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# The Interview Project: A Way of Bridging Theory and Practice in Early Childhood Mathematics Preservice Teacher Education

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# The Interview Project: A Way of Bridging Theory and Practice in Early Childhood Mathematics Preservice Teacher Education

**Abstract**

Twenty-nine early childhood preservice teachers (PSTs) participated in an Interview Project. The project's goals were for the PSTs to apply their knowledge of research on children's mathematics in their interactions with a child and to learn to listen to and learn from children. The purpose of the study was to evaluate the project and determine whether it met these goals. Pre and post data were collected, and I found that the PSTs showed a significant improvement in their ability to describe and analyze a child's mathematics and to use their listening to make appropriate instructional decisions. In addition, I found that the PSTs were rethinking their definitions of teaching and learning mathematics.

**Keywords**

Preservice Teachers, Mathematics, MATH 2008, Elementary, Children's Mathematics, Constructivism, Field Experience

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Since the 1980s, reformers have sought to improve what students get out of school by advocating for changes in the standards, in the assessment, and in the curriculum (Ball & Cohen, 1999). In response to this reform, teacher education programs face the challenge of improving preservice teachers' (PSTs') conceptual understanding of the subject matter and their abilities to examine students' mathematical thinking in a deeper and more complex way. "Changing teacher preparation to more fully engage core practices and pedagogies of enactment requires a significant shift in the practice of teacher education" (Grossman & McDonald, 2008, p.191). Crockett (2002) found that analyzing student thinking was the most powerful activity to lead teachers to reconsider the teaching and learning of mathematics.

As the instructor of the first mathematics content course in a series of three for early childhood majors, I felt it was important to incorporate an experience where the PSTs would use relevant research to describe and analyze a child's mathematical thinking. Although this is a content course, I wanted to integrate pedagogical experiences specific to the content, especially because the PSTs in our program do not take a mathematics specific methods course. The Interview Project is a course assignment where PSTs are required to describe and analyze a child's mathematical thinking using the frameworks introduced in the course and apply their analysis to inform their instructional decisions. The content focus of the interview is additive structured story problems. From the Interview

Project, I want the PSTs to see how capable children are of learning mathematics and solving problems so that they will learn to respect children's mathematical thinking even when they do not understand it.

There are two main goals of the Interview Project. One of the goals is for the PSTs to develop knowledge of the frameworks around additive structured story problems and for them to apply these frameworks in real time and retrospectively while teaching children. To meet the expectations of this goal, the PSTs need to use the provided frameworks (Appendix B) to describe and to analyze a child's mathematics. The second main goal of The Interview Project is for the PSTs to develop the ability to listen to and learn from children's mathematical thinking. "Clearly, the act of unpacking learners' mathematics requires listening to students" (D'Ambrosio, 2004, p. 139).

## Research Questions

For this study, I wanted to evaluate the extent to which PSTs were able to apply the frameworks they learned in class to the Interview Project. To do this, I was guided by the following research questions:

1) To what extent does the Interview Project increase PSTs' knowledge of the research and their ability to apply them in their interactions with a child?

2) To what extent does the Interview Project help PSTs learn to listen to and learn from children?

## Literature Review

### Skills Needed to Enhance the Interview Project

There are many skills that are needed in order to interview a child and describe and analyze his/her mathematical thinking. The skills that I have chosen to focus on with respect to the Interview Project are listening, choosing appropriate tasks, and reflecting on their experience.

**Listening**. A necessary part of describing and analyzing a child's mathematical thinking through an interview is listening. Davis identified three types of listening in which teachers could be engaged in; he also acknowledged that listening cannot be reduced to a set of skills and guidelines. The three types of listening identified by Davis are evaluative listening, interpretive listening, and hermeneutic listening. Evaluative listening is characterized by "listening for something in particular rather than listening to the speaker" (Davis, 1997, p. 359). The purpose for listening is to assess the correctness of a response. Interpretive listening is more information seeking. A teacher listening interpretively is working to understand how her students are making sense in order to to help them get to the "right understanding". When a teacher is listening hermeneutically, she is more readily able to learn mathematics from her students. Students' responses and ideas tend to direct the enacted lesson. Davis (1996) suggested that while you cannot observe listening occur, you can infer how a teacher is listening through how s/he responds to students. You can also infer how a teacher is

listening by what s/he is listening for and what s/he chooses to ignore.

**Choosing Appropriate Tasks**. Based on their current interpretations of the child's mathematical knowledge, the PST had to "make decisions concerning situations to create, critical questions to ask, and the types of learning to encourage" (Steffe, 2002, p. 177). Possible tasks can be determined by a teacher in part with respect to a children's zone of proximal development (ZPD) (Vygotsky, 1956).

> The zone of proximal development for a child is the distance between her actual development level as determined by independent problem solving and her level of potential development as determined through problem solving under the guidance or in collaboration with more capable peers (Vygotsky, 1978, p. 86)

From a constructivist's view, a ZPD relative to a child's specific scheme is determined by the modifications of the scheme the child might make during or as a result of his interaction with the teacher. This perspective obliges the teacher to consider differences among students' conceptions. The teacher must decenter and assume the mathematical viewpoint of the child (Steffe, 1991). As the child engages in the task, the teacher's model can be modified as a response to the new observations.

**Frameworks Needed to Describe and Analyze a Child's Mathematics**

There are several frameworks that I used in order to give the PSTs this

necessary knowledge.

**Framework #1: Additive Structured Story Problems.** The Cognitively Guided Instruction (CGI) framework provided a way of classifying story problems. This framework defines four structures of additive story problems, join, separate, part-part-whole, and compare. The context of the story can vary, as can the number size and the placement of the unknown, but the basic structure remains the same. A join problem involves a "direct or implied action in which a set is increased by a particular amount" (Carpenter, 1999, p. 7). A separate problem also involves an action, but with a separate problem, the initial quantity is decreased rather than increased. Another type of additive problem is the part-part-whole problem. This type of problem does not involve a direct or implied action; it involves two mutually exclusive subsets of a whole set. The last problem type identified by the CGI researchers is the compare problem. A compare problem is one where two distinct, disjoint sets are compared to one another. The difference, or the amount that one set exceeds the other, is the third quantity in the compare problem.

**Framework #2: Solution Methods.** In addition to providing a way to classify story problems, the CGI group (1999) also named several solution strategies that are common for children to use when solving these types of stories.

*Methods for solving addition.* If the solution to the problem is computed through addition, the common solution methods are to use direct modelling,

counting all, counting on, or using a number fact. *Direct modelling* is the most basic strategy, where children "use physical objects or fingers to directly model the action or relationships described in each problem" (Carpenter, 1999, p. 15). Over time, children's strategies become more abstract and efficient, and they replace direct modelling with counting strategies. The *count all* strategy is one where the child counts out each number that he is adding and also counts out the result. Let us use the problem 4+7 as an example. To solve this problem using a *count all* strategy, a child would count the first 4, "1, 2, 3, 4, ", then count the 7 "1, 2, 3, 4, 5, 6, 7"; then the child would put them together and count the total, "1, 2, 3, 4, 5, 6, 7, 8, 9, 11…11."

A more advanced counting strategy is called the *count on* strategy. Using the *count on* strategy, a child would begin counting from one of the addends and then stop counting when the number of steps that represents the other addend has been completed. For example, to solve 4+7, a child might say, "4 [pause], 5, 6, 7, 8, 9, 10, 11…11."

As children learn number facts and number combinations, they can use this knowledge to solve story problems as well. Using known number facts and decomposing numbers into their different combinations in order to help solve an additive problem is what Steffe (1982) calls strategic additive learning. For example, to solve 4+7, a child might say, "4 plus 4 is 8 and 3 more is 11." In this example, the child decomposed 7 into 4+3 because combining 4 and 4 first was

easier than adding 7. Doubles are one common strategy used for strategic additive reasoning. Van de Walle (2010) lists doubles, one more than, two more than, combinations of 10, making a 10, using 5 as an anchor, and near doubles as popular strategies that children use when strategically reasoning.

