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Chinese early childhood teachers' perspectives on mathematics education in play-based contexts

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ABSTRACT
Following the increasing impacts on the value of Western play-based pedagogy, early childhood (EC) teachers in China face developmental challenges related to understanding and implementing play-based mathematical education. The purpose of this paper is to explore Chinese EC teachers' perspectives on play-based mathematics teaching. In this qualitative study, semi-structured interviews and lesson plans are collected from six EC teachers in a Chinese kindergarten. Hedegaard's model is applied to frame analysis for capturing EC teachers' views and practices from a holistic perspective. The findings show that all six EC teachers valued play as a pedagogical tool for teaching mathematics, while their pedagogical decisions in applying play to children's mathematics are determined by the various demands from society, parents and children. The multiple demands from different perspectives result in challenges for teachers in designing collective play. This study revealed that only when play activity caters to the possibility of satisfying those demands can teachers pedagogically implement play for children's mathematical learning. The insights emerging from this study might address the pragmatic challenges that teachers face by enhancing teachers' professional development to support the advance of culturally sensitive play-based mathematics teaching in China.

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Introduction

Innovative approaches to early mathematics tend to draw on play to extend children's mathematical thinking and performance (van Oers 2010). Impacted by the progressive ideology and models of Western countries, early childhood (EC) education in China has been through a dynamic history of educational reform (Li et al. 2018). There has been increasing recognition of play as the primary context for children's learning in EC education in China (Gao et al. 2022, Qi and Melhuish 2017). This situation has been largely influenced by the legislation of the Chinese government. In 2001, the document *Guidelines for Early Childhood Education (Trial Version)* was released by the Ministry of Education of the People's Republic of China (2001), emphasising that play-based pedagogy should be promoted by EC teachers to support children's development. The Ministry

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of Education of the People's Republic of China (2012) has since refined the curriculum in the *Early Learning and Development Guidelines for Children Aged 3–6* (i.e. *Guidelines*) for teachers' instruction in play-based contexts. In the *Guidelines*, teaching mathematics is encouraged, to immerse problem-solving and self-discovery strategies in developing children's mathematical skills. Importantly, the knowledge of mathematics has always been highly appreciated in China, and young children are expected to learn and practice it (Zhang et al. 2020). With the renewal of the curriculum, Chinese EC teachers need not only to meet societal demands for the mathematical development of children but also to ensure that children are developing in a play-based context.

EC teachers play the most crucial role in the success of curriculum reform (Chen, Hui, and Wang 2017). Despite the political landscape that mandates these EC teachers to emphasise the advantages of adopting a play-based pedagogy, it is problematic for them to effectively reflect these concepts in their performance (Hu et al. 2014, Vong 2012). Play and learning are always paired in Western culture; however, there is a seeming contradiction between the two in Chinese culture, which has influenced Chinese perceptions of play (Wu et al. 2018). As Li and Chen (2017) have discussed, the deeply ingrained philosophies of Confucianism and the heritage of collectivism in China appear to contradict established play-based pedagogy. Since the Western play-based pedagogy approach focuses on a child-centred teaching practice, it appears to be a dramatic philosophical shift for Chinese EC teachers who value culturally shaped Confucian ideals on the superiority and authority of teachers (Hu et al. 2017; Fleer and Li 2020. Moreover, the collectivist orientation focuses on collective work instead of an individual child's desires and demands (Li and Chen 2017). Given that the policy *Guidelines* do not provide explicit theoretical and practice guidance regarding play-based pedagogy, Chinese EC teachers try to transplant Western models of play pedagogies into their teaching to meet the societal demands (Li and Chen 2017). By doing so, Chinese kindergarten practices have evolved a parallel form where play-based activities and teacher-centred teaching practices co-exist (Fleer and Li 2020). Yet, how Chinese EC teachers develop their play-based teaching approaches in mathematics education is starkly underrepresented in EC research (Li et al. 2018). After the *Guidelines* have been operating in educational reform in China for 20 years, it is timely to explore how teachers' views and beliefs influence the implementation of mathematics education in play in order to meet the societal demands in China.

