Mathematics Specialists: Development of Preparation Program and Research on Impact of Specialists

Bill Haver

Virginia Commonwealth University

The Mathematics Community in Virginia has been interested in Mathematics Coaches working with elementary school teachers for the past 20 years

- Virginia Council of Teachers of Mathematics
- Virginia Mathematics and Science Coalition
- Mathematics Supervisors
- University Mathematicians
- University Mathematics Educators
- Mathematics Staff of Virginia Department of Education

ASSUMPTIONS

- Many more students can be successful at understanding mathematics
- This success can be achieved with well designed teaching strategies by teachers with deep mathematics knowledge
- In-school professional development meeting specific mathematics needs of teachers is most effective means to improve student learning

Virginia Mathematics and Science Coalition Mathematics Specialist Taskforce

Chaired by Vickie Inge,
Stafford County Public Schools,
(Currently at the University of Virginia)

THREE INTERRELATED GOALS

- Strong preparation/support program available to prospective Specialists
- Scientific research measuring impact of Specialists and determining what work by Specialists has greatest impact
- Support of principals, school administration, Boards of Education, legislature, public

Strong Preparation/Support Program available to Prospective Specialists

- Course Development Teams
- Strong Masters Degree Program
  - Mathematics Knowledge for Teaching
  - Mathematics Education
  - Leadership
- VMSC Statewide Masters Degrees Program

RESEARCH

Support provided by the National Science Foundation and the U.S. Department of Education through the Virginia Department of Education

- This research is absolutely critical
- Decisions need to be evidence based
- Criteria for research is that it could turn out negative

RESEARCH

Involved school systems, Virginia Department of Education, funding agencies (including Virginia legislature).

Mostly it included hard work by the Specialists that we are recognizing today

- Treatment/control schools
- Case studies
- Interviews

BROADER SUPPORT

- Virginia Board of Education
- Virginia Department of Education
- Virginia Legislature
- School Administrators

Within Virginia and nationwide there is a commitment to basing decisions on evidence.

Today we are recognizing the work of those that have worked to seek this evidence.