*Methods for solving subtraction.* If the solution to the problem is computed through subtraction, then the common solution methods are direct modelling, counting all, counting down, counting down to, counting off, counting on to, or using a number fact. The *direct modelling* strategy, the *count all* strategy, and the *number facts* strategy have all been described in the previous section, and the same descriptions apply to subtraction.

The *counting down* strategy is a backward counting sequence that starts with minuend and stops counting when the number of steps that represents the subtrahend has been completed. Let us use the problem 9-6 to illustrate. Using the *count down* strategy, the child would say, "9 [pause], 8, 7, 6, 5, 4, 3…3." The *count down to* strategy is different in that the backward counting sequence stops when it reaches the number indicated by the subtrahend. Thus, the solution would be found by counting the number of steps taken to get from the minuend to the subtrahend. To solve the story problem above, a child might say, "9 [pause], 8, 7, 6…so, 3." Typically, the child monitors the number of steps with his fingers, with an action, or mentally.

Another strategy that children use to compute subtraction is the *count off*

strategy. This strategy is slightly different than the *count down* strategy in that the child does not count the number of steps; rather, the child counts the number of number words he is striking off. Thus, the solution is the number word that comes after the last stricken number word. For example, a child might say, "9, 8, 7, 6, 5, 4…3." The numbers 9, 8, 7, 6, 5, 4 were stricken off and the child counted 6 stricken numbers words.

The *count on to* strategy is a forward counting sequence that begins with the subtrahend and continues until the minuend is reached. The answer is the number of steps taken to get from the subtrahend to the minuend. If a child used the *count on to* strategy to solve the story above, he would say, "6, 7, 8, 9…so, 3."

**Framework #3: Levels of Whole Number Development.** In order to analyze the children's thinking based on their responses to the tasks, the PSTs learned the framworks on Gelman and Gallistel (1986) and Steffe et al. (1983).

*Counting principles.* The construction of a number sequence is preceded by the basic activity of counting. Gelman and Gallistel (1986) identified five principles that govern and define counting. The first is the stable order principle, stating that you need to know the counting words and be able to recite them in the correct order each time. The second principle is the one-to-one principle. One, and only one, number word has to be matched to each and every object. The third principle is the cardinality principle. When correctly following the first two principles, the number name allocated to the last object tells how many objects

you have counted. The fourth principle is the principle of abstraction. You can count anything – visible objects, objects of different shapes and sizes, things that are too far away to touch, sounds, etc. The last of Gellman and Gallistel's principles is the principle of order irrelevance. Objects may be counted in any order provided no other counting principle is violated. Children in the pre-numerical stage are sorting through and learning these counting principles based on their experiences with counting.

*Pre-numerical stages.* There are two counting stages identified by Steffe, von Glasersfeld, Richards, and Cobb (1983) as pre-numerical. The first is the perceptual counting stage. Children in this stage require the collection of countable items to be in their perceptual field. In the next stage, the figurative stage, children can count items that are not in their immediate perceptual field. This development means that the child can re-present an image of the countable items and count these images. Many children in the figurative stage will use sensory-motor items, such as fingers or taps, to stand in for the imagined objects.

*Initial number sequence.* The figurative counter will begin to develop the ability to unitize. Unitizing is the ability to re-present the countable objects, focusing attention on each individual item, making you explicitly aware of the number of counted items. He begins "to internalize their counting acts, and eventually interiorize the results of those counting acts" (Olive, 2001, p. 5-6). For example, the number word "four" represents the counting sequence "1, 2, 3, 4."

Steffe calls this a numerical composite. When a child has established numerical composites, he is in the numerical stage that Steffe calls the Initial Number Sequence (INS). A child with the INS could use the *count on* method to solve 6+3. Because a child with the INS has a numerical composite for "six", he knows that the word "six" refers to the counting activity of "1, 2, 3, 4, 5, 6" without actually carrying out the counting activity. Thus, he does not need to count the initial six.

*Tacitly nested number sequence.* When a child with the INS has shown the ability to "reinteriorize counting acts", it is possible that he will unite the records of counting into a composite unit. This essentially means that the child is aware that a collection of items can be considered one thing, a composite whole. With this new development, the child's monitoring ability has progressed. Putting up fingers has changed from the INS where fingers were the countable items to now putting up fingers serving as a record of a counting act as well as a countable item. This ability places the child in the Tacitly Nested Number Sequence (TNS).

*Explicitly nested number sequence.* There are several main elements that are crucial to make the leap from the TNS to the Explicitly Nested Number Sequence (ENS). One important element of the ENS is the ability to disembed. Disembedding is "a conceptual act that takes elements out of a given composite unit and uses them to make a new composite unit, but the elements that are taken

out of the composite unit are left in the composite unit" (Steffe, 2003, p. 243). Essentially, the child can take the composite unit from the whole-number sequence without destroying the sequence. Another element of the ENS is the recognition that a number can be constructed from iterable units of "1". That is, a child sees the number 5 as 1 five times as well as the counting act of "1, 2, 3, 4, 5." The ability to see iterable units of 1 gives the child the capability of disembedding any number of 1s from the composite unit without destroying the unit. For example, the number 15 can be seen as one unit containing the first ten items, and another unit containing the remaining items of the sequence. This advancement gives the child the ability to use strategic reasoning.

The complexity of a child's mathematics is astounding. The stages that I described provide a framework for teachers to better understand their students' construction of number. With this, teachers may be able to listen to their students, and shape their instruction around the students' mathematics. They can give students opportunities to make vertical progress in the construction of their number sequence.

## Methodology

I conducted an evaluative study documenting the overall effects of the Interview Project, a project where PSTs engaged in an interview with a child during their first mathematics content course for the early childhood teacher education program. My goal was to determine whether or not the Interview

Project was an effective way of helping PSTs learn to describe a child's mathematics, analyze a child's mathematics, and make appropriate instructional decisions based on the actions of the child.

**Participants**

The participants in my study were 29 preservice early childhood teachers at Georgia College enrolled in my section of the course Math 2008 in the spring semester of 2014. The pre and post Interview Project data were collected from all 29 PSTs individually, while the observation and interview data were collected from a subset of seven pairs of PSTs.

**Data Collection**

Data collection consisted of class products, observations, and interviews with a subset of the PSTs. Some data were collected at the beginning of the semester, when no classroom discussions had influenced the PSTs' knowledge, and then more data were collected after the Interview Project had been completed to determine any changes that occurred. All discussions and activities in the Math 2008 course that took place between the first day of class and the assignment of the Interview Project were focused on the frameworks needed to successfully participate in the Interview Project. Thus, the changes that occurred could be contributed to both the PSTs' knowledge of the frameworks and their participation in the Interview Project.


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**Class Products.** Because I was the instructor of the Math 2008 course, I had the unique opportunity to collect data through class products. To do a pre-Interview Project assessment, I implemented five tasks (Appendix C) that were specifically designed to help assess the PSTs' knowledge of the frameworks used in the class. Specifically, the tasks assessed the PSTs' knowledge of additive structured story problems, solution methods, levels of development, relative problem difficulty, and their ability to make appropriate instructional decisions.

The Interview Project was assigned around midterm of the semester, allowing for enough class time to be dedicated to discussions of the frameworks of Cognitively Guided Instruction, Gelman, Steffe et al., Van de Walle, and others. The PSTs were given a description of the project and a rubric (see Appendix A), indicating the expectations for the assignment. It was suggested that they work in pairs, allowing one PST to interview and question, freeing the other PST to take field notes on the child's responses, quoting when possible. The pairs then wrote a summary of their interview, describing the types of story problems that they asked, the solution methods that the child used, their analysis of the child's actions, and a reflection on their experience and how it affected their current and future instructional decisions. This summary was the main source of my post-Interview Project data.