Challenges in applying play-based pedagogy in China

Previous research has established that most Chinese EC teachers have endorsed the important role of play in learning (Pan et al., 2018, Wu et al. 2018), while many of them struggle to integrate play into the teaching of early academic skills (Hu et al. 2014). This dilemma for EC teachers stems from the fact that play-based pedagogy is challenging in both definition and practice (Rogers 2010). Play embraces many forms; the inconsistent definitions can lead to difficulties in understanding the role of play in children's development and in implementing play-based pedagogy (Fesseha and Pyle 2016). In this paper, we draw upon the cultural-historical concept of play, which explains that the nature of play is culturally constructed and implemented (Fleer 2021). We acknowledge that Chinese EC teachers perceive play as a cultural expression while they seek to implement play-based pedagogy.

Debates about EC teachers' roles within children's play might also complicate the implementation of play-based pedagogy (Pyle and Danniels 2017, Weisberg et al. 2016). Research has indicated that Chinese EC teachers value their roles in providing guidance in children's play in order to support conceptual learning (Hu et al. 2017, Wu et al. 2018). However, they identify several challenges that hinder them from carrying out a play-based pedagogy, such as supporting child-led play with creative resources (Gao et al. 2022), intervening in children's play and sustaining interaction with children (Hu et al. 2014). Children's readiness for primary school education is the main concern of Chinese parents and teachers therefore perform more instructional activities to achieve pre-set objectives to satisfy parents' demands (Wu et al. 2018). Meanwhile, Fung and Cheng (2012) have attributed the challenges to teachers' lack of confidence in convincing parents that play is a worthwhile experience. Consequently, EC teachers might return to the direct instruction of teaching to offer the expected educational results to parents (Wu 2014). More specifically, in China, whereas it is easy to recognise the direct instructional learning outcomes of children in the context of traditional directed teaching, it is difficult to identify tangible educational results of play (Gao et al. 2022, Vong 2012). Therefore, play-based pedagogical awareness is increasingly recommended for EC teachers in China; however, the gap between practice and pedagogy still exists (Chen, Hui, and Wang 2017, Gao et al. 2022, Qi and Melhuish 2017).

Teachers' beliefs and practices concerning children's mathematics learning in play

It is worth noting that EC teachers' beliefs in relation to teaching mathematics are receiving increasing attention in recent early mathematics research (Pelkowski et al. 2019, Zhu et al. 2021). Beliefs are described as 'knowledge or ideas accepted by an individual as true or as probable' (Evans et al. 2004, 303). They can be a powerful predictor of teachers' classroom practices that inform their teaching (Fives et al. 2015, Ren and Smith 2018). To effectively apply play-based pedagogy in China, examining EC teachers' beliefs relevant to their implementation of play-based pedagogy in everyday teaching is critical to developing this field (Wang and Bun Lam, 2017).

Although research indicates that mathematics-specific instruction is no longer the only approach to teach mathematics in China (Li et al. 2015), there is a paucity of research which has deeply conceptualised Chinese EC teachers' mathematics-related beliefs and practices in play-based contexts (Li et al. 2018, Zhu et al. 2021). Hu et al. (2017) examined the implementation of 10 mathematics lessons in a Chinese kindergarten and found that EC teachers' lessons reflected aspects of the curriculum demands (e.g. encouraging children's interaction and providing manipulative materials). Further, Li et al. (2018) argued that Chinese EC teachers have tended to adopt Western pedagogical approaches that promote child-centred teaching; however, they still favour more directed mathematical activities. Another quantitative study explored Chinese EC teachers' beliefs and mathematical teaching efficacy during block play (Zhu et al. 2021). They found that teachers' constructivist beliefs in mathematics teaching and learning significantly influenced the implementation of a more child-centred teaching practice, yet these studies provide fewer details regarding how teachers understand the role of play in teaching mathematics. More needs to be known about Chinese teachers' beliefs and

practices in play-based mathematics teaching after the *Guidelines* have been in operation for 20 years. This qualitative case study draws upon a cultural historical view of child development to investigate how EC teachers in China interpret and enact play-based mathematics teaching and to identify some key challenges that may affect their implementation of play-based mathematics education. The research is guided by the following questions:

- How do EC teachers in China implement a play-based pedagogy in mathematics teaching?
- What are their own views on the implementation of play-based mathematics teaching practices?

