Questions in informal teaching: A study of mother-child conversations

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Abstract

Questioning is a core component of formal pedagogy. Parents commonly question children, but do they use questions to teach? Research has shown that informal pedagogical situations elicit stronger inferences than the same evidence observed in non-pedagogical situations. Certain questions ("pedagogical questions") have similar features. We investigate the frequency and distribution of pedagogical questions from mother-child conversations documented in the CHILDES database. We show that pedagogical questions are commonplace, are more frequent for middle-class mothers compared to working-class mothers, are more frequent during free play than during daily routines, and are more frequent in mothers who ask more questions. The results serve as a first step towards understanding the role of questions in informal pedagogy.

Keywords: informal pedagogy; mother-child conversation; individual differences; socioeconomic status; CHILDES.

Introduction

To question well is to teach well.
- Henry Barnard, 1860, American Journal of Education

Asking and answering questions has been seen as a core component of teaching and learning at least since the days of Socrates. Research in education suggests that, as a teaching technique, questioning leads to improvements in learning outcomes (Shymansky, Hedges, & Woodworth, 1990; Wise & Okey, 1983), and preliminary research in cognitive development suggests that question asking may support rapid and effective learning (Blewitt, Rump, Shealy, & Cook, 2009). However, not all questions are created equal. We suggest that questions by a knowledgeable informant in the service of teaching ("pedagogical questions") are a special class of questions separate from other information-seeking or rhetorical questions (unlike previous approaches; cf. Olsen-Fulero & Conforti, 1983). We explore whether and how parent-child conversations include pedagogical questions in everyday interactions.

Questioning plays an important role in formal pedagogy: Teachers ask ~400 questions per day in a typical classroom setting (Gall, 1970), and these questions serve various functions from checking class work to motivate thinking (Black, 2001). The effect of questioning on students' learning has been summarized in a meta-analysis demonstrating that questioning has the largest impact on cognitive outcomes (such as general achievement, specific learning outcomes, and problem solving) as compared to the other dozen teaching techniques surveyed (Wise & Okey, 1983).

However, learning begins well before formal classroom experiences. Theory in cognitive development emphasizes the importance of everyday interactions in which adults help children learn—informal pedagogy (Csibra & Gergely, 2009; Tomasello, 1999). Recent advances in developmental psychology have shown that infants and young children are sensitive to adults' cues that suggest an intention to teach, such as joint attention, child-directed speech, name-calling, etc. (Csibra & Gergely, 2009) These "pedagogical cues" lead to strong inferences that the adult is showing important information, and they facilitate learning in various domains (Bonawitz et al., 2011; Butler & Markman, 2014; Sage & Baldwin, 2010; Topál, Gergely, Miklósi, Erdőhegyi, & Csibra, 2008; Vredenburgh, Kushnir, & Casasola, 2014).

One key factor for the effect of informal pedagogy on learning is whether an adult appears to be knowledgeable about what she is doing (Harris & Corriveau, 2011; Koenig, Clément, & Harris, 2004; Shafto, Goodman, & Frank, 2012). In particular, pedagogical demonstrations from knowledgeable others justify drawing stronger inferences than would otherwise be licensed by the data. Given the huge space of possibilities for any problem, being able to harness pedagogical inferences may bolster learning. For instance, Bonawitz, et al (2011) investigated how children explore a novel toy with multiple functions after watching an adult demonstrating one target function. Two conditions, among others, manipulated the knowledge state of the demonstrator: she either appeared to be knowledgeable and helpful when demonstrating the target function (pedagogical condition), or she appeared to be ignorant about the toy and activated the function by accident (accidental condition). Children were more likely to learn the target function in the pedagogical condition than in the accidental condition (similar examples in other domains of learning see Buchsbaum, Gopnik, Griffiths, & Shafto, 2011; Butler & Markman, 2014).

If a critical aspect of pedagogical demonstrations is to facilitate learning about the correct hypothesis (or set of hypotheses), then perhaps questions that are asked by one who *already knows the answer* will have similar functions. A learner who infers that the question asker already knows the answer, may thus infer that the *goal of the question is to teach the askee rather than acquire information for the asker*. As in the case of pedagogical demonstration, we suggest the questioner's knowledge state play an important role in learning. Do parents, like teachers, use questions for which they already know the answers to facilitate learning?

