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Children's developing knowledge of and reflection about teaching

David M. Sobel

Susan Letourneau

Brown University

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Abstract (Word Count = 122)

Four- to 7-year-olds ($N=61$) defined “teaching” and described what and how others had taught them, and what and how they had taught others. While 4-5-year-olds were often unable to define teaching, 6- and 7-year-olds most frequently defined teaching by describing processes that could cause knowledge change. Children who held process-based definitions were more likely to offer examples of what others had taught them, to identify who had taught them, and to describe being taught through direct instruction. They were also better able to describe how they had taught others. We consider the results in light of previous interviews in which children were asked to define learning, and discuss the implications for children's developing understanding of the connections between knowledge, learning, and teaching.

Children's developing knowledge of and reflection about teaching

A fundamental aspect of the human experience is the communication of information (Bloom, 2000; Tomasello, 2010). When communication is intended to change the knowledge state of another person, the communicative act can be described as *teaching*. Some have argued that teaching is a “natural cognitive ability” (Strauss, 2005, p. 368), in that teaching is a universal and basic form of communication that children learn through everyday social interactions rather than through explicit instruction. Even children as young as 3 can engage in acts of teaching (e.g., Ashley & Tomasello, 1998), and school-aged children often explicitly teach others (e.g., Brown & Palincsar, 1989; Flynn, 2010; Rogoff, 1990).

Moreover, teaching is related to children's developing knowledge of their own and others' mental states — in particular, what children understand about knowledge and beliefs (e.g., Astington, & Pelletier, 1996; Strauss, Ziv, & Stein, 2002; Wellman & Lagattuta, 2004; Ziv & Frye, 2004; Ziv, Solomon, & Frye, 2008). For instance, children's understanding of their own and others' knowledge allows them to infer whom to teach and to recognize situations that necessitate teaching because teaching can be motivated by recognizing knowledge gaps between individuals. The more children understand about knowledge, the more they should also recognize how different kinds of actions could be effective to support successful teaching. This line of research largely suggests that children's developing knowledge of teaching is related to their developing theory of mind – or understanding of others' mental states generally construed (see Knutsen, Frye & Sobel, 2014, for a review).

Children's understanding of teaching has usually been investigated in two ways: by examining what aspects of others' behavior children use to identify teaching, and by

investigating how children actually go about teaching others. As examples of the first, Ziv et al. (2008) showed that 5-year-olds but not 3-year-olds recognized that teaching occurred only when an individual intentionally demonstrated action to another person, and when this person was attending to the action. The situations that they set up examined children's judgments about whether teaching had occurred, or in other cases, whom a teacher would teach, based on the mental states of the teacher and potential students. As an example of the second, Ashley and Tomasello (1998) introduced pairs of children between 24-42 months with a novel goal-directed task, which they learned collaboratively. Once the pair had mastered the task together, one of the children was paired with a naïve partner, and the authors examined whether and how the more knowledgeable child taught the novice. The youngest children in the study could not engage in such communicative acts, but by 30 months, children communicated with one another about the task, and 42-month-olds engaged in intentional communication through specific, directed actions.

These data suggest that even young children begin to integrate their understanding of their own and others' knowledge into both the judgments they make about teaching and the ways they communicate information in order to teach others. What these studies do not do is examine how children define and reflect on their own experiences of teaching outside of the laboratory. If children's understanding of teaching is related to their developing knowledge of others' mental states, then one might expect to see further development past the fourth birthday, as children's ability to reflect on their own thoughts, pretenses, and emotional responses all develops between the ages of 4-8 (e.g., Eisbach, 2004; Flavell et al., 1995; Lagattuta & Wellman, 2001; Richert & Lillard, 2002). In particular, children's understanding of what teaching entails, and their metacognitive awareness of what and how they have been taught may develop during this period.

Although children's explicit understanding of teaching remains relatively unknown, there have been studies examining children's developing ability to reflect on their learning. Bemis, Leichtman, and Pillemer (2011) asked 4- to 9-year-olds questions whose answers they were likely to know. After giving the correct answer, children were asked how they had learned that answer. Even the youngest children could say how they learned the information, but their ability to do so was limited. Only 25% of 4-5-year-olds stated the source of their knowledge; 7-9-year-olds did so significantly more often, but only 45% of the sample did so.