Theoretical framework

In this study, the data were analysed and categorised by applying Hedegaard's (2012) model, adopting three interlinked perspectives, societal, institutional and personal, to apply a wholeness approach to understanding child development. Edwards, Fleer, and Bøttcher (2019) argued that the different perspectives in this model are entry points into a research study that enable researchers to approach a topic and study it based on the dynamic relationships between the perspectives. The current study chose the institutional setting, a kindergarten, as the entry point. EC teachers are included in this setting to reveal how their pedagogical perspectives on the activity settings contribute to children's developmental conditions.

Based on Hedegaard's model, the societal perspective is a macro standpoint, which represents the circumstances for institutional practice as cultural traditions, political material conditions and values (Fleer and Hedegaard 2010). In this study, the societal perspective refers to Chinese cultural values realised through kindergarten practices. Next, institutional perspectives involve a range of values and ideas related to ensuring a good life for children, which influence the teachers' interpretations of the demands in their work (Edwards, Fleer, and Bøttcher 2019). The institution's demands are themselves influenced by societal requests (Hedegaard 2012). To satisfy those demands, the institution places requirements on EC teachers, which affect their pedagogical perspectives and practices. Notably, since family practices differ from kindergarten practices, teachers have to acknowledge the reality across different institutional and societal contexts for promoting a broader view of children's learning and development (Fleer and Hedegaard 2010). Further, the personal perspective recognises the children as learners in the activity settings. In this sense, children, through understanding the opportunities and demands available to them, create their own social situations of development (Edwards, Fleer, and Bøttcher 2019). Dialectical thinking shows that institutional practices are not static, but dynamically changeable as a result of the demands of individual children in the concrete activity setting (Hedegaard 2012). Therefore, Hedegaard's model is chosen to analyse teachers' understanding regarding children's play in mathematics because it highlights the significance of contextual conditions and supports theoretical reflection on the complexity of interactions in those different perspectives.

Methodology

To explore Chinese EC teachers' perspectives and practices concerning mathematical play-based teaching in kindergartens, this study adopted a qualitative, case study research. We recruited six EC teachers from the Fu kindergarten (pseudonym) which is situated in Beijing, China. Prior to the commencement of the study, ethical approval was gained from the University's Human Research Ethics Committee (Approval Number –24,331). After receiving this approval, we approached potential participants and helped them to fully understand the aim and process of the project. To ensure their voluntary participation in the study, all teachers involved in the project received a participant explanation statement and were encouraged to consider whether they wanted to participate before they agreed to sign a consent form. Written informed consent was obtained from six participants. These participants had 10 to 17 years of teaching experience and had a bachelor's degree or diploma degree in EC education. All participants in the study identified as female and taught children aged 3 to 5 years old in six different classrooms (Table 1).

The participants were invited to share their lesson plans related to children's mathematical activity and emailed those materials to researchers before the semi-structured interview. Planning is a core competence of teachers, which combines knowledge, understanding, values and attitudes, and has a profound influence on teachers' classroom behaviours (Clandinin and Husu 2017). In order to reveal aspects of EC teachers' work and plans for the children's learning within their social and cultural contexts, we used lesson plans as supportive documents in examining the data to achieve the research aims.

Cohen, Manion, and Morrison (2018) outlined that in-depth interview support interpretive inquiry and permit the researcher to expose people's experiences and perceptions in more depth than other research methods. Namely, interviews can enter the phenomenon and gain multiple views to understand the participants' thoughts and feelings regarding the research topic. In this study, the online individual semi-structured interviews were scheduled according to the participants' availability and lasted approximately 40 min. The interviews were conversational in nature, with the researcher offering different perspectives and suggestions regarding the challenges of implementing early mathematics education in play, in order to develop reciprocal relations with the interviewees regarding their practices. To help guide conversation, the interview questions included, 'How do you support children's mathematics learning in kindergarten?', 'What is your perception of integrating mathematics in the play-

Table 1. Details of Early Childhood Teachers at Fu Kindergarten.

