A System for Analyzing Children and Caregivers' STEM Language and Inquiry in Structured Contexts:

Bridge Challenge, Grocery Store Experience, and Seed's Needs Parent Child Book Read

teaching together

Coding Manual

UTHealth
The University of Texas
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Introduction

This coding system was developed using categories and codes established across two separate research studies. The first was an Institute of Education Sciences study designed to examine children and adult's language as they engaged in shared informational texts with young children (Pentimonti et al., 2012, 2021). The second was a National Science Foundation study designed to examine informational book reading as well as two other structured activities – a grocery store game and a bridge building challenge (e.g., Zucker et al., 2024; Bambha et al., 2024). We provide these coding details to promote shared use of these or similar approaches that match the early STEM and literacy activities relevant to other studies. Please cite this work when adapting this coding scheme to fit your research that examines qualities of caregiver-child language.

Two areas of research guided our development. First is responsive, language support approaches for young children that include inquiry questions and academic level discourse related to science, technology, engineering and math (STEM; e.g., Justice et al., 2018; Peterson & French, 2008). Second is recent observational research around structured and unstructured STEM activities with young children (e.g., Acosta et al., 2023; Levine et al., 2020; Leyva et al., 2020; Pagano et al., 2020; Purpura, Napoli, Wehrspann & Gold, 2017; Westerberg et al., 2022). Collectively, these bodies of research point to the need to further investigate the science, math, and engineering content of parent-child discourse as well as the ways in which engaging STEM conversations are facilitated via responsive prompts from caregivers.

How to Use the Coding System

We outline a coding system with multiple components that is designed to analyze videotaped caregiver-child behaviors. You may choose to transcribe these activities, depending on the number and complexity of codes used. The coding system yields measures of the frequency of individuals' talk about different STEM domains. This requires coders to make a series of decisions:

1) ***Utterance level STEM Content analysis***
Decision #1 – Is the utterance related to the STEM content area of interest (engineering/STEM processes, math language, science/ biology processes)?
Decision #2 – If so, which category or STEM content area?
2) ***General Language Analysis*** (utterance level)
Decision #1 – What sentence type is the utterance (comment, directive, question)?
Decision #2 – If a question, what type? (e.g., Yes/No question, wh-question)

Codes in the STEM content analysis, general language analysis, and making connections categories are coded as *counts* - you will enter a 1 in the appropriate column of the coding template if they are present in an utterance.

Your coding team will need to make decisions about which codes in this document are relevant to the STEM activities you are observing. You may want to remove or add relevant codes. If you add additional codes that require complex decisions, you may need to review the videos/transcripts multiple times. The current list of codes can be applied by reliable coders in one pass through the video/transcript, but when we add other ratings we recommend two rounds of coding to ensure accuracy.

Rules within the Coding System

What Are the Primary Unit of Analysis?

Spoken *utterances* (a complete thought/sentence) are the primary units of analysis. A brief overview of utterances is provided in the Appendix, if needed. We recommend you consult other transcription rules and guides for more detailed information.

What If the Speech Is Inaudible?

Some utterances may be hard to interpret. Rules for excluding an unclear utterance are:

- Completely inaudible utterances are excluded from coding.
- Partially inaudible, unclear utterances may be coded during live/video coding only if a keyword was identified.
- For video coding, if an utterance cannot be deciphered after ONE time rewinding the video, it is excluded. This rule allows for coders to continue efficiently coding the reading session given.

What Is Included in Coding?

Only talk *directed to/between the focal parent and child* is coded during all tasks. Only *extra-textual talk* is coded during book reading, meaning talk by the focal adult and child that goes beyond reading of the text itself.

- Talk by others is not coded (e.g., other adult/child enters room and asks question).
- When the adult reads the text aloud, this is not coded as his/her own contribution to the task.
- If an adult inserts only 1-2 words during reading, this is not sufficient to be extra-textual talk.

What Is Excluded from Coding?

Many utterances contain *filler words* or content that *does not warrant coding* within this scheme. For example, talk that references formalities (thank you) or simple yes/no utterances are not coded. See details below.

What Constitutes the Task/Coding Session?

Coding starts when examiner instructions stop and the task activity begins, which is indicated when the examiner presses the timer to start. Coding will not start at the beginning of the video because there will be some transition time after beginning to record when the examiner shows the Participant ID number and reads instructions (see Examiner Protocol for details). Coding ends when the timer sounds and the examiner says that there is one minute remaining in the activity:

- When video coding, mark start and stop times at the top of the coding sheet in minutes, seconds (00:00).

A Note on Keywords

When a "keyword" for a code is present, you must mark that code. This approach reduces coder inferences and increases reliability. However, an utterance that *explicitly* addresses the focal behaviors can be marked without the presence of a keyword. Thus, coders should attend to keywords and also use broader code definitions to understand when a codeable behavior is clearly present. Ambiguous utterances are not coded to improve reliability and efficiency.

How Do You Code Non-English Utterances?

We expected to hear parent-child talk in English and Spanish within our samples. Coders should mark the languages observed at the top of the coding form. If coders are *not* bilingual, and more than 2-3 utterances occur

in a language other than English, notify the coding supervisor to determine another bilingual coder who can analyze these data.

What are Rules for Coding Different STEM Activities?