Sobel and Letourneau (2015) conducted a similar investigation, asking 4- to 10-year-olds what they thought "learning" meant. After children defined learning, the experimenter asked them to give examples of what they had learned in the past and describe how they had learned in each case. Almost all of the 8-10-year-olds they examined (95%) defined learning as a process involving a source or strategy that would result in a change in knowledge (e.g., "when your teacher tells you something"; "when you practice again and again until you know it"), while only ~42% of the 4-5-year-olds defined learning in that way. Their findings showed a clear linear trajectory for children's understanding of learning as a process. Most of the younger children did not define learning as a process; instead, they described it based on the types of content that could be learned (e.g., "like reading and math," ~16%), defined learning circularly (e.g., "learning is when you learn," ~2%), or did not respond to the question (~40%). Independent of age, the way in which children defined learning related to their ability to reflect on the ways in which they had learned information themselves. Children who defined learning as a process of knowledge acquisition were more likely to describe a source or strategy through which they had learned.

In the present study, we borrowed this approach to ask children what they thought teaching meant, and then asked them to reflect on situations in which they had been taught and in which they had taught others. Our goal was to describe children's developing understanding of teaching as a process that causes knowledge change. We also examined the relation between children's understanding teaching as a means of causing knowledge change and their capacity to reflect on what and how they had been taught and had taught others.

The current study focused on 4-7-year-olds for two reasons. First, although we did not present these children with an explicit measure of false belief, the majority of 4-7-year-olds would be expected to pass standard versions of the false belief task (e.g., Wellman, Cross & Watson, 2001), although there might be some age-related change between the younger and older children in our sample. Second, as reported above, not all of the children in Sobel and Letourneau's sample defined learning as a process, and children showed clear individual differences in their ability to reflect on instances of their own learning. We wished to document whether similar differences existed for teaching and determine the extent to which children's definitions of teaching related to their ability to reflect on their own experiences involving teaching.

Method

Participants

Thirty children between the ages of 4-5-years-old (14 male, 16 female $M_{age} = 59.34$ months, Range: 48.10 – 71.80 months) and 31 children between the ages of 6-7-years-old (12 male, 19 female; $M_{age} = 82.53$ months, Range 72.20 – 93.60 months) participated in the study. Children were recruited at Providence Children's Museum. While no formal measures of demographic information, SES, or school attendance were taken, the museum recruits children

from a diverse sample from the city of Providence; most children were Caucasian and from middle to upper-middle class families.

Procedure

All children were interviewed in a quiet room at the museum. Interviews were audio recorded and transcribed for analysis. First, children were asked, "What do you think 'teaching' means?" If children did not understand the question or did not answer, the question was restated, "What do you think it means 'to teach'?" If children still did not respond or said, "I don't know," the interview continued with the remaining questions.

Next, children were asked, "Can you think of something that someone has taught you?" If children provided an example, two follow-up questions were asked: "Who taught you that?" and "How did s/he teach you that?" After giving one example, children were asked this question twice more, giving them the opportunity to give up to three different examples. If children did not answer or could not think of any examples, they were still prompted twice more, and if they did not respond or could not think of any examples, the interview continued. Note that we did not verify the accuracy or truthfulness of the examples children gave. Instead, their examples were meant to illustrate the types of situations that children considered to represent "teaching."

Children were next asked, "Can you think of anything that you've taught someone else?" If children provided an example, they were asked, "Who did you teach?" (if they did not already state this information) and "How did you teach him/her that?" Again, children were asked this set of questions twice more, giving them the opportunity to give up to three different examples. If children did not respond or could not think of any examples, they were prompted three times and then the interview continued.

Finally, children were asked, "How else can you teach? Can you think of any other ways?" Children were again given three opportunities to answer this question.

Coding

Children's definitions of teaching were divided into the following categories, based on those used in Sobel and Letourneau (2015): 1) *No response* or "I don't know," 2) *Identity* answers, in which children defined teaching using the word "teaching" or "to teach," without further elaboration (e.g., "teaching is when you teach"), 3) *Learning* answers, in which children defined teaching using the word "learning" or "to learn" without further elaboration (e.g., "teaching means learning"), 4) *Content* answers, in which children defined teaching based on what was taught or could be taught (e.g., "teaching kids stuff like math or reading"), and 5) *Process* answers, in which children defined teaching by describing an action that could result in a causing a change in one's knowledge (e.g., "when the teacher reads you a book"). Additional examples of each type of response are provided in Table 1.

Table 1.

Examples of children's responses by category

Category	Transcribed response
<u>Definitions of Teaching</u>	
Identity	Teaching people. Teaching stuff. Teaching means that they teach you about different stuff.
Learning	To learn. You learn a lot.

It means that they need to learn new stuff.

