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Theory of mind and children's understanding of teaching and learning during early childhood

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Abstract: How children understand the concepts of teaching and learning is inherently underpinned by their mental state understanding and critical to the successful transition to formal schooling. Knowledge is a private representational mental state; learning is a knowledge change process that can be either intentional or not; and teaching is an intentional attempt to change others' knowledge state. Theory of mind (ToM) facilitates children's understanding of knowledge state and change as well as teaching and learning intention in various aspects, including knowing you do not know; knowing what other people know; knowing that other people do not know what you know; and knowing how knowledge comes about. This paper highlights the integral relation between children's ToM development and their teaching and learning concept based on review of empirical research and discusses the implication for early childhood education and school transition.

Subjects: Science; Social Sciences; Arts & Humanities; Theory of Mind; Teaching & Learning; Early Childhood

Keywords: theory of mind; understanding teaching and learning; school readiness; knowledge; intention

1. Introduction

Theory of mind (ToM) research in developmental psychology deals with the origins of children's mentality awareness. In addition to its consequences on children's social understanding and social functioning (e.g. Hughes, 2011), ToM development during early childhood has profound implications

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Zhenlin Wang is an assistant professor at the Department of Psychological Studies, the Hong Kong Institute of Education, Hong Kong. Trained as an early childhood teacher and developmental psychologist, she has been a teacher educator and a researcher for seven years. Her extensive research interests are reflected in her diverse publications covering the areas of children's understanding of teaching and learning, play, theory of mind, early childhood pedagogy, and school readiness. The research reported here draws connection between cognitive development research and early childhood education, with the aim of informing practice with empirical evidence.

PUBLIC INTEREST STATEMENT

In a trial that lead to his death, Socrates said: My only knowledge is knowing my ignorance. Knowing that you do not know is a difficult task, especially for young children. Does a four-year-old child know knowledge is private representational mental state; and teaching is an intentional attempt to change others' knowledge state, while learning is a knowledge change process that can be either intentional or not? According to empirical research reviewed here, the child most likely does not understand all these complicated concepts, due to the fact that she has yet to develop a comprehensive understanding of how the invisible and private mind works. The paper discusses how the limitation of children's understanding of mental states and processes affects their teaching and learning concepts, and what implication this has on early childhood education and transition to school.

to children's cognitive growth and school readiness (Astington & Pelletier, 2005; Blair & Razza, 2007). Especially, how children understand the concepts of teaching and learning is inherently underpinned by their mental state understanding and critical to the successful transition to formal schooling (Frye & Wang, 2008). Ironically, ToM research in the past has been focused on false belief and deception (Wellman, Cross, & Watson, 2001) instead of the process of knowledge acquisition, i.e. learning. In this paper, I highlight the integral relation between children's ToM development and their teaching and learning concept and discuss the implication for early childhood education and school transition.

The term "ToM" was coined by Premack and Woodruff (1978) to refer to the ability of inferring mental states of self and others. A sizable proportion of studies on ToM to date focused on the acquisition of false belief understanding during early childhood. The widely adopted false belief paradigm involves either a location change or an unexpected content. In the location false belief task (Wimmer & Perner, 1983), a protagonist called Maxi placed some chocolate in location A and went out to play. While he was absent, his mother removed the chocolate to location B. Children were asked to predict upon his return where Maxi would look for the chocolate, location A or B. In the unexpected content task (Gopnik & Astington, 1988), children were shown a candy container and asked to predict the content. While most children thought it was candy inside, it was revealed that the container actually contained pencils. Children were asked to recall what they thought was inside before the content was revealed, and to predict what a naïve new comer would guess the content was. It was demonstrated that young children had difficulty understanding that other people or they themselves had a false belief about either the location of the chocolate or the content of the candy container. In fact, a meta-analysis in 2001 (Wellman et al., 2001) based on 178 studies found that false belief understanding developed between 3 and 5 years of age across countries of origin and different types of false belief tasks. Wellman and his followers believe that the change during early childhood in false belief understanding reflects a genuine qualitative conceptual change (Wellman et al., 2001). More recent work, however, has developed new tasks and methods to test ToM development of participants from a wider age range. Evidence tends to suggest that there are two systems of ToM, an implicit system that is present from infancy, and an explicit system of ToM use that gradually emerges during early childhood (Apperly, 2012).