**Observations**. Because I was interested in the instructional decisions that the PSTs constructed and how these models informed their instructional

decisions, I needed to study their interactions with the child. Thus, I observed a subset of the PSTs' interviews with the child and took field notes, which included the PSTs' progression of tasks, the strategies used by the child, and instructional decisions that the PSTs made. I also audiotaped the observed PSTs' interview sessions for retrospective analysis. The subset consisted of seven pairs of PSTs.

**Interviews**. To triangulate the data, I conducted interviews with the PSTs that I observed. Interviews are believed to provide a 'deeper' understanding of social phenomena than would be obtained from purely quantitative methods, such as questionnaires or surveys" (Gill et al., 2008, p. 292). Thus, interviews served as a way to validate the data collected by the class products and observations. I interviewed the seven pairs of PSTs that I observed immediately after their session with the child as well as after the Interview Project was completed and the written report was submitted. The responses that the PSTs gave during their session interview and their final interview (See Appendix E) helped me to confirm or disconfirm the data from the written reports and observations.

## Data Analysis

### Pre-Interview Project

To assess whether or not the PSTs could describe a child's mathematics, I used Tasks 1 and 2, and to assess their analysis of the child's mathematics, I used Tasks 3 and 4. I was also looking for evidence that the PSTs could make instructional decisions based on the child's responses to whole number additive

story problems in Tasks 4 and 5. In order to assess these tasks, I used the rubric in Appendix D.

**Post-Interview Project**

Once the Interview Project was assigned, I began my post-Interview Project data analysis. This data consisted of class products, observations, and the PST interviews. When analyzing the written report, I looked for instances where the PSTs described the child's mathematics, analyzed the child's mathematics, and made instructional decisions (Rubric in Appendix A). I also used my observations and field notes to add depth and detail to the analysis. Figure 1 below shows the overview of the Interview Project's goals and the data that I analyzed in order to evaluate the project.

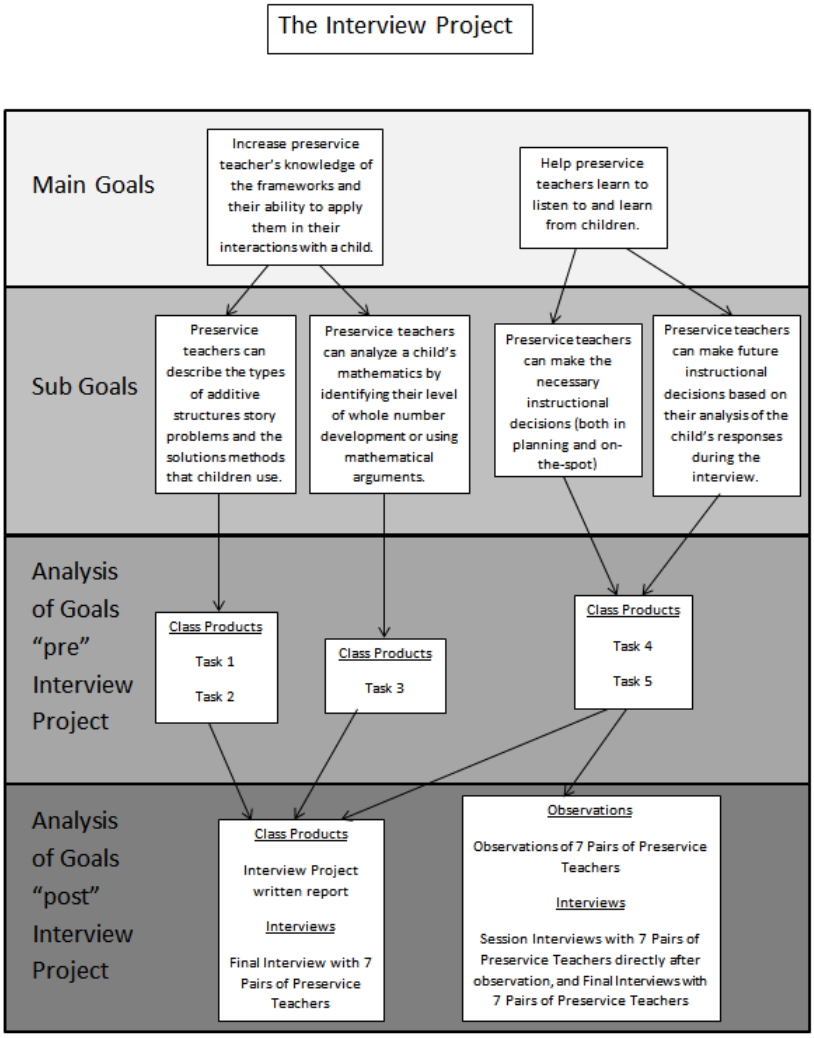


*Figure 1.* The Interview Project's goals and how they were analyzed.

## Findings

### PSTs' Knowledge and Application of the Research

The first main goal of the Interview Project was to increase the PSTs' knowledge of the research and to apply this research in a real life teaching

scenario. In the Math 2008 class, the PSTs were presented the language of Gelman (1986), Cognitively Guided Instruction (1999), Van de Walle (2010), and Steffe et. al. (1982) throughout the first four weeks of the semester (Appendix F). Therefore, it is not surprising that the PSTs' use of this language increased.

**Description of Child's Mathematics.** The description process is the first step that is essential in later analyzing the child's mathematics. The results of the pre and post assessments for the PSTs' abilities to describe a child's mathematical thinking are presented in Table 1.

Table 1

*Overall Pre and Post Assessment Scores for Describing a Child's Mathematical Thinking*

| | Average of Pre-Assessment | Average of Post-Assessment | Percentage Increase | t-score | Significance Level |
|---|---|---|---|---|---|
| Description of Child's Mathematical Thinking | 0.4267241 | 1.6896552 | 295.9596% | 20.407 | $\alpha<0.0005$ |

Overall, the PSTs showed a significant improvement in their abilities to use the frameworks from class to describe a child's mathematics. In a typical excerpt from the written reports, one pair of PSTs wrote,

> The first story problem we asked Josh was a join-result unknown problem with small numbers because we wanted to start with a simple problem.

> We asked him, "Emily has 7 Skittles. Ali gave her 5 more Skittles. How many Skittles does Emily have in all?" After a few minutes of silence, I asked him if he wanted to use the blocks that were sitting on his table. He nodded and then counted out 7 blocks then counted 5 more blocks and slid them across the table. Then, Josh counted all of the blocks, and said, "12." Josh used the blocks to directly model the problem and he used the count all method because he counted out each number in the problem and he counted out the result.

This pair of PSTs used the language of CGI to describe the structure of the story problem as a join result unknown and to describe the method that the child used to solve the problem as direct modelling and counting all.

Another typical response when describing a child's mathematical actions was

> We asked Ryan, "Caleb has 6 apples and 7 pears. How much fruit does Caleb have altogether?" This problem is a part-part-whole problem with the whole unknown. Ryan used strategic additive reasoning with the "using a double" strategy. He said, "6 and 6 is 12, then plus one more is 13." He is using strategic reasoning.

These PSTs used the language of CGI to describe the structure of the story problem, and they used the language from Van de Walle to describe his strategy as the "using a double" strategy. In addition, the PSTs recognized that the "using


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a double" strategy is one form of what Steffe et.al. call strategic additive reasoning.

Using the language from the CGI, Van de Walle, and Steffe frameworks was a necessary first step in the PSTs' constructions of the students' mathematical thinking. Subsequently, they could use their descriptions of their children's mathematics in order to provide evidence for their analyses.

