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Elementary Mathematics Prospective Teachers' Intended Contingent Teaching in Small Groups

Byungeun Pak (Graduate Student)
[1] Michigan State University, pakbyun1@msu.edu

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Despite its importance when it is employed in classrooms, scaffolding is limited in the classrooms. Many researchers have focused on contingent teaching, which is the first component of scaffolding. Given a lack of research on contingent teaching with prospective teachers (PSTs), this paper explores how PSTs intend to do contingent teaching in small groups when they engage in mathematics teaching. Building on research on contingent teaching, I analyzed 26 PSTs' written responses to scenarios in an online open-ended survey. The focus of the analysis was on how the PSTs would do contingent teaching that might support students to learn the subject matter. I present findings in relation to what the PSTs' responses showed in relation to contingent teaching with the subject matter. The findings will be discussed along with implications.

Keywords: scaffolding, contingent teaching, prospective teachers, cooperative learning, mathematics education.
ZDM classification: B59
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I. INTRODUCTION

> "If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly (Ausubel, 1968, p. vi)" (Van de Pol, Oort, & Beishuizen, 2014).

Five decades ago, Ausubel noted that teachers should start with understanding what students know and proceed to support them accordingly. This resonates with today's student-centered vision underlying reform-based teaching practices across subject matter areas, including mathematics (Kazemi, Franke, & Lampert, 2009; National Council of Teachers of Mathematics [NCTM], 1989). One of the teaching practices is scaffolding, which requires teachers to teach based on their understanding of what students know as its fundamental and crucial part. It consists of three features, such as adaptivity or contingency, fading of support over time, and transferring the responsibility for a task or for learning to the student (Van de Pol et al., 2014; Wood, Bruner, & Ross, 1976). Teachers have difficulty in an enactment of scaffolding, however, when the three features of scaffolding are used to assess the lesson (Elbers, Hajer, Jonkers, Koole, & Prenger, 2008).

Building on a sociocultural perspective on learning (Mercer & Littleton, 2007; Vygotsky, 1978), some researchers (Van de Pol et al., 2014; Van de Pol, Volman, & Beishuizen, 2011) have investigated the first feature of scaffolding, contingent teaching, in the context of small groups. Research on teachers' role in contingent teaching was limited in the context of small groups (Van de Pol, Volman, & Beishuizen, 2015). These researchers have contributed to a deeper understanding of contingent teaching in small groups. Contingent teaching has three components, such as diagnostic questions, checking understanding, and intervention support, which is described in the next section. The researchers are particularly interested in contingent teaching because of its importance in that scaffolding may be ineffective when teachers facilitate without a correct understanding of what students already know or without checking whether their understanding of students' understanding is correct.

In particular relation to teacher preparation, drawing on existing research on contingent teaching in small groups is valuable in supporting PSTs to learn to enact contingent teaching. It would not necessarily be sufficient to support PSTs to learn to teach contingently, building on existing research on contingent teaching. The support also needs to begin with understanding what PSTs know and can do. Hammerness and colleagues (2005) argued that "new teachers come to think about (and understand) teaching in ways quite different from what they have learned from their own experience as students" (p. 359). Given that, the contingent teaching may not be familiar with what PSTs have experienced as students. PSTs may come to teacher preparation programs with preconceptions about how teaching works. There are a few studies on contingent teaching on the part of PSTs. An exception is Anwar, Yuwono, Irawan, and As'ari (2017), which had only one PST as a research participant in a whole-class context. Therefore, it is necessary to understand how PSTs intend to do contingent teaching in small groups by working with a group of PSTs.

The research on contingent teaching has focused on subject matter areas, such as social studies and science, literacy, and mathematics. This current paper focused particularly on mathematics. In mathematics, many students tend to have difficulty in understanding critical mathematical concepts. To support such students, teachers need to diagnose students' mathematical ideas know and then proceed to support depending on the students' understanding in small groups (Chiu, 2004). Some researchers have done research on contingent teaching in mathematics on the part of novice teachers, including one PST (Anwar et al., 2017). On the part of PSTs, this contingent teaching would not be an easy teaching practice for PSTs to be effective without support. It calls for continuous research on contingent teaching in mathematics on the part of PSTs.

One way to support PSTs to learn to implement contingent teaching can be found by PSTs' written responses to a written scenario. Buchbinder and Cook (2018) conducted research where PSTs' written responses to a cartoon-based scenario were analyzed to examine PSTs' mathematical knowledge for teaching. They collected and analyzed PSTs' written responses, which allow them to examine how "PSTs imagine themselves in a teaching situation" (p. 132). Given examining written responses may lead to how they imagine themselves concerning contingent teaching, in this current paper, I use PSTs' written responses to scenarios to examine their intention in terms of contingent teaching.