Results of Quantitative Research Study

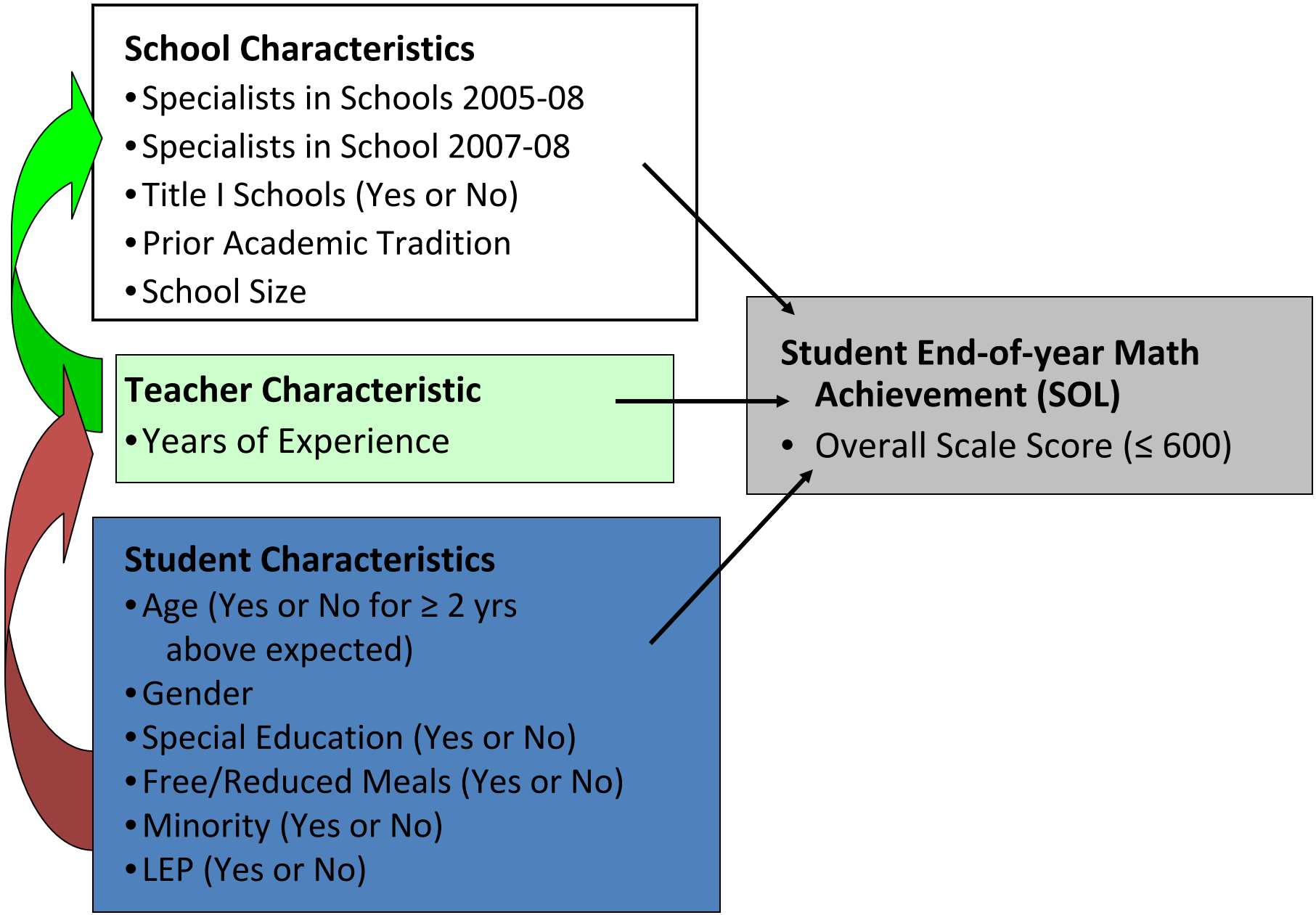
Patricia Campbell

University of Maryland

Three of the Quantitative Research Questions

- **What is the effect of elementary mathematics specialists on students' achievement over time as measured by the SOL's?**
- **Do elementary mathematics specialists impact the likelihood of students' performance on the SOL's being rated as "advanced proficient"?**
- **What is the effect of elementary mathematics specialists on teachers' beliefs about mathematics teaching and learning over time?**

Conceptual Map for HLM Analysis



Do elementary mathematics specialists significantly impact the mathematics achievement of the students in their schools, as measured by the SOL's?

YES!

Year by Year Scale Score Performance

Grades 3, 4, and 5

- **Overall, students in schools with elementary mathematics specialists for 3 years had statistically significant higher scores on the SOL's.**
- **This difference in achievement was NOT evident in the first year of placement of a specialist at any grade (in either cohort).**
- **The pattern of achievement was:**
  - **An increase in scores in Year 1,**
  - **Followed by a greater increase in scores in Year 2,**
  - **Followed by an even greater increase in scores in Year 3.**
  - **The size of the increases in Years 2 and 3 drive the statistically significant effect.**

Likelihood of Students Achieving "Advanced Proficient" Status

- **In Grades 4 and 5, students in schools with elementary mathematics specialists had a statistically significant greater probability of achieving "advanced proficient" status than did students in the control schools.**
- **This increase in the likelihood of achieving "advanced proficient" status did not become evident until the second and third year of specialist placement.**
- **A similar increasing pattern existed in Grade 3, but it was not statistically significant.**

Sample "Traditional" Beliefs Items

- **It is not very productive for students to work together during math time.**
- **If students use calculators, they won't master the basic math skills they need to know.**
- **The best way to teach students to solve mathematics problems is to model how to solve one kind of problem at a time.**

Sample “Making Sense” Beliefs Items

- **I often learn from my students during math time because my students come up with ingenious ways of solving problems that I have never thought of.**
- **I don’t necessarily answer students’ math questions but rather let them puzzle things out for themselves.**
- **Students can figure out how to solve many mathematics problems without being told what to do.**

Impact on Specialists on Teachers' Beliefs about Mathematics Teaching and Learning

- **The beliefs of teachers in schools with math specialists were significantly less traditional than those of teachers in control schools.**
- **The beliefs of teachers in schools with math specialists were no more in agreement with a "making sense" perspective than those of teachers in control schools, unless the teacher had high engagement with a specialist.**

