EXECUTIVE SUMMARY

Mathematics Academies 2011-2013
Cohort 1 Evaluation Study

Amber D. Stohr, March 2014

Commencing in 2011, the Mathematics Academies Initiative is a series of professional development academies (lasting 1 to 2 years, depending on cohort) with the primary objectives of (a) providing educators with a high quality professional development experience that enhances their mathematical content knowledge and pedagogical skills, and (b) increasing positive attitudes and confidence when providing mathematical instruction. As coordinator of the initiative, the West Virginia Department of Education (WVDE) Office of Special Programs (OSP) partners with regional education service agencies (RESAs) and local school districts to identify and invite teachers to the math academies, and with Carnegie Learning Inc., an external vendor, to provide instruction and materials. This research study is an evaluation of the first cohort (hereafter, Cohort 1) of the Mathematics Academies Initiative. Cohort 1, a 2-year cohort, began in the summer of 2011 and was completed in the spring of 2013. Each year the cohort focused on a different content area; Year 1 focused on proportional reasoning, and Year 2 on developing algebraic thinking.

Methods

The OSP sent a math academy description to special education directors across WV outlining the purpose, expected outcomes, and academy components, as well as a short list of appropriate participant characteristics to help directors determine whom to invite. OSP suggested recruitment of special educators who (a) served students in Grades 5 through 12; (b) taught mathematics either in a coteaching partnership or in a pull-out class; and/or (c) served students taking the general assessment—WESTEST 2.

This mixed methods study used three instruments each year to gather quantitative and qualitative data: (a) a post-professional-development survey (hereafter, post-PD survey) distributed shortly after the initial weeklong summer academy; (b) an end-of-year survey conducted at the conclusion of academy activities; and (c) when appropriate, a pre- and post-test assessment of mathematical content and pedagogical knowledge, the Learning Mathematics for Teaching assessment (LMT; Hill, Schilling, & Ball, 2004). The post-PD and end-of-year surveys collected perceptual information regarding (a) the quality of academy elements (i.e., instruction, materials, content, etc.), and (b) changes in knowledge, attitudes, and practices related to mathematics and mathematical instruction. The LMT assessment is an empirically validated research- and evidence-based instrument that measures changes in mathematics content knowledge and instructional capacity.

Findings

Of the 119 participants in the 1st year of the Mathematics Academies Initiative, nearly 80% (n = 95) responded to the post-PD survey, approximately 65% (n = 77) responded to the end-of-year survey, and 42 qualified to take part in an LMT assessment.[1] Those responding to at least one of the academy surveys represented 35 counties across the state. Participation decreased by 42 individuals for the 2nd year of the academy. Of the returning 77 participants, over 85% (n = 66) responded to the post-PD survey, all 77 (100%) responded to the end-of-year survey, and 34 completed a LMT assessment. The 77 returnees represented 26 counties in West Virginia.

[1] The LMT instrument is normed for elementary and middle school educators. The assessment was not appropriate for high school educators.

Quality of math academy elements

We measured the quality of the following academy components: (a) materials, (b) trainers, and (c) the overall PD experience. For both years of Cohort 1, trainers received the highest quality ratings. Overall composite scores were created by combining the results of the five trainer-related items and calculating a mean score. The composite scores, based on a 5-point scale where 5 is the highest possible score, ranged from 4.6 in the 2012-2013 end-of-year survey to 4.8 in the remaining three surveys. Reaffirming these findings, the vast majority of additional comments about trainers were positive in nature.

Survey participants also gave the overall quality of the PD excellent ratings. Composite scores from the seven-item set ranged from 4.6 to 4.7 across surveys. While Year 1 PD quality ratings were somewhat higher than those in Year 2, across all items at least 83% and up to 100% of respondents either strongly agreed or agreed that the PD was high quality.

Participants improved their attitudes and dispositions toward mathematics and mathematics teaching—especially their enjoyment of it, their sense of possessing the competence and knowledge they need to teach their students, and their confidence.