**Analysis of Child's Mathematics.** All of the PSTs were able to use their descriptions to assess the level at which the child was operating according to the frameworks and make inferences about the child's mathematical development. The results of the pre and post assessments to determine the PSTs' abilities to analyze a child's mathematics are presented in Table 2.

Table 2

*Overall Pre and Post Assessment Scores for Analyzing a Child's Mathematical Thinking*

| | Average of Pre-Assessment | Average of Post-Assessment | Percentage Increase | t-score | Significance Level |
|---|---|---|---|---|---|
| Analysis of Child's Mathematical Thinking | 0.16379310 | 1.8275862 | 1015.7895% | 46.614 | $\alpha<0.0005$ |

These overall scores show a statistically significant improvement in the PSTs' abilities to analyze a child's mathematics using the frameworks from class. In a typical response, one pair of PSTs wrote in their written report,

> We asked, "Meredith has 9 fish. Joey gives her 3 more fish. How many fish does Meredith have altogether?" This was a join-result unknown problem. She wrote down 9+3 and got the answer 12. We asked her how she solved the problem and she told us that she counted on her fingers and showed us how she did it. She said, "9…10, 11, 12." Because she used the count on strategy, we found that Sara was on the INS level. This indicated that she was definitely numerical, which was a new revelation. On all of the previous questions, she used the blocks. Being on this level indicates that she knew how to unitize. Sara understood that the number 9 represents 9 items. She didn't have to count to 9; instead, she could just start at 9.

After describing the story problem type and the method that the child used to solve the problem, this pair of PSTs identified this child to have her INS, which is language from Steffe et. al. In addition to identifying the level, the PSTs described what this indicates about the child's development. They used language such as numerical and unitize, which is language Steffe et. al. use to describe the levels of whole number development.

Another typical example of a pair of PSTs analyzing a child's mathematical thinking is

> We asked Lucy, "Hannah has 4 more marbles than Max. Max has 18 marbles. How many marbles does Hannah have?" In this problem, Lucy

used strategic additive reasoning. She solved by saying that 18 and 2 is 20 and two more is 22. This shows that Lucy is on the ENS level because she used derived facts. We made sense of her line of reasoning here:

| | |
|---|---|
| 18 + 4 | |
| = 18 + (2 + 2) | decomposed 4 |
| = (18 + 2) + 2 | associative property |
| = 20 + 2 | addition |
| = 22 | addition |

The PSTs were able to precisely describe what the child did to solve the problem; they were able to name this strategy as strategic reasoning and connect this strategy to Steffe's ENS. They were also able to write a series of equations and name the mathematical properties in order to analyze the validity of the child's strategic reasoning.

The frameworks of Steffe et. al. and Gelman provided the necessary language for the PSTs to analyze the child's mathematical thinking, using their previously written descriptions. Knowledge of these frameworks, along with the frameworks of CGI and Van de Walle, gave the PSTs the ability to map a child's mathematical thinking, which was not possible for them before the Math 2008 course or the Interview Project.

**PSTs Listening to and Learning from Children**

The second main goal of the Interview Project was to help PSTs learn to listen to and learn from children. I assessed this goal by looking for instances where the PSTs made any type of instructional decisions, whether they were planned prior to the interview, made on the spot during the interview, or discussed for use when working with the child again in the future. More specifically, I looked for instances where these instructional decisions were informed by their knowledge of the frameworks from class. The results of the pre and post assessments are presented in Table 3.

Table 3

*Overall Pre and Post Assessment Scores for Making Instructional Decisions*

| | Average of Pre-Assessment | Average of Post-Assessment | Percentage Increase | t-score | Significance Level |
|---|---|---|---|---|---|
| Making Instructional Decisions | 0.67672414 | 1.6724138 | 147.134% | 24.909 | $\alpha<0.0005$ |

The PSTs showed a significant improvement in their ability to make instructional decisions based on their knowledge of the research.

**Planned Instructional Decisions.** For most of these PSTs, this was the first time that they worked with a child to learn to listen to and be responsive to the child's mathematics. Thus, their planning could not be based on prior experiences. They relied on the knowledge that they had gained in class to inform

their planning. When interviewing a pair of PSTs immediately following their interview, I asked them, "Can you tell me a little bit about how you prepared for the interview?" One of the PSTs responded by saying,

> We wanted to ask him some simple questions first… to build his confidence. We wanted him to feel comfortable and not be scared or intimidated. So, we asked him a join problem-result unknown…6 pieces of bubble gum then got 4 more. We gave him this because the result unknowns are easier than the start or change unknowns. We did do some of those later, but we also started with small numbers to see if she could do those, then we went to bigger numbers.

This PST chose a particular order for her questions, using her knowledge of the additive structured story problems and each type's difficulty level, relative to the others. Because she said, "to see if she could do those", it seems that the PST was also anticipating two possible paths of the interview as well. If the child could easily work with small numbers, then she would begin to introduce larger numbers. If the child could not easily work with small numbers, then she would continue working with small numbers. The PST was planning for changes that might need to be made during the interview.

**Spontaneous Instructional Decisions.** As Simon (1995) suggested, the experience between the teacher and student, by the nature of its social constitution, is different from the one predicted by the teacher. Consequently, the

PSTs had to make spontaneous instructional decisions in response to the child's mathematical actions. Some of the PSTs changed the numbers in their problem; some changed the order of the problems; some skipped problems, but all of the PSTs showed evidence in their written reports of making at least one spontaneous instructional decision. One pair of PSTs told me during their session interview,

> When we asked him the join-change unknown problem, he didn't seem to understand how to do it. We had to help him using the blocks to explain. Then, the same thing happened with the join-start unknown problem. He really struggled with those…so we went back to result unknown problems. We did more join and separate with the result unknown….I used bigger numbers though, when I went back to the result unknowns.

This pair of PSTs showed that they were listening to the child, noticing his struggle, and they made the spontaneous decision to change the order of their prepared questions. They had prepared their questions in an order where they got progressively more difficult, but when they realized that the child had a difficult time with the change unknown and start unknown problems, they quickly abandoned their plan and made the decision to go back to the questions that were in his zone of potential development.

Another pair of PSTs made a spontaneous decision during their interview to change the numbers to larger numbers in order to establish the appropriate level of the child's whole number development. They wrote,

> Since John used the count on method many times, we knew he was on the INS level. So, in order to see if he was on the ENS level, we asked him the question, "Carl has 25 jellybeans. Tyler gives him 16 more. Now how many jellybeans does Carl have?" Originally, this problem had smaller numbers in it, but we changed them to higher numbers because the higher numbers may be difficult for him to count on using his fingers. The larger numbers would encourage him to find other strategies to solve the problem.

This statement suggests that this pair of PSTs was making spontaneous instructional decisions based on their in-the-moment analysis of the child's mathematics, and this analysis was informed by the frameworks from class. However, in order for this analysis to occur they had to use questions to probe the child's mathematics. It was clear that these PSTs were intentional with their choice of the size of the numbers. These PSTs were listening for a particular strategy, specifically counting on or strategic additive reasoning. This is an example of listening evaluatively (Davis, 1996) because they had a hypothesis and used a specific task to test that hypothesis. While Davis (1996) contends that there is no value in asking questions when we already anticipate a response, I feel that this excerpt shows the value in evaluative listening. The structure of the problem and the size of the numbers were specifically chosen in anticipation of a particular response. Listening for this response could help to determine whether

or not the child could use strategic reasoning, which would help to determine the child's level of whole number development. Listening for a particular response could also help the PSTs in making further instructional decisions, such as which question to ask next. However, I agree with Davis that teachers should not limit themselves to listening only evaluatively.

Besides information seeking questions, the PSTs also asked questions intending to elicit a particular response. Rather than taking the child's word that a particular task was too difficult or just giving the child the correct answer, they used prompting questions to help the child successfully arrive at the answer.