As a first step towards a broader goal of understanding the role of pedagogical questions in learning, we explore whether parents use pedagogical questions, and if so, how common they are. We do so by analyzing parent-child conversations from the CHILDES database (MacWhinney & Snow, 1990). We coded mothers' questions to their children into three categories: Pedagogical questions are those for which mothers know the answer; information-seeking questions are those for which mothers do not know the answer; and rhetorical questions are those not intend to be answered verbally. Analyzing parents' questions with regard to these categories will provide information about whether questions are used to guide learning in informal pedagogy. Additionally, we characterize cross-individual, cross-situational, and developmental variation in their use, and review relevant prior work briefly in the following sections, before presenting our results and discussion.

Contextual differences in questioning

Context plays an important role in guiding parent-child interactions. Research has identified general differences in conversations, as well as specific differences in questioning, across different contexts such as book reading, free play, mealtime conversations, caretaking interactions, and household routines (Dunn, Wooding, & Hermann, 1977; Goddard, Durkin, & Rutter, 1985; Snow et al., 1976). The general function and pace of the activities are likely causes of these different interactions by context. Snow, Dubber, and De Blauw (1982) have likewise suggested that contexts that are typically low-stress and non-goal-directed (e.g., free play) are more likely to elicit conversational interactions; whereas contexts that are typically high-stress and goal-directed (e.g., daily routines) are more likely to elicit directive interactions. Intuitively, a parent who is interested in engaging in conversation with their child is more likely to choose the relaxed moments of dyadic free-play, than instances in which daily routines must be quickly accomplished.

We investigate whether types of questions may also differ across these contexts: One possibility is that non-goal-directed activities like free play provide more opportunities for teaching, so that mothers would ask more pedagogical questions. On the other hand, it is also possible that non-goal-directed activities provide more opportunities for conversation, so that mothers would simply ask more questions of all kinds.

Individual differences in questioning

Might questioning differ across mothers and across families from different socioeconomic status (SES)? Research has identified both quantitative and qualitative differences in parent-child conversations across SES, and these differences are predictive of the "achievement gap" in children's learning outcomes (Hoff-Ginsberg, 1991; Hoff, 2013; Snow et al., 1976). Questioning has been shown to be an important part of the difference: One study (Snow et al., 1976) showed that mothers from academic middle-class families posed more wh-questions ("who", "what", "where", "when", "why", "how") and less yes-no questions than mothers from working-class and lower middle-class families. Indeed, one way mother-child conversation may relate directly to learning is through the use of questioning strategies common in formal pedagogy. We investigate this possibility by analyzing the distribution of pedagogical questions for mothers from different SES, as well as for mothers who ask many versus few questions.

Developmental changes in questioning

Developmental changes can be important in revealing the cognitive mechanisms that drive learning. Considerable evidence suggests that the types of questions children are asked changes with development (Levelt, 1975). Infants frequently hear "contingent queries" which ask them to repeat or clarify their utterances (Garvey, 1977; Wilcox & Webster, 1980), whereas toddlers and preschoolers hear more yes/no questions and wh- questions (Snow, et al., 1976).

The types of questions posed to children may also vary with development, especially in terms of the knowledge states of the questioner. Evidence suggests developmental changes in children's understanding and inferences about other people's knowledge states (Wellman & Liu, 2004). Similarly, research has shown that whereas 4-year-olds consistently mistrusted informants who were ignorant or inaccurate, 3-year-olds were less discriminating about who they trust for information (Clement, Koenig, & Harris, 2004). Do the types of questions parents ask change with their children's age? Evidence suggests that older children would be better prepared to correctly interpret pedagogical questions; however, it is possible that parents' use of questions may not reflect the changing cognitive capabilities of their children.