Cautions

- **The specialists in this study engaged in a high degree of professional coursework addressing math content, pedagogy, and coaching prior to and during at least their first year of placement. Do not generalize these results to "anointed" specialists.**
- **The significant positive effects of specialists on student achievement did not occur simply with the placement of a specialist in a school. This impact emerged as the specialists gained experience -- as a knowledgeable specialist and a school's instructional and administrative staffs learned and worked together.**

Conclusions from Case Study Research

Aimee Ellington

&

Joy Whitenack

Virginia Commonwealth University

A True Story

The elementary mathematics specialist met us at the school office and whisked us off to her *office* somewhere down one of the long hallways. After weaving through the corridors, we entered her office, which she shares with other specialists (e.g., special educator, child psychologist, etc). As we proceeded to her work area, she tells us about recent events. She has a new principal, one that supports her work much more than the previous one did. She welcomes the support and direction that the new principal plans to take. As she continues to recount the new initiative that her principal has established around the mathematics specialist's role this new school year, she suddenly realizes that it is time to begin her *morning rounds* to different classrooms. We will visit several classrooms, one every forty-five minutes or so, a first-grade classroom, followed by a third-grade classroom, followed by a special education classroom, and so on.

To be continued…

Four years later…

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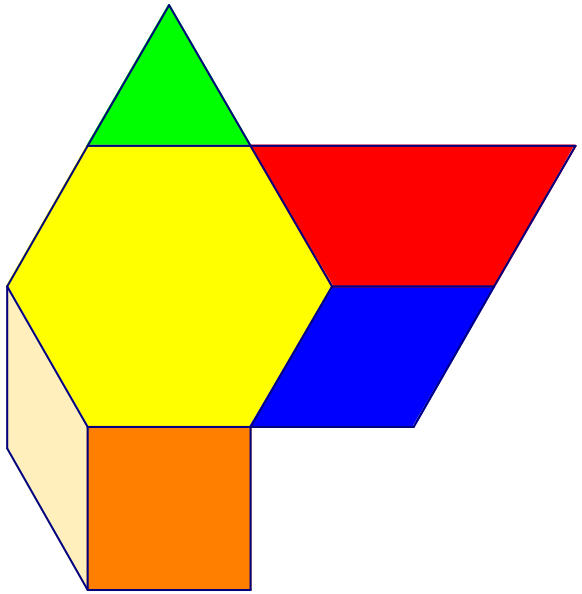
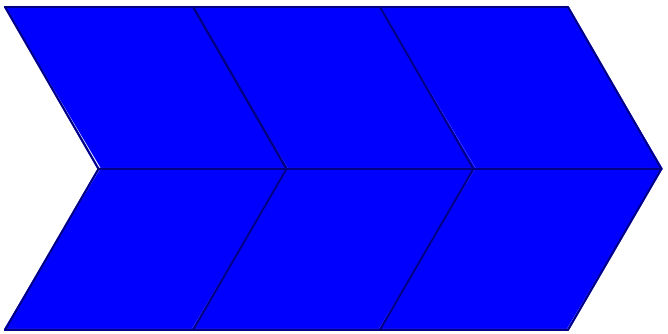
6. They benefit from collaborating with other specialists and district personnel.	What opportunities do specialists have to engage in ongoing professional development?
7. One of the specialist's goals is to build leadership capacity in the school building.	How can we support this work? What role might the principal play in this work?

The Funky Cookie Story



One of the student's cookies.



A Thought Experiment…

1. How might the math specialist capitalize on this situation in her work with teachers?
2. What mathematics might they explore together?
3. What activities might teachers exploit these ideas as they work with their students?
4. What might have happened if this situation had occurred in the regular classroom?

An Informal Definition

1. Mathematics Specialists are…
   - The most important persons in the school building with regard to mathematics instruction;
   - They know the students;
   - They know how these teachers teach these students;
   - They know the teachers;
   - They know and work with many of the parents; and
   - They know the inner workings of the school building (and district) infrastructure.

2. They know the curriculum across each of the six grade levels.
3. They are deeply committed to ensuring that every child has the same opportunities to learn, and they enact this goal every day.
4. They are lifelong learners of their craft.
5. They are agents of change that can affect how we teach and learn mathematics for understanding.
6. They are among the very few who can move the rhetoric of mathematics reform to realized, enacted action.