> We posed the question 10 + 20 = ? on a piece of paper. She said that it was too hard. Instead of moving onto another problem, we came up with an alternative route. We put one set of ten unifix cubes on the table and asked her how many were there. She replied instantly, "10." Then we said, "This is a little bit of a different question so think hard about this one. How many groups of 10 are on the table?" She thought for a moment, and then responded, "there is 1 group of 10!" We went on to put 3 rows of 10 unifix cubes on the table and posed the question to her again, "How many sets of 10 are on the table?" Again, she understood exactly what we were asking her. When we asked how she knew all of this, she responded with an answer that surprised us both! She held up her fingers and explained that 10 is like 1 just with a 0 on the end. So, 20 is like 2, 30

> is like 3, and so on. After hearing her explain her strategy, we posed the 10+20=? again. She thought for a minute, and came up with 30. When asked how she got that answer, she held up her fingers and said, "Cause 20 is 2 fingers and 10 is 1 finger and 2+1=3, so the answer is 30!"

The PSTs' moment of surprise indicates that they were not listening for something in particular. Rather they were listening to the child and interpreting her response based on their own knowledge of the discipline. By using the Unifix cubes, they prompted the child to be able to think in groups of ten but did not anticipate her connection to the symbols. By their questioning and willingness to be surprised, these PSTs were listening interpretively. They were able to listen to the child's mathematics and make sense of it even though it was different than how they thought about the task.

**Instructional Decisions for Future Work with the Child.** On the project description the PSTs were asked to respond to the question, "if you could continue to work with this child, what concepts or kinds of problems do you think would be productive work for her or him?" All of the pairs were able to thoughtfully respond to this question. In searching for evidence of where the PSTs were making instructional decisions for the imagined future session with the child, I found that 6 out of the 14 groups were vague and gave responses that were very explorational. In this excerpt, it seems clear that the PSTs were searching for what might be on the cusp of what is possible for the child. However, they did

not pinpoint any specific concept or relate their instructional decision back to the framework.

> If we were to continue working with Jeffrey, we would work on multiplication problems. He did not know, after reading the problem, whether or not it was appropriate to multiply. This is his ZPD because he struggled with these problems when he worked on it independently.

The other 8 groups (out of 14) were able to specifically address the levels in the framework and suggest directions for the child's mathematics related to particular types of word problems. One pair wrote,

> If we were given the chance to work with Bailey again, we would encourage her not to use the blocks as much. She used the blocks to help her answer every problem. We don't know if she used the blocks because they were sitting in front of her and she felt that she had to use them, or maybe she used them because she actually needed them. So, next time, we would give her more join and separate problems with the result unknown. We know she can solve these with the blocks, but we would want to see if she can solve them without the blocks. She may use her fingers in place of the blocks. That way, we would be able to tell if she is a figurative counter, rather than just a perceptual counter.

These PSTs used their analysis that the child was a perceptual counter to think about pushing the child to the figurative level by getting the child to become less

reliant on physical materials. They also named specific problems that they would give to the child in order to accomplish this. During my interview with this pair of PSTs, one of them stated, "We didn't notice that she used the blocks on every problem until we got home and looked back over our notes and listened to our [audio] tape." This shows that the PSTs' abilities to listen to the child's responses and analyze them did not stop at the end of the interview; it was ongoing.

**PSTs' Evolving Definitions of Teaching and Learning Mathematics**

For my research, I did not set out to study the PSTs' beliefs about the teaching and learning of mathematics. But from their written reports and their session interviews with me, I noticed that the PSTs seemed to be rethinking their definitions of teaching and learning mathematics. They were troubling the idea of teaching as telling and moving towards the notion of teaching as posing appropriate tasks. The PSTs were also becoming more aware of the different ways that children think and the importance of being open to these many ways.

**Rethinking the Teaching of Mathematics.** One of the ways that the PSTs were beginning to change their conceptions of teaching mathematics was that they were abandoning their thinking that teaching mathematics was telling a student how to act. There was evidence from 5 of the pairs of PSTs that showed this change. One example was from a written report, where one pair of PSTs wrote,

> This interview was incredibly informative for our future as a math teacher. It made us realize that skillful questioning is imperative in your instructional decisions. You can't just tell the student how to do the problem because they might not think the same way that you do. You have to let them use their own thinking to do it their own way. But, as the teacher, you have to know what type of questions to pose.

This pair of PSTs saw the value of questioning as a tool for teachers. They also highlighted the direct relationship between the teachers' questioning and the students' learning. In my interview with another pair of PSTs, one of them stated,

> When I was in elementary school, my teacher just told us how to do problems step-by-step and then we practiced that over and over again. I don't want to teach math like that…I'm scared that I might fall into that because that's all I know, but I think that teaching math should be more about giving the students opportunities to learn things in their own way. The teacher has to know what kind of tasks to give them to make those opportunities happen.

This PST was beginning to reconsider her definition of teaching as telling to teaching as giving learning opportunities through appropriate tasks. She also pointed out how difficult it is to teach in a different way than you were taught. Although she does not want to be a teacher who teaches by telling, she admitted that she may be drawn back to this type of teaching. This is consistent with

Simon's (1997) claim that "many teachers have developed their models of teaching in the context of thousands of hours as students in traditional classrooms…[which is] difficult to change" (p. 57). This quotation emphasized the structure that characterizes most mathematics classrooms throughout the country as a teacher centered classroom. These PSTs were beginning to change their view of teaching through transmission to teaching through the development of rich tasks.

**Incorporating Theory into Practice.** It is likely that most, if not all, of the PSTs in this study had never considered incorporating theory into their practice of teaching mathematics before this course. After they completed the Interview Project, 8 out of the 14 groups of PSTs referred to their interview with the child as a way to see value in using theory in their practice. In their reflection on the project, one pair of PSTs wrote in their written report

> When we learned the levels, I just kind of memorized them for the test, but then, when I actually had to figure out what level Ta'khia was on, it really made me see how beneficial they are. It doesn't mean as much until you're put in that position yourself.

These PSTs emphasized the importance of incorporating the theory that was taught in class into a real life experience with a child. Without this experience, the theory would not have had meaning to them.

Doyle (1990) identifies two types of knowledge. "Propositional knowledge" is the knowledge of research and theory. "Craft knowledge" is the knowledge of the skills of teaching. Doyle claims that these two types of knowledge learned separately are insufficient. He also asserts that PST education should include opportunities for PSTs to develop these two types of knowledge simultaneously. The PSTs in my study seemed to be doing just that. One PST said during her interview with me,

> It was helpful to have all of the information from class, like the different ways they might solve the problem and the Steffe levels. We were able to use it to watch him and understand him and the process of what he's doing while he's solving the problem. And since we knew the different strategies, we recognized them right away and I felt like I knew what level he was on before we even left the interview….It was cool to see all the stuff we talked about in class actually happening.

This PST clearly appreciated having the knowledge of the frameworks, implying that the interview would not have been as successful without it. The unique opportunity to interview a child gave her the chance to personalize the theory from class through the Interview Project. Thus, she was incorporating her "propositional knowledge" into her "craft knowledge".

**Rethinking the Learning of Mathematics.** Hiebert et al. (1997) describe four features of a productive mathematics classroom. One of those features is:

> Students have autonomy with respect to the methods used to solve problems. Students must respect the need for everyone to understand their own methods and must recognize that there are often a variety of methods that will lead to a solution.

In their written reports and their interviews with me, the PSTs showed a newfound respect for the variety of methods that students use to solve a problem. One pair of PSTs wrote,

> We recognize that our students will all have different ways of coming to a solution to a problem, and we think it is important to let them come to that conclusion on their own instead of always making them use the standard algorithm.

When I interviewed this same pair of PSTs, one of them stated,

> Before this class, I think I would've just expected the kid to use the standard algorithm to do everything, and if they didn't, I would've thought, 'Oh, they don't know what to do. They should've learned this in school…how to use the algorithm.'

