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Prospective Teachers' Considerations During the Lesson Planning Process

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This paper presents an action research project completed in a mathematics methods course for prospective elementary school teachers. The goal was to determine if instructional practices were effective at preparing teachers to use students' thinking to inform instructional decisions. The teachers' ability to predict students' strategies and the teachers' considerations during the planning process were investigated. The teachers selected a task involving the comparison of ratios, anticipated students' strategies for completing the task, and explained their rationale. The prospective teachers effectively predicted students' strategies; however, those student strategies were not a consideration during the task selection process for the majority.

Introduction

When reflecting on a concluded semester, I began thinking about the link between my research and teaching. My research focuses on cognitively guided instruction (CGI) and inquiry-based instruction (IBI). When instructional decisions are based off of analyses of one's students' thinking, in combination with knowledge of the ways students typically develop and interact with the content, the instruction is said to be cognitively guided. Inquiry-based instruction refers to teaching practices that involve placing students in a carefully constructed, and sequenced, series of problems or project scenarios from which they can construct their own understanding of complex concepts. I can be relatively sure, from reading my prospective teachers' lesson plans, that they grasped the constructivist nature of IBI. However, I began to wonder how successful I was at preparing them to use CGI. To successfully plan CGI, my prospective teachers needed to be able to analyze task characteristics and anticipate elementary students' approaches to those tasks to determine if the task was appropriately aligned with the lesson goal.

Objectives of the Study

The purpose of this study was to determine how effective the methods used were at preparing future teachers to plan lessons in a cognitively guided fashion. The objective was to investigate: (a) the extent to which prospective elementary school teachers consider the link between numerical structure and student thinking when selecting proportional reasoning tasks in the lesson planning process and (b) the prospective teachers' ability to anticipate students' thinking.

Theoretical Framework

An underlying assumption connects the objective to the purpose of the study; my successful demonstration of the importance of task considerations and their influence on student generated strategies would increase the likelihood that, during the task selection process, the prospective teachers: first, consider the instructional goal; and, second, simultaneously consider the task characteristics (e.g. context, numerical structure) and likely student strategies.

The framework guiding the initial memoing and coding was derived from de la Cruz' (2013) delineation of proportion problem types (distinguished by context or numerical structure), students' proportional reasoning strategies (e.g. unit rate, factor of change), and the link between the two.

Kemmis, McTaggart, and Nixon's (2013) action research methods were employed: (a) develop a plan and research questions, (b) observe effects by evaluating data, (c) reflect, (d) incorporate new effects or themes to develop a plan for the future. This paper presents the first steps in my action research, and scholarship of teaching and learning. Future steps will involve utilizing the results of this investigation to develop a new plan and to continue with action research.

The data collected consists of an observation journal, documents, and an open-ended questionnaire, all related to a single activity taking place over two class meetings. While the prospective teachers completed this activity, the researcher recorded observations regarding their dialog and regarding when students' strategies were considered in the selection process. Each group was asked to create a poster presenting the comparison task and the student generated strategies they anticipated. The purpose of collecting the posters was to document the types of comparisons chosen and types of strategies anticipated. Finally, the prospective teachers were asked to complete an open-ended questionnaire to further document their considerations when selecting the comparison. Answers to the questionnaire could then be triangulated with the researcher's observation notes.

Miles and Huberman's (1994) systematic data analysis was used to derive causal descriptions and lawful relationships among the data by using data reduction, data display, and conclusion drawing and verifying. The questions that guided the qualitative analysis of this data are: (a) What did the prospective teachers consider when selecting the comparison task? More specifically, did they consider the numerical structure of the ratios within the comparison, the goal of the lesson, and the likely strategies that such a comparison would elicit from fifth graders? (b) Did the prospective teachers accurately predict strategies fifth graders would use to solve their chosen comparison problem? (c) What types of comparisons did the prospective teachers choose?

Practices Used

Several steps were taken to promote CGI and develop the ability to predict the ways elementary students will interact with the content. First, there was a persistent focus on problem solving and student generated strategies. Across all concepts, the need for students to construct their own strategies prior to the introduction to formal procedures was discussed. The prospective teachers predicted strategies students would invent for operating with single-digit and multi-digit numbers, for estimating, for representing and adding fractions, and for several other concepts.