As noted, we were interested in three STEM-related activities and provide examples throughout this coding manual of these three activities:

- Grocery Store: A pretend play activity that required caregivers and children to pretend to "go shopping" with plastic food and use mathematics to check out with a cash register that included a simple calculator and pretend money.
- Bridge Challenge: An engineering challenge that required caregivers and children to build a bridge using cardboard, blocks and other standardized materials (e.g., tape, straws). The bridge needed to reach a specified height and be sturdy enough to hold a 2 pound weight and a toy car that moved across it without breaking.
- Book Reading: A shared book reading activity that required caregivers and children to read and talk about an informational text with related manipulatives (e.g., model of seed in different seeds of maturation to a full plant).

In each activity, we created separate protocols for research staff to observe and video record these activities in a standardized manner. We added rules to this coding guide that explained specific behaviors of interest and durations of the observation that were coded. We encourage coding teams to develop observation protocols and coding rules that are relevant to your activities.

Mutually Exclusive Codes

Some categories of codes were *mutually exclusive*. That is, if one code occurred, another code from the same category could not occur for the same utterance. Codes were designated as mutually exclusive if we felt each code corresponded to a theoretically distinct concept or if we wanted a greater level of specificity in the codes. For example, in our Engineering/STEM Process section beginning on Page 11, the process codes are mutually exclusive because we wanted to be more precise about the focus of the parent/child dyad. Likewise, in the Math Language section beginning on Page 15, Numeracy and Operations codes are mutually exclusive because the Operations codes were seen as a more highly specialized type of Numeracy code. That is, while a Numeracy code would indicate simply the presence of a number word, an Operations code would indicate that the talk involved manipulating or calculating with numbers in some way.

Excluded Talk

Our objective was to focus on meaning-related talk related to STEM and questions that elicited thinking or conversation. Therefore, we were not interested in various behavior-related talk or other interruptions. We eliminated many utterances that have no codeable content of interest. By excluding these utterances from further consideration in the frequency based/tallies coding, it simplified and focused the coding task. These utterances do not fall into the larger categories of STEM-related talk or are not audible.

Excludes/Fillers Utterances that do not have a substantial code and include fully inaudible utterances, abandoned utterances, noises or fillers.	
Inaudible talk	*XXX* (talk is inaudible) *I will xxx* (thought abandoned before codeable content) *XX the XX* (too little content to be codeable) *XX I have XX and XX* (too little content because only a "be verb" and pronoun)
Note 1: ***Rewind once rule*** - Do not rewind the video twice to attempt to interpret an utterance as this increases coding time. The goal is to quickly code understandable talk, rather than strain to interpret unintelligible talk. **Note 2:** Do not exclude ***partially*** **inaudible utterances**. If an utterance is partially inaudible, but has codeable content, you can mark the relevant behavioral codes. ● xxx means that the embryo is **growing**. = Codeable content, not excluded	
Filler words/ manners (Adult or Child)	● *Um, Uh, Er, Ew, Uh oh* ● *Oh, Ooo, Ah, Aww* ● *Oh my; Oh my gosh; Oh my goodness* (too vague) ● *Wow. Woah*. (Too vague for surprise expression and often used as filler) ● *Wha^* (abandoned utterance mid word) ● *Please. Thank you. You're welcome.* ● *Excuse me.* ● *Huh?* (meaning "what?" – this is a little more than filler, but too vague to code as a question) ● *{Gasp}* ● *[sounds/animal noises]*
Yes/No (Adult or Child)	● *Okay, Alright, Ok. Ok? Maybe.* ● *Yes, yeah, Mmhmm, Mm-mm, Uh huh, Maybe. Yes? Yeah? Maybe?* ● *No, nuh-uh, Oh no, No?* ● *I don't know* ● *I don't think so/I think so*
Overlapping talk	● Multiple speakers talking at the same time may be excluded and marked with xxx. However, if the focal child/parent's utterance is clear and interpretable, then you may code. Ignore parent talk to siblings or others. ● *[It's a xxx.]* ● *I see a xx.*
Adult Praise/ Behavior Related	Adult talk that praises child or gives positive feedback. ● *Right.* ● *Good job, Mason!* ● *Excellent.* ● *I need to go to the bathroom* ● *I'm hungry*

Exact Back-to-Back Repetitions (and exact recasts of the child' talk)	When adults and/or child repeat an utterance exactly, exclude the second utterance/exact repetition from further coding. This includes all back-to-back repetition. Not Coded – Exclude second utterance: ● *It needs to be three inches tall.* (Codeable) ● *It needs to be three inches tall*? (Excluded b/c verbatim recast of child's utterance) ● *He is sad*. (Meaning Feelings/Emotions) ● *He IS sad.* (Exclude repetition even if changed intonation)
Very general talk	● *So many things*. ● *I see it.* ● *--- things. These.* ● *These? Ok.*
Other Exclusions to Clarify Communication and Vague	● *That's what I said* ● *What did you say* ● *I can't hear you. or I heard you* ● *Okay listen* ● *Look, look at this*
Behavioral Monitoring	● *Listen to me.* ● *Are you paying attention?* ● *Stop doing that.*

STEM Content Codes

This coding scheme focuses on coding STEM-related talk, as that was the most meaningful content within our observed activities. For activities that focus on language- and literacy-related talk, we used other coding manuals (e.g., see the Systematic Assessment of Book Reading available at CLI Engage or here: https://public.cliengage.org/systematic-assessment-of-book-reading-sabr-2-0/).

