Mathematics Academies 2011-2013

Cohort 1 Evaluation Study

West Virginia Department of EDUCATION
Office of Research

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Executive Summary

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 respond-

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

ing 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.

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.

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.

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.

[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.

- 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.

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Introduction

At the request of the West Virginia Department of Education (WVDE) Office of Special Programs (OSP), the WVDE Office of Research (OR) is conducting evaluation studies across multiple years of activities related to the Mathematics Academies Initiative. The initiative is a partnership among West Virginia school districts, OSP, and Carnegie Learning, Inc., in which OSP provides coordination and Carnegie Learning provides the content training to teachers identified and invited through district offices. The first cohort (hereafter Cohort 1) to participate in the Mathematics Academies Initiative began in the summer of 2011 and concluded during the spring of 2013. Throughout the 2-year span, math academies provided specific content-area professional development (PD) to this group of primarily special education teachers from across the state of West Virginia. The purpose of the current study is to evaluate outcomes for Cohort 1.[3]

In collaboration with the OSP, the OR designed this evaluation study to measure the effectiveness and impact of the math academies in three areas: (a) the quality of academy elements (i.e. materials, trainers, overall PD); (b) the impact of the academy on teachers' attitudes and dispositions toward mathematics instruction; and (c) the impact of the academy on teachers' content and pedagogical knowledge in specific mathematics focus areas. While there are currently technical limitations in our ability to study possible links between the Mathematics Academies Initiative and student achievement gains in math (see Limitations, page 35), the initiative operates based on the assumption that "deeper understanding of the WV Next Generation Mathematics Standards and Objectives (NxGCSOs), mathematical reasoning and problem solving [will] enhance teachers' abilities to provide high quality instruction to maximize success for each student" (Farrell, 2014).

The math academies focused on two different content areas. In 2011, the content focus for Cohort 1 was proportional reasoning; in 2012 it was developing algebraic thinking. To increase statewide access for participants, academy activities were repeated in multiple locations across the state (Cohort 1 locations included the greater areas of Charleston, Huntington, Beckley, and Clarksburg/Bridgeport). Each academy year involved multiple activities beginning with a 5-day face-to-face summer academy and concluding the following spring with a 1-day face-to-face follow up. Additionally, academy activities included a 1-day face-to-face follow up in the autumn, and self-paced online modules (MATHia and Cognitive Tutor, developed by Carnegie Learning). Each year, academy participants received nearly 50 hours of face-to-face instruction. Further, during the 1st year Cohort 1 spent approximately 8 hours completing the online modules; in the 2nd year they used approximately 26 hours to complete the modules. Across both academy years, participants dedicated over 130 hours to math academy activities.

[3] This study was reviewed and approved by the WVDE Institutional Review Board (IRB); the study's approval number is IRB-CIS-010. Visit http://wvde.state.wv.us/research/IRB/ for more information.

This mixed methods study used three tools 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, the Learning Mathematics for Teaching (LMT) pre-/post-knowledge assessment. 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 mathematics instruction. The LMT assessment (developed by the University of Michigan[4]) is a research- and evidence-based tool that measured changes in content knowledge and instructional capacity.[5]

Primarily, the results of the study are organized by cohort year and content focus. First, we compare and contrast results from Year 1 post-PD and end-of-year surveys. Second, Year 1 LMT results (proportional reasoning) will be presented in the form of descriptive statistics; inferential statistics are used to test the significance of pre-to-post-test gains on the assessment. Third, results from Year 2 post-PD and end-of-year surveys are compared and contrasted. Fourth, Year 2 LMT results (algebraic thinking) are described and interpreted. Last, with a number of items unique to the end-of-year surveys, we will compare Year 1 results to those of Year 2. The report concludes with a discussion of study findings and recommendations to help inform decision making for future PD opportunities.

Relevant Scholarship

Academy content provided by Carnegie Learning is based on both the changing needs among classroom teachers and on evidence-based curriculum development. The following excerpt from Carnegie Learning's project proposal (Carnegie Learning, Inc., n.d.[a]) describes what prompted them to develop multiple content-focused math academies, and the research base they drew from:

> In 2008, the National Math Advisory Panel advised educators to make fundamental changes to curriculum and instruction in mathematics: Among these recommendations were: (1) focusing the K-8 curriculum to prepare students to connect learning to concepts they will need in later years of math; (2) applying knowledge from rigorous research on children's math learning; and (3) promoting more effective math teachers through better in-service and pre-service training (National Mathematics Advisory Panel, 2008). Based on these recommendations, NCTM developed new standards for the teaching of mathematics, and Carnegie Learning developed the K-8 Math Academies, applying the new research along with those new standards. All six courses offered by the K-8 Math Academies incorporate three key components: (1) grade-appropriate content, (2) pedagogy based on problem solving, and (3) heightened awareness of teaching as a basis for continuous professional growth.
>
> The first core element of the K-8 Math Academies involved Carnegie Learning's creation of specific grade-appropriate content spans. This development was based on the teaching prescriptions put forward by Lou Ann Lovin and John Van de Walle's

[4] Visit http://sitemaker.umich.edu/lmt/home for more information regarding the LMT.

