



Do Teachers Have the Opportunities They Need to Learn to Teach with Manipulatives?

Kristina K. Hill

Texas A&M University, tina7@tamu.edu,

Ali Bicer

Texas A&M University, alibicer@tamu.edu

Mary Margaret Capraro

Texas A&M University, mmcapraro@tamu.edu

Abstract

Teachers complete professional development through inservice provided by their schools, through summer workshops, or by attending conferences. A nationally known mathematics teachers' organization provides regional and annual conferences for teachers to learn new teaching techniques. Manipulatives are often used as teaching tools to help students learn mathematical concepts. In an effort to determine what concepts, standards, and grade levels manipulatives were presented at the regional and annual conferences of the national organization, the 2011 through 2014 conference programs were analyzed. Sessions dealing with manipulatives contained all standards and grade levels with fractions, number sense, and place values among the many concepts being explained using manipulatives.

Keywords: Manipulatives, Mathematics Teachers, Professional Development



Introduction

Physical manipulatives are “physical objects handled by individual students and small groups” (National Council of Superintendents of Mathematics, 2014, p. 34). Virtual manipulatives are pictorial images that provide for the construction of mathematical concepts that are interactive and Web-based (Moyer, Boyard, & Spikell, 2002). Pattern blocks, color tiles, algebra tiles, base ten blocks, interlocking cubes, colored chips, and fraction strips are examples of manipulatives that teachers have used to help students better understand mathematical concepts and “to translate abstractions into a form that enables learners to relate new knowledge to existing knowledge” (Moyer, 2001, p. 194).

Mathematical manipulatives provide students with a way to make abstract concepts more concrete. Students are able to control physical objects “to explore and develop an understanding of mathematical concept” (Bouck & Flanagan, 2010, p. 186). However, using manipulatives in the teaching of mathematical concepts is a challenge for some teachers due to these teachers’ lack of knowledge of effectively using manipulatives (Rees-Potter, n.d.). Sowell (1989) found mathematical achievement increased when teachers employed manipulatives. Professional development allowed teachers to gain the familiarity necessary to use mathematical manipulatives in the classroom (Langbort, 2001; Moyer, Salkind, & Bolyard, 2008).

The fifth mathematical practice of the Common Core State Standards initiated the use of concrete models as tools that can and should be used in the understanding of mathematical concepts. The initiative gave importance to teachers becoming knowledgeable about the use of manipulatives. The National Council of Supervisors of Mathematics (NCSM) has also encouraged the use of concrete objects (NCSM, 2014).

Professional Development

Professional development is an effective means for teachers to learn about changes in standards, grow their content knowledge, and increase student learning and understanding (Borko, 2004; Darling-Hammond & Richardson, 2009). Teachers are professionals and as such need to continuously hone their craft. Novice and veteran teachers alike are confronted with new instructional processes, technological advances, modifications in educational laws and procedures, and student learning requirements (Mizell, 2010).

Fullan (2007) wrote, “. . . student learning depends on every teacher learning all the time” (p. 35). School systems provide professional development as a way for teachers to



improve their performance and increase student achievement (Blank, de las Alas, & Smith, 2007; Mizell, 2010), but this goal is not always successful. Snow-Renner and Lauer (2005) found mixed results concerning professional development increasing student achievement. In an analysis of 1,300 studies, Yoon, Duncan, Lee, Scarloss, and Shapley (2007) discovered only nine studies had moderate effect sizes on student achievement. Based on these studies, the researchers believe there are three steps in the professional development process that affect student achievement: enhancement of teacher knowledge and skills which leads to better classroom teaching; better classroom teaching leads to increased student achievement. Student learning cannot be expected if any of the three steps are missing (Yoon et al., 2007).

Professional development may be provided by a school system through in-service opportunities (Blank et al., 2007) or through workshops, conferences, and/or college classes (Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009). The majority of professional development was provided through workshops (as cited in Gulamhussein, 2013). These learning environments provided to teachers are often led by teachers.

Purpose of Study

The present study was conducted to determine what manipulatives were being presented with what concepts at a nationally known mathematics teacher organization's regional and national conferences from 2011 to 2014.

Research Questions

1. Did the sessions that involved manipulatives at NCTM mathematics regional and national conferences from 2011 - 2014 include all mathematics content standards?
2. Did teachers at all grade levels have the opportunity to learn to use manipulatives at NCTM mathematics regional and national conferences from 2011 - 2014?
3. Are there more sessions involving manipulatives at NCTM regional conferences than at the NCTM national conference between 2011 and 2014?
4. What concepts were covered with manipulatives at NCTM mathematics regional and national conferences from 2011 - 2014?