Through facilitating knowledge transmission among individuals and from generation to generation, ToM has been attributing to the construction of our culturally embedded social mind (Bjorklund & Bering, 2002). The ability to view people as intentional agents distinguishes human learning from other animals. From a developmental perspective, ToM research breaks ground for the inquiry of the origins of understanding the mental characteristics of teaching and learning. Infants and young children rely heavily on joint attention as well as inference of others' knowledge and intention in their learning and language acquisition (e.g. Meltzoff, 2007; Sabbagh & Baldwin, 2001). With the development of mental state understanding, preschool children begin to appreciate the mental representational nature of knowledge, as well as the role of intention in teaching and learning (Frye & Ziv, 2005; Ziv & Frye, 2004; Ziv, Solomon, & Frye, 2008). Children with more advanced mental state understanding also demonstrate more advanced teaching skills. In a study by Davis-Unger and Carlson (2008), children with high false belief understanding scores used more strategies when they taught a confederate how to play a board game. Note that the relation between ToM and understanding of teaching and learning might be bidirectional (Davis-Unger & Carlson, 2008): it is likely that mature ToM ability facilitates understanding of teaching and learning; it is also possible that exposure to conflicting perspectives and knowledge differences may enhance children's understanding that beliefs can be inconsistent with reality (Wellman & Lagattuta, 2004).

How the learner understands her own learning process is not a brand new topic. Metacognition focuses on awareness and self-regulation of learning process (Flavell, 1979), whilst personal epistemology focuses on how knowledge is constructed and evaluated (Burr & Hofer, 2002; Kuhn & Weinstock, 2002). The contribution of ToM research is to reveal that ToM ability is a precursor of metacognitive self-regulation (Carruthers, 2009), and a facilitator in the development of personal

epistemology (Kuhn, 2000). A study with preschool children found moderate correlation between metacognitive regulation and early ToM development (Sperling, Walls, & Hill, 2000). A longitudinal study (Lockl & Schneider, 2007) found that children's ability to attribute false belief at 3 and 4 years of age predicted their metamemory ability at 5 years of age, controlling for language abilities. The authors argued that the representational ToM is the precursor of metamemory, and suggested that better understanding of one's own mentality might contribute to better metacognitive monitoring and regulation.

Kuhn (2000) proposed that children's epistemological understanding develops in a four-step sequence of realist, absolutist, multiplist, and evaluatist. The realist perceives people's assertions as copies of an external reality; whereas the absolutist sees the assertions as either correct or incorrect representations of the reality. Consistent to the timing of false belief understanding (Wellman et al., 2001), a milestone achievement emerges when children recognize objective knowledge and belief independent of single, true reality. The transition from the realist level to the absolutist level is a decisive moment in the development of epistemological thinking. It indicates the "transition from simple, unconscious, unreflective knowing about the world to a second-order, or metacognitive, reflection on the knowing claims of self and others" (Kuhn & Weinstock, 2002, p. 126).

2. Knowing that you do not know

ToM facilitates children's understanding of teaching and learning in various aspects, the first of which is to know that you do not know. A teacher who overestimates his or her own knowledge would attempt to teach regardless of his or her own ignorance or false belief. Frye and Ziv (2005) told three- and five-year-old children stories about a teacher who overestimated her own knowledge and asked them whether the teacher would try to teach. Only those who understood false belief could correctly point out the connection between the teaching intention and the teacher's false belief regardless of the teacher's actual knowledge state. Furthermore, being aware of one's own ignorance is the first step of intentional learning. As Gopnik and Astington (1988) duly pointed out, "[i]t is hard to imagine teaching someone who was unable to recognize that they had been wrong" (p. 27). Earlier work in metacognition suggested that people tend to be over confident in their self-assessment of knowing, learning, and remembering. Mills and Keil (2004) found when children were asked to judge how well they understood the working mechanism of things such as a toaster, they tended to overestimate: the younger the children, the higher their ratings. Preschool children could not realize they knew less than they thought, a phenomenon called *illusion of explanatory depth*.