Taken together, to support elementary mathematics PSTs to learn contingent teaching in small groups, the first action to be taken is exploration research on understanding what PSTs' contingent teaching in small groups looks like by using PSTs' written responses. As such, the purpose of this paper is to explore how PSTs intend to do contingent teaching in small groups when they engage in mathematics teaching in the future. To that end, first, I will describe what I learned from a body of literature on small groups and contingent teaching. Second, I will explain a data collection tool (four written scenarios in an open-ended online survey) and data analysis, including an analytic framework based on the literature. Third, I will present findings as a result of the analysis. In the end, I will discuss the findings and provide implications.

II. LITERATURE REVIEW

1. SMALL GROUPS WITH BENEFITS AND CHALLENGES

Mathematics education research has acknowledged the intellectual and social benefits of participating in small groups for student learning (e.g., Davidson, 1990; Yackel, Cobb, & Wood, 1991). For example, Lindquist (1989) suggested benefits for small groups in mathematics classrooms on the part of students such that small groups can "increase students' responsibility for their own learning", "encourage students to work together, a social skill that all persons need", and "increase the possibility of students solving certain problems or looking at problems in a variety of ways" (pp. 629-630). What these researchers have in common is that participating in small groups would be effective for intellectual and social learning benefits.

On the other hand, there are challenges students may experience in small groups (Esmonde & Langer-Osuna, 2013; Wood & Kalinec, 2012). Ding, Li, Piccolo, and Kulm (2007) noted that students in small groups may experience some challenges when no group member can answer the question, students exhibit problems communicating with each other, and/or some students dominate group work. If these challenges are continued, they would prevent students from getting the intellectual and social benefits.

One of the teaching enterprises is to maximize these benefits and minimize challenges in practice. In this regard, teachers should be able to plan and set up small groups (TeachingWorks, n.d.). Teachers also need to enable students in small groups to “practice and refine their growing ability to communicate mathematical thought process and strategies” (NCTM, 1989, p. 78). Notably, during small group work, teachers should use talk with students in order to encourage students to work together in small groups to increase the social as well as academic benefits (Mercer & Littleton, 2007). Teachers need to know how to use talk with students for the social as well as academic benefits.

2. CONTINGENT TEACHING IN SMALL GROUPS

As mentioned earlier, contingent teaching is known as a crucial part of scaffolding. In a literature review on scaffolding in the interaction between teachers and students, Van de Pol, Volman, and Beishuizen (2010) described research on the effectiveness of scaffolding with several subject matters. There were a small number of empirical studies on the effectiveness of scaffolding. The research all showed the benefits of scaffolding in relation to metacognitive activities of students, cognitive activities of students, and student affect. Even though the studies are not all related to small groups and particularly to contingent teaching, these benefits suggest, however, that given contingent teaching is an important part of scaffolding, teachers’ enactment of contingent teaching is beneficial for students in small groups as well.

As mentioned earlier, contingent teaching has three components (Van de Pol et al., 2011). Teachers ask to diagnose students’ thinking (diagnostic questions). They check whether their initial understanding of what students know and do not know is correct (checking understanding). Based on the checking, teachers go on to provide students with intervention in small groups (intervention support).

Van de Pol and colleagues (2011, 2014) distinguish contingent teaching from non-contingent teaching. Since the purpose of the researchers was to understand contingent teaching in practice, however, they did not pursue the nature of non-contingent teaching. According to them, teachers’ talk becomes non-contingent when any of the three components of contingent teaching is missing in the talk. For example, the teacher’s talk is related to non-contingent teaching when a teacher does not “use any diagnostic strategies” or “check the diagnosis” (Van de Pol et al., 2011, p. 201). The teacher’s talk is also non-contingent when he/she provides certain intervention support without diagnostic questions and checking understanding. These examples suggest that being non-contingent does not necessarily mean that the talk should lack all components of contingent teaching. Non-contingent teaching may be incomplete but may still have some components of contingent teaching.

Novice teachers' scaffolding practice, including PSTs, tend not to be associated with contingent teaching (Anwar et al., 2017). It means that PSTs are more likely to engage in non-contingent teaching. It suggests that support to learn to scaffold should also be given to PSTs in teacher preparation programs. This line of research working with PSTs seems less emphasized, however. For the support to be effective, it is necessary first to start with understanding the nature of non-contingent teaching on the part of PSTs.