Methodology

The regional and national conferences of a nationally known mathematics teacher organization were analyzed. The programs from all regional conferences from 2011 to 2014 and the annual national conference from 2011 to 2014 were located online. The total number of sessions offered during the national conferences ranged from 653 in 2014 to 733 in 2015.



The regional conference session offerings ranged from 218 in 2012 to 319 in 2011. The sessions' descriptions were searched with the keyword "manipulat" to find offerings of using manipulatives to teach students mathematical concepts. The full word "manipulatives" was not used so that the term "manipulate" would be included in the search. Information from the session was gathered as to the grade level targeted and concept standard focused on. All of these data were collected into an Excel spreadsheet.

Using an Excel spreadsheet and SPSS-22, each grade level and each content standard was given a numeric code. The numeric codes were used to analyze the data. Excel functions used in the analysis of the data included sort, count, sum, average, and stdev.p.

Results

Research Question 1: Did the sessions that involved manipulatives at NCTM mathematics regional and national conferences from 2011 - 2014 include all mathematics content standards?

From 2011 to 2014, all content standards were covered by the sessions in which manipulatives were the topic. Many sessions contained more than one standard. For some sessions it was difficult to determine the content standard based on the description provided of the session in the conference program. Using only the five content standards, 130 of the sessions (40.1% of the total number of sessions) dealt with number and operations, 42 sessions (13.0% of the total number of sessions) contained algebra content standards, 53 sessions (16.4%) addressed geometry, 3 sessions (0.9%) addressed measurement, and 4 sessions (1.2%) addressed data analysis and probability. Nine sessions contained a combination of numbers and operations, algebra, and geometry; six sessions contained algebra and geometry; and five sessions contained number and operations, and data analysis and probability.

Table 1. *Frequency of Content Standards -- All Conferences*

Content Standard	Frequency	Percent of Total
1.0 Number and Operations	130	40.1
2.0 Algebra	42	13.0
3.0 Geometry	53	16.4
4.0 Measurement	3	.9
5.0 Data Analysis and Probability	4	1.2



Breaking down each conference, both the 2014 regional and 2014 annual conferences offered sessions that contained at least one of the five content standards. The remaining conferences did not include the content standards of measurement or data analysis and probability with the exception of the 2012 and 2013 annual conferences, of which both included one session using data analysis and probability. The 2011 annual conference included a session that combined the number and operations and measurement content standards, while one of the 2011 regional conference included a session containing content standards of number and operations, algebra, geometry, and data analysis. The 2012 annual conference provided one session combining content standards of number and operations with data analysis and probability and one session combining geometry with measurement.

Research Question 2: Did teachers at all grade levels have the opportunity to learn to use manipulatives at NCTM mathematics regional and national conferences from 2011 - 2014?

When analyzing all conferences together, the frequency of sessions involving manipulatives occurring for all grade levels ranged from 30 sessions that combined grades 6-8 and 9-12 to 55 session provided for grades 3-5. Figure 1 illustrates the frequency of the manipulative sessions for all grade levels and combined grade levels.

An analysis of the individual years and regional versus annual conferences demonstrated that the 2013 regional conferences did not provide sessions for grades 6-8 as an individual group. There were seven sessions that combined grades 3-5 and 6-8, with four sessions for the combined grades 6-8 and 9-12. All other conferences across all of the years provided sessions for grades 6-8 as an individual group as well as for combined grade levels.