Composite scores for academy materials (calculated from a set of four items) ranged from 4.3 to 4.6. Respondents were less likely to strongly agree that the materials were high quality when compared with other PD quality items. However, the percentages of those who either strongly agreed or agreed remained remarkably high (from 75% to 100%).

Notably, very few survey participants chose "strongly disagree" for any of the PD quality items discussed above. This low occurrence along with large percentages of respondents choosing "strongly agree" and "agree" responses as well as high composite mean scores for all components suggest the Mathematics Academies Initiative was successful in delivering high quality PD to Cohort 1.

Finally, comments written by academy participants provided additional insights about the overall quality of the professional development. An overwhelming majority of the comments were positive; participants most often praised the trainers and the positive impacts the academy activities had on their math content knowledge and attitudes towards teaching mathematics. However, some comments were more critical of certain academy components. Most notably, participants questioned the usefulness of the software programs (Cognitive Tutor/MATHia), and the appropriateness of the math content for their special education students.

Attitude and disposition toward mathematical instruction

Impacts on attitudes and dispositions toward math and math instruction were measured by several survey items. When asked to compare the math academy to other PD they had participated in, between 60% and 80% of participants stated the math academy PD was more useful. Results also suggest many of the attendees implemented the skills and knowledge they gained as a direct result of the math academies. Further, each year, we asked participants to compare their sentiments toward math and math instruction prior to the academy against their viewpoints at the conclusion of the academy. To this end, we asked them to indicate "more", "about the same", or "less" in response to a series of statements. Results indicate 44% of Year 1 and 58% of Year 2 participants reported enjoying teaching math more after attending the math academy. Between 40% (Year 1) and 43% (Year 2) responded "more" to the statement, "Mathematics is my strongest subject to teach." Perhaps most telling, 62% and 66% (respectively by academy year) chose "more" for the item, "Overall I know the mathematics needed to teach my students." Finally, several participants provided additional comments stating that as a result of the math academy, they are now more confident when teaching math. Others said they enjoyed learning at the academy and now like teaching mathematics, some for the first time in their lives. These results suggest the Mathematics Academies Initiative made a positive impact on the attitudes and dispositions of teachers concerning math and math instruction.

Content knowledge in math focus areas

A key objective of the math academies was to increase content knowledge in specific focus areas: proportional reasoning in Year 1 and developing algebraic thinking during Year 2. Changes in knowledge among educators were measured using both self-reported survey items and the LMT pre-/post-assessments. At the conclusion of

Year 1, over 71% of participants reported an increase in their mathematics content knowledge; and 74% stated their knowledge base was more adequate to the task of teaching subjects related to proportional reasoning. At the conclusion of Year 2, nearly 80% of participants reported having stronger knowledge of algebraic functions and 75% said they had an increased ability to examine multiple representations of algebraic functions. Among items concerning the impact of both academy years, nearly 77% of participants reported their knowledge as more adequate for teaching subjects related to proportional reasoning and algebraic thinking; 78% said they were better able to differentiate high- and low-level cognitive tasks; 69% indicated stronger knowledge of the Standards for Mathematical Practice; and 66% reported increased confidence when analyzing mathematical tasks.

When examining pre-/post-LMT data, we found statistically significant mathematics content and pedagogical knowledge gains for proportional reasoning, but not algebraic thinking. The proportional reasoning findings provide compelling evidence to substantiate self-reported gains. However, Year 2's algebraic thinking LMT did not yield statistically significant results and as a result, increases in knowledge or pedagogy reported by teachers could not be verified.

Elements of effective PD present in the Mathematics Academies Initiative

While evaluation results indicate PD provided to Cohort 1 has been mostly successful, how do we know if the PD has been effective or not? To determine the answer, we refer to what current research considers best practices for implementing effective PD, and compare those elements to academy activities. According to a recent review of relevant research, there are five common elements to effective PD: (a) content and pedagogy focus; (b) coherence; (c) active learning; (d) collective participation; and (e) duration and timespan (Hammer, 2013).