Method

Sample

We searched the CHILDES database (MacWhinney & Snow, 1990) for transcripts that meet the following eight criteria: 1) The transcript was in English; 2) The conversation took place at home; 3) The conversation partners included a mother and a child, and did not include anyone outside the immediate family (interviewer, grandparents, relatives, friends, etc.); 4) The target child was between 3 and 6 years of age; 5) The conversation represented everyday talk, and was not a purposeful conversation such as an interview; 6) The transcripts for mother's and child's speech were not separated; 7) The transcript used punctuation marks, and had at least three question marks in it; 8) If there were multiple transcripts for a same child (such as in longitudinal studies), we only used the first (earliest) transcript that meets all other criteria.

The final sample was 94 transcripts from 14 studies (online supplementary material for a summary of the sample is provided at: http://shaftolab.com/YuCogsci16Sup.docx). Fifty-eight of the 94 transcripts came from one study

Table 1: Coding scheme for questions. Note that the subcategories of pedagogical questions and information-seeking questions are by nature asymmetrical: For example, mothers did not ask children generic questions for which they do not know the answer, so only pedagogical questions contain a "generic" subcategory; On the other hand, mothers always asked about children's needs, opinions, and status as information-seeking questions.

Category / subcategory	Description	Examples	Proportion (*SD*)
Pedagogical	Asker knows the answer of the question	—	23.8% (22.7%)
Generic	Testing child's knowledge about kinds, concepts, rules, or scripts	"What's 'A' stand for?"; "What'd you say [in this situation]?"	2.6% (9.0%)
Specific	Testing child's knowledge about a specific object, event, or person	"Who came for your birthday party?"; "What does this button do?"	21.1% (22.3%)
Information-seeking	Asker does not know the answer of the question	—	61.1% (23.6%)
Specific	Asking about a specific object, event, or person	"What did you do at school?"	28.1% (22.0%)
Check status	Asking about the child's needs, opinions, or physical/emotional/epistemic status	"Are you hungry?"; "Do you remember?"	22.9% (19.4%)
Clarification	Asking the child to repeat what he/she just said	"You what?"; "Huh?"	9.2% (11.2%)
Permission	Asking for permission	"Can I get you changed?"	0.9% (2.8%)
Rhetorical	No verbal answer is expected for the question	—	15.2% (15.9%)
Commands	Giving commands in a question form	"Can you help clean up?"	10.3% (13.0%)
Attention	Raising child's attention with a question	"Well?"; "Jack?"; "Be good, hear?"	4.8% (7.7%)

(Dickinson & Tabors, 2001) which recorded mealtime conversations in low-income, racially diverse families.

Coding Procedures

For each transcript, one coder first recorded the target child's gender, age, and the conversation partners from the heading of the transcript. The coder also recorded the social economic status (SES) of the family and the context of conversation if that information was available. Next the coder derived the total number of the mother's statements and questions in the transcript using tools provided by the database. The frequency of questioning (per 100 statements) was calculated by dividing the number of questions by the total number of statements, and then multiplying by 100.

Questions. For each transcript, two coders blind of the hypotheses independently coded the first 10 questions that 1) ended with a question mark; 2) was asked by the mother; 3) was directed towards the target child; and 4) did not contain missing words ("xxx"). Eight transcripts contained less than 10 such questions (with a minimum of 3 questions), and for those transcripts all questions were coded.

Each question was assigned into one of eight subcategories under one of three major categories (Table 1). The coders first determined whether the question was a pedagogical, information-seeking, or rhetorical question, and then determined their subcategories. Context before and after the question were used to help determine whether the mother knew the answer of the question. Since transcripts do not fully capture the history and details in mother-child interactions, this sometimes required an inference on the part of the coder. However, the inter-rater reliability was acceptable, which shows the majority of questions can be reliably categorized based on our coding scheme. When only the three major categories were considered, Cohen's $\kappa = .80$; When all eight subcategories were considered, Cohen's $\kappa = .78$. Inconsistent codes were reviewed and resolved by a third coder.

Context. After coding all 10 questions and answers for a transcript, one coder determined whether the main context of the conversation was 1) over meal, 2) during free play, or 3) during daily routines (e.g., dressing/bathing the child, preparing to leave). The other coder checked the code and discussed with the first coder if she did not agree.

Data analysis

All data was entered and analyzed in IBM SPSS 22. Two-tailed tests were used for all between-group comparisons, and an α level of .05 was used for all tests.

Results

A total of 907 questions were coded. Table 1 shows the proportion of each type of questions averaged across all transcripts.