Second, we specifically studied CGI as it relates to addition and subtraction word problems. The research findings of Carpenter, Fennema, Franke, Levi, and Empson (1999) that explicitly linked problem characteristics to certain student-constructed strategies were shared. The prospective teachers learned how to: analyze addition and subtraction story problems and categorize problems into the 11 types defined by Carpenter et al. Next, they predicted the strategies students would use to solve each of the 11 problem types, analyzed videos of pupils solving addition and subtraction story problems, and linked strategies to problem types.

Third, the prospective teachers completed two video analyses assignments. Each of the videos illustrated an authentic classroom scenario and provided a solid example of CGI in practice. To help the prospective teachers notice the classroom teacher's cognitively guided actions, they were asked to answer a series of questions which required them to analyze: (a) the link between task characteristics (e.g. context, numerical structure) and the classroom teacher's instructional goal, (b) students' strategies for solving the task, and (c) the classroom teacher's rationale for selecting and ordering the student strategies to be shared.

An activity was designed to assess the effectiveness of the three aforementioned methods in encouraging considerations that are consistent with CGI when planning lessons. The activity required pairs of prospective teachers to begin planning a lesson involving comparing ratios. The directions stated,

You are charged with the responsibility to design a lesson for a fifth grade class that involves comparing ratios. To make the lesson meaningful, we will be planning a lesson that involves comparing prices found in grocery circulars. Complete the following in the order that you feel is most appropriate:

- Select at least two similar items found in the provided grocery circulars that you would like students to compare (your lesson would be focused around this task);
- Anticipate the strategies fifth graders might employ to compare the prices you chose;
- Determine the goal of your lesson.

The pairs were asked to create a poster to share with the class and to answer the following reflection questions: (a) Of all the comparisons that could have been chosen, explain in detail why you chose these two items. (b) What did you consider when selecting the comparison? (c) What is the goal of the lesson?

Results and Discussion

Four main findings emerged from the analyses:

1. All of the prospective teachers considered the quantities involved in the rates when selecting a comparison. However, 50% of the prospective teachers considered the quantities in a significant way.
2. The majority of the prospective teachers did not consider their instructional goal, or the strategies students would likely use to complete the comparison, until *after* they had selected the comparison task.
3. When the prospective teachers considered their instructional goal or student strategies during the task selection process, they did not do so independently. Instead, they simultaneously considered the lesson goal, student strategies, and the relationship between the quantities involved.
4. The prospective teachers were able to effectively predict the strategies that students would most likely implement. Their predictions were consistent with those found to be most likely by existing research, due to numerical structure.

These findings indicate the success of the practices used to prepare prospective teachers to anticipate students' thinking. However, they also indicate the need for further steps to emphasize the interplay between instructional goals, task choices, and anticipated strategies.

When selecting items to compare, all of the prospective teachers were observed selecting items that would be familiar to fifth grade students; 75% indicated it was a specific consideration in their responses on the questionnaire. Group F said, “We chose to have Capri-Sun as our item to compare because many students drink it, so it is relevant to their lives. …” Similarly, Group B expressed, “We chose these two items because the students would be familiar with the item and would be able to visualize the 48 oz. carton [of ice cream]. …” According to Heller, Ahlegren, Post, Behr, and Lesh (1989), choosing a familiar item is a significant consideration because students tend to be more successful with proportional reasoning strategies when the context is familiar.

Although all of the prospective teachers considered the numerical structure involved in the comparisons during the selection process, only five of the eight pairs examined the numerical structure in a significant way, by discussing the type of quantities or the relationship between the quantities involved. To this effect, Group D wrote, “We wanted to set up a simple problem so we looked for an easy comparison using the same units and easy numbers.” In their problem, students were asked to determine the better deal for toilet paper, 12 rolls for $6.99 or 24 rolls for $11. They explained that the numbers were easy because “to get from 12 rolls to 24 rolls, you just need to multiply by two.” Three groups explained that they chose two ads with varying quantities, prices, and/or sizes, which was categorized as a numerical structure consideration. However, this reflection on numerical structure in absence of further thought regarding the relationship between the quantities was deemed insignificant. For instance, Group C said, “We chose to compare these two items because they are the same product but at varying sizes and different prices. This allows the students to be able to compare price and size and determine which deal is the better buy.” Similarly, Group H said, “We made sure there was a difference in price.” This type of rationale was not considered significant, because without some variation in price or quantity, the comparison would be trivial.