Content	<p>It means when somebody teaches you what math is, and what things are.</p> <p>Teaching means that you get to learn about some exciting stuff, like history.</p> <p>To show kids about different things like math and science.</p> <p>You learn how to do something, or if something's dangerous or if it's ok.</p>
Process	<p>Someone teaches you how to do something that you don't know how to do.</p> <p>Telling someone about something.</p> <p>Telling somebody how to do something.</p> <p>It means showing somebody how to do something so they know how to do it if somebody else asks them to.</p>

Examples of what others have taught them/they've taught others

Subject	<p>Just stuff from school... math and social studies.</p> <p>Multiplication and division.</p> <p>My dad taught me about electricity.</p> <p>My mom has taught me vowels.</p>
Convention	<p>To stay with your parents.</p> <p>Obedying your mom.</p> <p>How to share and be kind and nice to other people.</p> <p>You have to be nice to people so you don't get in trouble.</p>
Skill	<p>How to ride a bicycle without training wheels.</p> <p>How to draw.</p> <p>Daddy taught me to use a magnifying glass and to swim.</p> <p>Making origami.</p>
Fact	<p>I know that 'dog' is like D-O-G.</p> <p>How cold air sinks and hot air rises.</p> <p>They taught me 800 plus 800.</p> <p>How to spell a word.</p>

Descriptions of how they were taught/taught others

Direct Instruct.	<p>My mom explained me about multiplication and adding.</p> <p>My teacher told us how to do it and made us do flashcards.</p> <p>By telling me how to share and giving people their turn.</p>
Demonstration	<p>By showing me a whole bunch of times.<i>[Referring to being taught to tie shoes]</i></p> <p>He showed me how to swim and not to sink—he showed me how to kick my feet like this, on my belly.</p>

Help/Guidance	My dad helped me swing the bat. [<i>Referring to being taught about baseball</i>] She [<i>mother</i>] was helping me draw because I didn't know how to draw yet. My dad helps me count to 100. [<i>Referring to being taught about numbers</i>]
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Children's examples of what others had taught them were coded as follows: First, the content of what was taught was coded as either *No response* (if children failed to generate an example at all); a *subject* (meaning an academic or other generalizable topic, like math, colors, animals, etc.); a *convention* (meaning a social or nonsocial rule, e.g., be nice to others; red means stop); a *skill* (meaning a procedure or motor skill, e.g., writing, riding a bike); or a *fact* (meaning a singular piece of information that is not generalizable, e.g., Boston is the capital of Massachusetts). Additional examples of each response type are provided in Table 1.

Because children could give up to three examples, for subsequent analyses we determined whether children gave each type of response across all of their examples. In this way, analyses focused on the number of children who gave each type of example, not the number of examples given. We also coded whether children could identify who taught them (the source of the information) for each example, and for subsequent analyses, we looked across the examples that each child gave and determined whether he was ever able to identify a source.

Descriptions of how children were taught (i.e., the process) were broken down into several categories: *No response* (if children could not describe how they were taught); *direct instruction* (involving explanations or verbal instructions); *demonstration* (physically showing something or modeling an action); and *help or guidance* (offering assistance without direct instruction). After coding each example, we again determined whether each child ever mentioned each type of process in his/her examples. Additional examples of each process category appear in Table 1. Finally, examples of what children had taught others were coded using the same

content and process categories as above and examples of how one could teach were coded using the same process codes as above.

All responses were coded by two coders who were blind to children's ages and genders and to the purpose of the study. For children's definitions of teaching, agreement between coders (Cohen's kappa) was 0.82. For children's examples of what others had taught them and what they had taught others, agreement was 0.83 for content codes, 0.93 for coding of children's descriptions of sources, and 0.82 for children's descriptions of processes. Disagreements were resolved through discussion with the second author.

Results

No gender differences were found in any of our main analyses. We do not consider this variable further. We divide the results into four subsections. First, we analyze children's definitions of teaching. We then examine children's descriptions of what and how they had been taught (and by whom), and what and how they had taught others. For each analysis, we consider general correlations with age, as well as explicit differences between the younger half of our sample (4-5-year-olds) and the older half (6-7-year-olds). We use age as a correlate of children's understanding of knowledge and belief, which suggests that older children might be more inclined to describe teaching as a process that causes knowledge change.

Definition of Teaching.

The number of children giving each type of definition is shown in Table 2. For 4-5-year-olds, no response answers were common, with 33.33% of children not offering any definition of teaching. Identity and learning answers were next most common (26.67% and 23.33% of

children in this age group, respectively). In contrast, for 6-7-year-olds, process definitions were most common (45.16% of children in this age group), followed by learning and content definitions (22.58% of children gave each type of response).

