Curiosity and the Development of Question Generation Skills

Jamie J. Jirout
Carnegie Mellon University
jjirout@andrew.cmu.edu

Abstract

The current study investigates the relationship between children's curiosity and question asking ability. Generation of two types of questions was assessed: identification (yes/no questions asked to identify a target from an array) and understanding questions, asked to learn more about a topic. The latter was related to children's curiosity, as was the ability to recognize the effectiveness of questions in solving a mystery. Training on asking identification questions was effective in improving children's ability to ask that type of question, but did not transfer to the other task. Training on asking understanding questions was not successful. Children's curiosity did not influence the effectiveness of the training.

Curiosity-Question Asking Relationship

A primary instructional objective of most early science programs is to foster children's scientific curiosity and question-asking skills (Jirout & Klahr, 2011). However, little is known about the relationship between curiosity and question-asking behavior. While curiosity and question asking are invariably mentioned in national and state standards and in most preschool science curricula, they are rarely assessed (National Research Council, 1996; Worth, 2010). Instead, science assessments typically focus on domain-specific content, rather than on domain-general skills like question-asking. In this paper, we describe our work investigating the relationship between preschool children's curiosity and question asking, and assess the effectiveness of training children to ask different types of questions.

Curiosity

Lowenstein (1994) makes the interesting observation that while much is known about educating motivated students, less is known about how to actually motivate them. Children's natural curiosity has long been viewed as an intrinsic motivation for learning, and one that is quite important in early education. However, research on children's curiosity has not yielded any clear guidelines for developing and maintaining children's curiosity. One reason for the general ambiguity and vagueness about curiosity is that, until recently, the construct lacked an operational definition and empirically validated measure. A recent review of the curiosity literature provides an operational definition of curiosity as the threshold of desired uncertainty in the environment that leads to exploratory behavior. This definition was used to create an adaptive measure of young children's curiosity, and there has been preliminary support for the validity and reliability of this measure (Jirout & Klahr, 2011). In this paper, we describe our work using this measure to investigate the relationship between children's curiosity and their question asking ability.

Question Asking

The ability to ask questions is central to the processes of learning, reasoning, and understanding (Ram, 1991). Although young children ask many questions, and those questions are often successful in gaining some information, problem directed question asking skills do not develop until elementary school (Choinard, Harris, Maratsos, 2007; Cosgrove & Patterson, 1977). While questions can take many different forms, a common method of analysis considers the depth of information addressed by the question. In the current study, "Understanding questions" are similar to Graesser's (1992) "information seeking" questions. They are typically asked about a general area of knowledge and elicit in-depth responses, or to fill in some missing information or resolve confusing situations. "Identification questions", on the other hand, are similar to Graesser's (1992) "verification question". These are feature-focused, addressing the goal of filling in a specific, small gap in one's knowledge, and are the type typically addressed in the question-asking literature on young children. Several studies have demonstrated effective methods of training children in question-asking behavior, although the results of these studies have had mixed results on the effectiveness of training with young children (preschool age). Kindergarten students are the youngest children in which training has consistently shown to improve question-asking behavior, with successful training methods typically using direct instruction and/or some form of modeling (Courage, 1989; Cosgrove & Patterson, 1977; Zimmerman & Pike, 1972; Lempers & Miletic, 1983). These studies, however, rarely look at the transfer of training specific type of question asking skill on other types of question asking abilities.

Research Objectives

The goal of the present project is to investigate the relationship between children's curiosity and question-asking ability, and to study the effect of an intervention designed to develop question-asking skills. While curiosity and question-asking are commonly treated as if they were approximately synonymous, this is not true of the way we define and measure both constructs in the current study. Curiosity is defined as the threshold of desired uncertainty in the environment which leads to exploratory behavior, while question asking – in this specific project – is regarded as the more general act of being able to verbally request specific information (such as in our generation task) and to generate questions to solve simple problems (such as in the referential task). Additionally, we look at children's ability to discriminate between helpful and not helpful questions (discrimination task). We investigate three research questions in this paper:

1. What is the relationship between curiosity and children's question asking ability?
2. Can children learn to ask both identification and understanding questions through explicit training, and/or practice, and does this training transfer to other inquiry skills?
3. Does curiosity influence the effectiveness of training and practice on children's question asking ability?

Method

Participants and Setting

A total of 97 preschool through first grade students participated in this study, with a mean age of 5.12 years. Ethnic distribution was representative of the local suburban populations, and genders were equally represented.