Though the majority of the class considered the numerical structure present when determining which items to include within their comparison task, neither the instructional goal nor students’ thinking generally factored into the decision making process. Only three of eight groups mentioned a strategy students would use to compare rates in their expressed rationale for their task decision. The same three groups were the only ones to link their rationale to their instructional goal. For instance, Group B stated, “We chose the Breyer’s ice cream that had a price for one of the item [unit rate]. The price for the Hood ice cream is presented as a ratio [$5 for 2 cartons]. The students will have to determine the price of one carton." Thus, Group B selected this comparison to encourage their students to find a single unit rate, which they also stated as their goal: "Students can compare prices of cartons of ice cream by dividing a fraction." Similarly, Group A aimed for a unit rate with their choices. They communicated, "We considered the students' prior knowledge in relation to division and fractions," which was closely aligned with their goal, "for students to relate the problem to division." All of the considerations of the prospective teachers are summarized in Table 1.

According to the existing literature, we can predict the proportional reasoning strategies students are likely to use by examining the numerical structure of the proportion (e.g. Cramer, Post, & Currier, 1993; Miller & Fey, 2000; Singh, 2000; Weinberg, 2002). In all cases, the prospective teachers anticipated the strategy that is most consistent with the research findings. Table 2 illustrates the problems selected by the prospective teachers, identifies their numerical structure, and names the most likely strategy corresponding to the present numerical structure according to the literature.

Implications

The purpose of this research was to examine and improve instruction, as it relates to CGI. I wondered whether or not prospective teachers, at the end of the course in methods for teaching elementary mathematics, would plan lessons in a manner that is consistent with CGI. That meant that the prospective teachers would make instructional decisions based upon their students' thinking. More specifically, the prospective teachers needed to be able to predict students' strategies and analyze aspects of tasks that would influence those strategies.

Many studies have shown that prospective teachers and new teachers struggle to identify the ways in which students will approach problems. According to Kastberg, D'Ambrosio, and Lynch-Davis (2012), "The thinking of teachers is shaped by an adult understanding of the problem and an algorithmic approach they have mastered often does not resemble the way in which the students approach the problem." The results of this study imply that the methods employed to practice and develop this skill in the prospective teachers was effective. A concerted effort was aimed to provide several varied opportunities for the prospective teachers to think like a student: anticipating, interpreting and explaining students' thinking.

Table 1

The Prospective Teachers' Considerations during the Task Selection Process

Pairs	Familiar Item	Numerical Structure: Varying Quantities or Sizes*	Numerical Structure: Relationship between the quantities	Strategies	Goal
A	✓		✓	✓	✓
B	✓		✓	✓	✓
C	✓	✓			
D	✓		✓		
E		✓			
F	✓	✓			
G			✓	✓	✓
H	✓		✓		