Children's age in months was negatively correlated with the presence of no response answers, $\rho(59) = -.34, p = .01$, and identity definitions, $\rho(59) = -.36, p < .01$. Age was positively correlated with the presence of content, $\rho(59) = .25, p = .05$, and process definitions, $\rho(59) = .25, p = .05$. Children's age was not correlated with the presence of learning definitions, $\rho(59) = .15, p = .25$. When the two age groups were compared directly, significantly more 6-7-year-olds offered a process definition of teaching, compared to the 4-5-year-old group, $\chi^2(N = 61) = 5.77, p = .02, \phi = .31$.

Table 2

Definitions of Teaching by Age Group

Age Group	N	Response Type				
		<u>No response</u>	<u>Identity</u>	<u>Learning</u>	<u>Content</u>	<u>Process</u>
4-5	30	10 (33.33%)	8 (26.67)	7 (23.33)	0 (0.00)	5 (16.67)
6-7	31	2 (6.45)	1 (3.23)	7 (22.58)	7 (22.58)	14 (45.16)
Total	61	12 (19.67)	9 (14.75)	14 (22.95)	7 (11.48)	19 (31.15)

Note: Numbers in parentheses indicate the percentage of children within each age group who gave each type of response. These categories were mutually exclusive, so children were categorized as giving only one type of response.

Reflecting on Being Taught by Others

When asked to give examples of what others had taught them, children gave between 0 and 3 examples ($M = 1.59$). There was a significant correlation between children's age in months

and the number of examples they gave, $\rho(59) = .33, p = .01$. We next analyzed whether each child ever described a subject, convention, skill, or fact in any of the examples that they generated, and the remaining analyses were based on the number of children who provided each type of example, not the number of examples given. Table 3 shows the number of children who gave examples involving subjects, conventions, skills, and facts, or who did not respond to the question, divided by age group and children's initial definitions of teaching (i.e., whether they generated a process account of teaching or otherwise).

Nonparametric correlations were calculated among age in months, children's definitions of teaching (i.e., whether they generated a process account of teaching or otherwise), and the presence of each type of content example. Age was negatively correlated with no response answers, $\rho(59) = -.38, p < .01$, and positively correlated with both subject examples, $\rho(59) = .50, p < .01$, and fact examples, $\rho(59) = .25, p = .05$. When the two age groups were directly compared, significantly more 4-5-year-olds gave no response (33.33% of this age group, see Table 3) compared to 6-7-year-olds (3.23%), $\chi^2(1, N = 61) = 9.35, p < .01, \phi = -.39$. The older children were more likely to offer examples of subjects, with 58.06% of 6-7-year-olds giving this type of example, compared to 16.67% of 4-5-year-olds, $\chi^2(1, N = 61) = 11.12, p < .01, \phi = .43$. The frequency of other types of examples did not differ between the two age groups.

Next, children who gave process definitions were compared with children who gave other definitions of learning. All children who had given process definitions of teaching gave at least one example when asked what others had taught them. In contrast, 26.19% of the children who gave other definitions of teaching did not offer any examples, $\chi^2(1, N = 61) = 6.07, p = .01, \phi = -.32$. Children who defined teaching as a process were also more likely to describe being taught facts (21.05% of children with process definitions, see Table 3), compared to children with other

definitions of teaching (4.76%), $\chi^2(1, N=61) = 3.92, p = .05, \phi = .25$. This difference, however, seemed to be best explained by the fact that older children were more likely both to generate process-based definitions of teaching and to give examples where they were taught facts, as the correlation between holding a process definition of teaching and the presence of a *fact* example was not significant when controlling for age, $\rho(58) = .20, p = .12$. No other response type significantly differed between children with and without process-based definitions of teaching.

Table 3

Number of Children Giving Different Content Examples among their Responses to "Can you think of something that someone taught you?"

Definition of Teaching	Age	N	Content Response type				
			<u>NR</u>	<u>Subject</u>	<u>Convention</u>	<u>Skill</u>	<u>Fact</u>
Process	4-5	5	0 (0.00)	1 (20.00)	1 (20.00)	3 (60.00)	1 (20.00)
	6-7	14	0 (0.00)	7 (50.00)	1 (7.14)	7 (50.00)	3 (21.43)
	Tot.	19	0 (0.00)	8 (42.11)	2 (10.53)	10 (52.63)	4 (21.05)
Other	4-5	25	10 (40.00)	4 (16.00)	1 (4.00)	12 (48.00)	0 (0.00)
	6-7	17	1 (5.88)	11 (64.71)	3 (17.65)	8 (47.06)	2 (11.76)
	Tot.	42	11(26.19)	15 (35.71)	4 (9.52)	20 (47.62)	2 (4.76)
Total	4-5	30	10 (33.33)	5 (16.67)	2 (6.67)	15 (50.00)	1 (3.33)
	6-7	31	1 (3.23)	18 (58.06)	4 (12.90)	15 (48.39)	5 (16.13)
	Tot.	61	11 (18.03)	23 (37.70)	6 (9.84)	30 (49.18)	6 (9.84)

Note: Values indicate numbers of children who gave each response type. Because children could generate more than one example, individual children could give more than one type of response. Numbers in parentheses indicate the percentage of children within each age group who offered each type of response.