3. SUBJECT MATTER CONTINGENT TEACHING AND NON-SUBJECT MATTER CONTINGENT TEACHING IN SMALL GROUPS

Most research on contingent teaching is associated with subject matter-related diagnostic questions, checking understanding, and intervention support. Van de Pol and colleagues have worked with her colleagues with a focus on subject-matter-related contingent teaching (Van de Pol et al., 2014; Van de Pol et al., 2011). In subject-matter contingent teaching, for example, a mathematics teacher asks diagnostic questions, such as "how do you know that?" or "what does an equal sign mean?" and checks their diagnosis. The teacher may proceed to provide subject-matter-related intervention support (e.g., taking examples regarding equivalence) depending on students' understanding of the mathematical concept. This subject matter contingent teaching presupposes students on task in small groups. As mentioned earlier, what students may talk about in small groups, however, is not always related to the subject matter (Ding et al., 2007; Esmonde & Langer-Osuna, 2013; Wood & Kalinec, 2012).

When the students experience challenges in small groups, one support for teachers to do is contingent teaching on what is going on in the small group, which is non-subject matter. For example, the teacher may ask questions to understand how students see their problems (a diagnostic question) when they exhibit problems communicating with each other in a small group. The teacher may make sure if the teacher's understanding is correct in terms of what happened (checking understanding). The teacher may provide intervention support by modeling how to talk and listen to each other (intervention support). As shown in this example, the teachers' talk needs to be contingent teaching with non-subject matter to guide students to subject matter-related talk with peers, which I define in this current paper as non-subject-matter-related contingent teaching.

Given challenges students may experience in small groups, non-subject matter contingent teaching in the context of small groups would be valuable. The research on non-subject matter-related contingent teaching in small groups to is rare in the field. To support PSTs to engage in an effective contingent teaching, it is necessary to start with understanding the nature of non-subject matter contingent teaching on the part of PSTs.

III. RESEARCH METHODLOGY

1. PARTICIPANTS AND SETTING

Twenty-six elementary PSTs from a large Midwestern university-based teacher education program participated in the study. IRB approval was obtained for the previous study and all participants provided consent. All of the PSTs were in the student teaching stage of their teacher preparation program and were concurrently enrolled in a mathematics methods course during the Fall 2016 semester. After they had completed ten consecutive hours of teaching in mathematics in October, the PSTs took a survey between late November and early December, 2016. I chose this particular time to administer the survey hoping that the PSTs would have more sense of ways to interact with students in small groups from their recent teaching experiences and observations of their mentor teachers' teaching.

The methods course in which the participants were enrolled placed emphasis on student-centered teaching. The course encouraged PSTs to adopt cooperative small groups as part of their teaching strategy in mathematics instruction. The course, for example, used the ideas from the five teaching practices related to facilitating mathematics discussions in small group context: anticipating, monitoring, selecting, sequencing, and connecting (Smith & Stein, 2011). Additionally, the PSTs' placement classrooms varied widely in terms of their use of small groups.

2. DATA COLLECTION

I used an open-ended online survey to collect the data. I focused on four survey items. Each survey item was designed to relate to how PSTs would intervene in small groups and for what purposes. Each item included a hypothetical scenario and three prompts.

The written scenarios were built on the literature in relation to how teachers intervene in small groups. Specifically, I modified excerpts from Chiu (2004), Chapin, O'Connor, and Anderson (2009), and Dekker and Elshout-Mohr (2004) into Scenarios 1, 2, and 3, respectively. I also created an excerpt in Scenario 4 where an idea of a low-status student was not heard by peers even though the ideas might have a potential to contribute to a small group discussion, which has been a research focus of Cohen and Lotan (2014). When I modified or created these four scenarios, I expected these scenarios to invoke PSTs' certain ways to intervene in small groups, such as evaluating students' ideas, mediating students' thinking, helping group interaction proves go smoothly, and treating status issues. Each scenario depicted interactions among students in a small group with different contexts, such as grade level, math content, and status of students (Appendix A).

I expected Following each scenario, the first prompt asked PSTs to write a description of their understanding of what was going on in the small group. The second prompt asked PSTs to list the comments/questions they would use after reading each scenario. The third prompt asked PSTs why they would intervene in that particular way.

The four survey items have two features in common that may show a potential to analyze the data for this current paper. First, these items described certain interaction episodes in small groups. Second, PSTs were asked to make responses to these episodes. Third, these episodes portray that students seem to have difficulty in communicating with each other. The PSTs' written descriptions in this study showed how the PSTs would ask questions or make comments to support students to work together in small groups. These descriptions would involve to some degree components of contingent teaching, such as diagnostic questions, checking understanding, and intervention support. Even though the responses made by the PSTs to these survey items are initially designed to explore PSTs' intervention actions and purposes, as I mentioned earlier, analyzing the data will serve to provide a broad sense of the nature of PSTs' contingent approach in relation to small groups.