Measures

Three measures of question-asking ability were used, as well as a measure of general inquiry skill and curiosity.

Referential task: Participants identify a target picture from an array of eight pictures differing on three binary dimensions (e.g., leaves differ on size, color, and shape). Students see either bees or leaves (set A) and either worms or clouds (set B) at pretest, and the alternate from set A for posttest and B for delayed posttest. For each array, students are given no information about the target for two trials (e.g., "The special one is a leaf"), one dimension for one trial (e.g., "The special one is a small leaf"), two dimensions for one trial (e.g., "The special one is a red, round leaf"), and three dimensions for one trial (e.g., "The special one is a big, yellow, pointy leaf"). The dimensions are given for the first array of the pretest only.

Generation task: Participants watch a short (~1 minute) video with a song about bees (pretest), leaves (training), worms (posttest) or clouds (delayed posttest). They are then asked to generate questions to learn more about the video topic. Questions are not answered during the task – children are told that the questions are being recorded so that the experimenter can find out the answers to them for a book that is being made for the class. Children's responses are coded as questions or non-questions

Discrimination task: Participants use charts to categorize eight questions as "helpful" or "not helpful" in identifying a mystery animal. The questions are read and answered individually by the experimenter. The child is then prompted to place the question where it belongs, in either the "helpful" or "not helpful" box. There are four helpful and four not helpful questions, but children are permitted to place any number of questions in either of the boxes, and can move the questions from one box to another at any time during the task. At the end of the task, children are allowed to explore and find out what the animal is.

Curiosity is indicated by the amount of uncertainty children choose to explore during a computer game. Children play a game about travelling under the sea in a submarine that has two windows, which can be opened to reveal a fish. On each of 18 trials, children may open one of the two windows, each of which provide different amounts of information, resulting in different levels of information/uncertainty. The task is adaptive, with the difference between the two levels decreasing until the levels differ by a single degree. The total amount of uncertainty explored throughout the task is used as the curiosity score.

Intervention

Three conditions were included: Identification question training (N=33), understanding question training (N=32), or practice only (N=32). Participants assigned to the identification question training received instruction on the referential task, and practice only on the generation task. Participants assigned to the understanding question training received instruction on the generation task, and practice only on the referential task. Participants in the practice only condition completed both the referential task and the generation task, receiving no instruction.

The identification question training was adapted from Courage (1989). This training provides children with instruction on generating categorical questions to identify the target picture from an array of distractor pictures, using the referential task. Children are told why it is beneficial to ask categorical questions instead of making guesses, and are given an example of how to ask categorical questions to identify an unknown target from an array. Children then complete five trials of the referential task, and received feedback and assistance asking categorical questions if they try to guess.

The understanding question training uses modeling and scaffolding to encourage children to ask open ended questions about a science topic, using the generation task. Children are told that questions can be asked to learn about different topics, and then two topics are presented, with three questions modeled to learn about each of those topics. Children then complete the question generation task, but instead of an open ended request for questions, they are provided with a question word to use in generating a question (e.g., "Can you ask a question about leaves that begins with the word, 'why'?"). If children are unable to generate a question, the researcher modeled a question and then asked children to generate another one. Children were asked to generate questions using the words 'why', 'how', and 'what', and then asked if they could think of any additional questions to ask.

Research Design

Students were randomly assigned – within school and grade – to one of two training conditions or a control group. Assignment was completed before pretest. A three (grades: pre-k, kindergarten, 1st grade) x three (conditions: identification-training, understanding-training, control), between-subjects design was used.

Participation included five sessions, with a total participation time of approximately one hour: computer pretest, hands-on pretest, training, immediate posttest, and delayed-posttest. The immediate posttest was administered immediately following the training. The delayed posttest was administered approximately one week after the training. All tasks were counterbalanced within session, and the order of the two pretest sessions was counterbalanced. Research assistants administering the posttests and delayed posttests were blind to experimental condition. Sessions were recorded and transcribed for coding after all sessions were complete.

Data Collection and Analysis

Data were collected over five sessions: Two pretest sessions, training, immediate posttest, and delayed posttest. Pretest sessions included the referential, discrimination, generation and curiosity tasks, training and immediate posttest included the referential and generation tasks, and delayed posttest included the referential, discrimination, and generation tasks. The two pretest sessions each take approximately 15 minutes to complete, the instruction and immediate posttest each take approximately 5 minutes, and the delayed posttest takes approximately 20 minutes to complete.