For each example the children gave, they were also asked, “Who taught you that?” and “How did s/he teach you that?” Table 4 shows responses between the age groups, and divided based on whether children generated a process definition of teaching. Because children could generate several examples, and we asked these questions for each example, the source column of the table reports the number of children who generated a source for any of the examples they reported. Similarly, the Process Response Type columns indicate the number of children who generated a process of that type in any one of the examples they generated.

Age was significantly correlated with children's ability to describe a source (i.e., to identify who taught them in any of the examples they provided), $\rho(59) = .44, p < .01$. The presence of a process definition of teaching also correlated with children's ability to identify a source, $\rho(59) = .33, p = .01$, and this correlation remained significant when controlling for age, $\rho(58) = .26, p = .05$. However, this correlation might have been driven by the fact that children who did not define teaching in terms of a process were more likely not to respond to these questions. Among children who offered at least one example of something that they had been taught, almost all children were able to describe who it was who had taught them (this included 19 of the 20 4-5-year-olds who had offered at least one example, and all 30 of the 6-7-year-olds who had provided at least one example).

Children's age was also correlated with descriptions of being taught through direct instruction, $\rho(59) = .36, p < .01$, as was whether the child had a process definition of teaching, $\rho(59) = .34, p = .01$. This latter correlation remained significant when controlling for children's age, $\rho(58) = .28, p = .03$. Correlations between children's age, definitions of teaching, and other response types were not significant.

Table 4

Number of Children who Cited Sources and Processes in Response to "Who taught you that?" and "How did s/he teach you that?"

Definition	Age	N	Source	Process Response Type			
				<u>No response</u>	<u>Instruction</u>	<u>Demonstration</u>	<u>Guidance</u>
Process	4-5	5	5 (100.00)	1 (20.00)	2 (40.00)	2 (40.00)	0 (0.00)
	6-7	14	14 (100.00)	7 (50.00)	8 (57.14)	3 (21.43)	4 (28.57)
	Total	19	19 (100.00)	8 (42.11)	10 (52.63)	5 (26.32)	4 (21.05)
Other	4-5	25	14 (56.00)	9 (36.00)	2 (8.00)	7 (28.00)	3 (12.00)
	6-7	17	16 (94.12)	7 (41.18)	6 (35.29)	6 (35.29)	2 (11.76)
	Total	42	30 (71.43)	16 (38.10)	8 (18.05)	13 (30.95)	5 (11.90)
Total	4-5	30	19 (63.33)	10 (33.33)	4 (13.33)	9 (30.00)	3 (10.00)
	6-7	31	30 (96.77)	14 (45.16)	14 (45.16)	9 (29.03)	6 (19.35)
	Total	61	11 (18.03)	23 (37.70)	6 (9.84)	30 (49.18)	6 (9.84)

Note: Numbers in parentheses indicate the percentage of children within each age group. Source refers to the number of children who could report who taught them for at least one of the examples they generated. Because children could generate more than one example, individual children could be counted more than once among the Process Response Types.

Reflection on Teaching Others

When asked for examples of what they had taught others, children gave between 0-3 examples ($M = 0.75$). This is significantly different from the number of examples children gave of what they had been taught ($M = 1.59$), Wilcoxon Signed Rank Test, $z = -4.74$, $p < .01$, $r = .61$. Age was not correlated with the number of examples children gave. Table 5 shows the types of content descriptions that children gave in these examples, based on age group and children's initial definitions of teaching (i.e., process or other). Age in months was positively correlated

with the presence of subject examples, $\rho(59) = .372, p < .01$, and negatively correlated with the presence of convention examples, $\rho(59) = -.27, p = .04$. When the two age groups were compared directly, significantly more 6-7-year-olds gave subject examples (22.58% of this age group) compared to 4-5-year-olds (3.33%), $\chi^2(N = 61) = 4.96, p = .03, \phi = .29$. Other response types were not significantly different between the two age groups. The presence of a process definition of teaching was not correlated with any particular type of content that children described in their examples of teaching others.

Table 6 shows the processes children mentioned when asked to describe *how* they had taught others. Children's age was correlated with descriptions of direct instruction, $\rho(59) = .30, p = .02$, but not with any other response type. When the two age groups were compared, 29.03% of 6-7-year-olds described teaching others through direct instruction, compared to 6.67% of 4-5-year-olds, and this difference was significant, $\chi^2(N = 61) = 5.16, p = .02, \phi = .29$.