3. DATA ANALYSIS

1) Analytic Framework

In the literature review, studies (Anwar et al., 2017; Elbers et al., 2008) suggest that PSTs may be using more non-contingent teaching, which would be associated more with the subject matter than non-subject matter. I highlighted the necessity to investigate how PSTs would interact with students in small groups in terms of contingent teaching and the subject matter. To explore the nature of the whole picture of (non-)contingent teaching along with (non-)subject matter on the part of PSTs, I present an analytic framework (Figure 1).

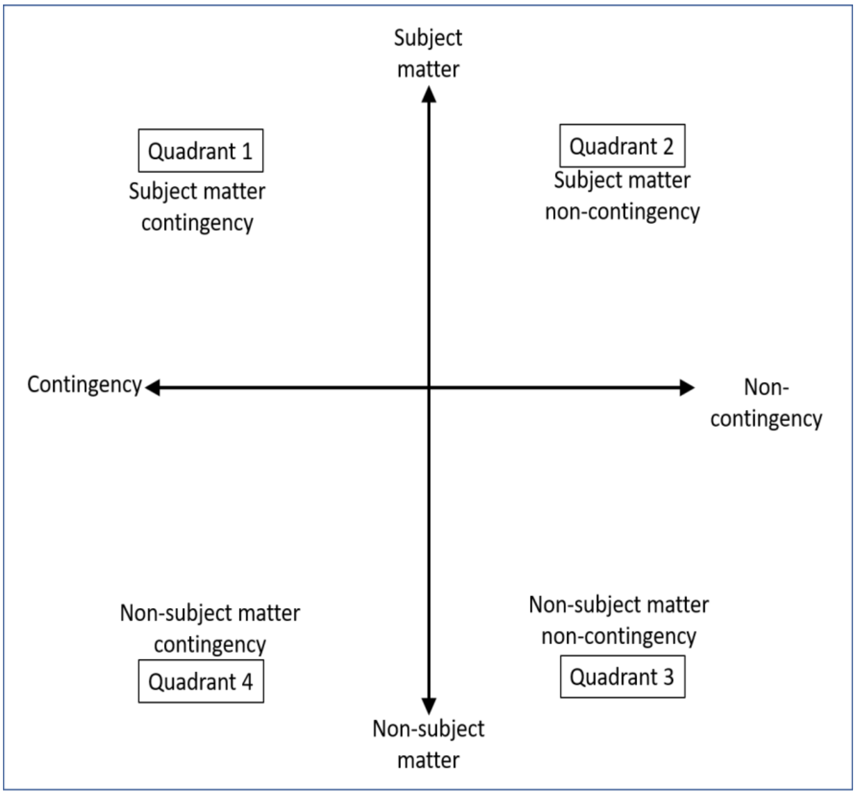

Figure 1. Analytic framework

In the framework in Figure 1, the horizontal axis is divided into contingent and non-contingent teaching. Additionally, the dimension regarding the subject matter and non-subject matter is represented by the vertical axis. As such, this framework is organized into four quadrants. Each PSTs' talk would belong to one quadrant. For example, a PSTs' talk would be located in Quadrant 1, when it has all three components of contingent teaching and is subject matter-related. Another PSTs' talk would be located in Quadrant 2, when it has one or two of the three components of contingent teaching and is subject matter-related. I use this framework as an analytic framework because it can allow me to account for the nature of contingent teaching on the part of PSTs.

2) Data Analysis

In this paper, I used thematic analysis (Glesne, 1999) to examine the response data in each scenario closely. For each scenario, I coded only the responses of the PSTs who responded to the second prompt for each scenario. Of the 26 PSTs, the numbers of PSTs who made responses to the second prompt in the first, second, third, and fourth scenarios were 23, 20, 18, and 18 PSTs, respectively. I excluded two responses in Scenario 2 and two responses in Scenario 3 since they described no intention to interact with students in small groups. As such, I took 23, 18, 16, and 18 responses, totaling 75 responses into consideration for analysis.

Table 1. Numbers of the PSTs who responded to each scenario

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Total
Numbers of the responses to analyze	23	18	16	18	75

First, I coded all responses to the second prompt with respect to whether questions and comments in each response are contingent or non-contingent in the sense of the three components, such as diagnostic questions, checking understanding, and intervention support. I focused on the second prompt, among three prompts, because the second prompt included PSTs' intended questions and comments. I also did so to distinguish non-contingent from contingent teaching. Second, I identified whether questions and comments in each response are the subject matter or non-subject matter to understand how contingent teaching addresses the subject matter. Third, I located each response into one of four quadrants in the framework (Figure 1). Fourth, I identified ways contingent and non-contingent teaching appear by scenario to see how contingent teaching differs from scenario to scenario.