The STEM Content Codes are divided into three categories: engineering/STEM process, math language, and science/biology concepts. These categories correspond to the talk that we expected to be elicited in each of our three activities (bridge building, grocery store, and book read respectively). We were also interested in how these content codes might occur *across activities*. For example, engineering/STEM process language includes talk related to planning and goal-setting, which might also be relevant in activities such as the pretend grocery store, which required parents and children to stay within a fixed budget. The definitions of each of the STEM Content Codes were therefore crafted to be broad enough that they could be applied to talk within any of the three activities.

More than one STEM Content category can be coded for a single utterance, but there are specific rules (listed in the sections below) about which codes were mutually exclusive.

How to Use these Codes?

Each of codes is explained in a table formatted like below that includes the definition, keywords, features of the codes, and sample utterances.

Code Name **Definition**: Concise explanation of the meaning of this code.	
Keywords: When a "keyword" for a code is present, you must mark that code. This approach reduces coder inferences and increases reliability. **Possible keywords**: These words may indicate the presence of a code, but not in every context.	
• Specific features of this code	Sample utterances

Engineering/STEM Process

There are four engineering/STEM process codes. These processes can occur in cycles and happen out of order, although goal setting typically occurs at the beginning of the activity. These codes are *mutually exclusive* – each utterance may receive only one process code. Utterances that appear to contain more than one process should be checked to see if they can be split or coded according to the highest-level process in the below hierarchy.

1. Setting a goal or reference task models
2. Planning what to do next
3. Testing
4. Redesign and change

Goal Setting

For the most part, this code occurs BEFORE the activity begins; however, this code may also occur mid-task when referencing the objectives.

Keywords: goal, aim, objective, purpose, reason

Bridge Building - Possible keywords and phrasing: kind of bridge; the model (the images provided)

Grocery - Possible keywords: we have to, have to/need to get healthy foods, let's learn what foods are good for you.

- Can code **Setting Goal or Purpose** in the middle of the activity without referencing a model or specific key words - but needs to include a **cue to remember a previous goal** or a **reminder of the goal**.

Book Read - Possible keywords: let's learn how seeds/plants grow, let's learn what a seed needs to grow into a plant

- Goals might reference "sharing a science book" or a goal that is shared or established between the dyad.

• **Early discussion to think through designing** a bridge that meets the requirements. • Restating the **objectives** of the activity • Looking at the **model pictures** of bridges and thinking about which kind you want to make. • If this occurs **after** the initial bridge building it must include a keyword, reference the model bridges, explicitly reference building a new bridge, or contain **reminders** of goal/objective.	**Bridge Building** • *The **goal** is to…* • *Which kind of bridge do you want to make?* • *We can make/build a…* • *Which picture do you want to use to model our bridge?* • *Hey remember, it's gotta be able to hold this.* • *"What did she say, it needs to be…"*--when recalling the objectives given by the examiner
• Restating the **objectives** of the activity. • Looking at materials and making statements of **goal** • If this occurs **after** the initial beginning of Grocery activity, it must include **reminders** of goal/objective of purchasing healthy food and staying within $12.	**Grocery Store** • *The **goal** is to…* • *We have to* …. (pick a fruit and a vegetable; stay within the budget of $12) • *Remember, we're trying to get healthy food*
• Restating the **objectives** of the activity. • Setting their own **goal or objective** • The book read is more of a fluid activity and goal setting might occur at any point	**Book Read** • *The **goal** is to…* • *We have to read the book to learn…..* • *Let's keep reading to learn……..* • *Let's put these [models of seed/plant] in order*

Planning

This code refers to utterances that include talk about brainstorming what to do next. This often occurs after the initial goal setting or redesign. Planning utterances are future-oriented and refer to an action.

Across all activities:

Keywords: next, first, second, third, last, after, should, now, will [do]

Possible Phrases: how do you know, how, make happen, then, when-then, so (meaning thus or therefore, but not as comparison or filler word), what if…, maybe/ maybe if, in order to, need to, can, could

- Sequencing words like **next, first, last**, indicate the sequence of events is being planned
- **Imperatives** or **wondering** statements about future actions "We should…." Or "We could…"
- The use of **suggestions** "Let's + *an action*" (for example: "let's put") often indicates planning
- **Conditional statements** about what will happen if or when certain conditions are met/changed.
- There are few activity-specific differences in the planning code, so only general guidance is given here.

Bridge Building

- ***Let's*** *make a base/support/etc.*
- *What do you think we* ***should*** *do* ***next****?*
- *What do you want to do with these?*
- *So* ***maybe*** *if we were to put some of these on the bottom.*
- *Do you think we* ***should*** *use straws?*
- *Can we use that****?***
- ***Let's*** *put some tape here. (not a directive but softer suggestion)*
- ***Could*** *we try … to (solve problem).*
- *We need to start with a sturdy base.*

Grocery Store

- ***Let's*** *look at all this stuff.*
- *What do you think we* ***should*** *do* ***first****?*
- *So* ***maybe*** *if we pick our favorites.*
- *We* ***could*** *make a list to* ***start****.*
- *Do you think we* ***should*** *use this?*
- *Can we use that****?***

Book Read

- ***Let's*** *look inside the book.*
- ***Should*** *we see what's in the book?*
- *Want to do this* ***first?***
- *So* ***maybe*** *if we match them up…..*
- *Do you think we* ***should*** *use these?*
- *We* ***could*** *use the ...*

Testing

Utterances in question form that reference testing the requirements: e.g., height, budget

Statement that references testing the requirements and/or outcome of testing

Keywords: *tryout, test,, check, enough, (in)sufficient, (in)adequate, necessary, required, enough*

Reference to Requirements: Bridge *tall enough, strong enough, sturdy enough.* ***Grocery*** *- let's use the calculator to check.*
Reference to a goal: Book *- Let's see if your plants (manipulatives) match the book.*

Note: For book read, all mentions of testing will be about comparing the models to see if they are in the right order/match the information in the book.

