<0.001$), both at a low level but highly significant. We found no significant correlation between professional self-efficacy and the other roles.

3.2.3. Classroom-related characteristics

Free play time correlated significantly positively with the classroom manager role ($r=0.13$, $p<0.05$), whereas the setting was significantly positively correlated with the director role ($r=0.14$, $p<0.05$), both at a low level. No other roles had any significant correlation with the classroom-related predictors.

3.2.4. Play-related characteristics

Exploratory play was significantly negatively correlated with the director ($r=-0.19$, $p<0.01$) and positively with the classroom manager ($r=0.15$, $p<0.05$). A small significant positive correlation was found between dramatic play and co-player ($r=0.18$, $p<0.01$). Construction play was significantly negatively correlated with the classroom manager ($r=-0.14$, $p<0.05$) role and significantly positively correlated with the director ($r=0.17$, $p<0.01$) and the tutor and stage manager ($r=0.15$, $p<0.01$) roles. Games with rules correlated significantly positively with the co-player role ($r=0.13$, $p<0.05$) and significantly negatively with that of classroom manager ($r=-0.13$, $p<0.05$). These correlations reported at a low level. No other roles were significantly correlated with play-related characteristics.

3.3. Multilevel regression analysis

The data had a hierarchical structure with several observation cycles per teacher. A random intercept model was chosen to account for the nesting of the data. First, an intercept-only model was run to calculate the ICC values for each role: co-player ($ICC=0.12$), director ($ICC=0.45$), tutor and stage manager ($ICC=0.48$), redirector ($ICC=0.36$), and classroom manager ($ICC=0.20$). These values showed a substantial amount of variance for teacher- and classroom related characteristics at the between-level that needs to be controlled for. The resulting model with 286 observations cycles and 78¹ teachers fitted the data very well [$\chi^2(60)=167.42$, $p<0.001$, CFI=1.00, RMSEA=0.00, SRMR_{within}=0.001, SRMR_{between}=0.011].

3.3.1. Teacher- and classroom-related predictors at the between-level

Teachers' work experience and professional self-efficacy predicted a few roles with moderate to strong effects (see Table 4). Teachers' work experience was negatively related to the classroom manager ($\beta=-0.47$, $p<0.001$), but not to other roles. Teachers with a higher professional self-efficacy assumed less the role of tutor and stage manager ($\beta=-0.35$, $p<0.01$), and more the role of redirector ($\beta=0.40$, $p<0.01$). No other roles were linked to teachers' professional self-efficacy. Free play time was marginally significantly related to the classroom manager ($\beta=0.31$, $p<0.10$) at a moderate level. However, the setting was moderately negatively associated with the co-player ($\beta=-0.45$, $p<0.05$) and demonstrated that teachers in kindergarten less frequently assumed the co-player role than teachers working in childcare centers. No other significant relations were found. In summary, teacher- and classroom related predictors explained 9–36% of the variance in the roles.

¹ The number of cases decreased due to two missing questionnaires.

TABLE 3 Descriptive statistics and bivariate correlations of all study variables at the level of observation cycles.

		<i>N</i>	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8	9	10	11	12
Teacher roles during free play																
1	Co-player	289	1.69	0.94	1											
2	Director	286	1.83	0.99	0.00	1										
3	Redirector	284	1.82	1.00	-0.16**	-0.00	1									
4	Tutor and stage manager	290	2.66	1.00	0.09	-0.08	-0.38***	1								
5	Classroom manager	291	2.22	0.97	-0.13*	-0.12*	-0.06	-0.13*	1							
Teacher-related characteristics																
6	Work experience	286	13.07	10.36	-0.12*	0.14*	0.12*	-0.11	-0.18**	1						
7	Professional self-efficacy	286	4.14	0.37	-0.12	0.45	-0.25***	0.24***	0.02	0.19**	1					
Classroom-related characteristics																
8	Free play time ^b	286	0.42	0.49	-0.05	-0.11	0.08	0.02	0.13*	0.03	0.22***	1				
9	Setting ^c	291	0.60	0.49	-0.10	0.14*	0.04	-0.01	-0.05	0.25**	-0.04	-0.17**	1			
Play-related characteristics																
10	Exploratory play ^a	291	0.31	0.46	-0.09	-0.19**	-0.11	0.00	0.15*	-0.05	0.07	0.01	-0.19***	1		
11	Dramatic play ^a	291	0.11	0.32	0.18**	-0.00	0.09	-0.01	-0.03	0.10	-0.02	-0.06	0.03	-0.24***	1	
12	Construction play ^a	291	0.29	0.45	-0.01	0.17**	-0.19	0.15**	-0.14*	0.02	-0.08	-0.05	0.17**	-0.43***	-0.23***	1
13	Games with rules ^a	291	0.08	0.28	0.13*	0.09	-0.05	-0.05	-0.13*	-0.05	0.04	0.00	0.14*	-0.20***	-0.11	-0.19***