[5] The LMT assessment is available among specific content focus areas for elementary and middle school teachers.

> (2006) work emphasizing (1) appropriately differentiated grade span and (2) stretch as the dual bases for the teaching of mathematics in the elementary grades.
>
> The second core element of the Math Academy development, problem-solving in a student-centered classroom, underlies all Carnegie Learning's pedagogical approaches to mathematics instruction. Problem-solving in both teaching and learning is based on John Anderson's ACT-R model of learning and performance (Anderson 1993) and John Van de Walle's (1999) work applying problem solving specifically to the teaching of early mathematics to children. Both performance knowledge in Anderson's (1993) work, or "network" knowledge in Van de Walle's (1999) rest on research-backed assumptions that both mathematics and the teaching of mathematics can only be learned by actively doing, not by just passively listening or watching. In Carnegie's K-8 Math Academies, instructors facilitate teachers' learning through problem-solving, enabling educators to learn exactly as their students do, by actively engaging in discourse with colleagues and peers around their learning to enhance and sustain it.
>
> The third core component reflects a heightened awareness about teaching. This component, based on the research of Brookfield (1995), facilitates teachers' metacognitive reflections on their own teaching practices. In this project, the Math Academies will provide the initiation of this process of reflection. Coaching in the technique and an active online Community of Practice will provide the essential follow-up.

Additionally, the online modules accompanying the math academies (Cognitive Tutor and MATHia) have a strong research and evidence base. According to Carnegie Learning (Carnegie Learning, Inc., n.d. [b]), the Cognitive Tutor software—based on the ACT-R theory of learning, memory, and performance—has been validated in more than 50 publications. For more information about Carnegie Learning's curriculum and software development, visit their website at http://www.carnegielearning.com/research/.

Methods

Population Characteristics

In the spring of 2011, the OSP sent a math academy description to county and regional education service agency (RESA) special education directors 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 to the math academies. These guiding characteristics included selecting special educators who

- serve students in Grades 5 through 12,
- teach mathematics either in a coteaching partnership or in a pull-out class, and/or,
- serve students taking the general assessment—WESTEST 2.

Sampling Procedures

We invited all academy attendees to voluntarily participate in the evaluation and we included all legitimate responses to the surveys and assessments in the data analysis.[6]

Data Analysis

We used both quantitative and qualitative techniques to analyze the data collected for this study. Descriptive statistics including frequencies (i.e., percentages) and measures of central tendency and dispersion (i.e., means and standard deviations) were calculated for the quantitative sections of the post-PD and end-of-year surveys. Further, we conducted qualitative analyses of the open-ended/additional comments collected with both surveys. We classified and categorized these data; representative and especially descriptive examples are provided later in this report.

A team of OR researchers and support staff scored, matched, standardized, and tested for statistical significance the data collected from the Learning Mathematics for Teaching assessment (LMT). Statistical significance was established by conducting a series of *t* tests; a *t* test determines if the difference in mean scores between two groups (such as pretest and posttest) is not simply the result of chance. We used paired-samples *t* tests with the LMT data since we could match each individual's pretest to their posttest. Pre- and post-LMT assessment means were considered significantly different when *t* tests yielded *p* values of 0.05 or less. A *p* value of 0.05 or less indicates a 95% probability that the survey results were not observed due to chance. Further, we calculated effect sizes using Cohen's *d*. Akin to their name, effect sizes measure the magnitude of difference in the mean scores between two measurements—in this study the pre-and post-LMT scores. As a measure of strength be-

[6] An example of a response deemed not legitimate was an LMT assessment result from a participant who instructed at the high school programmatic level (the LMT is appropriate for elementary and middle school levels only). Another example includes surveys that were less than 50% complete.

tween the differences of two mean scores, effect sizes are not affected by sample size. Cohen (1988) interpreted effect sizes lower than 0.15 to be negligible, between 0.15 and 0.40 to be small, between 0.40 and 0.75 to be medium, between 0.75 and 1.10 to be large, and above 1.10 to be very large.