Participant name (pseudonym used)	Educational background	Years of work experience	Age of children taught
Tian	Bachelor of early childhood education	10 years	5 to 6 years
Ya	Diploma of early childhood education	12 years	3 to 4 years
Dan	Bachelor of early childhood education	17 years	4 to 5 years
Bing	Diploma of early childhood education	17 years	5 to 6 years
Ping	Diploma of early childhood education	16 years	4 to 5 years
Juan	Diploma of early childhood education	15 years	4 to 5 years

Table 2. Data analysis procedure.

Level of interpretation	Progressive focus in data analysis
Level 1: common-sense interpretation	Systematically read and re-read the raw data; highlighted key phrases in the MS Word files, created analytical memos and then data were tagged based on the initial comments and salient features regarding teachers' views and practices of play and mathematics.
Level 2: situated-practice interpretation	Reflected on the underlying meaning of the common-sense interpretations from the overall data set, and then elaborated those data into potential themes and sub-themes. According to the theoretical framework (e.g. societal, institutional and personal perspectives), data are applied and explicated during this analysis procedure to comprehend the teachers' intentional orientation in different mathematical practices.
Level 3: thematic interpretation	Through analysing the situated-practices interpretations and connecting these with the research aim, relationships between those themes were represented in the form of thematic maps to identify emergent themes related to the underpinning theoretical framework.

based curriculum?' and 'What would you like to know more regarding the implementation of a play-based curriculum in mathematics?' Through dialogue-based interviews, the participating teachers also had the chance to reflect on their own teaching practices.

To address the purpose of the research, this study applied a wholeness approach, drawn from Hedegaard (2008), to interpret and analyse the data. There are three levels of interpretation that function as a system; common-sense interpretation, situated practice interpretation and thematic interpretation (Fleer 2014). Common-sense interpretation does not rely on explicit theoretical concepts, but rather on clear relationships where simple patterns in the interaction can be found (Hedegaard 2008). Then, the data analysis goes to the second spiral of interpretation, situated practice, which employs theoretical concepts (Hedegaard 2008). In this sense, researchers will select conceptual lenses to revisit the data for finding conceptual patterns. The third level of data analysis, thematic interpretation, is inextricably linked to the research aims (Hedegaard 2008). This generalisation is based on the situated interpretation, which intends to uncover significant patterns in connection to the study goals (Hedegaard 2008). Table 2 illustrates the progressive focus in data analysis for reflecting on meanings attributed to situations and identifying answers to the research questions.

Findings

Teacher's conceptualisations of play and mathematical learning

Although the six Chinese EC teachers conceptualised the role of play in learning mathematics differently, they all indicated that play is meaningful for children's mathematical learning, from their perspective.

For example, Tian believed that play is bound to stimulate children's interest in mathematical learning and help her to integrate mathematics into teaching. She clarified that, 'play is a catalyst for learning mathematics, children can learn shapes and numbers better in play since they are more actively engaging in different games'. As Tian described, 'when I mention playing games, I can feel children are full of passion and desire to learn'. Ya explained also, 'mathematics is abstract, and without really manipulating objects children cannot fully understand what numbers mean'.

Dan quoted from the curriculum *Guidelines* and explained, 'as highlighted in the *Guidelines*, play is children's everyday central activity, and teaching children's mathematics in play is appropriate since children can learn through their previous experiences'.

The definition of play itself does not seem as central in their discussion. Instead, they interpreted how play can promote mathematical learning through a web of their own teaching experience. Overall, those examples reveal that teachers recognised the significance of learning mathematics through play, and they valued play as one of their teaching methodologies in supporting children's learning of mathematical content knowledge.

Teachers' best practices in supporting children's mathematical learning

Two types of mathematical activity are frequently mentioned by teachers, group play activity and games with concrete materials.

Group-oriented activity

Five teachers mentioned that group play activity was the most effective way for children to learn mathematical content knowledge. For instance, Tian asserted, 'mathematics elements in the group activity are more concentrated, and children can learn mathematics systematically'. To clarify that she used play-based pedagogy instead of traditional teacher-directed activity, Tian gave an example that, 'children enjoy the theatre play by showing their performance based on a storybook as a group, and we always use picture books and different materials to support children's mathematical learning in those activities, because it is interesting and instructive'. Further, Tian highlighted parental approval for play-based teaching methods when she stated:

> Since children are going to transit from kindergarten to primary school soon, parents are willing to see whether children can learn some targeted mathematical content knowledge during class. When we held 'Open Day' activities, parents showed great approval for this teaching method based on the theatre play.