Contextual differences in questioning

Seventy-two out of the 94 transcripts were coded as conversation over meal (687 total questions); 17 were during free play (170 total questions); and 5 were during daily routines (50 total questions). Overall *frequency* of questioning did not differ across contexts: average number of questions per 100 statements was 34 for meal, 37 for free play, and 32 for daily routines, $F(2, 91) = 0.50$, $p = .61$, $\eta^2 = .01$. However, the composition of questions did differ (Figure 1). The proportion of pedagogical question was significantly

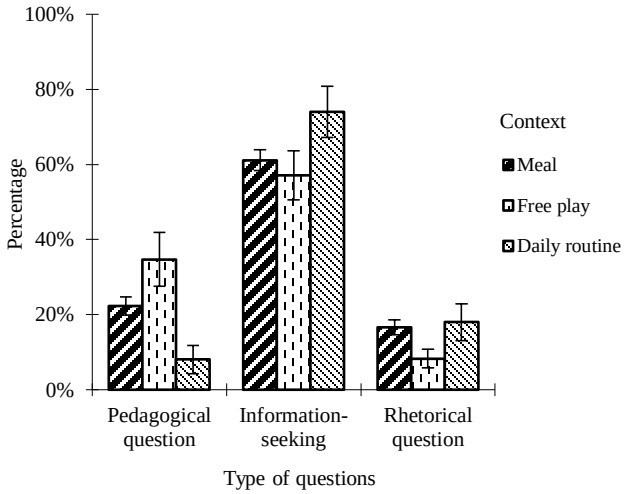

Figure 1. Proportion of pedagogical, information-seeking, and rhetorical questions across contexts. Pedagogical questions were more commonly asked during free play than during daily routine. Information-seeking and rhetorical questions did not differ significantly across contexts. Error bars denote *SE*.

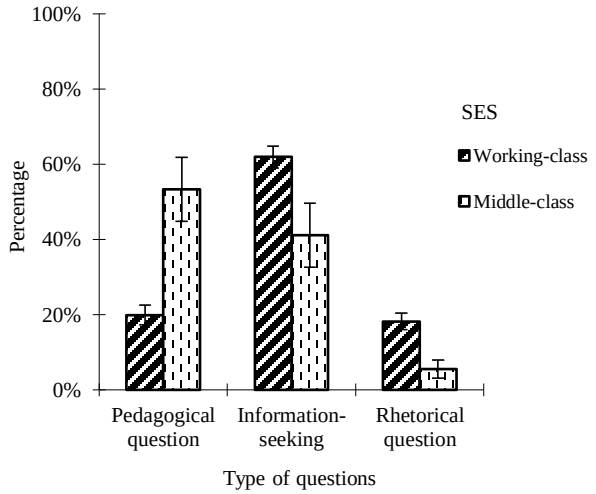

Figure 2. Proportion of pedagogical, information-seeking, and rhetorical questions for working- and middle-class SES. Higher SES asked more pedagogical questions and fewer information-seeking and rhetorical questions. Error bars denote *SE*.

different between contexts, $F(2, 91) = 3.52$, $p = .03$, $\eta^2 = .07$, with Post-hoc Bonferroni corrected test showing that mothers were more likely to ask pedagogical questions during free play (34.7%) than during daily routines (8.0%), $p = .05$, $d = 1.0$. Given the small sample size, we confirmed this difference with a nonparametric Mann-Whitney U Test, and the result was marginally significant: $z = 1.80$, $p = .07$. The proportion of pedagogical questions during meal time (22.2%) was not significantly different from the other two contexts, ps > .2. Unlike pedagogical questions, the proportion of information-seeking and rhetorical questions were not significantly different between contexts, Fs < 2.1, ps > .14.