Next, we compared children with and without process definitions of teaching. When asked how they had taught others, 31.38% of children with process definitions of teaching failed to respond, compared to 76.19% of children with other definitions of teaching, a significant difference, $\chi^2(N = 61) = 11.08, p < .01, \phi = -.43$. Having a process definition of teaching was negatively correlated with a failure to respond to this question, $\rho(59) = -.43, p < .01$, and this correlation remained significant when controlling for age, $\rho(58) = -.41, p < .01$. Having a process definition of teaching was positively correlated with the presence of examples involving help or guidance, $\rho(59) = .34, p = .01$, and this correlation also remained significant when controlling for children's age, $\rho(58) = .31, p = .02$. No other significant correlations were found.

Table 5

Number of Children Giving Content Examples in Response to "Can you think of something that you've taught someone else?"

Definition	Age	N	Content Response type				
			<u>No Response</u>	<u>Subject</u>	<u>Convention</u>	<u>Skill</u>	<u>Fact</u>
Process	4-5	5	2 (40.00)	0 (0.00)	1 (20.00)	2 (40.00)	0 (0.00)
	6-7	14	4 (28.57)	3 (21.43)	0 (0.00)	5 (35.71)	3 (21.43)
	Total	19	6 (31.58)	3 (15.79)	1 (5.26)	7 (36.84)	3 (15.79)
Other	4-5	25	14 (56.00)	1 (4.00)	5 (20.00)	8 (32.00)	1 (4.00)
	6-7	17	8 (47.06)	4 (23.53)	2 (11.76)	4 (23.53)	0 (0.00)
	Total	42	22 (52.38)	5 (11.90)	7 (16.67)	12 (28.57)	1 (2.38)
Total	4-5	30	16 (53.33)	1 (3.33)	6 (20.00)	10 (33.33)	1 (3.33)
	6-7	31	12 (38.71)	7 (22.58)	2 (6.45)	9 (29.03)	3 (9.68)
	Total	61	28 (45.90)	8 (13.11)	8 (13.11)	19 (31.15)	4 (6.56)

Note: Values indicate numbers of children who gave each response type. Because children could generate more than one example, individual children could give more than one type of response. Numbers in parentheses indicate the percentage of children within each age group who offered each type of response.

Reflection on How Else to Teach

Children then provided examples of how else one could teach. Children gave between 0-2 examples ($M = 0.44$), and children's age in months was correlated with the number of examples they gave, $p(59) = .41$, $p < .01$. Table 7 shows the processes children mentioned when asked how else one could teach. Age in months was negatively correlated with a failure to generate any process in response to the question, $p(59) = -.37$, $p < .01$, and positively correlated with descriptions involving direct instruction, $p(59) = .42$, $p < .01$. When the two age groups were compared, 93.33% of 4-5-year-olds failed to generate any process response, compared to 51.61%

of 6-7-year-olds, $\chi^2(N = 61) = 13.20, p < .01, \phi = -.46$, and 3.33% of 4-5 year-olds mentioned direct instruction, compared to 41.94% of 6-7-year-olds, $\chi^2(N = 61) = 12.85, p < .01, \phi = .46$.

Table 6

Number of Children who Described Various Processes in Response to "How did you teach him/her that?"

Definition	Age	N	Process Response Type			
			<u>No response</u>	<u>Instruction</u>	<u>Demonstration</u>	<u>Guidance</u>
Process	4-5	5	2 (40.00)	1 (20.00)	2 (40.00)	0 (0.00)
	6-7	14	4 (28.57)	4 (28.57)	3 (21.43)	3 (21.43)
	Total	19	6 (31.38)	5 (26.32)	5 (26.32)	3 (15.79)
Other	4-5	25	19 (76.00)	1 (4.00)	6 (24.00)	0 (0.00)
	6-7	17	13 (76.47)	5 (29.41)	2 (11.76)	0 (0.00)
	Total	42	32 (76.19)	6 (14.29)	8 (19.05)	0 (0.00)
Total	4-5	30	21 (70.00)	2 (6.67)	8 (26.67)	0 (0.00)
	6-7	31	17 (54.84)	9 (29.03)	5 (16.13)	3 (9.68)
	Total	61	38 (62.30)	11 (18.03)	13 (21.31)	3 (4.92)

Note: Values indicate numbers of children who gave each response type. Because children could generate more than one example, individual children could give more than one type of response. Numbers in parentheses indicate the percentage of children within each age group who offered each type of response.

