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Title: Children's question asking and curiosity: A training study

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Abstract Body

Limit 4 pages single spaced.

Background / Context: 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, question-asking behavior, and general inquiry skills. 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 pre-school children's curiosity and question asking, and assess the effectiveness of training them 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 resulted in an operational definition of curiosity as the threshold of desired uncertainty in the environment which leads to exploratory behavior. This definition was used to create an adaptive measure of young children's curiosity, and the validity and reliability of this measure have been demonstrated (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. "Understanding questions" are typically asked about a general area of knowledge and elicit in-depth responses, or are asked in order to fill in some missing information or resolve confusing situations. "Identification questions", on the other hand, are more 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). None of these studies, however, have looked at the transfer of training this specific type of question asking skill on other types of question asking abilities.

Research Objectives: Although educational legislation, standards, and curricula all emphasize the importance of children's curiosity in education, it remains an elusive and inconsistently-defined construct, primarily because of the lack of an operational definition (and associated measurement procedure). Recent work has produced an unambiguous, operational definition and measure of young children's curiosity (Jirout & Klahr, 2011). The goal of the present project is to use this measure of curiosity 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 use 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?

Participants and Setting: All assessments were conducted individually by the researchers at the participants' schools during the 2010-2011 school year. Participants were 75 students recruited from kindergarten and first grade classes at two suburban charter schools, and 31 preschool children from four suburban daycare centers. Participants' ethnic distribution was representative of the local population, and genders were equally represented.

Intervention: Participants are randomly assigned to receive one of three interventions: Identification question training, understanding question training, or practice only. The first intervention – identification question training – was adapted from Courage (1989). This training provides children with instruction on asking categorical questions to identify the target picture from an array of distractor pictures, using the referential task described below. 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.

In the understanding question training, the researcher uses modeling and scaffolding to encourage children to ask open ended questions about a science topic using the generation task described below. 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 described, 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.

Children in the practice-only condition did not receive any explicit instruction. During the instruction section of the study, participants in all conditions completed both the referential and generation tasks. 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.

Research Design: Students were randomly assigned – within school and grade – to one of two training conditions or a control group. Assignment was completed before pre-test. Additional participants were recruited to bring each experimental group to an N of 30 when excluding those who were at ceiling at pre-test, resulting in final Ns for the experimental groups as 31 in the identification-training group, 32 in the understanding-training group, and 36 in the control group. A three (grades: pre-k, kindergarten, 1st grade) x three (conditions: identification-training, understanding-training, control), between-subjects design was used.

(Please insert Figure 1 here)

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 one week after the training, however due to student absence or school schedules some delayed posttests were given 6 or 8 days after 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: All data were collected over five sessions: Two pretest sessions, training, immediate posttest, and delayed posttest. Pretest session A included the referential, discrimination, and general inquiry tasks, pretest session B included the generation and curiosity tasks, training and immediate posttest included the referential and generation tasks, and delayed posttest included the referential, discrimination, generation, and general inquiry 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. Data collection has been completed for kindergarten and first grades, and preschool data collection will be complete in May.

Measures.

(Please insert Table 1 here)

Referential task. Assesses children's ability to use categorical questions to solve simple problems. (Adapted from Courage, 1989).

Discrimination task. Assesses children's ability to recognize helpful and not helpful questions when trying to solve a mystery.

Generation task. Assesses children's ability to generate questions in order to learn about a science topic.

General inquiry task. Assesses children's ability to learn and explain about a novel toy after up to three minutes of exploration.

Curiosity. Curiosity is indicated by the amount of uncertainty children choose to explore during a computer game. On each of the 18 game trials, children must choose which to explore between two different levels of information/uncertainty.

(Please insert Figure 2 here)

Our hypotheses for our specific research questions are as follows:

1. We expect children's curiosity to correlate positively with question-asking ability.
2. The two instructional interventions are 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 expect that curiosity will influence the effectiveness of the training conditions, with high curious children benefiting more.

Correlational analyses will be used to assess the relationship between children's curiosity and question asking ability. The effectiveness of the training strategies will be assessed using multiple regression analyses with training condition, grade level, and curiosity as predictor variables for each of the outcome variables described above. Pretest scores on each of the measures will be included to control for differences in pretest ability.

Findings: Preliminary analyses were conducted on the limited sample currently available (kindergarten and 1st grade), including variables from the referential, discrimination, and generation task measures. Results of correlation analyses indicate significant, positive correlations between children's curiosity and all measures of question asking ability (r values range from .242 - .550, p values <.05). There was a main effect of age group (older children out preformed younger children), and all groups improved on question asking ability from pretest to posttest and those gains remained at delayed posttest (p values <.01). MANOVA analyses indicate some group differences on the different tasks, and the influence of curiosity on the effectiveness of the different training conditions approaches significance (p values <.10). More complete analyses will be reported after all analyses are conducted in May, 2011.