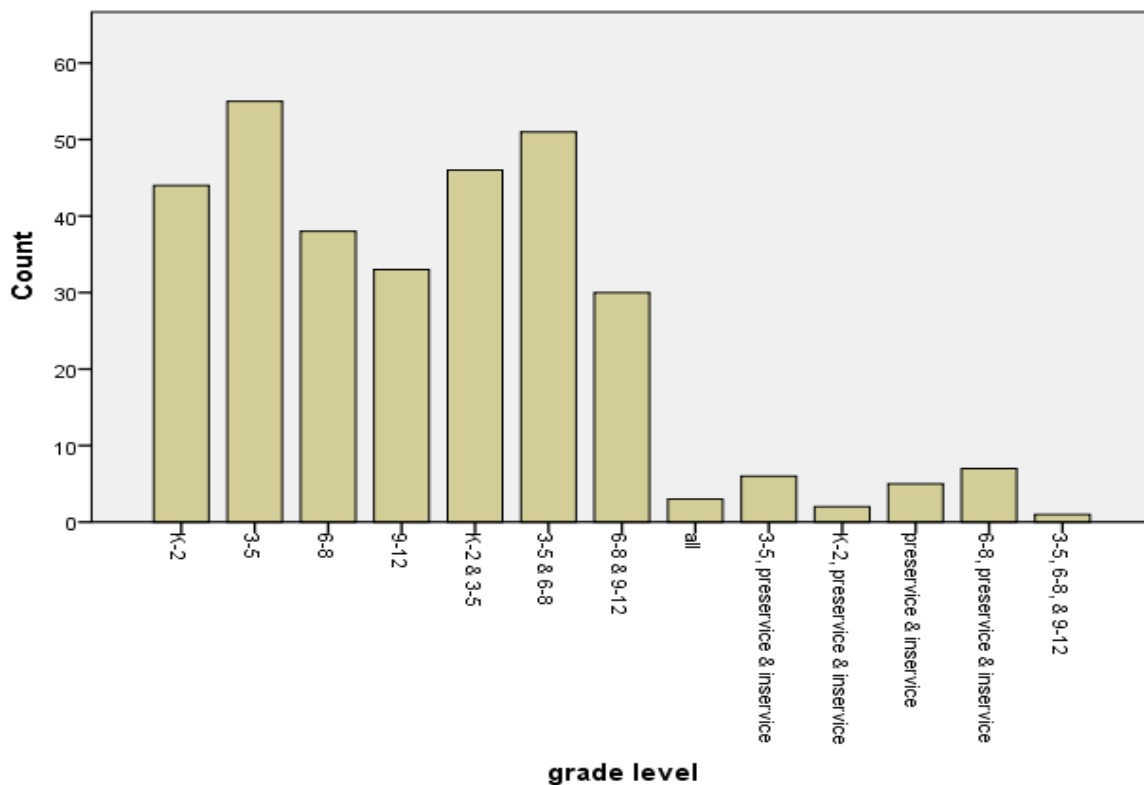


Figure 1. Frequency of manipulative sessions per grade level.

Research Question 3: Are there more sessions involving manipulatives at NCTM regional conferences than at the NCTM national conference between 2011 and 2014?

In order to find the number of sessions with manipulatives as the topic, the number of sessions at regionals for each year was added; then a mathematical average was taken. The same can be said for the annual conferences. The total number of sessions at the regional conferences was 160, which resulted in a mean of 40 ($SD = 7.6$). The total number of sessions at the annual conferences was 34.5 ($SD = 4.4$). As indicated in the Figure 2, there were more manipulative sessions at regional conferences than at the annual conferences during 2011 and 2014. Figure 2 illustrates the frequency of manipulative sessions according to conference so that a comparison across the years can be made.

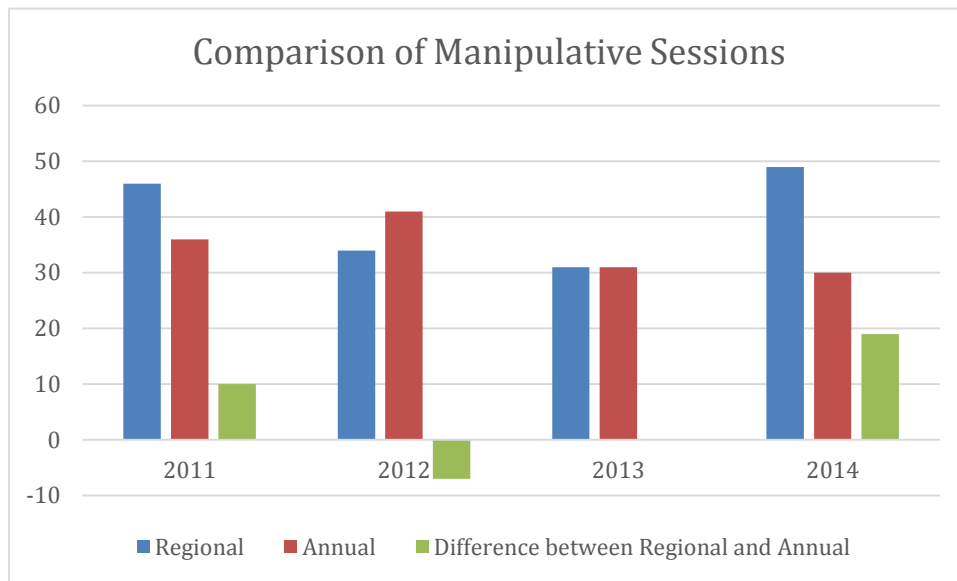


Figure 2. Frequency of manipulative session according to conference.

Research Question 4: What concepts are covered with manipulatives at NCTM mathematics regional and national conferences from 2011 - 2014?