Arguably, Cohort 1 of the Mathematics Academies Initiative practiced four of the five elements. Math academies were content focused (proportional reasoning in Year 1 and developing algebraic thinking in Year 2) with an emphasis on increasing pedagogical capacity. They exhibited coherence; activities progressively built upon one another, were in alignment with school goals for instructional improvement, as well as the Standards for Mathematical Practice and the Common Core/WV Next Generation Mathematics Standards and Objectives. Academies incorporated active learning into all face-to-face sessions; participants took the role of students while trainers modeled appropriate and successful teaching techniques. Further, with 100 hours of direct contact over 2 years, academy activities exceeded the minimum recommendation of 30 hours per year. The single element not utilized by Cohort 1 math academies was collective participation (participation of a group of teachers/personnel from the same school). However, beginning with Cohort 3 (2013-2014), the OSP actively encouraged coteaching pairs as well as math coaches, math specialists, grade-level math teams, and math curriculum teams from the same district or school to attend the academy as a group.

The Year 1 pre/post Learning Mathematics for Teaching assessment data, revealed statistically and practically significant mathematics content and pedagogical knowledge gains for proportional reasoning, which substantiated self-reported gains. However, the Year 2 algebraic thinking LMT did not yield statistically significant results.

Limitations of study

The limitations of this evaluation study are typical of other studies that rely on participant perceptions as collected in a survey. Self-reported information always contains a risk of response bias. Respondents may exaggerate or underestimate, may have recall difficulties, and/or may report information they perceive as socially acceptable. Further, less than 100% of academy attendees participated in each of the surveys and the academy lost over 40 attendees from Year 1 to Year 2. While high survey response rates mitigate the likelihood of a nonrepresentative sample of academy participants, the potential for response bias still exists. Additionally, while the LMT was appropriate for measuring changes in knowledge and pedagogical capacity among elementary and middle school programmatic levels, the study lacked a tool to measure whether or not any knowledge or pedagogical changes occurred at the high school programmatic level.

Ultimately, professional development efforts are undertaken to positively impact student achievement. The ideal design for this study would have included linking academy attendees with their students and examining the difference in mathematics gains for these students against a suitable comparison group. This would more readily allow us to assess if a relationship exists between participation in the math academy and student outcomes. Currently, our data system lacks the capacity to reliably match teachers to their students. Addressing this issue would require further research, feasibility studies, and substantial time and effort.[2]

Conclusion and Recommendations

Evaluation results as well as current research suggest Cohort 1 of the Mathematics Academies Initiatives was successful in achieving its primary objectives as well as delivering effective PD. Recommendations for future math academies include:

- Continue offering academy activities that include elements of effective professional development (PD).
- Encourage special education directors to recruit participants from counties that were not represented in Cohort 1.
- Review academy content and classroom examples, and consider providing more strategies and scaffolding that special education students may need to be successful with grade-level, standards-based instruction.
- Promote collective participation by encouraging the recruitment and participation of coteaching pairs and/or teams of teachers and specialists from the same school or district.
- Continue to develop the algebra content knowledge and instructional skills of middle school special education teachers.
- Consider the feasibility of determining if any correlation exists between the Mathematics Academies Initiative and gains in math performance and/or proficiency among special education students.

References

Hammer, P. C. (2013). *Creating the context and employing best practices for teacher professional development: A brief review of recent research*. Charleston, WV: West Virginia Department of Education, Division of Teaching and Learning, Office of Research.

Hill, H. C., Schilling, S. G., & Ball, D. L. (2004). Developing measures of teachers' mathematics knowledge for teaching. *The Elementary School Journal, 105*(1), 11-30.

The full report is available on the WVDE Office of Research website: *http://wvde.state.wv.us/research/reports2014.html*.

[2] Such study designs may become possible in the near future, once the WVDE has completed plans to deploy a roster verification solution for the purposes of educator evaluation. Such a system requires educators and principals to verify the students for whom each teacher is responsible.