Holding a process definition of teaching was also negatively correlated with a failure to respond to this question, $\rho(59) = -.37, p < .01$, and positively correlated with examples involving help or guidance, $\rho(59) = .27, p = .03$. Both of these correlations remained significant when controlling for children's age, No response: $\rho(59) = -.31, p = .02$; Help or guidance: $\rho(59) = -.31, p = .02$. When children with and without process definitions of teaching were compared, 47.37%

of children with process definitions gave no response to the question, compared to 83.33% of children with other definitions, and this difference was significant, $\chi^2(N = 61) = 8.42, p < .01, \phi = .37$. Finally, 10.53% of children with process definitions described help or guidance as a way of teaching, while none of the children with other definitions of teaching did, and this was also a significant difference, $\chi^2(N = 61) = 4.57, p = .03, \phi = .27$. No other correlations were found.

Table 7

Number of Children who Described Various Processes in Response to "How else can you teach?"

Definition	Age	N	Process Response Type			
			<u>No response</u>	<u>Instruction</u>	<u>Demonstration</u>	<u>Guidance</u>
Process	4-5	5	4 (80.00)	0 (0.00)	0 (0.00)	1 (20.00)
	6-7	14	5 (35.71)	7 (50.00)	4 (28.57)	1 (7.14)
	Total	19	9 (47.37)	7 (36.84)	4 (21.05)	2 (10.53)
Other	4-5	25	24 (96.00)	1 (4.00)	3 (12.00)	0 (0.00)
	6-7	17	11 (64.71)	6 (35.29)	3 (17.65)	0 (0.00)
	Total	42	35 (83.33)	7 (16.67)	6 (14.29)	0 (0.00)
Total	4-5	30	28 (93.33)	1 (3.33)	3 (10.00)	1 (3.33)
	6-7	31	16 (51.61)	13 (41.94)	7 (22.58)	1 (3.23)
	Total	61	44 (72.13)	14 (22.95)	10 (16.39)	2 (3.28)

Note: Values indicate numbers of children who gave each response type. Because children could generate more than one example, individual children could be counted more than once. Numbers in parentheses indicate the percentage of children within each age group who offered each type of response.

Discussion

The current study examined children's understanding of teaching by asking them to define what teaching means and to describe examples of what and how they had been taught and had taught others. Four- and 5-year-olds were as likely to provide no definition of teaching as they were to describe teaching as a process that could cause knowledge change. By ages 6-7, children most frequently described teaching in this manner. Older children were also more likely to describe teaching in terms of content that can be taught, and were able to give more examples of what they had been taught in the past. These results suggest that although young children show an intuitive grasp of teaching through their interactions with others (e.g., Ashley & Tomasello, 1998; Strauss, 2005), they may begin to articulate an explicit understanding of teaching as an action that could result in knowledge change after the preschool years.

Nevertheless, we cannot conclude that children who generated a process definition of teaching explicitly recognized the relations between teaching and knowledge, or that they are aware of all the possible ways that teaching could result in a change in one's knowledge. For instance, Sobel, Li, and Corriveau (2007) found that children develop an understanding of the role that mental states like attention and intentionality play in learning, and the same might be true for teaching, with children gaining a more sophisticated understanding of the interconnectedness of various mental states and what they reveal about whether someone can or should be taught. In the present study, we identified process definitions of teaching when children described an action that would cause knowledge change. We did not specifically limit ourselves to definitions that involved exclusively mental state language. Although children did generate such definitions (see e.g., the first and fourth examples in Table 1), we wanted to consider process in a more general manner, recognizing when children conceptualized teaching

as an active process, whether or not they specifically mentioned knowledge. Although holding such a process definition does not necessarily indicate an explicit understanding of the relation between teaching and knowledge, defining teaching by describing actions that could affect knowledge is more consistent with an emerging understanding of this relation than defining teaching only in terms of what is being taught.

We also found connections between children's definitions of teaching and the examples they gave of teaching from their own lives. Children with process definitions of teaching were better able to give examples of being taught by others, and they were more likely to describe being taught through direct instruction. Children with process definitions were also better able to describe how they had taught others and how they could teach. Nevertheless, children with and without process definitions of teaching did not generate qualitatively different types of examples of what they had been taught (with the possible exception of "facts," which were described more often by older children and those who had given process definitions). Holding a process definition had a greater impact on children's ability to answer questions about how they been taught, how they had taught others, and how else one could teach.

Most children in the current study were able to give examples of what they had been taught and what they had taught someone else. Such results potentially relate to children's developing metacognitive understanding of knowledge and are consistent with various findings that suggest children develop the capacity to reflect on instances in which they have learned (Bemis et al., 2011; Bemis, Leichtman & Pillemer, 2013). This work demonstrated age-related change in children's metacognitive ability to reflect on their learning, similar to what we present here. The present study extends these findings by considering if children's explicit understanding

of teaching relates to their ability to reflect on their own experiences of being taught and teaching others.