In the unexpected content false belief studies, three-year-olds could not easily report their previous false belief about the identity of a disguised object (e.g. Gopnik & Astington, 1988), even when they were reminded of their previous false belief with video clips of their own former responses (Zelazo & Boseovski, 2001). Young children could not remember how or when they learned what they knew (Gopnik & Graf, 1988; Taylor, Esbensen, & Bennett, 1994). Taylor et al. (1994) taught children novel facts and asked them whether they had known the fact before the teaching event. Four-year-old children reported that they knew the facts for a long time. Note that children's difficulty in remembering their previous mental states or when learning had occurred was not due to a memory deficit. In Taylor et al.'s (1994) study, even though the four-year-olds could not remember they had just learned a new color name, the same children could correctly report they had received a sticker for participating in the study. Rather, young children's difficulty with the source of the knowledge is related to their ToM restrictions. A study by Burr and Hofer (2002) specified a close link between children's knowledge source justification and their false belief understanding.

In order to accurately remember when learning happened and what has been learned, one needs to construct an episodic memory of the learning event and be able to distinguish the mental representational difference before and after the learning. It was suggested that the development of episodic memory (Naito, 2003) is associated with children's ToM. Before young children develop a representational ToM, remembering what they have learned and when will remain a challenge. Supporting this view is the contrast between children's reports on behavioral learning and factual

learning. While children could not remember they learned a new fact, such as a color name, just minutes before, they could easily report that they learned a novel action at the same time (Esbensen, Taylor, & Stoess, 1997).

Similar *I knew it all along* effect is found in children's hindsight bias. Bernstein, Atance, Meltzoff, and Loftus (2007) developed a set of hindsight tests for children. Children were shown computer-generated pictures of various degrees of degradation and asked to identify what the picture was as soon as they could, with the picture being gradually revealed step by step from the most obscure view to the clearest view. Hindsight bias was calculated using the ratio of baseline identification point (identifying the picture without knowing what it was) divided by the hindsight identification point (identifying the picture knowing what it was). Three- to five-year-olds showed robust hindsight bias. Their performances on hindsight bias and ToM tasks were significantly correlated, controlling for age, language ability, and inhibitory control.

3. Knowing what other people know

Learning from others' testimony makes up a significant portion of our knowledge base (Harris, 2002). Seeing other people as a source of knowledge, according to Flavell and Miller (1998), requires children "to be aware of the knowledge state of the other person and that such knowledge may or may not be the same as their own" (p. 82). Even toddlers have an implicit awareness of knowledge differences in people that allows them to learn selectively from different sources. For example, children learn words better from knowledgeable speakers than from ignorant speakers (Sabbagh & Baldwin, 2001). However, young children do not appear to have an explicit understanding of other people as a source of knowledge. Three-year-olds could not remember where they learned a fact after being told by others, compared to older children (Gopnik & Graf, 1988). In an ambiguous referential task (Sodian, 1988), four-year-olds, but not six-year-olds, tended to think the person who was given ambiguous and indecisive instruction knew just as well as the one who was given precise information.

Compared to verbal communication, pointing is an evolutionarily more fundamental communicative channel to exchange information. Povinelli and DeBlois (1992) tested three- and four-year-olds' comprehension of knowledge transfer through pointing. In their study, the experimenter hid a surprise under one of the four cups, and then communicated the information to children via pointing. Both three- and four-year-olds could correctly locate the surprise; whereas only four-year-olds could explain how they knew where to look. Four-year-olds also showed appreciation of others' knowledge state based on perceptual access; they were able to discriminate two experimenters' pointing based on which one was present when the surprise was hidden.

Recent development in the area of children's learning from testimony suggests children are increasingly better at justifying the source of knowledge. Koenig (2012) showed that 3- to 5-year-old children appropriately judged perceptual access, reliable testimony, and inference as better reasons for belief than pretense, guessing, and desiring, and they preferred to seek and accept new information from a speaker who used the better reasons. Studies found that children selectively trusted informants based on their expertise (Mills, 2013). Four-year-old children could attribute different kinds of knowledge to experts in the corresponding areas; and they could use this knowledge when choosing informants to learn from (Lutz & Keil, 2002).