- Statements and questions that reference the stated task requirements in the utterance
- This involves use of the ruler to see if the bridge is high enough or the weight and car to see if it is strong/sturdy enough.
- If the adult-child test the requirements but only use implicit terms (for example: let's see), this is sufficient (Let's give it a go.)
- **This also includes statements about the outcome of the test (e.g., It holds the weight!)**

Bridge Building

- *Do we have **enough** blocks?*
- *Now, let's **test** our bridge?*
- *What size does it have to be?*
- *Let's **check** to see if it holds the weight.*
- *It didn't break/fall.*
- *OK, now let's see if it holds the car.*
- *Will it hold it?*
- *You broke it/It broke.*

Grocery Store

- *Do we have **enough** money?*
- *Let's **check/count** to see how much we have left.*
- *How many things have we gotten?*
- *We have X dollars left. How many more things can we buy?*

Book Read

- *Does [the model] look like the book?*
- *Can you show me how a seed grows? [referencing manipulatives]*
- *Can you show me what would happen next to the seed? [referencing manipulatives]*
- *Is this the right order - is this one next?*

Redesigning

This code refers to asking questions or making statements about trying to fix or make changes to something (stating the problem and solution). This *can* occur after testing or without formal testing.

Possible Keywords: solve, solution, problem, challenge, trouble, dilemma, conundrum, work out (as in solve), resolve, fix, mend, repair, better, improve, tweak, enhance, upgrade, make progress

Reference to Improved Requirements: Bridge*: taller, stronger, sturdier, get stronger, get better;* ***Grocery Store****: healthier, cost less;* ***Book Read****: order*

Possible Keywords: so, so that, in order to, results in, because, 'cause/cuz, why, since, cause, effect, reason, if-then, if/then (on their own when used in a causal manner), how do you know, how, make happen, when-then, what if…, in order to

Bridge Building: *Let's make this stronger.* ***Grocery Store***: *Let's try to spend less money.* ***Book Read***: *let's change the order*

- This includes many planning statements WHEN the speaker references a solution (e.g., **if then, fix, improve).**
- If a formal test occurred, then statements to improve the design after that are coded as redesign.

Bridge Building

- Even without a formal test, a speaker can identify a way to redesign the bridge or fix a problem that are coded here because of keywords or because it is implied that their idea is an improvement to the current design (it's better if, we can improve…).
- Addition of enhancements to the bridge at the end of the bridge building process

Book Read

- To count as redesign, parent/child has to reference *changing* something, not just say that something is in the wrong order.

Bridge Building

- *How can they* ***solve*** *this* ***problem****?*
- *Do you think that this will* ***work/fix it****?*
- *We need to make it* ***sturdier*** *so it…*
- *If it wasn't strong enough, is there something we can use to make it* ***stronger****?*
- *We could make it* ***longe****r or we could make it* ***wider****.*
- ***What if we moved the block here…***
- *We need to start with a sturdy base so it won't fall.*
- *We can't do it because…*
- *This is not really a bridge because it is on the ground.*

Grocery Store

- *We need to put something back because we don't have enough money.*
- *What if we got more vegetables instead?*

Book Read

- *Let's change the order of the model.*
- *No, the pieces go like this!*

Math Language

We consulted with experts at Purdue University to develop the Mathematics codes below (e.g., Bryant et al., 2024; Purpura et al., 2017). More than one math language code can be coded for each utterance, except for Numeracy & Operations, which are *mutually exclusive*, with operations overriding numeracy.

Measurement & Size

This code refers to the numerical measurement of size/length/height and weight capacity as well as references to quantity and comparisons between objects.

Spatial Keywords: size, length, gauge, assess, dimensions, scale, inch; *vertical*: tall/er, short/er, height, high/er, low/er; *horizontal*: wide/r, narrow, thick, thin, skinny, fat, deep, shallow, longer; big/er, small/er, little, enormous, huge, giant, gigantic, itty-bitty, tiny, teeny, heavy, light

- Words that reference size or height of an object.
- This can include the comparison of objects relative to one another or a particular measurement
- Discussions comparing the properties of one object to another.
- These references to spatial dimensions can include comparative ending such as –er, –est.
- This can include number statements made while referencing the physical ruler.