Conclusions: Positive relationships between children's curiosity and the range of question asking abilities measured were observed, suggesting that more curious children ask more questions, are better able to use questions to solve simple problems, and are better at discriminating between helpful and not helpful questions. Preliminary analyses suggest that children can benefit differently on these tasks with different training protocols and that training in specific skills can transfer to other related skills, and that curiosity level might influence the effectiveness of the interventions. Final analyses will be conducted after data collection is complete. There were limitations in using the same measures across age group, because older children were more likely to test-out of the study at pretest. Additionally, forms of some measures differed in difficulty level and could not be counterbalanced between pretest and posttests, so it is not possible to look at gain on those measures although they do provide pretest ability and posttest ability in order to investigate group differences. This study describes new approaches of looking at the domain general inquiry skills curiosity and question asking, which – despite being present in science standards and curricula goals – are often overlooked in assessments. Preliminary results suggest effective methods of developing children's question asking abilities, as well as for individualizing instruction for children differing in curiosity level.

Appendices

Appendix A. References

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Appendix B. Tables and Figures

Table 1. Measures of children's inquiry skills

Measure and outcome variable	Description
Referential task Outcome measure: Ratio of categorical to guessing questions, total number of categorical questions asked, and ability to ask any categorical questions	Participants must identify a target picture from an array. Five arrays – bees, leaves, worms, clouds, and houses (used for training) – have 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. (Adapted Courage, 1989)
Discrimination task Outcome measure: Accuracy of children's categorization of helpful and not helpful questions	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.
Generation task Outcome measure: Number and type of questions asked	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 .
General Inquiry Outcome measure: Number and type of questions asked, number of exploratory behaviors	Participants are presented with a novel, unusual toy, and asked to learn as much as they can about it to help the researcher describe it. They are specifically instructed to learn what it is, what it does, and how to play with it. Once a child stops on his own during the task, or after three minutes exploring the toy, the child is prompted to explain what he has learned about the toy, specifically "what it is, what it does, and how to play with it." The same two toys are used for all students for pretest and delayed posttest.

Figure Captions

Figure 1. Study design: Timeline and description of test sessions, including the measures administered and duration.

Figure 2. Screenshot and description of the curiosity game.

Figure 1

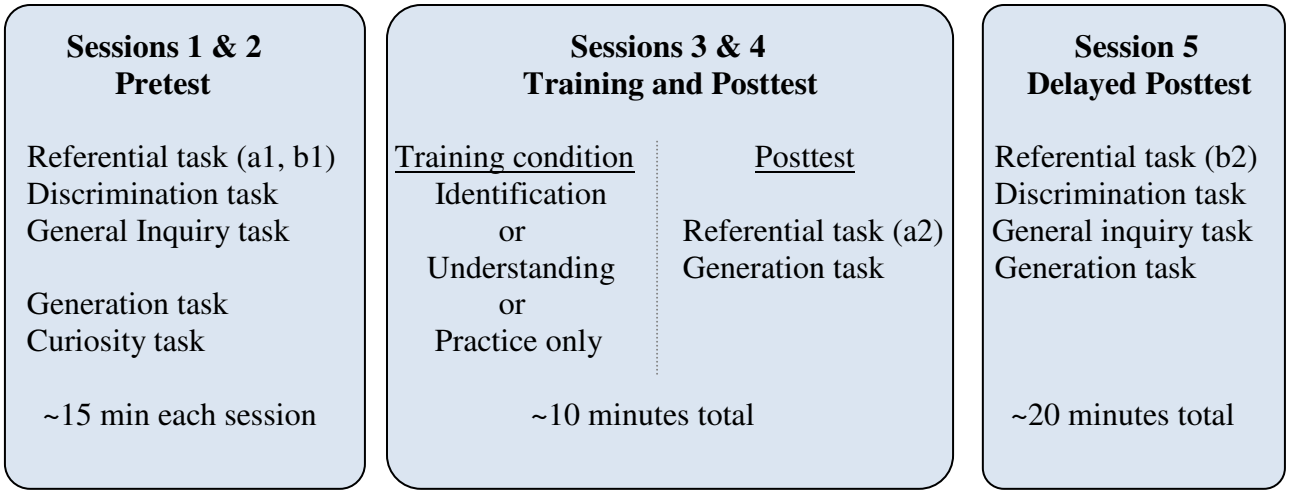
Sessions 1 & 2
Pretest
Referential task (a1, b1)
Discrimination task
General Inquiry task
Generation task
Curiosity task
~15 min each session
Sessions 3 & 4
Training and Posttest
Training condition
Identification
or
Understanding
or
Practice only
Posttest
Referential task (a2)
Generation task
~10 minutes total
Session 5
Delayed Posttest
Referential task (b2)
Discrimination task
General inquiry task
Generation task
~20 minutes total

Figure 2

Curiosity game for preschoolers: "Underwater Exploration!"

In the curiosity game, children choose which of two windows to open in order to see what kind of fish is outside the window (of the submarine). For each of several trials, the panel adjacent to each initially closed window shows one to six fish, or a question mark. The number of possible fish corresponds to the amount of uncertainty associated with each window.

In the middle panel shown here, the window on the left has maximum uncertainty and the window on the right has the minimum uncertainty (if the child chooses it, they know for sure which fish will appear). The middle panel contrasts two levels of uncertainty: window A will reveal one of 3 fish, window B will reveal 1 of 6 fish. Children work their way through a decision tree of 18 trials contrasting varying levels of uncertainty.

Curiosity is indicated by the amount of uncertainty the child prefers throughout the task.