False belief understanding is related to the ability of evaluating an informant's trustworthiness (Mills, 2013). Not knowing others can hold false beliefs, young children might think there is only one right answer to everything, and everyone should know it, therefore be more focused on the correctness of a statement given by an informant. Children who understand that a belief can be inaccurate might be more willing to weight the level of accuracy when evaluating competing claims. This line of research demonstrated that rather than learning from a previous accurate informant indiscriminately, three- to five-year-old children could use mental state reasoning to excuse past inaccuracy arisen from the speaker's limited information access. They tended to believe somebody whose past inaccuracies were due to false belief (Nurmsoo & Robinson, 2009). Furthermore, as children's

understanding of the mind advanced, they increasingly balanced the risk of learning falsehoods from unreliable speakers against that of rejecting truths from speakers who made excusable errors (Robinson & Nurmsoo, 2009).

4. Knowing that other people do not know what you know

Children's insufficiency in understanding knowledge as a private mental property is responsible for over-attributing knowledge to naive others and themselves. This phenomenon has been extensively researched under various labels such as egocentric perspective taking (Piaget & Inhelder, 1956), curse of knowledge (Birch, 2005), and epistemic egocentrism (Royzman, Cassidy, & Baron, 2003). Epistemic egocentrism is not only present in children, but also an enduring phenomenon in adults' judgment and decision-making (see Royzman et al., 2003 for review). As pointed out by Ziv and Frye (2004), teachers do not always know that their students do not know. Even though young children appreciated those who had knowledge should be the teacher, regardless of age and status, only those who had a grasp of the private nature of mental property understood that teacher's false belief of students' knowledge state would affect their teaching intention (Ziv & Frye, 2004).

Young children tend to erroneously assign their own knowledge and belief to others. In the unexpected content task (Gopnik & Astington, 1988), three-year-olds consistently answered pencils when being asked what a naïve child would think was in a candy container after seeing pencils in it. In the unexpected location task (Wimmer & Perner, 1983), the participating children had seen the transformation of the location; whereas the story protagonist Maxi had not. Young children consistently claimed Maxi would look for the chocolate in the new location. Both the naïve child in the first story and Maxi in the second story did not have perceptual access to the real content or the true location, yet children thought they knew the truth just as they themselves did. Three- and four-year-olds over-attributed knowledge about the content of a box to a child or a puppet who had not seen the inside of the box in the knowledge acquisition tasks (Pillow, 1999). In the partial or ambiguous information tasks (e.g. Sodian, 1988), four-year-olds thought those who only had access to an unidentifiable portion of a picture knew what the picture was; and those who were given ambiguous and indecisive information about a hiding place knew where the communicator was indicating.

Over-attributing one's own knowledge and belief to others results in premature understanding of what learning is in young children. Learning is a change in the learner's knowledge state or understanding. Coincidences that resemble a learning outcome without the representational change are not learning. In philosopher John Searle's thought experiment of the *Chinese Room* (1980), a person who does not know Chinese could nevertheless generate reasonable answers to questions written in Chinese with the assistance of a super computer. However, as Searle argued, simply being able to manipulate symbols without the semantics does not constitute knowledge. The same is true for the concept of learning. What distinguishes knowledge from behavior is that knowledge is a mental property. A behavioral marker often is the explicit expression of knowledge. For example, a person can write a letter *O* because she *knows* how to write it. However, a person who does not know how to write a letter *O* can nevertheless draw a circle that perfectly resembles the letter *O*. A behavior that resembles the explicit expression of knowledge without the mental representation does not count as knowing. And the process leading to such a behavior without genuine knowledge change does not count as learning either.

Wang (2010b) presented various versions of the letter *O* story to four- to six-year-old children and asked them whether the characters in the stories learned in the end. The results suggested that young children over-attributed knowledge and learning to accidental coincidences that did not involve mental state change. They tended to think those who drew a circle learned how to write a letter *O* regardless whether they experienced the knowledge change or not. For younger children, knowing the learning contents themselves was likely to trigger epistemic egocentrism that hindered learning judgment. By over-attributing their own knowledge to other people, four-year-old children

picked randomly between the two characters. Using novel learning contents that children were not familiar with, such as a foreign or made-up language, however, made young children less affected by epistemic egocentrism therefore improved their performance to a certain extent.