This pair of PSTs believed that there was one correct way to solve the problems, which was to use the standard algorithm. But, after their interview with the child, this belief was challenged. They saw the importance of letting students use their own personal strategies, even if it is not the standard procedure taught in most schools. Another pair of PSTs wrote,

> We saw that there are many ways to get an answer to a certain problem. Children are more capable than they are given credit for. Teachers need to allow children to use their own mathematical thinking and intuition to solve problems instead of forcing them to use one particular method.

Among the 14 written reports, 12 of them contained comments similar to the ones above. These comments show that the PSTs were reconsidering the way that children learn mathematics. Instead of seeing the learner as the passive receiver of the teacher's knowledge, the PSTs were beginning to see perceive the learner as "already possessing systematic and relevant knowledge to build off of" (Barnes, 1995, p. 147).

Through their comments in their written reports and their interviews with me, it seemed that the PSTs experienced powerful changes in their conceptions of what it means to teach and to learn mathematics. Through constructing children's mathematics, they changed their own constructions of mathematics. One pair of PSTs wrote in their written report, "Overall, the main thing we got out of this project is a rejuvenated mindset on teaching math and a new appreciation for how children learn math."

## Summary and Conclusions

Steffe and D'Ambrosio (1995) claimed that for a mathematics teacher to operate under a contructivist epistemology, s/he must be a teacher "who studies the mathematical constructions of students and who interacts with students in a

learning space whose design is based, at least in part, on a working knowledge of students mathematics" (p. 148). I set out to study the extent to which the Interview Project increased PSTs' knowledge of the research and their ability to apply them in their interactions with a child. The PSTs in this study showed a statistically significant improvement in their abilities to both describe and analyze a child's mathematics after they had been exposed to the frameworks in class and completed the Interview Project. I do not claim that these changes were due solely to the Interview Project. The Interview Project was a culminating project that, to be effective, required the PSTs to learn the necessary language from the frameworks before conducting their interview with a child. Thus, the several weeks spent in class going over these frameworks were an essential factor in the changes that occurred. The Interview Project, though, gave the PSTs the authentic experience of working with a child that was necessary for them to apply the frameworks that they learned in class. I claim that the observed changes were due to the experiences and lessons that the PSTs had in the Math 2008 class leading up to and including the Interview Project.

I also set out to determine the extent to which the Interview Project helps PSTs learn to listen to and learn from children. The PSTs showed a statistically significant improvement in their abilities to make instructional decisions based on their ability to listen. I concluded that the PSTs were listening both evaluatively and interpretively, but I saw no evidence of hermeneutic listening (Davis, 1996).

These findings support D'Ambrosio's (2004) claims that PSTs are not likely to engage in hermeneutic listening. However, I found that there is value in evaluative listening, unlike D'Ambrosio's (2004) suggestion that evaluative listening is "not sufficient to help the teacher build a model of the child's mathematics" (p. 139).

Perhaps the most significant finding in my study is that through the experience of the Interview Project, the PSTs not only learned the frameworks and how to apply them, but they were able to redefine their notion of what it means to teach and learn mathematics. In their research, the Cognitively Guided Instruction group also found that "learning to understand the development of children's mathematical thinking leads to fundamental changes in teachers' beliefs" (Carpenter et al., 1999, p. 105). At the end of the project, the PSTs in my study were viewing the teaching and learning of mathematics in a way that is more consistent with what the National Council of Teachers of Mathematics (NCTM, 2000) endorses as reform oriented. This development is an example of a teacher in the beginning of transition. Simon et al. define teachers in transition as "teachers whose practices have changed and are changing as a result of participation in current mathematics education reforms" (Simon et al., 2000, p. 579).

## Implications for Teacher Education

**The Interview Project as a Way of Moving Toward Reform.** NCTM has, since the early 1980s, been advocating for reform in mathematics education. One of their suggestions on being a successful teacher in this era of reform is discussed in the assessment principle. The assessment principle asserted that

> assessment should be more than merely a test at the end of instruction to see how students perform under special conditions; rather it should be an integral part of instruction that informs and guides teachers as they make instructional decisions. Assessment should not merely be done *to* students; rather, it should also be done *for* students, to guide and enhance their learning (NCTM, 2000, p. 22).

Additionally, NCTM advised that one's beliefs about the teaching and learning of mathematics can be changed during PST education. Several researchers (Crockett, 2002; Fennema, 1993, 1996; Vacc, 1999) found that giving teachers the opportunity to analyze students' thinking and make instructional decisions is one of the most powerful ways to change a teacher's beliefs to ones that are more consistent with the reform movement suggested by NCTM's *Principles and Standards* (2000) and *Principles to Actions* (2014). The Interview Project is one such opportunity for PSTs. In her final interview with me, one PST said,

> Now, I feel like I know more about what it means to do constructivist teaching. We have talked about it in this class and in other classes, but I struggled to understand what it would look like in a real classroom. This

> is the first time I understood it…I would have never thought about sitting down with my students and doing something like this, trying to analyze and understand their thinking. I probably would've just taught like I was taught, writing on the board and giving worksheets and homework.

For this PST, the Interview Project was an essential component that began her transition of beliefs from traditional teaching to reform teaching. This example suggests that mathematics education reform is not going to happen naturally or easily. Thus, teachers and PSTs need opportunities to listen to children and make sense of their mathematics.

**Pedagogical Experience in a Content Course for Early Childhood Majors.** "Teaching is about weaving together knowledge about subject matter with knowledge about children and how they learn, about the teachers' role, and about classroom life" (Ball, 1990, p. 12). A mathematics content course can be about numbers and operations, geometry, algebra, or data analysis, and an educational psychology course could focus on theories of learning. But a methods course is typically where PSTs have the opportunity to weave everything together. Some early childhood teacher education programs, such as the one in which my participants were enrolled, do not include a methods course that specifically focuses on the content of mathematics. As an instructor of the Math 2008 course, I felt that pedagogical experiences needed to be integrated in their content courses.


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The Interview Project is an example of an experience that weaves together the PSTs' mathematics content knowledge and pedagogical knowledge. Their interview with the child gave them the opportunity to enact their content knowledge of additive structured story problems and the solution methods that children use as well as the pedagogical knowledge of how to analyze the child's mathematical actions and make instructional decisions based on these actions.

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# APPENDIX A

## DESCRIPTION AND RUBRIC FOR THE INTERVIEW PROJECT

**Title:** Interview a Child
**Project Goals:** With this project you are beginning to learn to listen to and learn from children. I want you to see how capable children are of learning mathematics and solving problems. You are learning to respect children's mathematical thinking even when you do not understand it. Allow what you learn from children to influence how you think about your own mathematical thinking and allow it to inform your teaching. In this sense you will be assessing a child's developmental level with respect to whole number. You will be using this interview to describe a child's mathematics, analyze their mathematics using the framework from the course, and apply your analysis to inform your instructional decisions (if you were to work with this child again). In this part you may also discuss any on-the-spot instructional decisions you made while working with this student.
**Description:** For this project, you will interview a student (elementary age) to learn about her or his strengths and areas of potential development in mathematics. The purpose is to reflect on what you learn from the interview. Write a summary of the interview you conducted. The review should contain the following information:

1. General information such as your name, the name (use a pseudo-name), age, and grade of the student you interviewed, any pertinent information about the child you would like to mention.
2. Your analysis, including all of the mathematical problems you posed and a brief summary of the child's response. Say more than "The child solved the problem correctly." Explain how the child solved the problem or what the child said to indicate that she or he could not solve the problem. Some children will not be able to explain how they solved a problem. If this happens, simply indicate this in your summary. Note any behaviors you see the child exhibiting such as counting on fingers or moving lips. Discuss what you learned from this experience. Did anything surprise you? If you could continue work with this child, what concepts or kinds of problems do you think would be productive work for her or him? What kinds of problems would you think would be in their ZPD or right on the

edge or it? Why do you believe this? What, if any, implications does interviewing have for you as a teacher?