Continued from Page 1…

As we enter the first-grade classroom, the mathematics specialist hits the floor running. She follows the classroom teacher's lead regarding the pacing of the lesson. She interjects questions to further clarify a child's thinking during the whole class discussion. She communicates with the classroom teacher briefly as the students begin their small group work. She then speaks with different children, listening and responding as they explain their thinking. She stops at one child's desk because he is not working on his assignment, nor does the regular teacher expect him to since he lags at least two years behind his fellow classmates in all subjects. The mathematics specialist adjusts the activity, and works for several minutes with this child before moving on to another child's desk. After 30 minutes or so, we proceed to the next classroom. There we observe a similar routine. After three classroom visits, we bid goodbye because we must visit a different school building. As we leave this building, we wonder how the mathematics specialist works at this pace for hours on end with such energy, purpose and confidence. It does not matter which school building we enter, what leadership activities we observe, our question is always the same. What motivates, energizes and sustains the mathematics specialist as she engages in her daily work? The answer comes immediately: the students.

Thank you for making it possible for us to "see what we understand" so that we can "understand what we see."

(Paraphrased from Labinowicz, 1985)

Impact of Specialist Preparation Program on Participants

Horizon Research, Inc.

Sean Smith

Overview of Courses

- Five mathematics courses
  - To give specialists content to support elementary teachers
  - Deeper knowledge of mathematics than students or elementary teachers would be expected to know
- Five education courses
  - To give specialists strategies to support elementary teachers
  - Deep knowledge of coaching strategies
  - Deep knowledge of mathematics education research

Course Rigor

- 60 – 80 hours of in-class time per course, plus extensive out-of-class work
- Intellectually challenging content and assignments

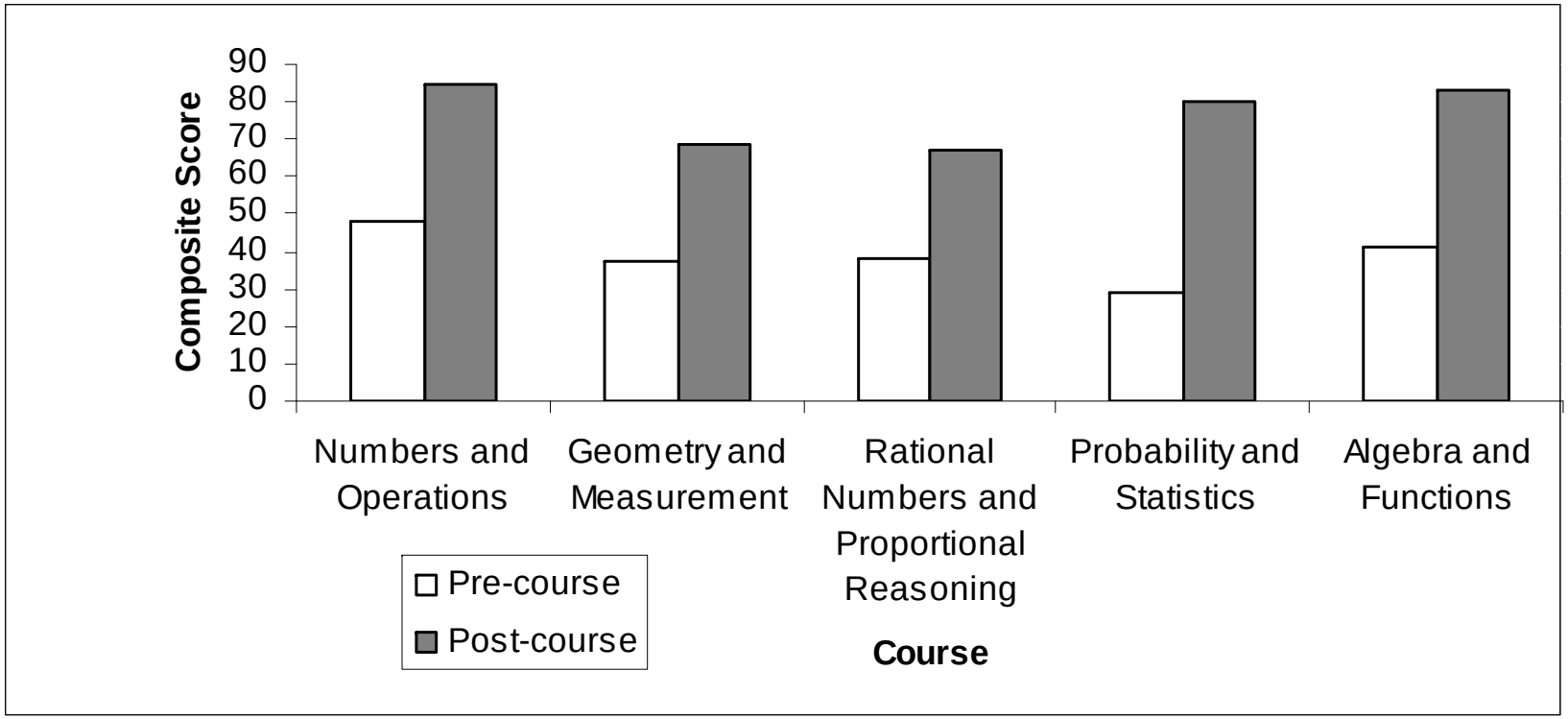
Impacts on Specialists' Content Knowledge