5. Knowing how knowledge comes about

Based on the assumption that both teaching and learning are reciprocal processes involving intentional engagement and awareness of knowledge difference, Frye and colleagues (Frye & Wang, 2008; Frye & Ziv, 2005) identified four types of teaching and learning: *uninstructed development* with no intention in either teaching or learning; *scaffolding and discovery learning* with teaching intention but no learning intention; *imitation and observational learning* with learning intention but no teaching intention; and *direct instruction and collaborative learning* with both teaching and learning intention. Children could correctly attribute the teaching and learning intention to direct instruction (Frye & Ziv, 2005), however, young children had trouble understanding imitation or guided discovery (Frye & Ziv, 2005; Ziv et al., 2008). When the teaching intention was absent, as in the imitation story, three-year-old children over-attributed teaching intention even though the teacher was not aware of the presence of the learner. When the teaching intention was embedded in games, as in the guided discovery, they failed to recognize the teaching intention and thought the teacher really wanted to play a game. Children's understanding of teaching intention was associated with their false belief understanding.

Unlike teaching, which is "an intentional activity to increase the knowledge (or understanding) of another, thereby reducing the knowledge difference between teacher and learner" (Ziv & Frye, 2004, p. 458), intention is neither a sufficient nor a necessary condition for learning. On the one hand, one could learn new knowledge through intentional learning such as intentional practice, imitation, and paying attention to the teacher's instructions. On the other hand, one could also learn new knowledge through implicit learning or discovery learning without a learning intention, such as learning the melody of a song by overhearing it (Sobel, Li, & Corriveau, 2007), or creating the color green by accidentally mixing blue with yellow. According to the Bayesian probabilistic learning model (Gopnik & Wellman, 2012), children constantly discovery causal structures based on statistical information of successful, most occurring coincidences.

Intention is causally self-referential (Searle, 1983), and human actions are assumed intentional until proven otherwise (Rosset, 2008). Young children tend to impose an intention to accidents (Russell, Hill, & Franco, 2001), or attribute intention to passive movement and certain bodily functions such as knee-jerk reaction and sneezing (Lang & Perner, 2002; Montgomery & Lightner, 2004). Wang (2010b) told 4- to 6-year-old children stories either involving a learning intention or not and asked whether the characters in the stories tried to learning. She found children had trouble making sense of intentional learning that was failed, and more importantly, even six-year-old children over-attributed learning intention to accidental discovery and implicit learning without learning intention. Similar to children's understanding of the concept of teaching, both children's intention judgment and learning judgment were moderately correlated with their mental state understanding after controlling for age.

Taken together, children tend to give more credit to themselves in terms of knowledge and learning than they truly deserve. They have trouble understanding that knowledge as a private mental state is not unanimously shared among people, which is reflected in their epistemic egocentrism and failure of recognizing other people as knowledge source. However, with ToM development, children become more shrewd learners by taking into consideration of other people's past false belief in their selective trust of testimony. They also start to incorporate (false) belief when predicting teaching and learning intention, and recognize the complex relationship between the teaching and learning outcome and the underlying intention, or the lack thereof.

6. Implication for early childhood education and transition to school

ToM research highlights the importance of the awareness of knowledge state and knowledge difference between the teacher and the learner, as well as the role of teaching and learning intention in knowledge acquisition. This mind oriented teaching and learning concept challenges both the

traditional behaviorist's learning concept and the more progressive constructivist's learning concept. On the one hand, behaviorist's learning theory views the mind as a file cabinet or a container that stores knowledge (Bereiter, 2002). Such a physicalized idea of the mind fails to see the mind as an active, self-propelled, and motivated driving force in learning. However, being knowledgeable does not simply mean how many data one can hold in the brain-as-a-container, it rather means developing a new view of mind that constructs knowledge (Olson & Katz, 2001). Only when a learner is consciously aware of own mental states and the changes in them, both motivational and epistemic mental states, could he or she realize his or her own knowledge deficit and the necessity to learn, therefore become teachable. Preschool curricula can keep children busy in doing all sorts of hands-on activities, but do children really have an idea of what they are doing? A child who thinks the goal of school activity is to do would not take the responsibility and make the effort to learn. Learning in the school context has to be effortful, with sustained attentional control and working memory resources (Geary, 2005). Teachers need to engage children mentally in learning by making teaching intention explicit, and emphasizing the knowledge change.