Individual differences in questioning

Out of the 94 transcripts, 62 were documented as from working-class[1] (592 total questions), 9 were documented as from middle-class families (90 total questions), none were from upper-class families, and 23 were not specified (225 total questions). Overall frequency of questions was not different between working-class and middle-class mothers: average number of questions per 100 statements was 35 for working class and 37 for middle class, $t(69) = 0.56$, $p = 0.58$. However, the composition of questions differed by SES (Figure 2). On average pedagogical questions consisted a smaller proportion of questions in working-class families (20.0%) than in middle-class families (53.3%), $t(69) = 4.41$, $p < .001$, $d = 1.57$. In contrast, the proportion of information-seeking questions was higher in working-class families (62.0%) than in middle-class families (41.1%), $t(69) = 2.52$, $p = .01$, $d = 0.90$. The proportion of rhetorical questions was also higher in working-class families (18.2%) than in middle-class families (5.6%), $t(69) = 2.13$, $p = .04$, $d = 0.76$. These results held with nonparametric Mann-Whitney U Test: Pedagogical questions: $z = 3.45$, $p < .001$; information-seeking questions: $z = 2.18$, $p = .03$; rhetorical questions: $z = 2.39$, $p = .02$.

To separate the effect of context and SES, we performed three stepwise regression analyses, one each for the proportion of pedagogical, information-seeking, and rhetorical questions, with context entered in the first layer and SES entered in the second layer (context was dummy-coded; for SES working-class = 0; middle-class = 1; unspecified cases were excluded). Results showed that SES had an effect in addition to context for pedagogical and information-seeking questions but not for rhetorical questions, pedagogical question: $\Delta F(1, 67) = 10.88$, $p = .002$; information-seeking question: $\Delta F(1, 67) = 6.33$, $p = .01$; rhetorical question: $\Delta F(1, 67) = 0.48$, $p = .5$. After controlling for context, higher SES predicted more pedagogical questions, $\beta = .65$, $p = .002$; less information-seeking questions, $\beta = -.54$, $p = .01$, and did not predict rhetorical questions, $\beta = -.15$, $p = .5$.

The composition of questions was also related to the frequency of questioning. The frequency of questioning was positively correlated with the proportion of pedagogical questions, $r(92) = .26$, $p = .01$.[2] That is, the more questions were asked, the more likely those questions would be

[1] As described in the CHLDES corpus: The majority of working-class samples (58/62) were from a study of low-income families (70% of the sample had 1987 annual household income of < $25,000). The other transcripts came from studies describing their sample as "working-class" and "upper-working-class."

[2] Because the proportion of the three types of questions were not normally distributed, we confirmed these correlations using Kendall rank test. Results were similar: between frequency of questioning and pedagogical questions, $r_\tau = .17$, $p = .02$; information-seeking questions, $r_\tau = -.08$, $p = .27$; rhetorical questions, $r_\tau = -.18$, $p = .02$.

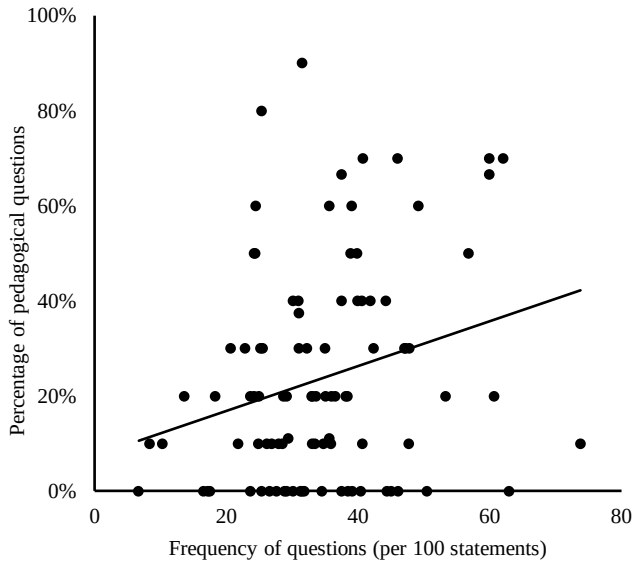

Figure 3. Percentage of pedagogical questions is positively correlated with the overall frequency of questions—pedagogical questions made up a larger proportion for mothers who asked many questions compared to those who asked few.