Evaluation Data

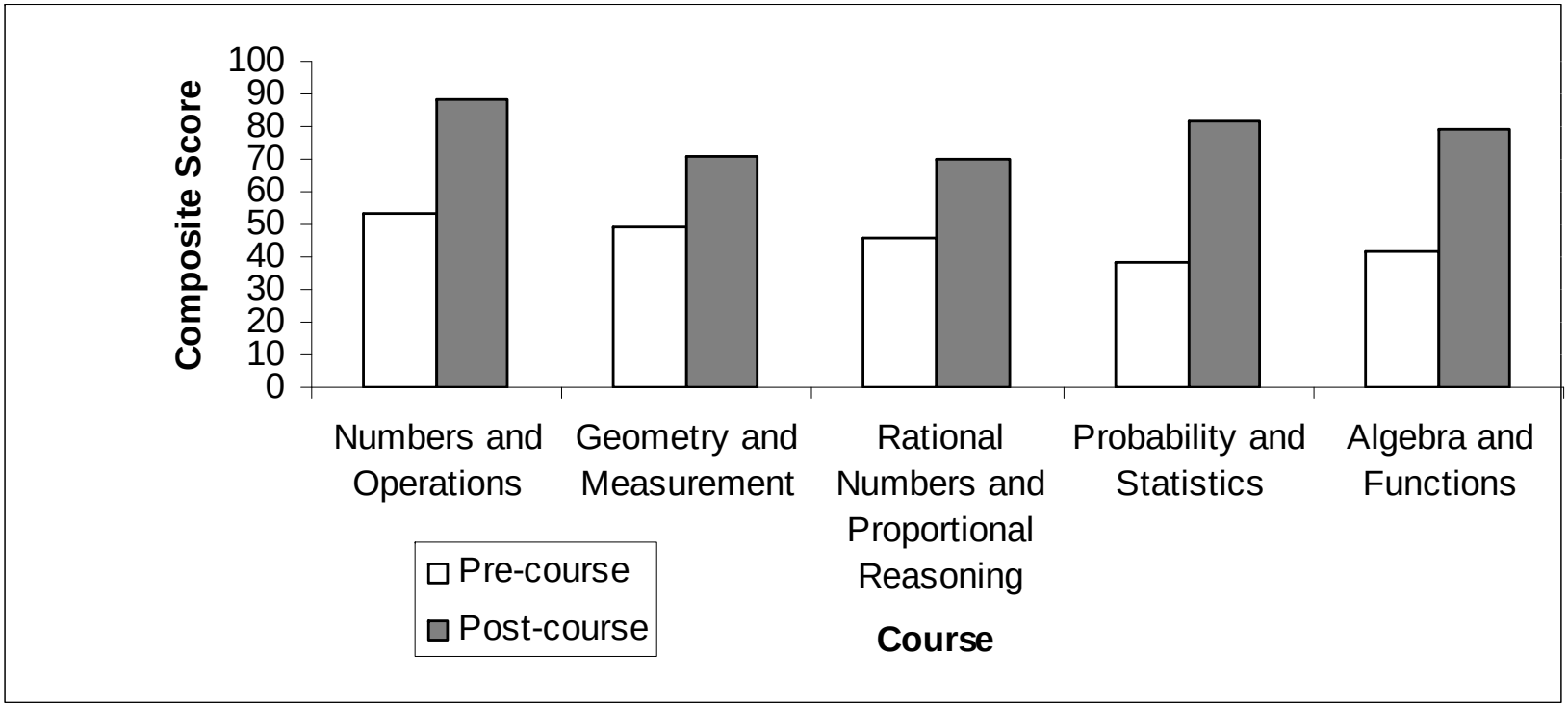
- Post-course questionnaires
- Interviews
- Pre- and post-course tests