Bridge Building

- *Is it three **inches** or **higher**?*
- *It's very strong and it's very **tall**!*
- *Is it **big enough** for the car, or do you think it needs to be **bigger**?*
- *It's a **little too big**.*
- *How can we get our bridge **high off** the table?*
- *What would make it **high**?*
- *We could make it **longer** or we could make it **wider**. ****

Grocery Store (probably rare)

- *This fruit is **bigger** than this vegetable.*

Book Read (probably rare)

- *The plant is so **big** when it's grown!*
- *It's getting **bigger**!*
- *It's so **small** right now.*

Comparison/Ordering Keywords: measure, capacity, more, less, most, a lot, a little, least, greater (than), less (than), least (if mathematical – not the phrase *at least*), more (comparative), strength, strong, sturdy, tough, firm, durable, force, weigh, heavy, light, weak, wobbly, even, too few/much, same number/amount, **in order (book read)**

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- **Ordering/Comparisons of size or amount**
- **Bridge Building**
- If the parent or child hold the ruler, any utterances containing a keyword while measuring are coded as Measure/Size
- Discussion about the capacity of an object or its ability to withstand great force or pressure
- **Book Read**
- Includes references to the order of manipulatives

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Bridge Building

- *Let's use the **same number** of blocks on each side.*
- *We need **less** on this side.*
- *We have to go **from 1, 2, 3 on the ruler**.*
- *Is it **strong** enough?*
- *The car is **too heavy** for the bridge.*

Grocery Store

- *We have **more** fruits than vegetables.*
- *These cost **more** than we can afford.*
- *We only have a **little bit** of money left.*

Book Read

- *The seed needs **a lot of** sunlight/water.*
- ***Most** seeds need water.*
- *Let's put the seeds **in order**.*

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Note 1: "How should we make it bigger?" and other problem-solving questions also code as a Redesign/Change statement.

Note 2: If an utterance contains 2 keywords, assign 1 tally for the utterance ("It is **big** enough or should we make it **bigger**?")

Note 3: Similar to inch, pound/ounce would be coded as measure/size because it is a unit of measurement.

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Numeracy

This code refers to counting a string of numbers, naming the number of objects in a set

Keywords: one; two; three; four; five; six; seven; eight; nine; ten; eleven; twelve; and so on…; how many; how much; count; miscount

Note: Operations overrides numeracy - if the keywords for operations are present, code operations NOT numeracy - no double coding

• Counting: this includes rote counting, counting one-to-one correspondence, or counting numbers in sequential order • Saying a number name	**Across all activities** • ***One, Two, Three, Four****…* • ***Count*** *with me* • *Let's* ***count*** *and see how many we have.* • *Hand me* ***one*** *of those sticks/food items/seed models.* • *We need* ***one*** *red block/dollar/model piece.*
• Cardinality: naming the actual count or number of objects in a set regardless of their arrangement or order • Subitizing: the act of looking at a small set and identifying the number without counting	• ***Two*** *straws/dollars, right?* • *That's* ***three****. (subitizing, not counting)*

Note 1: A counting string (1, 2, 3…) only counts as one utterance/one codeable unit.

Note 2: The pronoun "one" is not a quantity *(eg.: the green one = pronoun).* But, "one" as a modifier of a noun is sufficient to be a quantity: eg.: *hand me one fruit = modifier codeable as Measure/Size/Quantity)*

Note 3: When referencing a number with a measurement, code the number as numeracy as well (two codes).

Operations

This code refers to operations that add or subtract objects/values

Keywords: add, subtract, minus, plus, equals, total, sum, "all together", calculate

Note: Operations trumps numeracy - if the keywords for operations are present, code operations NOT numeracy - no double coding

• Mathematical processes used to solve a problem. Here, operation is defined as a mathematical process *other than counting.* • Note: Operations trumps numeracy.	**Across all activities** • *Let's count the* ***total number*** *of foods* • *We had three straws and we* ***added*** *one more.* • *Let's* ***add*** *one more fruit.* • *Twelve foods* ***equals*** *twelve dollars.* • *How many models do we have* ***left****?*

Shapes & Orientation

This code refers to identifying shape attributes - square, circle, triangle, points, sides, round

2D/3D Shape Keywords: shape, circle, rectangle, square, triangle, circle, oval, diamond, pentagon, hexagon, octagon, parallelogram, quadrilateral, rhombus, polygon ellipse, semicircle; sphere, globe, cone, cylinder, pyramid, cube, rectangular prism; pattern,

Possible keywords: same kind

• References to two- and three-dimensional objects and spaces • References to portions of shapes, such as lines, arcs • Discussion involving description of an object relative to its geometrical shape	**Across all activities (most common in bridge)** • *Let's continue with the **same kind** of block.* • *I made a **triangle**.* • *I'm going to make these little **triangles**.* • *What **shape** does this look like?* • *What does this look like…a **circle** or a **rectangle**?* • *Look, a **square**!* • *How many **sides** are there? (explicit)*

Spatial feature keywords: side, edge, border, line, bend, curve, round, straight, flat, corner, point, bottom, under, over, left, right, near, far, close, between, in-between, base, together, apart, center

Possible Keywords: (on)top, (in)front, (in)back, beneath, below, behind

• References to features and properties of objects • References to these dimensions can include comparative ending such as –er, –est	• *Put another on the **top**.* • *We need to get it **straight in line**.*

Orientation keywords: same, different, opposite, pattern, rotate, flip, turn, upside down, right side up, upright, sideways, backwards, right side up, upside down, across, around

• Description of objects in relation to their shapes orientation in space, including relative orientation or transformation of objects in space	• *What if we **flip** it over?* • ***Turn** the book this way.* • ***Turn** it the other way.*

Note 1: This code only refers to geometrics and do not include references to actual measurements, sizes, heights or weights as these fall under Measure and Size (M/S)

Note 2: The words "on", "up", "down" and "in" are not sufficient to code for Shape/Orientation as standalone words, e.g.: "Put it up" or "Put it down"

Science and Biology Concepts

The science/biology category was designed to capture talk about specific biology concepts related to the science book read (e.g., Living Things, Growth & Change), as well as more abstract science concepts or ideas (i.e., understanding the function of something/what something does) to help extend this category across our three STEM activities. More than one science/biology code can occur in a single utterance.