pedagogical (Figure 3). Frequency was not correlated with the proportion of information-seeking question, $r(92) = -.04$, $p = .7$, and was negatively correlated with the proportion of rhetorical question, $r(92) = -.30$, $p = .003$.[2] The correlation coefficient for pedagogical question was significantly greater than that for both information-seeking and rhetorical questions (pedagogical question vs. information-seeking question: Fisher's $z = 2.03$, $p = .04$; pedagogical question vs. rhetorical question: Fisher's $z = 3.85$, $p < .001$). The same results were found when context was controlled for, with pedagogical questions being more prevalent in proportion as the overall frequency of questions increased $r(91) = .25$, $p = .01$. But, no effect of frequency on proportion of information-seeking questions, $r(91) = -.04$, $p = .7$, and a negative effect of frequency on rhetorical questions, $r(91) = -.30$, $p = .003$. The differences between correlation coefficients also held up when controlling for context (pedagogical question vs. information-seeking question: Fisher's $z = 2.01$, $p = .04$; pedagogical question vs. rhetorical question: Fisher's $z = 3.83$, $p < .001$). These results suggest that the frequency of questioning is differently related to the proportion of each type of question—pedagogical questions made up a greater proportion as the total number of questions increased.

Age changes in questioning

The sample consisted of 42 3-year-olds, 41 4-year-olds, and 11 5-year-olds. The three age groups did not differ on any measurement of questioning behavior, Fs < 1.4, ps > .2. When treated as a continuous variable, age did not correlate with of any measurement of questioning behavior, rs < .16, ps > .13.

Discussion

Educators use questions for which they already know the answer to guide students' learning. Our results suggest that parents do as well. Consistent with research in language learning and academic achievement, we found the composition of mothers' questions differs by context and SES. The proportion of pedagogical questions were higher during free play than during daily routines. Mothers from working-class families asked fewer pedagogical questions than mothers from middle-class families, even though the overall frequency of questioning did not differ. Furthermore, pedagogical questions were more prominent among mothers who asked more questions overall.

We did not observe any developmental changes in the type of questions mothers ask their children. It is possible that this was due to the narrow age range we focused on (3-6 y), and the developmental changes occur either before or after that age range. This would be somewhat surprising given the developmental changes that are going on during this period. In particular, pedagogical questions depend on children's understanding of other people's knowledge states, and 3-5 years of age may be a period of rapid change in children's (explicit) understanding of other's beliefs (Wellman & Liu, 2004). Research on epistemic trust, however, does suggest that children's understanding of ignorance versus knowledge arises somewhat earlier (Nurmsoo & Robinson, 2009), which would be sufficient to differentiate pedagogical from information-seeking questions.

The contextual, individual, and SES differences found in this study may serve as a starting point for investigating the mechanisms behind sociocultural influences on parents' questioning behavior, and their implications on children's learning. The lower proportion of pedagogical questions in low SES settings is surprising. Given that free play was more likely to be associated with pedagogical questions, it is possible that lower SES families do not have as many free play opportunities in their regular daily routines (Snow et al., 1976). However even after controlling for context, we found an effect of SES, suggesting that this difference may be rooted in something deeper than varying degrees of free play in these populations. This points to the importance of investigating the origins and methods of minimizing these differences. Indeed, recent interventions involving parent-child question asking have been shown to significantly influence conversation in low SES families (Ridge, Weisberg, Ilgaz, Hirsh-Pasek, & Golinkoff, 2015). The majority of questions used in Ridge et al's intervention appear to be pedagogical queries, suggesting an important positive route for these kinds of questions in future research.

This study builds upon and extends an accumulating literature on the role of informal pedagogy in children's learning. The results indicate that parents may teach not only through direct instruction, but also through asking questions for which they know the answer. A critical next step, then, is to evaluate children's inferences from these pedagogical questions, and relate that to their learning outcomes. Doing

so will help bridge theories of pedagogy and active learning by considering cases where teaching happens not by giving the evidence itself, but by giving the place to look for evidence.

The sample for our study comes from the CHILDES database, so the scope is limited to information made available, and for the available variables the data were not balanced. Random-assignment experimental work is needed to confirm these results, and to extend them to cover other important factors such as culture. Regardless, these results demonstrate that pedagogical questioning is common in informal pedagogy, and that it varies across individuals and contexts. Thus, we have provided solid evidence that future controlled studies will be investigating questions that are not only of theoretical interest, but are also relevant to understanding children's learning in everyday life.

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