3. Note: Avoid evaluative statements about the child, such as, "she was really smart" or "he seemed slow." You do not know enough about the child to make such statements, and besides, those statements provide no useful information. Instead, provide details such as, "When I asked her how many marbles she has if she started with 8 and her friend gave her 9 more, she solved it by saying '8 and 8 is 16, and one more is 17.' I thought that was neat because I would not have expected a child to do that, "I asked him this question and he just looked at me. I asked him if I should repeat the question and he said 'no.' I did not know how else to reach him."

**Rubric:**

| **Components of the Project** | **Description** | **Points** |
|---|---|---|
| Instrument | Selects or designs an instrument or task that will help assess a student's level of whole number development. Your task(s) need to be open enough to allow for multiple entry points. If the student uses a traditional algorithm, then you may want to ask them to explain it or ask them to try the problem in a different way. You will have a difficult time assessing the SMT if all they do is follow an approach that didn't come out of their own logical necessity. | **4** |
| Description of SMT | Description of the Mathematical Actions of the student on the task(s) This part needs to be as detailed as possible. You'll need to discuss the classification of the story problems (Join-Change Unknown, etc.) that the children solved and what strategies they took based on the language used | **4** |


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| | | |
|---|---|---|
| | from class (Direct Modeling, Counting on from largest, etc.). Be sure to describe a child's strategy in the child's language and use the language from class as well. | |
| Analysis of SMT | Uses Steffe & colleagues' or Gelman's Model or language from the text as a framework to analyze the student's mathematical thinking displayed on the tasks. You will need to discuss what their actions imply about the level at which the child is operating (Perceptual Counters, Motor Item Counters,…,INS, INS+, SAR).<br>If a child uses an invented strategy, write a series of equations that justifies why this strategy will always work. Be sure to use the equal sign appropriately and state the properties used at each step. | **4** |
| Application of SMT | What on the spot decisions were made: Questions asked or problems skipped, changed, or enhanced? What next? How will your analysis of the student's mathematical thinking inform your instructional decisions? Based on what you saw the student do, what problems do you believe would be on the on the edge of her/his ZPD?<br><br>Since this is difficult for even the most veteran teachers, who get to rely on their experiences with children. You will have to rely on the existing literature. You will need to site at least three resources for your project | **4** |

| | | |
|---|---|---|
| | that show you were looking for how to respond to this student.<br><br>What did you learn from this particular student that you could apply to your future teaching? What, if any, implications does interviewing have for you as a teacher? | |
| Total | | **16** |


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# APPENDIX B

## BRIEF DESCRIPTION OF THE FRAMEWORKS PRESERNTED IN MATH 2008 CLASS

| | **Framework** | **Ways of using the Framework for The Interview Project** |
|---|---|---|
| **Description of Child's Mathematical Thinking** | Cognitively Guided Instruction (CGI) | Classifying Story Problems (Join-Result Unknown, Separate-Change Unknown, etc.)<br><br>Identifying Children's Strategies (Direct Modelling, Counting on from the larger number, etc.) |
| | Van de Walle | Identifying Children's Strategies (Near doubles, Using Tens, etc.) |
| **Analysis of Child's Mathematical Thinking** | Steffe et al. | Identifying Child's Level of Whole Number Development (Perceptual Counter, Initial Number Sequence, Strategic Additive Reasoning, etc.) |
| | Gelman | Identifying Counting Principles (Cardinality, One-to-one, etc.) |

# APPENDIX C

## 5 PRE-INTERVIEW PROJECT TASKS

**Task 1**

Read the story problems below. Organize them into 2 or more groups. Then,

describe why you

organized them into these groups.

| | | |
|---|---|---|
| Connie had 5 marbles. Juan gave her 8 more marbles. How many marbles does Connie have altogether? | Connie has 5 marbles. How many more marbles does she need to have 13 marbles altogether? | Connie had some marbles. Juan gave her 5 more marbles. Now she has 13 marbles. How many marbles did Connie have to start with? |
| Connie had 13 marbles. She gave 5 to Juan. How many marbles does Connie have left? | Connie had 13 marbles. She gave some to Juan. Now she has 5 marbles left. How many marbles did Connie give to Juan? | Connie had some marbles. She gave 5 to Juan. Now she has 8 marbles left. How many marbles did Connie have to start with? |
| Connie has 5 red marbles and 8 blue marbles. How many marbles does she have? | | Connie has 13 marbles. 5 are red and the rest are blue. How many blue marbles does Connie have? |
| Connie has 13 marbles. Juan has 5 marbles. How many more marbles does Connie have than Juan? | Juan has 5 marbles. Connie has 8 more than Juan. How many marbles does Connie have? | Connie has 13 marbles. She has 5 more marbles than Juan. How many marbles does Juan have? |

Carpenter, T. (1999). *Children's mathematics: Cognitively guided instruction*. Portsmouth, NH: Heinemann.

**Task 2**

Watch each videotape of a child solving a story problem. How did the child solve the problem? Can you describe their method? Then, show how the child would solve the following related problem.
(The videos being used are from *Children's Mathematics: Cognitively Guided Instruction* by Carpenter et al.)

1) a) How did the child solve the problem? Describe their method as best you can.

b) How would the child solve the following problem?
Related Problem: To make lemonade, Calvin put 3 lemons in a pitcher. Then, he decided it needed more lemons and added 4 more lemons to the pitcher. How many lemons are in the pitcher now?

2) a) How did the child solve the problem? Describe their method as best you can.

b) How would the child solve the following problem?
Related Problem: Julio has 5 stickers in his sticker book. His friend, Jason, gave him some more stickers for his birthday, and now he has 11 stickers. How many stickers did Jason give him?

3) a) How did the child solve the problem? Describe their method as best you can.

b) How would the child solve the following problem?
Related Problem: Johnny has 8 stickers in his sticker book. His sister has 3 stickers in her sticker book. How many more stickers does Johnny have than his sister?

4) a) How did the child solve the problem? Describe their method as best you can.

b) How would the child solve the following problem?
Related Problem: Debbie has 7 books on her shelf. If she puts 8 more books on her shelf, how many books will she have altogether?


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**Tasks 3 and 4**

After watching each video of a child solving a story problem, respond to the following questions:
a) Based on what you just saw, what can you tell me about this child's level of development?
b) What would you do next? What task would you give this child now that you've seen this clip?

(The videos being used are from *Integrating Mathematics and Pedagogy to Illustrate Children's Reasoning* by Phillip et. al.)

1) a) Based on what you just saw, what can you tell me about this child's level of development?

b) What would you do next? What task would you give this child now that you've seen this clip?

2) a) Based on what you just saw, what can you tell me about this child's level of development?

b) What would you do next? What task would you give this child now that you've seen this clip?

3) a) Based on what you just saw, what can you tell me about this child's level of development?

b) What would you do next? What task would you give this child now that you've seen this clip?

4) a) Based on what you just saw, what can you tell me about this child's level of development?

b) What would you do next? What task would you give this child now that you've seen this clip?

**Task 5**

Determine which of the two story problems is more difficult. Circle the story problem that you believe is the more difficult one. If you believe that they have the same difficulty level, circle neither.

1)
A) Connie had 5 marbles. Juan gave her 8 more marbles. How many marbles does Connie have altogether?
B) Connie has 5 marbles. How many more marbles does she need to have 13 marbles altogether?

2)
A) Connie has 5 marbles. How many more marbles does she need to have 13 marbles altogether?
B) Connie had some marbles. Juan gave her 5 more marbles. Now she has 13 marbles. How many marbles did Connie have to start with?