Questionnaire Data

Impact on Perceptions of Content Knowledge



Impact on Perceptions of Teaching Preparedness



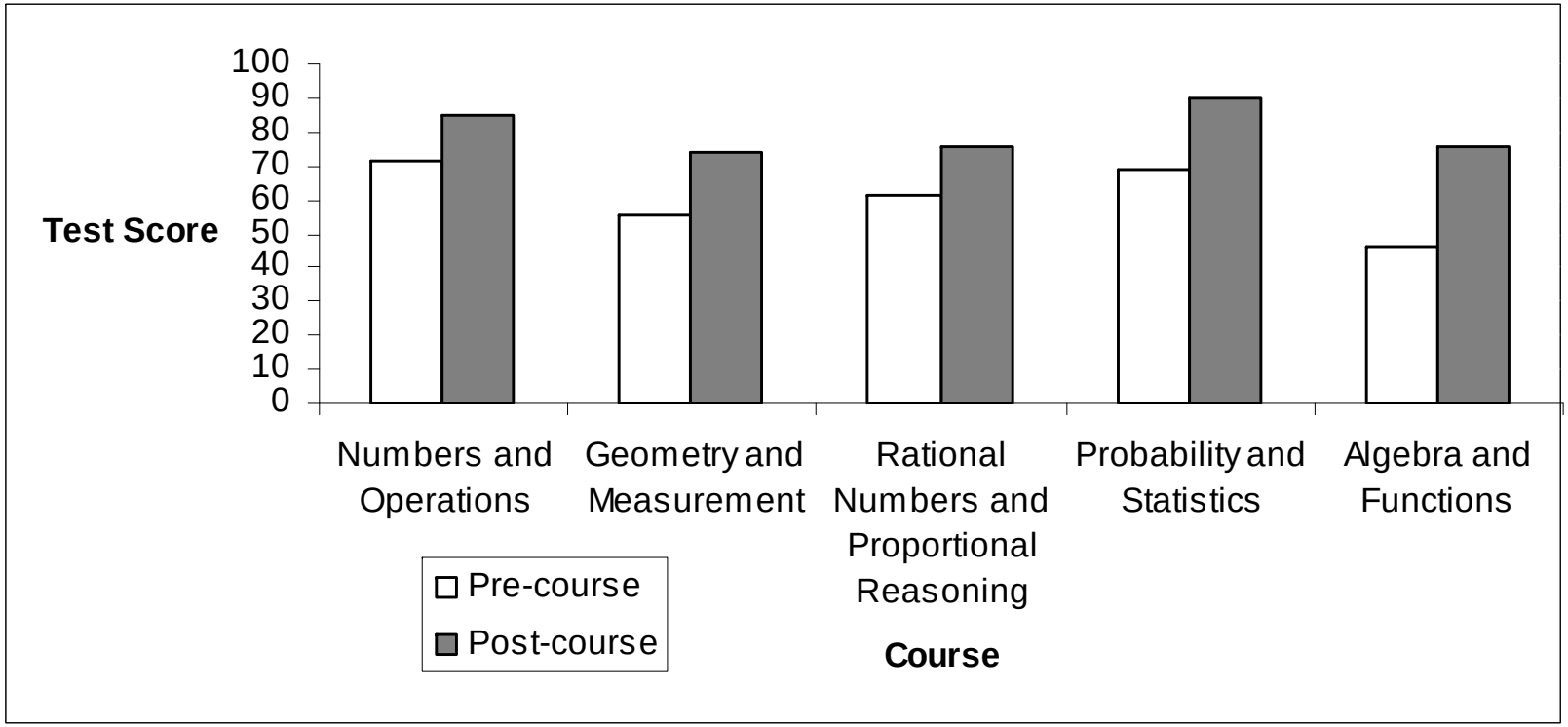
In Their Own Words

I understand the how and the why behind fraction algorithms. Not only do I now understand the how and the why, but I am able to model them concretely and share and verbalize my thinking with others. (Questionnaire response)