^a 0 = No; 1 = Yes, ^b 0 = Less than 2h; 1 = More than 2h, ^c 0 = Childcare center; 1 = Kindergarten.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

TABLE 4 Multilevel regression model predicting teachers' externally assessed roles during free play.

		Co-player	Director	Redirector	Tutor and stage manager	Classroom manager
		β (SE)	β (SE)	β (SE)	β (SE)	β (SE)
BETWEEN-level						
Teacher-related characteristics						
	Work experience	-0.29 (0.21)	0.15 (0.15)	0.07 (0.16)	-0.11 (0.14)	-0.47*** (0.15)
	Professional self-efficacy	0.07 (0.07)	0.14 (0.15)	0.40** (0.14)	-0.35** (0.11)	0.06 (0.18)
Classroom-related characteristics						
	Free play time ^a	-0.16 (0.17)	-0.18 (0.12)	0.04 (0.14)	0.14 (0.12)	0.31 [†] (0.17)
	Setting ^b	-0.45* (0.20)	0.08 (0.12)	0.12 (0.12)	-0.06 (0.12)	0.15 (0.18)
	R ²	0.36 [†] (0.21)	0.09 (0.07)	0.20 [†] (0.11)	0.15 [†] (0.09)	0.28 [†] (0.15)
WITHIN-level						
Play-related characteristics						
	Exploratory play ^c	0.02 (0.07)	-0.05 (0.07)	-0.16 (0.10)	0.15 (0.10)	0.01 (0.08)
	Dramatic play ^c	0.25* (0.10)	0.05 (0.08)	-0.07 (0.10)	0.21* (0.10)	-0.10 (0.08)
	Construction play ^c	0.15 [†] (0.09)	0.24** (0.09)	-0.09 (0.09)	0.32*** (0.09)	-0.19* (0.08)
	Games with rules ^c	0.23** (0.08)	0.17 [†] (0.09)	-0.17** (0.06)	0.13 (0.10)	-0.21*** (0.06)
	R ²	0.09* (0.04)	0.09 [†] (0.05)	0.03 (0.02)	0.07 [†] (0.04)	0.06 [†] (0.03)

^a 0 = Less than 2 hours; 1 = More than 2 hours, ^b 0 = Childcare center; 1 = Kindergarten; ^c 0 = No; 1 = Yes, β = Standardized regression coefficient; SE = Standard error. CFI = 1.00, RMSEA = 0.00, SRMR_{within} = 0.001, SRMR_{between} = 0.011. [†] $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

3.3.2. Situational play-related predictors at the within-level

The multilevel regression analysis (see Table 4) showed that almost all types of children's play except exploratory play predicted different teachers' roles to varying extents. Dramatic play was significantly positively related to the roles of co-player ($\beta = 0.25, p < 0.05$) and tutor and stage manager ($\beta = 0.21, p < 0.05$) at a low level but not to other roles. Construction play significantly positively predicted the roles of director ($\beta = 0.24, p < 0.01$) and tutor and stage manager ($\beta = 0.32, p < 0.001$) at a low to moderate level, and the co-player role marginally at a low level ($\beta = 0.15, p < 0.10$). Moreover, construction play was significantly negatively linked to the classroom manager ($\beta = -0.19, p < 0.05$) at a low level. Games with rules predicted teachers' roles with low to moderately significant effects. When children were playing games with rules, teachers were more likely to act as a co-player ($\beta = 0.23, p < 0.01$) and less in the roles of redirector ($\beta = -0.17, p < 0.01$), and classroom manager ($\beta = -0.21, p < 0.001$). In addition, a marginally significant relation was found between games with rules and the director role ($\beta = 0.17, p < 0.10$). In summary, play-related predictors explained 6–9% of the variance in the roles.