<table>
<tr><td colspan="2">Function
This code refers to the structure/function/purpose of an object or organism.</td></tr>
<tr><td colspan="2">Keywords: purpose; responsibility; job; role; help; helps to; function; make(s)</td></tr>
<tr><td>• Explicitly references the role or function of a component of an activity - often in the form of an explanation or question</td><td>• What does it do?
• It … [description of what something does or how it works]
Bridge Building
• It will help make the bridge stronger.
• How can we make it taller?
Grocery Store
• Healthy foods make us feel good/grow.
• Let’s use the cash register/calculator to add this up.
Book Read
• What does the water help the plant do?
• The role (job) of the sun is to….
• The roots get food for the plants.</td></tr>
</table>

Growth & Change

This code refers to changes that occur either over time or as something/someone grows.

Keywords: grow; change; become a [blank]; gonna get X (not gonna be); build
Note: Growth and change can be double coded with Living Things.

• References change or transformation due to natural or physical processes	**Bridge Building** • *We **built** a very long bridge.* • *Our bridge was short, but now it is tall.* • *Now our bridge can hold the car.* **Grocery Store** • *Healthy food helps you **grow.*** • *It's **gonna** melt / **gonna get** melty* **Note**: does not include talk about math-related talk such as the number of items in the basket, the amount of money left, or making change **Book Read** • *Now the seed grew up!* • *The plant is **growing** because it got enough water/sun.* • *We **grow** plants/seeds.*

Living Things

This code refers to characteristics of living things or what something needs to live.

Keywords: need(s)

Possible Keywords: sun, water, seed, soil, rain, alive, living, healthy, allergies, hunger, thirst

Note: Living Things can be double coded with Growth & Change.

• References to characteristics of living things or characteristics of the environment that support life (*what living things need*) • References to caring for living things (including caring for your body) • References to living vs. non-living things • **Note**: will occur most often in the book read	**Grocery Store** • *We need to eat vegetables to help our bodies.* • *You can't eat that because you're **allergic**.* • *I'm **hungry** so I'll eat it all up.* • *But what if we get **thirsty**?* **Book Read** • *The plant **needs sun** and **soil**.* • *It's going to **need water**.* • *The plant gets **thirsty** just like you.* • *The plant **needs sun**.* • *Why does the plant need sun?* • *The plant needs food from the roots. (need)* • *Flower plants have roots and green stems. (characteristics)*

Other Science

This code refers to other science references not captured above (i.e., concepts beyond biology).

Keywords: force, speed, temperature - hot/cold

• References to physical or chemical processes (including cooking) • [might be rare]	**Bridge Building** • *We need to make sure the bridge is tall enough so the car can get enough **speed**.* **Grocery Store** • *If we combine X and Y, we can make a cake!* **Book Read** • *If the ground gets too cold, it might freeze.*

General Language Codes

General language codes will co-occur with the STEM content codes. However, within the utterance types code, this is a mutually exclusive and exhaustive code. That is, each utterance can be only one utterance type. The question types of utterances are of particular interest in caregiver-child discourse and are further coded with the subsequent Question codes detailed below. One-word utterances do not receive general language codes.

Utterance Type

Note: Utterance type codes are mutually exclusive and exhaustive - each utterance will have exactly one utterance type code and they will not co-occur. **One-word utterances will not receive an utterance type code.**

• **Comment**: Declarative sentence (also include exclamatory sentences in this category) • **Directive**: Imperative sentence • **Question**: Interrogative sentence (e.g., What comes next?) • ***Note***: Question utterances will be coded according to subcategories - see below.	**Comment** • *That's a big piece!* • *The plant grew a lot.* **Directive [present focused]** • *You gotta put this in your basket.* • *Put this here.* • *Let's do this next.* **Question - see subcategory codes** • *What should we do next?* • *What do I do with this?*

Question Codes

All questions must be assigned to one of five question categories:

1.) Yes/No Questions/Fill-in-the-Blank Prompts/Auxiliary Verb Questions [closed]
2.) Wh-questions [open]
3.) Why questions [open]
4.) How much/how many questions [open]
5.) How procedural questions [open]

All questions will also be categorized as closed or open according to the color-coding above. Closed questions restrict children's range of possible answers, while open questions typically encourage more elaborative responses.

Closed Questions

Yes/No Questions & Fill-in the Blank Prompts

Questions that can be answered with "yes" or "no" as well as questions that can be asked with a single word or a name/one word question between two children. This includes closed and auxiliary verb questions.

Keywords: Have (Has, Had, Having), Can (Could), Do (Does, Did), Will (Would), all "To Be" forms (Am, Is, Are, Was, Were, Being, Been, etc.), May, Might, Must, Need, Shall, Should

Possible keyword: Dare (Dare you…?)