4. INTER-RATER RELIABILITY

To determine inter-rater reliability, I worked with a colleague whose research focus is on mathematics teacher education and on teachers' talk patterns. We coded 20 percent of the 75 responses, including responses from each of the four scenarios, separately and later compared our coding. The agreement rate was .86 for the three components of contingent teaching and .84 for (non-)subject matter contingent teaching of each component. After discussing the reasoning behind our coding, the disagreements were resolved.

IV. RESULTS

I. COMMON PATTERNS ACROSS SCENARIOS

Across scenarios, as shown in Figure 2, the majority of these PSTs' responses were located in Quadrant 2. It means that 56 of 75 responses were subject matter non-contingent teaching. It means that they had one or two of the three components of contingent teaching. Next, 14 responses were in Quadrant 1. It means that they had the three components of contingent teaching, which were subject matter-related. There were 5 responses that could be located neither into Quadrants 2 and 3. These responses had two components of contingent teaching, and one of the two components was non-subject matter-related. I describe each of these patterns in this section.

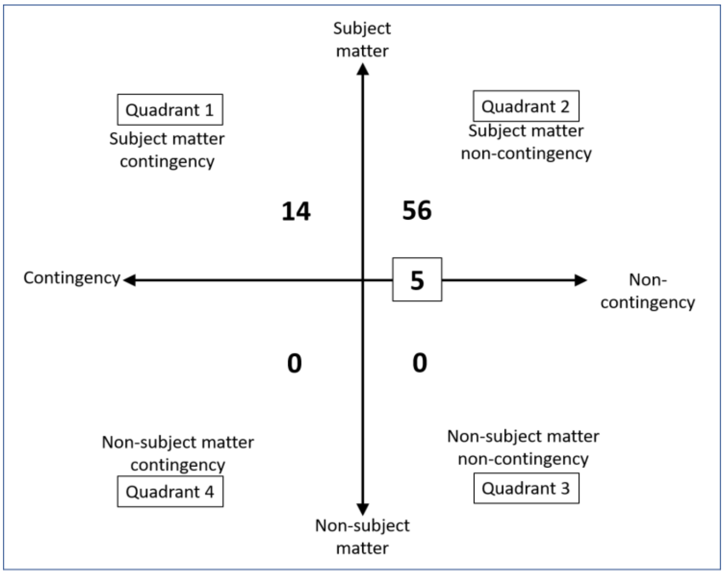

Figure 2. General patterns of PSTs' responses in the framework

II. SUBJECT MATTER CONTINGENT TEACHING

1) Common Patterns

As shown in Quadrant 1 in Figure 2, a small number of all responses was contingent teaching. Only 14 responses (19 % of 75 responses) were contingent teaching, as shown in Table 1. All responses in Quadrant 1 were related to subject matter contingent teaching. For instance, in the first scenario (see Appendix A), where the student initiated the talk (e.g., "Teacher! I have a question! [You walk over.] I think I need to put 13 in the square [pointing to the square]"), a PST made a response such that

> I would intervene first by asking the students what the equals sign means to them. I would let the two discuss with me there and see what they come up with. From their [*sic*] I would make sure they know that the equal sign means that the things on both sides are equivalent to each other. Then I would give them more time to discuss what the equal sign would mean and why there is a seven on the one side.

In the fourth scenario, where a student (Minjun) tried to contribute to group discussion but were not heard, the same PST made to a response such that

> I would ask the students what they think they should do. Then I might prompt them by asking if they think it would be okay if they randomly picked two numbers to add. I asked them what they think might happen to their answer if they chose random numbers in comparison to other groups.

These responses start with diagnosing what students know a mathematical concept (e.g., what they know about equal sign) or think (e.g., what they should do) and then proceed to check their understanding of what students understand (e.g., seeing what they come up with). They intervene in the small groups by questioning to support students to work on the concept. Like these examples, all responses in Quadrant 1 showed subject matter contingent teaching.

2) Differences by Scenario

Responses regarding subject matter contingent teaching appeared with different frequencies in each scenario. As shown in Table 1, these contingent-related responses appeared dominantly in Scenarios 1 and 2, where the student initiated the interaction. In Scenarios 3 and 4, where the students did not initiate the interaction and struggled with understanding what to do, there was little response regarding contingent teaching.

Table 1. Contingent teaching in each scenario

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Total
Contingent	7	6	0	1	14

III. SUBJECT MATTER NON-CONTINGENT TEACHING

1) Common Patterns

As shown in Quadrant 2 in Figure 2, Fifty-six responses (75 % of 75 responses) written by 26 PSTs were non-contingent across scenarios. As shown in Table 2, these responses included questions or comments that had one or two components of contingent teaching, such as diagnostic questions, checking understanding, and intervention support. These non-contingent teaching were the subject matter.