4. Discussion

The aim of the present study was to externally assess the roles of teachers during children's free play in two ECEC settings, childcare centers and kindergartens, and to investigate their relations to teacher-, classroom-, and play-related predictors. For this purpose, we developed a standardized observation scale (TRFP-O) that distinguishes five active roles that teachers may assume during free

play: co-player, director, redirector, tutor and stage manager, and classroom manager. Teacher- and classroom-related predictors included teachers' work experience, teachers' professional self-efficacy, available free play time, and the ECEC setting. In addition, a play-related predictor was included and operationalized as the type of children's play. This contained four types of children's play: exploratory play, dramatic play, construction play, and games with rules. To the best of our knowledge, this is the first study to address three levels of predictors of teachers' roles in free play and the situational characteristics of the type of children's play with which they engage. In addition, teachers' roles in free play were analyzed using a multilevel approach that considered the hierarchical data structure. The study succeeded in observing and analyzing data from 80 teachers, a significantly larger sample than previously reported in observational studies about teachers' roles during free play (e.g., File, 1994; Tajik and Singer, 2018). Finally, data was assessed using a newly developed standardized observation scale, adding to previous studies that either assessed primarily qualitative, unstandardized data (Jung, 2013; Gaviria-Loaiza et al., 2017) or self-reported questionnaire data (e.g., Ivrendi, 2020; Wustmann Seiler et al., 2022). Our results demonstrate that teachers' roles during free play are mainly explained by teacher- and classroom-related predictors and less by the type of children's play.

4.1. Assessment of teachers' roles during free play using the TRPF-O

The study showed that it is possible to reliably distinguish and assess the five active roles assumed by teachers during free play using our external observation scale (TRFP-O). The interrater reliability

with intraclass coefficients from 0.72 to 0.93 was satisfactory. Findings on the frequency of the roles were congruent with previous studies showing that the tutor, stage manager, and classroom manager roles were observed most frequently (Aras, 2016; Gaviria-Loaiza et al., 2017; Ivrendi, 2020; Wustmann Seiler et al., 2022). However, there were also discrepancies with previous studies, probably due to different types of assessment such as questionnaires and observations. For example, the role of co-player was reported as the second most preferred role in the questionnaire study by Ivrendi (2020) but was observed least frequently in the present study. It seems that teachers overestimate the amount of time they actually participate as co-players in children's play. In addition, the discrepancy might be due to the difference in samples in group size (smaller groups; Ivrendi, 2020) or children's ages (younger children; Grigoropoulos, 2021). The director role was also reported more frequently when assessed with questionnaires (Grigoropoulos, 2021) than in our study which assesses the roles through observation in live situations. This was the case even though this particular role was already softened and operationalized as less directive as part of the live observation. However, the director role is also favored mainly in the context of younger children (Ivrendi, 2020; Grigoropoulos, 2021). In contrast, the role of redirector was not assessed in the questionnaire studies, hence no data is available for a comparison. In previous qualitative observational studies, the redirector role was rarely observed, just as it was in the present study (Gaviria-Loaiza et al., 2017).

4.2. The significance of teacher-related predictors

The teacher-related characteristics of work experience and professional self-efficacy were found to be strong predictors for certain roles. For example, work experience proved to be a significant predictor of the role of classroom manager: the more experience a teacher had, the less the role of classroom manager was observed. This is in line with Wustmann Seiler et al.'s (2022) findings and indicates that experienced teachers might react less to children's rule violations or socio-emotional problems. It is also possible that teachers with more work experience are better able to prevent such situations altogether, for example through an elaborated organization of the play and learning environment or through more effective promotion of the children's social-emotional competences. If teachers have fewer day-to-day classroom management tasks as a result, they have more time for other activities that support children's play or learning. However, the result of the present study does not indicate which roles these teachers then assume more often in this extra time. Previous studies have indicated that experienced teachers interact less with children during free play and more frequently report the passive uninvolved role (Ivrendi, 2020; Grigoropoulos, 2021). This finding aligns with the constructive perspective according to Piaget's theory and rather reflects a more traditional image of older and thus more experienced teachers who believe that adults should stay outside of children's free play so as not to interrupt children's natural learning (Wood and Bennett, 1998; O'Connor, 2014). More recently, Vygotsky's social constructivist theory has been favored and discussed in relation to the concept of guided play (Zosh et al., 2018). Professional self-efficacy predicted the role of the redirector in the present study. Teachers who rated themselves higher in professional self-efficacy