• **Auxiliary verbs are helper verbs**. Moving these to the front of a sentence turns it into a question. • In English, polar interrogatives (yes/no questions) are formed by fronting an auxiliary, and adding a dummy auxiliary "do" if the main verb is not an auxiliary (*The dog is running > Is the dog running?; He wants to eat > Does he want to eat?)* • The response to these questions is usually yes/no. • Auxiliary verbs are often at the front of the question (*Will he feel sad?*), but not always (*If you take that from Diego, will he be sad?*).	• *Do you like it?* • *Will he go?* • *Have you been to the jungle before?* • *Can you find the letter B?* • *May I have another?* • *Would you like a turn?* • *If a plant doesn't get enough water, what will happen?* • *<u>Do you think</u> [the sprout] will flower or grow more leaves?* • *When it rains, <u>do you think</u> the seed will grow?*
• Other questions that are slightly **more informal** ways of asking a yes/no question than the auxiliary-verb question format (*See that? You think he's cool?*) • Listen for a **rise in intonation** to infer that these utterances are questions. • **Either/or, forced-choice questions** are designed to elicit a simple response so they are also coded as Yes/No Q	• *Do you see that?* • *You like it?* • *Want a red or blue crayon?*

Completion prompts/Cloze

Implicit prompt for child to fill in a word/phrase that is not part of the text, using a cloze technique/rising intonation prompt.

• This elicitation form is when the adult pauses to allow the child to complete the sentence or a phrase/word/part of a word. • This includes rising intonation at the end of the adult utterance to indicate to the child it is their turn to fill in the missing word. • Even if the child does not respond to the prompt appropriately by filling in the missing word, you can still code the adult's attempt to use this strategy.	*A: This is a…* *A: The plant is growing a le…. (a leaf).* *A: It's r…. (red). (Cloze used to scaffold/hint* *2 + 2 makes…?*

Note 1: The **explicit grammatical wording question** codes (Auxiliary, Wh- Q, Why Q, How Q) trump the less precise question types (Turn-Taking Q, Yes/No), but they are still coded as the same.

Note 2: Directives are not coded as questions: eg.: *"tell me, show me*"

Tag questions are not coded as questions. Questions tagged onto the end of a declarative sentence are typically rhetorical questions or are seeking a simple affirmation.

This is a list of most tag question forms:	
X, hasn't he? *X, didn't he?* *X, isn't he?* *X, doesn't it?* *X, won't he?* *X, shouldn't he?* *X, can't he?* *X, okay?* *X, right?* *.X, remember?* *X, is she?*	*Do X, will you?* *Oh, I'm X, am I?* *Oh, you do, do you?* *X, won't you?* *X, is it?* *X, aren't I?* *X, aren't you?* *X, shall we?* *X, huh?* *X, maybe?* *X, do you see/ ya see?*

Open Questions

Wh- Questions

Wh- basic question + interrogative sentence form.

Keywords: Who, what, when, where, which

• Wh- questions start with *or* contain one question word and are phrased as a question to elicit a response. • Interrogative sentences are used in asking questions and are designed to elicit a response. • You may code a question that contains a Wh- word in a position other than the initial position - *He has a long what*?	• *What happened?* • *Where is the seed growing?* • *Who is this?* • *Which one is…?* • *This is a what?* • *You want to see who?* • *And he did what?* • *What did you say?*

Note: Do not code "why" questions here - those are coded elsewhere because they tend to elicit a more elaborate response. "you know what!" is a statement not a question.

Why Questions

Why + interrogative sentence form.

• **Why** interrogative sentences are used in asking a question and must include the word "why."	• *Why are they ___?* • *Why do you think that?* • *She did that, why?* • *Why did it fall?*

How Many/How Much Questions

How + interrogative sentence form, and will always address quantity.

• **How** interrogative sentences are used in asking a question and must include the word "how." • Questions pertaining to the quantity of something and contain the phrases, "How many" or "How much".	• *How **much** is that?* • *How **much** do we owe?* • *How **much** money do we have?* • *How **many** do we have?* • *How **many** are there?*

How Procedural Questions or

How do you feel/emotion questions

How + interrogative sentence form, and address steps/series of events, how they unfold and how they make you feel.

- **How** interrogative sentences are used in asking a question and must include the word "how."
- Emotions: questions pertaining to feeling/emotion
- Procedures: questions about how to complete an action

- *How does this compare to ___?*
- *How do we make a bridge?*
- *How do you know?*
- *How do you feel about this?*
- *How can we fix it?*

Note: If there are **two question words embedded in a sentence** (*When she doesn't share, how does he feel?* = How Feeling Q), coders should ignore the subordinate/dependent clause and **code the main/independent clause.**

Coder Training & Reliability Procedures

To be a reliable coder, coders should complete steps provided by their project supervisor. We provide general tips below. However, team leaders are responsible for creating more detailed step-by-step procedures to ensure that coders will be able to analyze complex behavioral data reliably.

Coding Forms: The lead coder/project supervisor and other investigators are responsible for deciding which codes to keep, revise, or remove from this original manual. Then, teams add additional codes to fit their projects. For example, we often add task specific codes to indicate whether the child/caregiver achieved success in a particular task (e.g., did they build a bridge that met the specifications for height). The final set of codes are then converted to a coding form or spreadsheet where each utterance (row) can be classified as present or absent (columns).