Table 2. Instances of responses of non-contingent teaching with the subject matter

Categories		Responses	Total
One component	Diagnostic questions	14	29
	Checking understandings	1	
	Intervention support	14	
Two components	Diagnostic questions-Intervention support	14	27
	Diagnostic questions-Checking understandings	8	
	Checking understanding-Intervention support	5	
Total			56

In more detail, 29 responses (38 % of 75 responses) had one of the three components of contingent teaching. All these responses were related to the subject matter. For instance, a PST responded to the second scenario, "What is your question? (elicit student responses) You are wondering where the tenth is in 5, where would it normally be?" The PST used only two diagnostic questions to elicit what students knew in relation to the decimal addition.

Twenty-seven responses (36 % of 75 responses) had two of the three components. All but five responses were related to subject matter contingent teaching. For instance, another PST made a response with two components (a diagnostic question and an intervention support) to the second scenario,

> I would first ask the students to tell me what an equal sign is or what an equal sign tells us to do. I would wait for their responses. I would then say something like "The equal sign tells you that the numbers on either side of it should be the same." I would then ask them to think about what number the left side equals to, and then I would hint to the fact that again that the two sides should be equal.

In the first sentence, the PST indicate that the teacher made sure he/she correctly understood that students understood about an equal sign, which I view as a subject matter diagnostic question. In the third and fourth sentences, the PST described a comment or hinted the PST intended to provide to mediate the student's thinking, which I see as a subject matter intervention support. This example shows non-contingent teaching because checking understanding is missing. It also shows that the questions and intervention by the PST were subject matter-related. Like this example, in the responses in Quadrant 2, the PSTs made subject matter non-contingent responses that lack one of the three components.

2) Variations by Scenario

As shown in Table 2, 29 responses had one component of contingent teaching. Each scenario has a different frequency of one of the three components. As shown in Figure 1, in Scenarios 2, 3, and 4, different PSTs made responses that include only one component, such as diagnostic questions and intervention support. Across scenarios, checking understanding rarely appeared.

Out of the 27 responses that have two components, the types of the combination between two components appeared with varying degrees depending on scenario. The combination of diagnostic questions and intervention support were dominantly present in the PSTs' responses from Scenarios 1, 3, and 4 (Figure 1). The other two combinations, such as checking understanding and intervention support, and diagnostic questions and checking understanding, were less present in the PSTs' responses from all scenario.