Figure 1 shows the lesson plan she offered, including the objectives, materials and lesson procedure. As indicated by its title, this lesson uses a picture-based story book, *Gingerbread Man*, to develop a theatre play for teaching addition and subtraction.

Another teacher, Dan, showed her lesson plan and explained that play-based learning has the potential for mathematical learning when stating that:

> The group play activity is appropriate for learning common mathematical content knowledge together. We design group lessons drawing upon children's prior knowledge and experience, for example, based on the traditional game, we re-designed 'What's the time, Mr Wolf?' and created two circles as the sheep's homes. I ask the children how many sheep are in this home, how many sheep are in the other home and how many sheep we have in total. Through this play experience, children are able to learn the decomposition and combination of numbers, actively thinking to solve problems.

Hence, it can be observed that Tian and Dan both value group play activities in supporting children's mathematical content knowledge learning. They see the importance of role-play based on storybooks (e.g. theatre play) or related to traditional games (e.g. What's the time, Mr Wolf?).

"Gingerbread Man" Lesson Plan

Activity objectives:

1. Understand the plot and perceive the changes in the number of characters during the gingerbread man's escape.
2. Experience the fun of story performance.

Activity preparation:

· picture book gingerbread man · pictures of characters in the story (a set) · magnetic board and marker

Activity process:

Listen to the story: gingerbread man (understand the story, understand the sequence of characters)

1. The teacher tells a story (the first clip)

· Questions after the story: who is in the story? What happened?

Remember the order in which the characters appear.

After the gingerbread man escaped, elderly lady, elderly man, the cow, the little squirrel, and the brown bear ran out one after another in order to chase the gingerbread man.

2. Performance story: gingerbread man (perceived the change in the number of characters during the gingerbread man's escape)

(1) Introduction of performance methods:

Children's story performance: Children who participate in the performance choose a "role" and appear in order; When the characters are talking, they should stand still and speak loudly to the audience. The children watch the performance carefully and help to talk about the "dialogue" of the characters.

(2) Children's story performance

· Key questions: who's going after the gingerbread man? How many characters are there now?

Are there more or fewer people?

How many are on the run? How many are chasing?

How to represent it?

· They came one after another to chase the gingerbread man, and the number of pursuers grew larger and larger.

(3) Tell the second half of the story and guess the end of the story.

· Teacher tells the second half of the story

· Question: how many characters are left?

What do you think will happen to the number of characters?

Figure 1. Tian's lesson plan.

Games with concrete materials

Four teachers valued games with concrete materials in supporting children's mathematical learning. In their opinion, the mathematical learning centre offers numerous choices for children to select the games in which they are interested. Ya highlighted, 'depending on the children's ability, we might have to change or adjust those materials, and those mathematical games are classified according to the different mathematical learning objectives, such as number operation, comparison, measurement and graphic space'. Further, Bing believed that construction play (e.g. Lego and block play) is useful for children's mathematical development; however, the teachers must provide suitable guidance. Similarly, Ya described the game she had created and said, 'if we provide clear, step-by-step instructions to show children how to play, then they can practice graphics and space through this game'.

Reflecting on teachers' perceptions of best practices in teaching mathematics, it can be noted that they have mathematics orientation as their teaching agenda while they design the play activities. Notably, they all placed great emphasis on the important role of adults in mathematical play, both in terms of activity planning and participation in play.

Challenges of teaching mathematics in children's play

All participants expressed concerns regarding integrating mathematics into children's play. Specifically, a distinct challenge repeatedly recognised in the teachers' interviews is that mathematical play activity is difficult to plan. In this regard, Tian said, I cannot forget that a child said to me, 'teacher, I don't want to play your game, I want to play my game'.

Tian explained that it is difficult to plan attractive mathematical play activities for children, 'I do not know whether all the mathematics knowledge can be turned into play. Sometimes you have to put mathematics into play, hence it is not as much fun'. She explained that when she designs a play-based mathematical activity, 'it's easy to turn it into a false play (play that is completely adult led). The teachers feel too tired to guide children to play, and the children do not like to play'. Tian felt it challenging to design a meaningful whole-group lesson by herself and highlighted, 'when we design the whole-group lesson, we normally refer to the lesson plans in books or learn from other kindergartens' lesson plans'.