- Initial transcription is the easiest way to code behavioral data. We recommend you consult other sources for learning to transcribe utterances reliably.
- If you are not transcribing, a paper form or other online data entry will allow you to count the relevant utterances. However, you likely need to reduce the number of codes to reliably code without a transcript.

Coding Group Training: The lead coder/project supervisor and other investigators are responsible for preparing slides, videos or other appropriate materials to help all coders learn to recognize the codes in action.

Know the Codes*:* Carefully **read the manual**, make note of your questions, and attend group trainings.
Learner objective – Knowledge: Coders should be able to name codes at this stage.
Practice Describing Codes: Review the **training slides** and the **training transcripts/videos** during a group training. (1 group transcript coding)
Learner objective – Comprehension: Coders should be able to describe and define codes at this stage; ask the lead coder/Principal Investigator questions to improve conceptual understanding.
Practice Classifying Behaviors: **Practice coding** adult/child behaviors and classifying them with the correct code using practice videos with a reliable coder/supervisor (i.e., 1 independent practice video)
Learner objective – Application: Coders should be able to distinguish codeable adult/child behaviors and classify them accurately in practice coding materials. This is a key stage to discuss any misconceptions or errors before attempting reliability coding.

Apply Codes Accurately: Complete coding for a series of **reliability videos** #1-#4 that have already been coded by your leader coder/master coder. Submit each one to the coding supervisor for feedback before coding the next video.
Learner objective - Analyze: Coders should be able to distinguish codes with an average agreement level across all items that is $\geq$ 85%. If coders are unreliable they should review manuals training materials and ask questions; then complete additional reliability videos #5 and #6 until each coder has three videos that meet this reliability threshold.

Code! Code! Code!: When coders have met this reliability criteria they are released to **code real data independently**. Most coders are required to code between 5-10 videos per week but coding assignments will be determined by the lead coder.
Coder objective – Analyze Data: Coders should focus on both accuracy and efficiently meeting their weekly coding goals.

Coding procedures:

- Coders log what data they are coding in the team's tracking sheet.
- Coders keep this manual with them for reference during coding.
- Coders participate in regular coding team meetings and/or review written communication about coding updates/clarifications.
- Ask the lead coder about any complex or unfamiliar utterances. There will be behaviors coders are unsure how to code and these must be taken up the chain to ensure a consistent decision is made and communicated to the team.

Monitor Coding Accuracy: Coders must meet drift check reliability standards. You will be blindly assigned quiz videos every 6 weeks. If you do not demonstrate reliability of >80% on these videos you must stop coding and begin a retraining process.

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Appendix

Identifying Utterances in Spoken Language

For this coding scheme, all extra-textual talk is coded at the utterance level. Since an utterance is the unit of analysis, coders must be able to segment speech into utterances. The formal definition of *an utterance is "an independent clause with its modifiers."* This includes one main clause with all subordinate clauses associated with it. You cannot further break an utterance without changing its essential meaning.

Identifying Speakers

The coder must identify which speaker the utterance should be ascribed to – there are three possible types of speakers you will hear in shared reading sessions:

A: Adult – this talk is further coded, unless reading the text itself.

C: Child – this talk is further coded.

Cs: Multiple children talking at the same time – only the target child's talk is coded.

Identifying Utterances

A spoken utterance typically represents a single written sentence. Some sentences may be quite short; others may be longer. If there is a three second pause consider it a new utterance. Procedural utterances based on the child's actions are considered separate utterances. Grammatically speaking, utterances may contain one or more clauses. Main clauses can be stand-alone and can be segmented as one single utterance. Subordinate clauses DEPEND on the main clause to make logical sense; thus, the subordinate clauses are not separated from the main clause.

***Examples*: Main clauses are bold**; subordinate clauses are underlined in the following examples.

A: **What is happening on this page** where he's yelling?

C: **He's kicking his legs** cuz he doesn't want a bath!

A: When you told him it was bath time **he saw** that the duckie was missing.

Utterances may contain *one* coordinating conjunctions that links together two main clauses within a single utterance. Common coordinating conjunctions include *and, but, so* (but not "so that"), or, *and then, then*. The SABR allows one coordinating conjunction per utterance.

***Examples*: Main clauses are bold;** coordinating conjunctions are underlined in these examples.

A: **They're having a problem in this picture** and **I think that's because they're so angry**.

C: **He is not angry anymore,** but **she doesn't know that**.

Talk by one speaker that includes several different topics can be contained in one utterance or two.	A simple utterance: **That's a watermelon**. A complex utterance: **You are going to put the watermelon back** if we don't have enough money. A complex utterance: Ok, Simon, **let's see what happens to the seed next** as we leave the seed life cycle here.
Talk with noticeable pauses or changes in intonation indicates an utterance break.	A: utterance 1: This book is about… (pauses and looks around the room). A: utterance 2: I think this book is about seeds. A: question utterance 3: Do you think this book is seeds? (Rising intonation signals end of utterance)
When a speaker has a **false start, this counts as one utterance**.	False starts are unnecessary repetitions or instantaneous revision of words in a speaker's sentence. Ignore false starts and do not code them. Point to the, point to the plant that you think comes next. What is … How do you know that those are the eggplant seeds?

Incomplete sentences may be coded if there is codeable content.	C: Bacon C: I want the bacon cuz… (Interruption) C: Look at the blocks.
Procedural Utterances With a break	A: What did you buy from here? C: *picks up item* A: tomato C: *picks up item* A: and lettuce