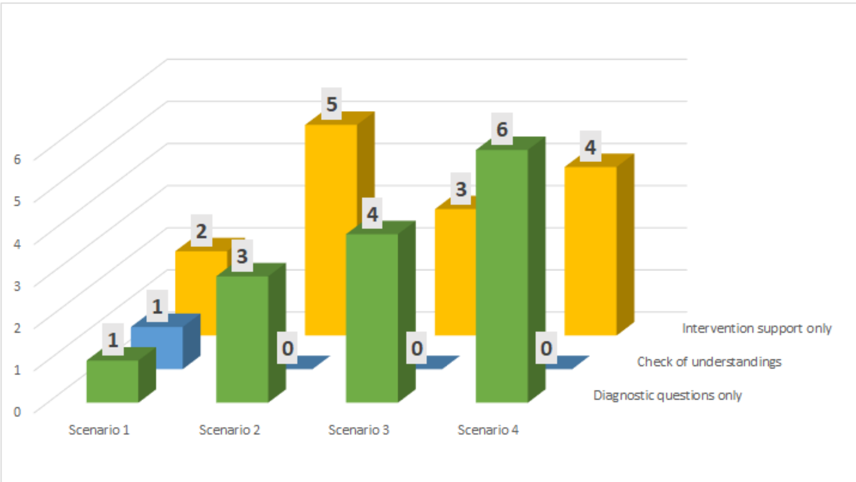

Figure 3. Instances of one component in each scenario

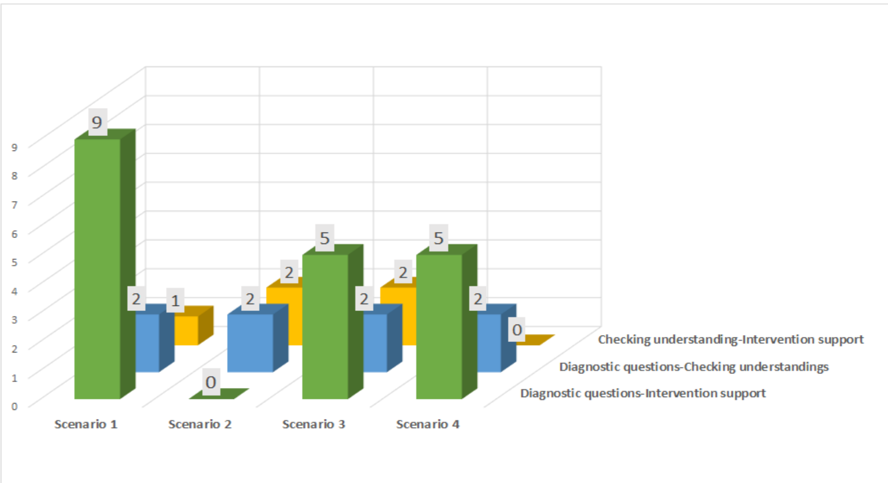

Figure 4. Instances of two components in each scenario

IV. NON-SUBJECT MATTER-RELATED NON-CONTINGENT TEACHING

Between Quadrants 2 and 3 in Figure 2, five responses had combinations between diagnostic questions and intervention support, which is thus non-contingent teaching. These five responses appeared only in Scenario 3, as shown in Figure 4, where the teacher in the scenario set up a talk norm and expected the students to work together. All of them began subject matter diagnostic questions and ended with non-subject intervention support. For example, a PST made a response to the third scenario that

> I would ask “So what are we thinking over here?” I would wait for their responses and then I would say, Robin what do you think about what Ebbie and Kathy did with the shape? Then I would prompt them to continue talking and remind them to work together as a whole group.

This example shows that the PST diagnose what students think of the problem by asking question “So what are we thinking over here?” This question is a subject matter-related question because the PST would ask the students to think of their mathematical ideas that the group members might share. The PST ended with encouraging students to talk together as a group, which is a non-subject matter intervention support. Like this example, five PSTs made responses with subject matter diagnostic questions and non-subject matter intervention support.

V. DISCUSSION AND IMPLICATIONS

In this section, I discuss three salient points in relation to the findings. First, the finding suggests the nature of non-contingent teaching on the part of PSTs by using their written responses, which may inform what support PSTs need to learn to teach contingently in their math instruction. Eighty-one percent of all responses were non-contingent teaching in terms that the responses did not include one or two components of the three components of contingent teaching, such as diagnostic questions, checking understandings, and intervention support. Mainly, the finding shows that when the non-contingent teaching responses of the PSTs had one component, they had more diagnostic questions or intervention support. When they had two components, they also had more of the combination of diagnostic questions and intervention support than the other two combinations. This combination shows that non-contingent teaching may be as much complex in its nature as contingent teaching.

The attention of the existing research on contingent teaching (Van de Pol et al., 2014; Van de Pol et al., 2011) has been paid to the nature of contingent teaching in classrooms and how to support teachers in a professional development regarding contingent teaching. This current paper differs from these researchers in that it puts an emphasis on understanding the non-contingent teaching in small groups. This current paper, however, does not make a claim that undermines the importance of understanding teachers' contingent teaching. Rather, it claims that examining non-contingent teaching in small groups on the part of PSTs may also allow teacher educators to support to help PSTs become better at contingent teaching.

Second, this paper suggests that regardless of whether the responses are contingent teaching kind or not, the PSTs' intended contingent teaching may be subject matter-related. As mentioned earlier, the existing research on contingent teaching has focused on subject-matter-related contingent teaching in small groups. As such, the researchers (e.g., Anwar et al., 2017; Van de Pol et al., 2011) showed the subject-matter-related contingent teaching only. In other words, these researchers did not show how non-contingent teaching was related to subject matter kind. These researchers acknowledged in their research that non-contingent teaching has some components of contingent teaching, which they suggested would not lead to quality scaffolding. The finding in this paper showed that the PSTs' responses in relation to non-contingent teaching in small groups were related to the subject matter.

As mentioned earlier in the literature section, students may experience challenges in small groups, and teachers may do non-subject matter contingent teaching to deal with the challenges. In this paper, I did not find the PSTs' responses did not have non-subject matter contingent teaching. It is possible, however, that in such cases, PSTs might do contingent teaching that were non-subject matter in small groups.

Third, the finding suggests that PSTs need to get more support in relation to checking understanding when they learn to use contingent teaching. As shown in Figure 3, which portrayed instances of one component in each scenario, checking understanding was very rare across scenarios. In Figure 4, which illustrated instances of two components in each scenario, checking understanding was relatively small, given a relatively small number of the combination between diagnostic questions and checking understanding and the combination between checking understanding and intervention support appeared across scenarios. Across scenarios, the combination of diagnostic questions and intervention support appeared more. This different combination points out a possibility that without checking out whether their understanding of students' understanding is correct or not, PSTs may ask questions to diagnose students' thinking and jump to particular intervention support. In terms of scaffolding, intervention support that is not built on checking understanding may not be helpful if the teacher's initial understanding is incorrect (Van de Pol et al., 2011).