Hypotheses

1. We expected children's curiosity to correlate positively with question-asking ability.
2. The two instructional interventions were expected to lead to the highest scores on the related tasks (i.e., the task used in the training), and higher scores overall than the practice-only condition.
3. We expected that curiosity will influence the effectiveness of the training conditions, with high curious children benefiting more.

Children were split into high- and low-curious groups using a median split. Pretest scores on each of the measures are included to control for differences in pretest ability.

Results

1. What is the relationship between curiosity and children's question asking ability?

Children in the high-curious group asked significantly more questions on the generation task than children in the low-curious group (means = 2.20 and 1.35, respectively, p = .003), with the number of total verbal responses not significantly different (p = .417). High-curious children also scored significantly higher than low-curious children on the discrimination task (means = 5.13 and 3.98, p = .003). There was no difference between high- and low-curious children's performance on the referential task.

2. Can children learn to ask both identification and understanding questions through explicit training, and/or practice, and does this training transfer to other inquiry skills?

As a result of non-normal distributions, ordinal regression models were used for analyses. On the referential task, training condition, age group, and pretest ability were significant predictors of children's posttest ability (p values = .018, .025, and <.001, respectively). Within treatment, only the identification training condition beta value was significantly different from the control group (baseline).
Children in the identification training group were 7.4 times more likely to be in a higher ability group than children in the control group (p =.013). Within age group, 1st grade

Table 1 Regression of referential task outcomes, posttest

	p	Beta	Exp(B)
ID-training	.013	1.998	7.378
U-training	.665	0.333	1.386
Kindergarten	.061	1.617	5.039
1st Grade	.007	2.407	11.098
Pretest group=1	.000	3.823	45.727
Pretest group=2	.000	5.247	290.007

Treatment condition=control, age group=preschool, Pretest group=0 at Baseline
Threshold beta values: Group 0=3.895, Group 1=5.515

and kindergarten children were both more likely to be in a higher ability group than preschool children (11.1 and 5.0 times more likely, *p* values = .007 and .061, respectively). Pretest ability group was the most influential variable on the likelihood of being in a higher posttest ability group (see Table 1 for odds ratios). However, only age and pretest ability were significant predictors of ability on the referential task at delayed posttest (*p* values = .001 and .002 respectively).

On the generation task, only age, and pretest score were significant predictors of children's posttest ability (*p* values = .001 and .002 respectively). Within age group, the difference between kindergarten and preschool children was not significant, but 1st grade children were 8.0 times more likely to be in a higher ability group than preschool children ($p < .001$). Pretest ability was the most influential variable on the likelihood of being in a higher posttest ability group, with the odds ratio increasing by 1.5 times for each question asked at pretest. Only age group, pretest ability and posttest ability were significant predictors of delayed posttest ability (*p* values = .029, .016, and .001, respectively). Within age group, the difference between kindergarten and preschool children was not significant, but 1st grade children were 5.8 times more likely to be in a higher ability group than preschool children (*p* = .009). Pretest score increased the odds ratio by 1.4 times for each question asked, and posttest score increased the odds ratio by another 1.7 times for each question asked (see Table 2 for odds ratios).

Table 2 Regression of generation task outcomes, posttest

	p	Beta	Exp(B)
Kindergarten	.436	0.400	1.492
1st Grade	.000	2.080	8.002
Pretest score	.002	0.395	1.485

Age group=preschool, pretest score=0 at Baseline
Threshold beta values: Group 0=1.284, Group 1=3.285

There was no effect of condition on children's posttest score on the discrimination task, nor was pretest score a significant covariate (*p* values >.10).

3. Does curiosity influence the effectiveness of training and practice on children's question asking ability?
Curiosity was not a significant predictor of the posttest or delayed posttest scores for any measure, and did not influence the effectiveness of the different training condition on children's question asking ability (*p* values >.10).

Conclusions

High-curious children ask more information seeking questions and are better at discriminating between helpful and not helpful questions. There was no relationship between curiosity and the referential task, suggesting that curiosity is not related to asking validation questions. Children trained on the referential task were significantly more likely to score higher than children in the other two conditions, but this improvement was no longer significant a week later. Training on asking information seeking questions did not improve children's question asking ability on any of the measures. High- and low-curious children were equally likely to improve on all tasks.

The very small amount of training given was a limitation of this study. Perhaps more training over time would have a greater impact on children's question asking. Forms of some measures turned out to differ in difficulty level, so it is not possible to look at gain on those measures. It would be beneficial to analyze gain scores, so future work should address the revision of these measures to make that possible.

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