Assessing students' conceptual and procedural learning for graphing lines and functions through application problems.

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Introduction:

Students have difficulties in problem solving for various subjects because their conceptual understanding of these subjects, and related procedural knowledge are not established and supported enough in mathematics instruction.

The purpose of my research was to increase my students' conceptual and procedural understanding of graphing functions by modifying my lesson plans to incorporate relevant application/word problems. By doing so, students will be able to think critically about the meaning of various steps of graphing functions, and solving related problems. In addition, they will be able to analyze the graphs involved in these problems. My main research questions were:

- To what extent will application/real-world questions help my Algebra-2 students to increase their conceptual and procedural learning for graphing lines and functions?
- What are my students' most common conceptual and procedural difficulties in graphing lines, functions, and analyzing data on these graphs?

Investigation:

My research study investigated underlying reasons for my students' difficulties in solving math problems related to graphing piecewise functions and exponential decay/growth functions in my Algebra-2 classes in light of conceptual and procedural knowledge interrelationships.

Qualitative analysis of student work showed me that there needed to be a better and more effective conceptual learning of these mathematical concepts in my classes. In addition to this, conceptual learning must be accompanied with effective and useful procedural knowledge/ skills, such as how to use the order of operations or steps for solving basic algebraic equations, which will facilitate student learning significantly. In order to achieve this, I identified two different functions for graphing (piecewise functions and exponential decay/growth functions) and taught these concepts by integrating application and word problems into my lesson plans.

Connection to Industry:

Today's employers are looking for professionals that are able to generate, process and interpret written and quantitative data to improve on existing processes. Not only on a cost saving basis but also on an efficiency level which will generate better conditions for their employer. Therefore, employees' ability to analyze such data correctly, is crucial for their future success. In turn, explaining and quantifying the logic behind their findings to other colleagues and superiors, in a way that is understandable by all stakeholders involved, will support the success of their future careers.

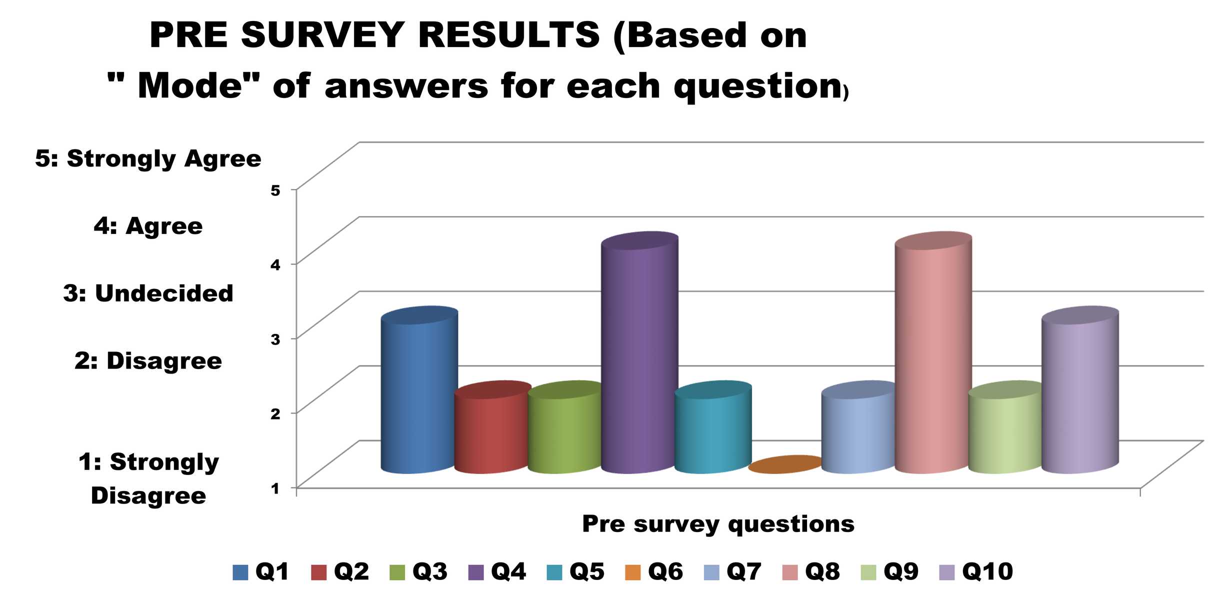
Methods:

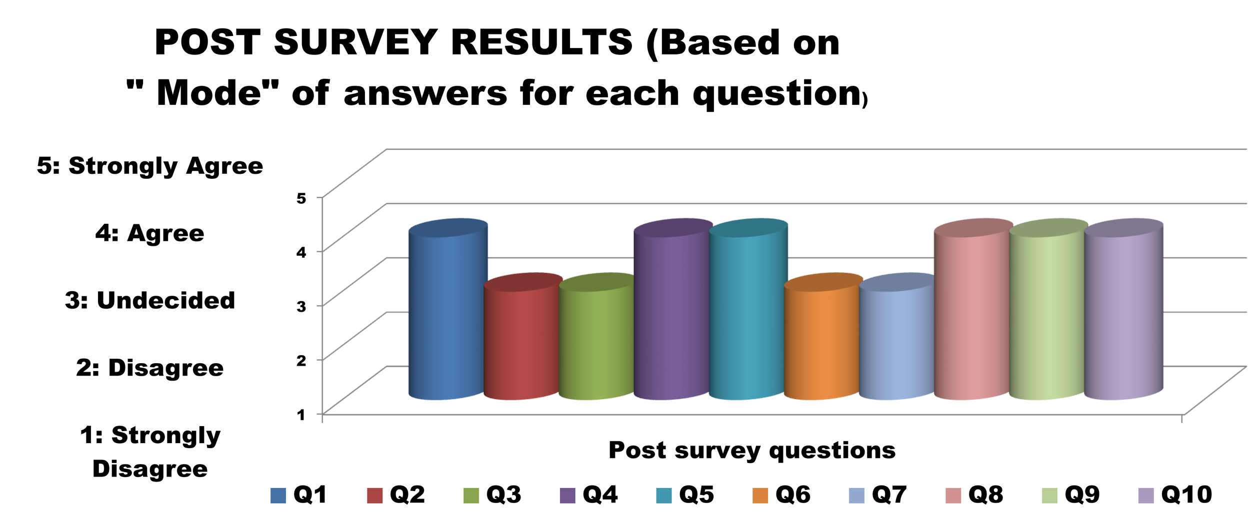
Forms of quantitative data for this study included a pre-survey after a homework assignment, and post-survey after an application/word problem assignment for two math subjects. I analyzed this data by using frequency counts. I looked at modes of answers given for each question asked in the pre and post surveys. A pre survey was given after students completed a regular homework for the first subject (graphing piecewise functions), and a post survey was given after students completed an application problem for the same subject. A graphical comparison of the answers gathered from pre and post surveys can be seen in Graph 1. For the second subject (graphing of exponential growth/decay functions), I also used pre and post surveys. A graphical comparison of the answers gathered from pre and post surveys can be seen in Graph 2.

In addition, I collected qualitative data to analyze students' procedural and conceptual learning. Data collection for both math subjects took about 2-3 weeks. A total of 30 students were included in the study. These students are from my 4 different periods including regular and Honors Algebra-2 classes.

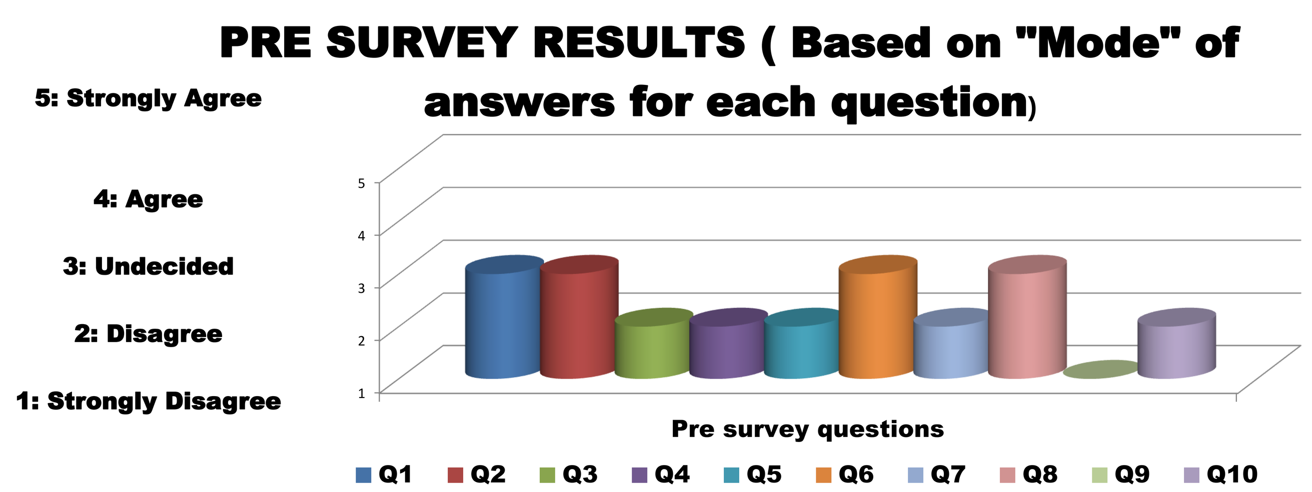
Results:

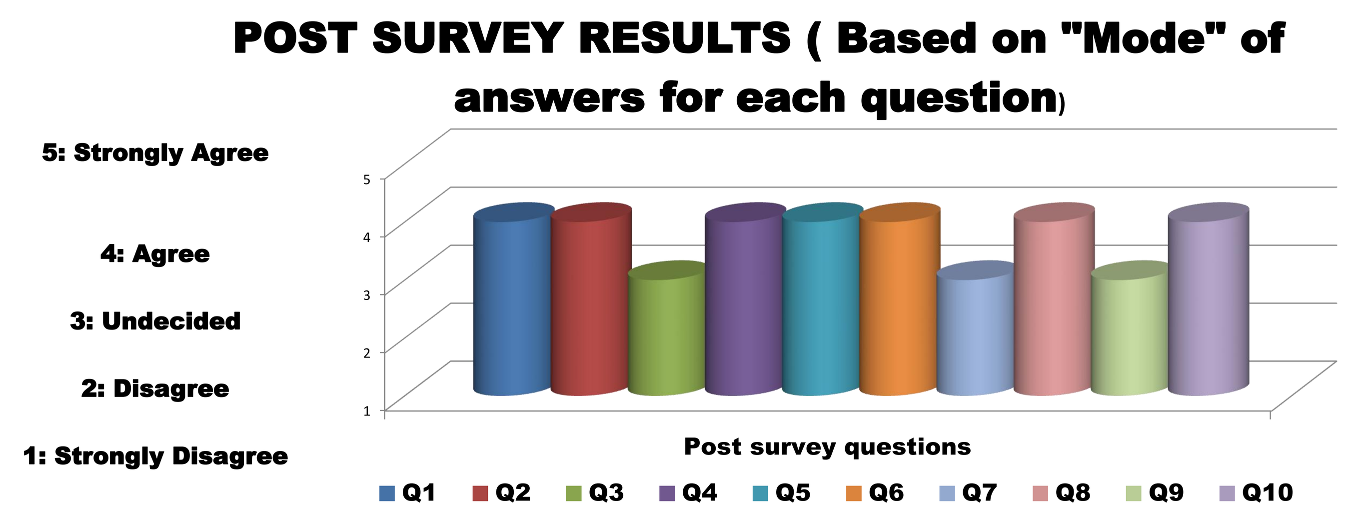
PROBLEM -1 (Quantitative findings for Application Problem, Piecewise Functions)





PROBLEM-2 (Quantitative findings for Application Problem, Exponential Growth & Decay)





Findings and Conclusion:

All students' scores improved on problem sets after engaging in the application and word problems exercises demonstrating their increased conceptual and procedural understanding of graphing lines and functions. Main areas of improvements in student learning were:

- ❑ **Increased conceptual understanding of why there are different graphs such as lines and curves for different functions.**
- ❑ **Increased conceptual understanding of different components of graphs such as meaning of slope of a line, relationship between variables on a graph.**
- ❑ **Improved ability to analyze a given data set and to create a graphical solution to a real life math problem.**
- ❑ **Increased student confidence in explaining meaning of numbers, mathematical signs, vocabulary, and interpreting data on graphs.**
- ❑ **Fewer procedural algebraic mistakes in math calculations because the real life context of problems encourages students to think before doing the math.**

Quantitative and qualitative analyses of both application problems showed that real life connections through application problems help increase student motivation. Application problems also increase the "likeability" of math concepts in students' minds. Increased student interest in math concepts help overall student learning both conceptually and procedurally.

Changes to Classroom Practice/Future Work:

According to Joe Boaler, students must construct their own mathematics learning in different contexts in which they can make their own decisions and personal choices. In this environment, they will be more motivated to learn mathematics because they will value learning mathematics, and will be able to transfer mathematics content across different real life contexts (Boaler,1993).

Therefore, in order to achieve maximum increase in conceptual and procedural learning, teachers' effort to design and implement application driven instruction and lesson plans is essential. Based on my experience in my study, I will strive to improve my lesson plans and instruction to increase student learning in the coming years as follows:

- ❑ **Integrate application problems/real life connections into my lesson plans to make math more meaningful for students.**
- ❑ **Create a learning environment that encourages all students to communicate math concepts and ideas by writing, explaining, and discussing among them.**
- ❑ **Measure student learning periodically and make necessary adjustments to my teaching to accommodate all students' diverse learning needs.**

References:

Jo Boaler. (1993). Encouraging the Transfer of 'School' Mathematics to the 'Real World' through the Integration of Process and Content: Context and Culture Educational Studies in Mathematics Vol. 25, No. 4, 341-373

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