On the other hand, constructivist theory in education heavily criticizes the discipline-oriented, knowledge transferring teaching and learning; and promotes child-centered, knowledge constructive, society oriented, and preparing-for-life education. Influenced by the idea that knowledge is socially constructed and the child is an active participant in meaning making (Wood, 1998), early childhood education nowadays promotes child-centered, self-regulated learning models. However, it remains an empirical question whether the level of metacognitive demands of these models is compatible with preschool children's developing understanding of what knowledge is and where knowledge comes about. It has been argued that until they understand people as mental agents with thoughts and beliefs, children could not develop internal private dialogues and self-regulating speeches that are essential to metacognitive strategies (Tomasello, Kruger, & Ratner, 1993). Teachers need to take children's developmental level on ToM into consideration when applying self-regulated teaching and learning models in early childhood education settings. It does not mean that teachers have to wait till children fully understand knowledge change, belief, and learning intention before applying such teaching and learning models. Instead, small-steps, closely scaffolded instruction focusing on the elaboration of the learning goals and strategies will enhance children's ToM development.

Mental state understanding helps children to succeed in school through numerous ways, such as representational capacity, language ability, narrative understanding and literacy, intentional learning and objective knowledge, social competence and collaborative learning, and the first steps in scientific reasoning (Astington, 1998). Understanding the concepts of teaching and learning may as well be an important component of school readiness. Formal schooling involves knowledge such as arithmetic and literacy children would not normally learn following their biological timetable of maturation. Effortful teaching and intentional learning require both the teacher and the student to be aware of the goals and the mental processes of the teaching and learning activities. Hence children's ToM should be an advantage for entry to school. It is advocated that the entry age for formal schooling should be after five years of age (Whitebread, 2013), which is coincidently the age of mastering the false belief concept (Wellman et al., 2001). Research in children's understanding of teaching and learning from a ToM perspective would shed light on how early curriculum should prepare children to better adapt the institutional oriented, highly structured formal classroom learning when they go to school.

To be more specific, to prepare young children for formal schooling, educators and parents alike need to develop epistemological dialogue with them. Conversations about mental states, both others' and self's, as well as comparison between mental states and reality will help children to better understand the intangibility of mental states and the inference processes that lead to mental states. In everyday interaction with young children, for example, adults could use more mental state discourse such as believe, guess, think, and reason with children and talk about what they know and how they know what they know. Children's picture book is a good source of mental state talk due to

the fact that the image in picture books can supplement the text to materialize mental states therefore making it easier for young children to follow the inference process (Wang, 2010a). Another good source of is autobiographic episodic memory. Talking about events in personal life history helps children to understand how knowledge, in this case, memory of those events, comes about. The use of mental state discourse is by no means limited to shared book reading or life history narratives though. Playful interactions such as pretend play, guessing game (e.g. what is in a surprise gift bag?), hide-and-seek, and drama all have the potential to develop into an enriched mental state discourse involving desire, intention, knowledge, ignorance and false belief.

Further research in this area should take a closer look into direct instruction and collaborative learning. If direct instruction and collaborative learning involve both teaching and learning intention (Frye & Wang, 2008), they should be most applicable in terms of boosting motivation and delivering result in formal schooling. However, educators need to go beyond the traditional behaviorist's view of direct instruction and the more progressive constructivist's view of discovery learning, and start to focus on mental processes of knowledge acquisition by facilitating students' goal setting, self-monitoring and regulation, and peer tutoring. Future research should also widen the age range of participants in the teaching and learning study from a ToM perspective. Much younger children demonstrate an implicit ToM (Apperly, 2012), and they do take advantage of it in their learning (Sabbagh & Baldwin, 2001), which falls in the imitation and discovery learning category in Frye and Wang's (2008) terms. On the other hand, ToM keeps maturing during middle childhood and adolescence. Understanding how ToM facilitates both earlier imitation and discovery as well as more sophisticated personal epistemology after early childhood is crucial to our knowledge of how the mind works and our teaching and learning practice from a life span perspective.

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