This current paper shows what elementary mathematics PSTs' intended contingent teaching may look like in terms of (non-)contingent teaching and (non-)subject matter. I acknowledge that it might not be reasonable to think that these findings can be generalized to the PSTs' contingent teaching in actual practice because these findings are based on the elementary mathematics PSTs' written responses to scenarios. Given the benefits of analyzing PSTs' written responses to scenarios, however, which Buchbinder and Cook (2018) recognized in their research, these findings in this current paper may allow teacher educators to understand contingent teaching that PSTs may imagine and start from the understanding to find ways to support PSTs to do contingent teaching with (non-)subject matter. By starting from what they understand PSTs' knowledge, like Hammerness and colleagues (2005) argued, teacher educators also come to engage in contingent teaching in a broad sense. These findings also call for more research on how (non-)contingent teaching is related to (non-)subject matter on the part of PSTs given understanding this relationship is also one way to make contingent teaching take place in mathematics instruction.

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Appendix A: Four scenario items in the open-ended online survey

1) Scenario 1

(1) You are teaching second grade students about the meaning of the equal sign. You asked students in small groups to work on a math problem: 8 + 5 = □ + 7. When you are circulating around the classroom, you hear what students in a small group are saying.

Dan: What are we supposed to do?
Ada: [Shrugs her shoulders] add 8 to 5 [counting on with her fingers]. So we get 13. It goes into the square.
Dan: But how about 7?
Ada: I don't know…
Kay: I think we…need to add 7 to the square… [mumbles something quietly but unclear]
Dan: Teacher! I have a question! [You walk over.] I think I need to put 13 in the square [pointing to the square]

2) Scenario 2

(2) You are a fifth grade teacher. Your students are working together in small groups on decimal addition problems. One of the small groups is working on a decimal problem: "<u>5 + 0.4</u>". You are hearing their talk as follows as you monitor.

Anna: I don't think it matters which way you do it.
Andy: Let's use one of the word problems to see if it makes a difference. [she reads] "Andy put 5 gallons of gasoline into the gas can. He kept filling and adding another four-tenths of a gallon. How much gas is now in the can?"
Jesse: I think maybe Hank is right. I thought you just lined up the numbers but if you add five and point four like this [Kei writes the problem down], the answer is wrong; it's too small. Like five gallons of gas plus four-tenth more is more than five.

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   5
+0.4
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Hank: I think it is because we have to add the same things- like we add hundreds and hundreds with big numbers so now we have to add tenths and tenths or ones and ones.
Anna: But where are the tenth in five? [Raises her hand for your help and talks to you] We need your help.

3) Scenario 3

(3) You are teaching fourth grade students about lines of symmetry for two-dimensional figures. You are asking them to work together on a task: Identify line-symmetric figures and draw lines of symmetry. On a one-page handout, there are six figures, four of which are line-symmetric figures. At the introduction of the lesson, you clarified to the whole class your role and expressed your expectations. You will not provide any help with the content. Your expectation is that students need to work collaboratively and discuss, showing each other their work, giving each other explanations, and critiquing each other. As you monitor, you listen to the interactions between students in a small group. You decide to keep listening to their talk.

Kathy: Do you think that your way works out?
Robin: Yes… You did it first like this (pointing to a line of symmetry Kathy drew on the handout).
That's not the way I thought.
Ebbie: Stop it now, man… You need to explain…
Kathy: We have to talk a lot, so
Robin: Okay, then I will listen…
Ebbie: Okay, we now have to choose one of the figures and fold it in halves…

Some time later, Kathy and Ebbie discuss closely together and Robin doesn't seem to participate. You notice this and you decide to intervene in this small group.

4) Scenario 4

(4) You are a third grade teacher. You asked students in small groups to solve an open-ended task: Jane had [8, 9, 15] candies. Her mother gave her [3, 6, 18] candies. How many candies does Jane have now? You assigned individual students in small groups to roles: recorder, facilitator, checker, and cleanup. Now you are monitoring small groups. You are listening to students talking in a small group.

Jimmy (facilitator): How should we start to solve it?
RuAnn (checker): Pick two numbers and…. I don't know...
Minjun (cleanup): … (shrugs his shoulder.)
Jimmy (facilitator): What do you think (stares at group members.)
Ashley (recorder): I don't know.
Minjun (cleanup): …
RuAnn (checker): What do you think, Minjun?
Minjun (cleanup): I think... we need to... first...make numbers easy to add…(shrugs his shoulder, looks away, and, as usual, mumbles something quietly. But nobody can hear.)