Within each content standard, certain concepts were demonstrated with manipulatives. The top concepts taught with manipulatives between 2011 and 2014 during all regional and annual conferences were fractions, number sense, place value, problem solving, patterns, area, transformations, decimals, equations, and integers. Other concepts were included, but they were not limited to geometric concepts such as proofs, similarity, and polygons, and algebraic concepts such as factoring and functions. Of the top 10 concepts, fractions were the topic of 15.77% of the sessions that used manipulatives. The second most common concept taught using manipulatives was number sense (6.31%). Following close behind number sense with 5.63% was place value. (See Figure 3.)

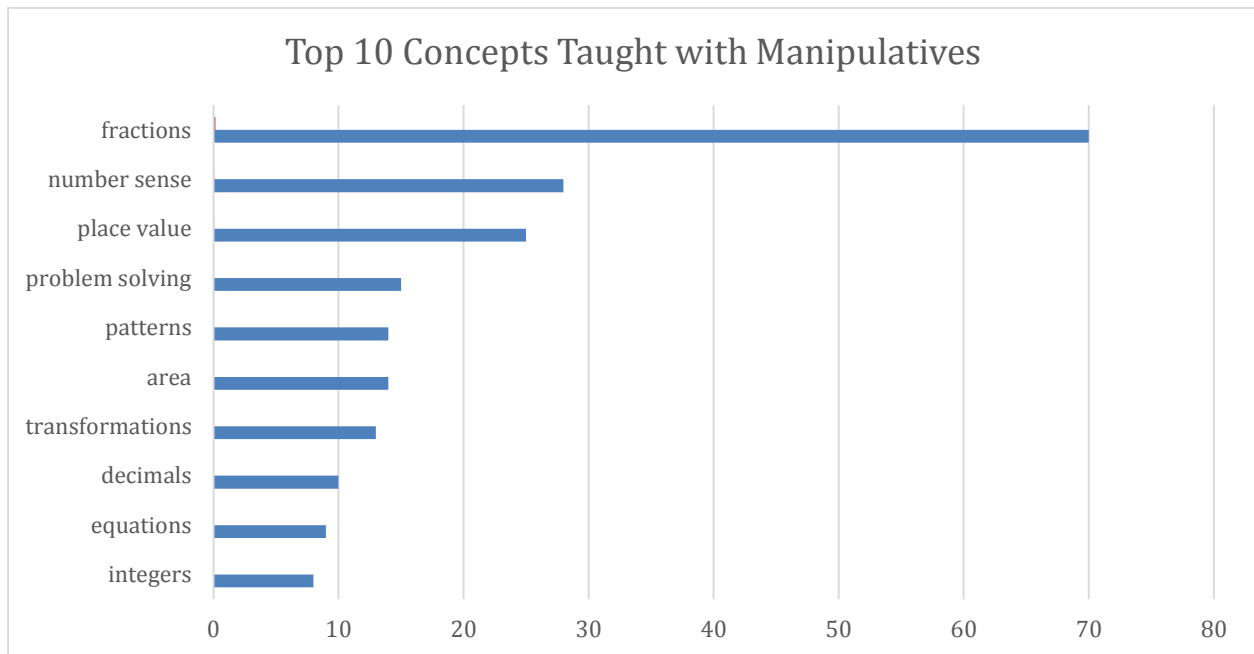


Figure 3. Top 10 concepts taught with manipulatives.

Discussion

Professional development providers who deliver training directed toward a specific instructional practice advance teaching practice (Desimone, Porter, Garet, Yoon, & Birman, 2002). Teachers are urged to use concrete material to help their students understand abstract concepts (Carbonneau, Marley, & Selig, 2013; Langbort, 2001; Sowell, 1989). Although workshop style professional development has been proven by some researchers to be ineffective (Darling-Hammond & Richardson, 2009), workshop/conferences continue to provide teachers with information on how to teach mathematical concepts using manipulatives. As the results of this study indicate, there are a number of concepts that can be taught with manipulatives that will make abstract concepts more concrete for the students.

This analysis suggests that there are more concepts taught at the lower grades in which manipulatives would be more useful than for concepts taught at the upper grades. One possible reason for this is due to the fact that there are more sessions dealing with fractions than any other concept. Fractions have been found to be difficult for students to understand, and the use of manipulatives tends to help make understanding fractions more concrete (D. Goldsby, personal communication, November 1, 2015).

Numerous mathematical concepts in the upper grades that are conducive to the use of manipulatives are being underrepresented in the conference types of professional



development. For example, geometry concepts such as polygons, similarity, and central angles were each presented in only 1.58% of the manipulative sessions. Functions and factoring, algebra concepts presented in the upper grades, were presented in less than 1.58% of the sessions. Additional investigation is proposed to compare the different types of instruction presented for a particular concept at different grade levels.



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