Ya, Bing and Dan professed that they find it difficult to create play activity relevant to mathematics since they are mandated to reflect from various aspects. Ya described her multifaceted thoughts when designing activities in the kindergarten setting, needing to consider, 'the children's interest; the curriculum requirements; children's capabilities related to the teaching content; how to keep the playfulness in the lesson; the parents' expectations, and curriculum learning objectives, etc . . . we just need to consider too much'.

Moreover, Dan stated, 'we need to recognise children's existing knowledge and their interests. I am so confused sometimes on what to do, and what to do next'. This quote illustrates that the teacher Dan values children's prior knowledge and interest; however, she does not know how to incorporate their interests and acknowledgement of children's prior knowledge into mathematics teaching. Juan also shared that 'sometimes I was thinking am I designing the appropriate play activities for children? I wonder how play appears to a child?' Moreover, Dan believed that planning play activity in mathematics 'requires using all of the teachers' abilities'. In the same vein, Bing expressed facing similar challenges in planning, and she commented 'planning appropriate mathematical play activities for children requires teachers to master the content knowledge of mathematics, while combining this with their understanding of children's abilities and interests in mathematics'.

On discussing the challenges these teachers have to address, it can be seen that they all realise that play-based activities are not easily designed to meet curriculum requirements, considering parents' expectations, the children's interests and competence in learning identified mathematics content knowledge and their own competence to teach mathematics.

Discussion

Figure 2 represents how Hedegaard's (2012) model was applied in this study, underpinning the entire analytical process.

Societal perspective

Drawing upon Hedegaard's (2012) wholistic model in this study made it possible to connect the societal perspective with teachers' perceptions and the institutional

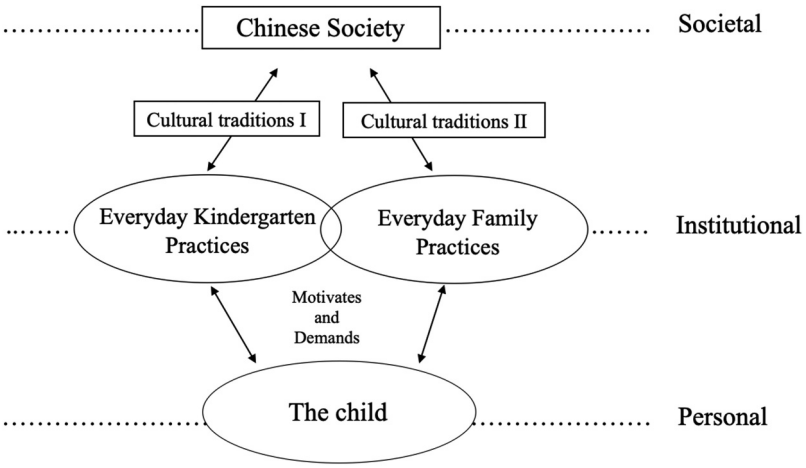

Figure 2. Model applied in this study. Figure partly adapted from *A model of children's activity settings in different institutions* (Hedegaard 2012, 130).

perspectives for analysing their definitions of play in children's learning of mathematics. The interviews revealed that all six Chinese EC teachers were willing to apply play in the teaching agenda, as a tactic to teach mathematical content knowledge. This finding aligns with the finding of Wang and Bun Lam (2017) and Wu et al. (2018) that most EC teachers in China have endorsed the vital role of play in learning and play is viewed as instrumental in providing children's academic learning.

Although Chinese EC teachers place great emphasis on play activities, how they are construed as play activities relies mostly on teacher-directed experiences (e.g. picture books and adapted play activities chosen and organised by the teachers). Respect for authority figures is instilled in Chinese collectivist culture; teachers feel obliged to maintain control of the classroom (Hu et al. 2017), which results in teacher-oriented play activities predominating in the participating teachers' practices. For example, Tian and Dan described their structured lesson plans, and Bing and Ya explained their purposeful intervention in children's games that were shown in the interview. From the societal perspective, it can be inferred that these teachers' descriptions of play mirror the cultural traditions in China.