Table 2

Numerical Structure and Strategy Predictions by the Prospective Teachers

	Comparison	Ratios	Numerical Structure: Unit rate provided	Numerical Structure: Integer FOC - within	Numerical Structure: Integer FOC - across	Numerical Structure: No Integer FOC	Strategy corresponding to numerical structure	Strategy Predicted
A	String Cheese: 1 pkg for $3.99 2 pkgs for $7	$\frac{\$3.99}{1}$ or $\frac{\$7}{2}$	✓	✓	✓		Unit rate	✓
B	Ice cream: 1 carton for $3.99 2 cartons for $5	$\frac{\$3.99}{1}$ or $\frac{\$5}{2}$	✓	✓	✓		Unit rate	✓
C	Cookies: 20oz for $3.99 2-13oz for $4	$\frac{\$3.99}{20}$ or $\frac{\$4}{26}$				✓	Comparison is obvious	✓
D	Toilet Paper: 12 rolls for $6.99 24 rolls for $11	$\frac{\$6.99}{12}$ or $\frac{\$11}{24}$			✓		FOC-across	✓
E	Soda cans 3-12 packs for $10 24 pack for $4.99	$\frac{\$10}{36}$ or $\frac{\$4.99}{24}$				✓	Common denominator (12 cans)	✓
F	Juice boxes: 1 box for $1.77 2 boxes for $4	$\frac{\$1.77}{1}$ or $\frac{\$4}{2}$	✓	✓	✓		Unit rate	✓
G	Yogurt: 10 for $10 4 for $3.89	$\frac{\$10}{10}$ or $\frac{\$3.89}{4}$		✓			Unit rate	✓
H	Soup cans: 5 for $5 2 for $4 10 for $10	$\frac{\$5}{5}$ or $\frac{\$4}{2}$ or $\frac{\$10}{10}$		✓	✓		Unit rate or FOC - across	✓

Note. FOC-within = factor of change within a single ratio, numerator to denominator; FOC-across = factor of change across ratios, numerator to numerator or denominator to denominator.

On the other hand, this study demonstrates the need for further clarification related to lesson planning and considerations while planning. Reflection revealed that, although much time was dedicated to writing lesson plans (e.g. writing clear and measureable objectives, incorporating transition statements, linking assessments to objectives, etc.) and completing lesson analyses, the process of developing a plan (e.g. selecting the major task or activity) was given less attention. On the topic of developing a plan, a few steps to planning, prior to writing a lesson plan, which included determining the instructional goal, selecting a task or activity, anticipating students' strategies and difficulties, and identifying requisite knowledge were outlined. More attention could have been given to explicate that selecting a task should not be done without consideration given to the ways students may approach the task and the link between those approaches and the instructional goal. Additionally, practice could be improved by modeling the planning process in the methods course. For instance, we could complete a task selection activity similar to the comparison activity, where the instructional goal, tasks, and students' strategies are considered simultaneously.

Due to the cyclical nature of action research, this project will continue in subsequent iterations of my elementary mathematics methods course. I am currently using the results of this study to develop a new plan to improve and study my own teaching, which incorporates the aforementioned ideas. Although this research is not generalizable, the hope is that the results may encourage others to reflect on their own practice.

References

Carpenter, T. P., Fennema, E., Franke, M. L., & Empson, S. B. (1999). *Children's mathematics: Cognitively guided instruction.* Portsmouth, NH: Heinemann.

Cramer, K. A., Post, T. R., & Currier, S. (1993). Learning and teaching ratio and proportion: Research implications. In D. Owens (Ed.), *Research ideas for the classroom* (pp. 159-178). New York: MacMillen Publishing Company.

De la Cruz, J. A. (2013). Selecting proportional reasoning tasks. *Australian Mathematics Teacher, 69*(2), 14-18.

Heller, P., Ahlgren, A., Post, T., Behr, M., & Lesh, R. (1989). Proportional reasoning: The effect of two context variables, rate type and problem setting. *Journal for Research in Science Teaching, 26*(1), 205-220.

Kastberg, S., D'Ambrosio, B., & Lynch-Davis, K. (2012). Understanding proportional reasoning for teaching. *Australian Mathematics Teacher, 68*(3), 32-40.

Kemmis, S., McTaggart, R., & Nixon, R. (2013). *The action research planner: Doing critical participatory action research. Singapore: Springer*.

Miles, M.B. & Huberman, A.M. (1994). *Qualitative data analysis: An expanded sourcebook.* London: Sage Publications.

Miller, J. L., & Fey, J. T. (2000). Proportional reasoning. *Mathematics Teaching in the Middle School, 5*(5), 310-313.

Singh, P. (2000). Understanding the concepts of proportion and ratio among grade nine students in Malaysia. *International Journal of Mathematical Education in Science and Technology, 31*(4), 579-599.

Weinberg, S. L. (2002). Proportional reasoning: One problem, many solutions. In B. Litwiller & G. Bright (Eds.), *Making sense of fractions, ratios, and proportions* (2002 Yearbook ed., pp. 138-144). Reston, VA: NCTM.