were more likely to focus on children's academic learning during free play. This aligns with the existing body of evidence in which professional self-efficacy is positively related to students' academic adjustment, mediated by instructional support (Zee and Koomen, 2016). In the present study, however, this instructional support related more to academic learning than to children's learning through play, because teachers who rated themselves higher in their professional self-efficacy were observed less in the reactive role of tutor and stage manager, which helps children to implement their play ideas or to find their way into play if necessary. In contrast, in Wustmann Seiler et al.'s (2022) questionnaire study, teachers with higher self-efficacy reported acting more frequently as tutors. It seems that teachers perceive themselves differently in the role of tutor than they appear in the external assessment.

4.3. The relationship between teachers' roles and classroom-related predictors

The ECEC setting proved to be the strongest classroom-related predictor. Results showed that teachers in kindergarten act less as co-players who play actively with children than teachers in childcare centers. This may be due to the different characteristics that are inherent to the two settings. For example, children are *per se* older in kindergarten, the group size is larger, and the teachers have a higher educational qualification than is the case in childcare centers. The correlation of group size with the co-player role is congruent with Ivrendi's (2020) finding that teachers were more actively involved when there were fewer children in the group. However, it is possible that teachers are generally more proactive in supporting younger children's play due to their developmental age and possibly less play experience. This was also shown in Ivrendi's (2020) questionnaire study, which found that teachers of older children were less likely to take the proactive role of the director giving children suggestions and making decisions about their play. Another classroom-related predictor, the amount of time children spent in free play, proved to be less significant for externally assessed teachers' roles, contrary to Wustmann Seiler et al.'s (2022) findings in a questionnaire study. In other words, teachers who provide more than 2 h of free play time on average were not involved differently in children's play than teachers who provide less time for free play.

4.4. Differences in teachers' roles during free play depending on the type of children's play

The roles teachers assumed during free play were explained by three types of children's play which were mainly categorized as goal-oriented or cooperative: dramatic play, construction play, and games with rules. During more goal-oriented types of children's play, construction play and games with rules, more roles were observed with reference to children's play, co-player and director, and fewer roles without, classroom manager and redirector. Moreover, during more cooperative types of children's play, dramatic play and games with rules, teachers were more likely to assume the proactive role of co-player. The reactive role of the tutor and stage manager was observed most frequently during dramatic and construction play. It

appears that children repeatedly show a need for support during more goal-oriented and cooperative play without specific rules, for example, by asking the teachers for advice or play materials. The findings are consistent with current research that states that most teachers were involved in types of children's play that are goal- and product-oriented (Kontos, 1999; Tsai, 2015). In contrast to Shin and Spodek (1991) and File (1994), teachers were also reactively and proactively involved in open-ended dramatic play. The two roles without reference to children's play, redirector and classroom manager, were observed less frequently during goal-oriented types of play: construction play and games with rules. This indicates that children in goal-oriented types of play require less classroom management. In addition, teachers seem to focus less on academic content in these types of children's play because children are already engaged in cognitively demanding play. In contrast, exploratory play, which makes the fewest social and cognitive demands, was not confirmed as a predictor of teachers' roles. Exploratory play focuses on children's sensomotor processes (Johnson et al., 1999), so teachers may want to deliberately withdraw to enable children to have a variety of experience in such play. Also, it is possible that no specific need for teacher involvement arises in these open-ended types of children's play.