I think my content knowledge of the graphing and representation of data has greatly improved. I had an idea about box-and-whiskers plots, but I really understand the ideas of the inter-quartile range, and I know how to use them for comparing sets of data. (Interview response)

Test Scores

Impact on Content Knowledge



Impact on Views About Instruction

We asked:

In considering the next time you teach [course topic], what changes in your classroom practices do you foresee yourself making?

They said:

I foresee myself giving my students more time to develop algorithms on their own. I also foresee allowing my students to share their way more and giving them time to explore and develop their own efficiency. (Numbers and Operations)

I plan to have children build their conceptual knowledge, as I did in this class. I plan to have students make conjectures of their own rather than hearing the rule from me. (Geometry and Measurement)

I want to let students share their thinking and strategies for solving problems. I am much more prepared to get to the real mathematics in the lesson and want to focus on big ideas like part-to-whole relationships and equivalency. (Rational Numbers and Proportional Reasoning)

In Summary

- Substantial impacts on perceptions of content knowledge
- Substantial impacts on assessed content knowledge
- Substantial shifts in thinking about classroom instruction

Public Policy Considerations

David Blount and Judy Singleton
Commonwealth Educational Policy Institute

Constitution of Virginia, Article VIII - Education

Section 1. Public Schools of high quality to be maintained.

The General Assembly shall provide for a system of free public elementary and secondary schools for all children of school age throughout the Commonwealth, and *shall seek to ensure* that an *educational program of high quality* is established and continually maintained.

Constitution of Virginia, Article VIII - Education

Section 2. Standards of quality; State and local support of public schools.

Standards of quality for the several school divisions shall be determined and prescribed from time to time by the Board of Education, *subject to revision only by the General Assembly*.

The General Assembly shall determine the manner in which funds are to be provided for the cost of maintaining an educational program meeting the prescribed standards of quality, and *shall provide for the apportionment of the cost of such program between the Commonwealth and the local units of government comprising such school divisions.* Each unit of government shall provide its portion of such cost by local taxes or from other available funds.

VIRGINIA GENERAL ASSEMBLY

- Requested VBOE to include specialist endorsement in licensure revisions (2005)
- Passed resolution commending school boards employing math specialists (2006)
- Appropriated one-time $150,000 salary support for Cohort I 3rd year (2007)
- Amended SOQ to require school help for students having difficulty in math (07)
- Created science, math, and technology education study in Virginia (06-08)

VIRGINIA BOARD OF EDUCATION

- Created K-8 mathematics specialist endorsement (2007) (174, as of August 4, 2009)
- Recommended SOQ change requiring math help for struggling students (2007)
- Recommended employment of K-8 mathematics specialists (2007)
- Encouraged and supported DOE in actively helping divisions improve math achievement, e.g. data use, curriculum guides, professional development (ongoing)

PARTNER SCHOOL DIVISIONS

- Fulfilled all requirements under the NSF-TPC research and pilot study (04-09)
- Assumed all costs, in excess of the $25,000 NSF grant stipend per specialist, for each of the first two years of service of each trained specialist
- Allocated additional local funds to support Cohort I specialists for 3rd year (07-08)
- Provided all funding to continue Cohort I specialists for 4th year (08-09)

Where We Go From Here

Loren Pitt

University of Virginia

&

Vandi Hodges

Hanover Public Schools

Ongoing Efforts

- The State of Virginia
- Our Partner Universities
- Virginia Mathematics and Science Coalition

are committed to math specialists and will offer courses and programs in the future.

Middle School Mathematics Specialists

- VMSC Task Force Report

  http://www.vamsc.org

- Middle School Math Specialists Grant

  NSF MSP Institute: Middle School Mathematics Specialists ($4,947,929)

Rural Mathematics Specialists Grant

DRK-12: Researching the Expansion of K-5 Mathematics Specialist Program into Rural School Systems ($4,713,685)