Both Ya and Dan mentioned how the *Guidelines* curriculum influences their understanding regarding play in children's learning; thus, in order to meet policy demands, teachers consciously use play in relation to children's learning. Further, Hu et al. (2015) claimed that educational objectives are often based on the collectivist culture in China, and collective activity is considered culturally appropriate. In fact, from a societal perspective, this finding explains why the group-based play activity, oriented to collective learning practices, was recommended by most teachers. Insights emerging from those findings suggest that their perspectives respond to the cultural traditions in valuing the collectivism orientation, and that the rationale for implementing group play activity is affected by the cultural traditions. Hence, those teachers' beliefs regarding play tends to reflect the needs and demands of the Chinese society and cultural traditions.

Institutional perspectives

The institutional perspective in Hedegaard's (2012) model indicated that children engage in family practices and transition to kindergarten practices, and the different institutions have their own practice traditions. Hence, teachers' plans must not only meet the kindergarten's demands regarding implementing play-based activities, but also fulfil parents' expectations regarding the enhancement of children's mathematics knowledge through the institutional practices.

On combining the data collected in the interviews and the lesson plans, it becomes apparent that Chinese EC teachers are more adept at implementing planned activities that have mathematical meanings. That is, this type of mathematics-oriented, extended play activity seems to dominate the participants' pedagogical practices for teaching mathematics. This finding reveals that Chinese EC teachers tend to preserve the practice of activities that are more goal-oriented (Li et al. 2015). Significantly, Tian actively tried to develop a role play-based group activity to prepare children for primary school and justified it by stating that parents showed support for this way of teaching. This finding contradicts findings from Wu (2014), who argued that, to satisfy parents' academic expectations, Chinese EC teachers hesitate to use the play-based pedagogy approach as a replacement for direct instruction. As Tian articulated, her communication with parents in the kindergarten *Open Day* was an efficient method to introduce the benefits of mathematical learning through play. Similarly, the teachers' play-based group activity lesson plans demonstrate structured learning aims, which are more academically oriented and make it easier for parents to recognise specific learning outcomes.

Thus, the teachers tried to balance academic needs with play-based pedagogy to satisfy parents' demands. Indeed, Fenton, MacDonald, and McFarland (2016) have illustrated the importance of a reciprocal relationship between teachers and parents in supporting the development of children's mathematical skills. Based on Hedegaard's (2012) model, a wholeness approach to working collaboratively with parents is useful as the means to foster a play-based pedagogy since this ensures cultural alignment between the kindergarten and family contexts (i.e. two different institutional practices). It is evident that the teachers' beliefs regarding the best practices of mathematical activity are influenced by the need to ensure that teaching meets parents' demands, and the teachers tend to focus on demonstrating children's more observable learning results.

Personal perspectives

In terms of Hedegaard's (2012) model, the personal perspective represents the child and refers to the child's understanding of the opportunities and the demands to learn and develop through institutional practices. As Worthington (2018) indicated that mathematical learning becomes more meaningful when children can draw on their personal cultural knowledge to explore their mathematical knowledge. Hence, children's motives and interests in play and learning need to be considered in the institutional practices (Hedegaard 2012). In this respect, planning appropriate activities, that can not only embed children's perspectives but also reflect the teaching agenda, was an expressed source of difficulty for these teachers when enacting mathematical play activities.

For instance, Tian was concerned about how to motivate children in play and to further support their learning. She explained that the play activities that she developed did not appeal to children and she considered them to be *false play* and realised that the activities lacked consideration of children's perspectives. Therefore, children easily lost interest and motivation to participate in the play activity. This finding is in line with Moyles and Worthington's (2011) argument that 'planned' and 'structured' play activity may result in the marginalisation of play. Further, *false play* is identified as play in which teachers are excessively involved. Although teachers' participation in play tends to support children's academic learning, play activities which contain too much teacher guidance could unintentionally reduce children's engagement (Pyle and Danniels 2017).