When prompted for examples of teaching, children usually generated more examples of information others had taught them than examples of what they had taught others. This might align with their experiences, in that they are usually the recipient of teaching as opposed to being the teacher. This finding, however, might also reflect children's more privileged understanding of when their own knowledge changes (as opposed to when another's knowledge changes). Differences in children's understanding of their own versus others' knowledge might parallel differences in their ability to recount what they were taught as opposed to what they taught another. This might be particularly true if children understand teaching as a process that causes knowledge change, and future investigations should examine this possibility.

When asked who had taught them, both the older and younger children in the sample were usually able to describe who had taught them, and children often readily volunteered this information. Similarly, in Sobel and Letourneau's (2015) interviews about learning, children frequently mentioned sources in their answers if they understood learning as a process of knowledge change, but not overall. Unlike the present study, however, Sobel and Letourneau (2015) did not explicitly ask children from whom or where they learned information, only to describe how they learned in general. Bemis et al. (2011, 2013) did explicitly ask this question, and found that children were able to answer it at much lower frequencies than what we see here for their knowledge of teaching. This suggests that children do interpret teaching as a social action, involving others, while learning can be more solitary and not necessarily reliant on others.

Finally, comparing the present findings to the work by Bemis et al. (2011, 2013) and Sobel and Letourneau (2015) suggests similar developmental trajectories for children's explicit understanding of learning and teaching. For instance, when children were asked to define learning, Sobel and Letourneau found that 42% of 4-5-year-olds and 67% of 6-7-year-olds defined learning as a process involving knowledge change, compared with 17% and 45% of children here respectively. There is an increase in process definitions between the age groups for both learning and teaching. We have suggested that the mechanism for this increase is children's increasing understanding of mental states. However, it is possible that the age-related differences we observed can be explained by the fact that many more 6-7-year-olds are enrolled in formal education. As a result, these children might be exposed to more language about teaching in academic environments, but also through parental questions at home (e.g. "What did the teacher teach you today?"). We do not want to discount the importance of starting formal education or of parental involvement in children's development; at the same time, we do not believe that this is the only mechanism that underlies the changes we have observed. Sobel and Letourneau (2015) found that children's generation of process-based definitions of learning continued to develop after age 7, which suggests that formal schooling alone does not cause children to possess a process-based account of learning. Although we did not examine older children in the present study, we would predict similar results here. This, however, remains an empirical question.

When considering the results of Sobel and Letourneau (2015) alongside the present study, we also note a difference in the frequency with which children define learning versus teaching as processes that involve knowledge change. However, children in the present study often defined teaching in terms of learning (see Table 1), while they never defined learning in terms of teaching in Sobel and Letourneau's sample. Defining teaching as learning might

indicate a lack an understanding that teaching *causes* someone to learn, but suggests that children recognize that the two acts are related and potentially that both involve changes in knowledge. When the process and learning codes are combined together here, 40% of 4-5-year-olds and 67% of 6-7-year-olds generated this kind of definition – almost identical to Sobel and Letourneau's results. Future studies should explicitly compare children's definitions of learning and teaching using a within-subject design to examine whether children's understanding of these concepts develops in tandem or dependently on one another.

To conclude, while 6- and 7-year-olds in the present study were more likely than younger children to define teaching as a process that causes knowledge change, children of all ages were usually able to give examples of what they had been taught and what they had taught others. This suggests that the communicative and situational cues that help children recognize teaching in everyday life may also help them come up with examples in these interviews, even when they cannot define teaching itself as a process that results in knowledge change. Consistent with Strauss (2005), teaching might be a natural form of social interaction in young children, who are inclined to teach and be taught early in development. Beyond this, the present study shows that children themselves recognize instances of teaching and can describe what they have been taught or have taught others. Preschoolers might intuitively recognize when others are trying to teach them, and may use such cues to identify (and perhaps describe) situations that involve teaching. Nevertheless, their descriptions of teaching others and being taught might be couched in external activities, behaviors, or situations, rather than internal mental states. Only later in development might children demonstrate a more abstract understanding of teaching and describe the kind of natural cognition that involves greater metacognitive knowledge. An explicit understanding of teaching as a process that causes knowledge change appears to develop after the onset of an

understanding of false belief, much as it does for children's understanding of learning (see Sobel et al., 2007). A critical next step in this work is to consider the specific relations between children's understanding of learning and teaching, and to investigate whether such concepts relate to the child's own learning in formal and informal settings.

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