4.5. Strengths and limitations

The present study was the first to use a standardized observation scale to assess teachers' roles during free play. The study also examined various characteristics related to the teacher, the classroom, and the type of play in which children are engaged that may influence teachers' roles in this play. We drew data from 291 observation cycles in two Swiss ECEC settings: childcare centers and kindergartens. In addition, the situational play-related predictors at the observation cycle level were examined in a multilevel analysis for the first time. The five roles were rated on the developed scale (TRFP-O) to ensure that they were clearly distinguishable and achieve the most objective recording of roles and to allow observer agreement. The observation scale was used on a relatively large sample with satisfactory interrater reliability. The five roles varied in how teachers positioned themselves during play and their teachers' activity level, representing their guidance and control in play. Furthermore, the roles differed in the reference of teachers' behavior to children's play reflecting teachers' intention, such as supporting children's play processes or supporting academic learning or social-emotional behavior. However, this classification is highly complex and can sometimes seem confusing. Further studies could examine how to reduce complexity when categorizing the roles without losing critical information. In further quantitative studies, for instance on the effectiveness of play involvement on children's development, the complexity could be reduced by assessing the roles in combination or by focusing solely on selected roles, depending on the research question. In addition, future studies should also include the passive roles of onlooker and uninvolved so that the whole continuum of teachers' play involvement can be represented. The advantage of external assessment over questionnaire studies is the absence of bias arising from teachers' subjective perceptions and social desirability. The disadvantage is that the ratings only reflect what was evident at that specific time of observation. It is quite likely that atypical situations

occur, or participants behave differently than usual during the observation due to social desirability. However, because the observers stayed in the background and were present for several hours, it can be assumed that individual atypical situations were less salient. However, to demonstrate the reliability of the TRFP-O observation scale, its test-retest reliability should be analyzed in future studies. Furthermore, it is recommended to redefine the highest value of the five-point scale from *always* to *very often*, so that the whole scale can be increasingly exploited. In addition, it remains open whether the correlations with the setting were due to the age of the children, the group size, or teachers' educational background. Moreover, further studies should capture the specific characteristics of the children during observation, including age, playfulness, and support needs, to examine the extent to which teachers adapt their play involvement to children's needs. A good fit between the children's needs and the level of adult guidance has been described as a prerequisite for children's independent play (Trawick-Smith and Dziurgot, 2011). The authors showed that teachers with a higher level of education succeeded in doing so better than teachers with a lower level of education. In addition, the participants had registered for the study voluntarily. Therefore, it is possible that teachers who were particularly interested in the topic of play and playfulness were involved. Teachers who are less interested in play may act differently during children's free play, so a risk of selection bias cannot be excluded. Finally, the sample size is limited by the extensive and complex data collection involved in external observation.

4.6. Implications for practice

The results described above stimulate reflection on the roles the teachers assumed in free play and indicate potential for development in teacher education and training. The following questions can, for example, be addressed: Why do teachers with increasing professional experience and higher self-efficacy not increasingly take on active roles with reference to children's play: co-player, director, tutor and stage manager? What are the reasons for teachers' restraint in open-ended types of children's play? Is it justifiable for teachers to foster academic learning during free play if it interrupts children's play? Presenting teachers with such questions increases their awareness of their own role in free play. In this way, high-quality interactions that promote both children's play and development can be initiated intentionally.

5. Conclusion

The present external assessment of teachers' roles in free play showed that teachers were involved in children's play in ECEC in various ways. Using a newly developed scale (TRFP-O) enabled observation of five active roles: co-player, director, redirector, tutor and stage manager, and classroom manager. We were able to show that teachers were more proactively involved, for example as co-player and director in goal-oriented types of children's play than in open-ended types. However, the roles that teachers assumed during children's free play depend more on the teachers' work experience and professional self-efficacy and less on the type of play

in which children are engaged. The setting, whether childcare center or kindergarten, was a significant predictor only for the role of co-player, but not for the other roles. This indicates that setting differences are not relevant for most of the roles that teachers assume during free play.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Ethics Committee of the Faculty of Philosophy of the University of Zurich. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

CR: Data curation, Formal Analysis, Investigation, Writing – original draft. ID: Data curation, Investigation, Writing – review & editing. PL: Conceptualization, Funding acquisition, Methodology, Writing – review & editing, Supervision. CW: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Writing – review & editing, Supervision.

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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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