On the basis of Hedegaard's (2012) model, it can be observed that some participating teachers were willing to consider children's perspectives to some extent when designing activities, but that this is challenging to achieve. For example, Dan and Juan professed that play activity should be based on children's previous mathematical knowledge and interests, while acknowledging that they do not know how to understand children's perspectives and abilities and to design activities based on them. Similarly, Tian stated that she had trouble planning group play activities and had to refer to books and activities developed in other kindergartens. This suggests that she possibly did not pay much consideration to planning from the children's perspectives (i.e. the motives and demands from the personal perspective), and instead focused more on achieving academic learning goals in a play-based manner (i.e. the demands from the social and institutional perspectives). Hence, she sought a replication of previous models of play that she believes have been successful in other environments to support children's mathematical learning. Moreover, some play activities that teachers develop only reveal their perceptions of children's interests and may not reflect children's own immediate and authentic interests that have personal and cultural meanings (Worthington and van Oers 2016). This finding indicates that teachers faced challenges in acknowledging the children's motives and demands in their planning for mathematics teaching.

Importantly, all of the teachers implied that when designing play activity, they found it challenging to cope with the diverse sets of expectations and requirements (e.g. *Guidelines*, children's perspectives, and parents' expectations). Thus, from the different perspectives in Hedegaard's (2012) model, the complexity of teaching practices can be observed as well as the challenges imposed by diverse needs and demands on teachers in implementing play-based learning in teaching mathematics. That is, their expressed pedagogical intention was to take children's perspectives to create the motivating conditions for children to engage in play in order to achieve the teacher's pedagogical demand for mathematical learning, whereas they expressed their lack of competence in the delivery of play-based mathematical teaching methodologies that acknowledge children's motives and interests.

Conclusion

The main purpose of this case study is to develop an insider understanding of the perspectives of EC teachers in China regarding the relationship between mathematics and play, and the ways in which they engage in mathematics teaching based on play. The case study shows that although the six Chinese EC teachers participating in the

current investigation define play in mathematical education from different perspectives, all of them valued play as a pedagogical tool for teaching mathematics and their understanding was largely influenced by Chinese cultural traditions and government demands. Most of the teachers highly recommend collective activities for children's mathematical learning, which implies the appropriateness of play-based group activities within the cultural context. In addition, the findings present a positive view of the EC teachers' efforts to develop culturally sensitive play-based learning in the Chinese context.

The findings, guided by Hedegaard's (2012) model, suggest that multiple demands from different perspectives result in difficulties for teachers in designing collective play. The study confirms Fleer and Li's (2020, 13) argument that 'teachers experienced tension while they conceptually struggled with the play-based programme required by the National Guidelines in the context of Confucian values'. Teachers' interviews have indicated a tension between their pedagogical intentions to recognise children's perspectives in play and their use of collectively oriented group teaching which focuses on the academic content. It was evident in our study that the play-based group teaching practices (e.g. theatre play based on a children's storybook) can be designed to reflect the cultural value of group teaching while acknowledging children's interests in character roles in play. This informs us that a new practice tradition needs to be promoted supporting group-oriented play-based mathematical teaching while valuing children's interests and prior knowledge.

In addition to this evolving understanding of teachers' views on the play-based pedagogies in mathematics teaching, we also found that the teachers faced challenges in taking children's perspectives in order to develop authentic play for children. One of the main issues they need to address is identifying how to incorporate children's authentic perspectives, including their motives, interests and intentions, to create the conditions in play-based activity settings which will promote children's mathematics learning. Although this is a small-scale study, its findings indicate some potential future research directions for delving deeper into the field of play and learning mathematics in China. This study found that appropriate professional development is needed, since teachers expressed that they struggle with implementing play-based pedagogy, and their insights into the understanding of play could be further supported. Overall, further research surrounding play-based pedagogy in China will help to establish a stronger rationale for pioneering appropriate play practices and creating better opportunities for children's learning and development.

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Authors' contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Wenxuan Zhang, Liang Li and Leigh Disney. The first draft of the manuscript was written by Wenxuan Zhang and all authors commented, wrote and edited on subsequent versions of the manuscript. All authors read and approved the final manuscript.

Ethics approval

This study was approved by the Human Research Ethics committee of Monash University (Ethics approval number: 24331).

Availability of data and material

The datasets generated and analysed during the current study are not publicly available due to confidentiality and privacy but are available from the corresponding author on reasonable request.

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