3)
A) Connie had 5 marbles. Juan gave her 8 more marbles. How many marbles does Connie have altogether?
B) Connie has 5 red marbles and 8 blue marbles. How many marbles does she have?

4)
A) Connie had some marbles. She gave 5 to Juan. Now Connie only has 8 marbles. How many marbles did Connie start with?
B) Connie has 13 marbles. She gave 5 to Juan. How many marbles does Connie have now?

5)
A) Connie had some marbles. Juan gave her 5 more marbles. Now she has 13 marbles. How many marbles did Connie have to start with?
B) Connie had 13 marbles. She gave 5 to Juan. How many marbles does Connie have left?

6) Below is a story problem that can be solved by the computation 8+5.

Connie has 8 marbles. Juan gave her 5 more marbles. How many marbles does Connie have altogether?

Your task is to write a different story problem that is MORE DIFFICULT than the one above to solve, but can still be solved by the computation 8+5.

7) Below is a story problem that can be solved by the computation 8-5.

Connie has 8 marbles. She gave 5 to Juan. How many marbles does Connie have left?

Your task is to write a different story problem that is MORE DIFFICULT than the one above to solve, but can still be solved by the computation 8-5.


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APPENDIX D

RUBRIC FOR PRE-INTERVIEW PROJECT TASKS

| **Goal** | | **Does Not Meet Goal (0)** | **Partially Meets Goal (1)** | **Meets Goal (2)** |
|---|---|---|---|---|
| Description of Child's Mathematical Thinking | Task 1 | Organized the story problems into groups that did not have any structural connection (i.e. put all of the "joins" together and "separates", or put all the "initial unknowns" together and the "difference unknowns" together. | Organized the story problems into groups with structural connections but was not able to describe why they organized them into those groups. PST may have also organized the story problems into groups, where some groups had structural connections but others did not. | Organized the story problems into logical groups and gave an accurate description of why these groups were appropriate. |
| | Task 2 | Gave an inaccurate description of how the child solved the story problem or simply repeated verbatim the child's process. Was not able to solve a similar problem using the same method as the child. | Could solve a similar problem using the same method as the child, but was not able to name the method or accurately describe it. | Was able to name the child's solution method (or accurately describe the method) and solve a similar problem using the same method as the child. |
| Analysis of the Child's Mathematical Thinking | Task 3 | PST gives no response or a response that does not accurately describe the child's level of development. The | PST attempts to describe a level of development but cannot justify it. | PST correctly describes a level of development based on the child's response to the story problem and justifies it. |

| | | | | |
|---|---|---|---|---|
| | | PST may estimate the child's age or grade level, but offers no developmental level. The PST may describe the child as "slow" or "smart" but does not give a reason for this description. The PST may attempt to describe a level, but their reasoning is based on how quickly the child gives the answer or whether or not the child gives the correct answer. The PST may also simply state what the child did (for example, "the child counted the blocks to find the answer") but does not offer any insight into how this helps to describe the child's developmental level. | | |
| Instructional Decisions | Task 4 | PST gives no response or gives or simply suggests that they would give a "harder problem". | PST's response is vague or explorational. The PST may give a suggestion such as "work on subtraction" or "give a problem with larger numbers", but does | PST gives a specific task that is on the cusp of the child's developmental ability, using the child's response to the given story problem as guidance. |


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| | | | not identify a specific task. | |
| | Task 5 | Part 1 – PST correctly identifies 0-2 of the relative difficulty problems (correctness is determined by CGI suggestions)<br><br>Part 2 – PST does not respond to either question or responds to both questions incorrectly. A response is marked incorrect if the story is not more difficult than the one given. The PST may respond with a story problem that can be solved with the same computation but the story has the same structure as the one given. The PST may also respond with a story problem that is more difficult than the one given but it cannot be solved with the required computation. | Part 1 – PST correctly identifies 3-4 of the relative difficulty problems (correctness is determined by CGI suggestions)<br><br>Part 2 – PST responds to only one question correctly. A response is marked incorrect if the story is not more difficult than the one given. The PST may respond with a story problem that can be solved with the same computation but the story has the same structure as the one given. The PST may also respond with a story problem that is more difficult than the one given but it cannot be solved with the required computation | Part 1 – PST correctly identifies all 5 of the relative difficulty problems (correctness is determined by CGI suggestions)<br><br>Part 2 – PST responds to both questions with a story problem that is more difficult than the one given, but it can be solved using the same computation. |

# APPENDIX E

## FINAL INTERVIEW QUESTIONS

1) One of the goals of The Interview Project is to describe and analyze a child's mathematics. Why or why not do you think describing and analyzing a child's mathematics is a helpful tool for teachers?

2) Another goal of The Interview Project is to learn to listen to children. Why or why not do you think listening is a helpful tool for teachers? Why or why not? Did you use your listening skills during your interview to make instructional decisions? Did you use your listening skills after your interview to make future instructional decisions?

3) What did you get out of The Interview Project?


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# APPENDIX F

## OUTLINE OF MATH 2008 COURSE

| Week: | Content Covered | Activities |
|---|---|---|
| 1 | Syllabus, Introductions, Research Discussion, Pre-assessment for research | Pre-assessment activities (Tasks 1-5) |
| 2 | Gelman's Counting Principles<br><br>Counting Methods (count all, count on, etc.)<br><br>Subitizing | Alphabet Counting Activity (intended to bring out Gelman's Counting Principles and some of the counting methods)<br><br>Watch videos (IMAP and CGI) to identify Gelman's principles and counting methods. |
| 3 | Steffe's Levels of Whole Number Development | Watched videos (IMAP and CGI) to identify child's solution method and to speculate which of Steffe's levels of whole number development. |
| 4 | Additive Structured Story Problems (join, separate, compare, and part-part-whole)<br><br>Models for Solving Additive Structured Problems (set model, length model) | Watched videos (IMAP and CGI) to identify the story problem structure, the child's solution method, and to speculate which of Steffe's levels of whole number development. After identifying all of these, I also asked, "What would you do next? What type of question do you think would be appropriate and why?" |
| 5 | Test 1 | The Interview Project description and rubric was handed out in class and discussed. |
| 6 | Multiplicative Structured Story Problems (multiplication, measurement division, and partitive division) | The Doorbell Rang (read book and handout)<br><br>What To Do With Those Remainders? |

| | | |
|---|---|---|
| | Models for Solving Multiplicative Structured Problems (set model, length model, area model, array model, and combinations model)<br><br>Remainders<br><br>Multiplication and Division by Zero | |
| 7 | Computation (Addition and Subtraction)<br><br>Making Sense of Children's Invented Methods<br><br>The Traditional Algorithms for Addition and Subtraction | Watched videos (DMI) and wrote a series of equations that proved whether or not the child's strategy was mathematically correct.<br><br>Using base ten blocks or bundles of toothpicks, we acted out the steps of the traditional algorithm to better understand the reasoning behind each step, bringing special attention to the regrouping step. |
| 8 | Computation (Multiplication and Division)<br><br>Making Sense of Children's Invented Methods<br><br>The Traditional Algorithms for Multiplication and Division.<br><br>The Advantages of Invented Strategies over the Traditional Algorithm | Watched videos (DMI) and wrote a series of equations that proved whether or not the child's strategy was mathematically correct.<br><br>Using base ten blocks or bundles of toothpicks, we acted out the steps of the traditional algorithm to better understand the reasoning behind each step. |

| | | |
|---|---|---|
| 9 | Test 2 | |
| 10 | Spring Break | |
| 11 | Meaning for Fractions | PSTs conduct interviews, Observations of Interviews |
| 12 | Meaning for Fractions | PSTs conduct interviews, Observations of Interviews |
| 13 | Operations with Fractions | Final Interviews |
| 14 | Operations with Fractions | |
| 15 | Test 3 | |
| 16 | The Interview Project Due and Presentations | |