Post-PD Survey

The post-PD survey contains 26 multiple choice items and 4 opportunities for participants to provide additional comments. Table 1 displays the four sections of the survey. Items had either multiple-choice response options or were based on 5-point Likert-type scales of agreement. Survey items were the same for both Year 1 and Year 2. We employed an online survey platform for the post-PD surveys. Coordinators from the OSP and OR worked together to ensure all academy attendees were invited to participate in the surveys. We sent an initial e-mail invitation, followed by up to four reminders to nonrespondents, containing hyperlinks to the surveys. The surveys were launched 2–4 weeks after the summer academies; the data collection period lasted approximately 4 weeks.

Table 1. Cohort 1 Post-PD Survey Organization

Section		Number of items
I.	Participant demographics	5
II.	PD quality, usefulness, and implementation feedback*	12
III.	PD trainer and materials feedback*	9
IV.	Additional comments	1

*Section contains one or more additional comment boxes

End-of-Year Survey

The end-of-year surveys were considerably longer and have greater variation from Year 1 to Year 2 than the post-PD surveys. The Year 1 end-of-year survey consisted of 57 multiple-choice items and six opportunities for additional comments; the Year 2 survey included 58 multiple-choice items, one open-ended item, and the same six opportunities for additional comments. For some multiple-choice items, the response choices were based on Likert-type scales. However, the surveys used a variety of response scales (i.e., 3-point, 5-point, etc.) to assess agreement, frequency, support, and so forth.

While the number of end-of-year survey items did not differ greatly from Year 1 to Year 2, the organization and content were considerably different. Both surveys were organized into seven sections as reflected in Table 2. The end-of-year surveys followed the same dissemination and data-collection protocol as the post-PD surveys. All academy attendees received invitations to participate in the online surveys via multiple e-mails containing hyperlinks to the online questionnaires. Data collection began 2–4 weeks after the final spring follow-up meeting and remained open for 4–5 weeks.

Table 2. Cohort 1 End-of-Year Survey Organization

Survey	Section		Number of items
Year 1	I.	Demographics and mathematical knowledge/attitudes	13
	II.	Academy activity attendance	3
	III.	PD quality, usefulness, and implementation feedback*	20
	IV.	PD trainer and materials feedback*	9
	V.	Organizational support*	8
	VI.	Suggestions for future PD activities*	4
	VII.	Additional comments	1
Year 2	I.	Demographics and mathematical knowledge/attitudes	14
	II.	Activity attendance, comparison of Year 1 vs. Year 2 and content specific items	9
	III.	PD quality, usefulness, and implementation feedback*	16
	IV.	PD trainer and materials feedback*	9
	V.	Organizational support*	7
	VI.	Suggestions for future PD activities*	4
	VII.	Additional comments	1

*Section contains one or more additional comment boxes

Learning Mathematics for Teaching Assessment

The LMT assessments are research-based pre-/post-tests developed by the University of Michigan's School of Education to measure elementary and middle school teachers' mathematical knowledge and pedagogical abilities in specific content areas. The University of Michigan describes the LMT as follows:

> Our project investigates the mathematical knowledge needed for teaching, and how such knowledge develops as a result of experience and professional learning. We do so through the writing, piloting, and analysis of problems that reflect real mathematics tasks teachers face in classrooms - for instance, assessing student work, representing numbers and operations, and explaining common mathematical rules or procedures. Assessments composed of these problems are often used to measure the effectiveness of professional development intended to improve teachers' mathematical knowledge (LMT, n.d. [b]) .
>
> Items in each category capture whether teachers can not only answer the mathematics problems they assign students, but also how teachers solve the special mathematical tasks that arise in teaching, including evaluating unusual solution methods, using mathematical definitions, representing mathematical content to students, and identifying adequate mathematical explanations.
>
> Each elementary (K-6) item has each been piloted with over 600 elementary teachers, yielding information about item characteristics and overall scale reliabilities for piloted forms. Our middle school items have each been piloted with over 300 middle school teachers (LMT, n.d. [a]).

Most LMT assessments consist of two equated forms (A and B), and depending on content focus, each form typically includes 13-16 items. If a participant takes Form A at the pretest (administered during the first day of the summer academy), then they take Form B as a posttest (administered at the spring follow-up), and vice versa. To reduce the possibility of test-retest effects, the majority of items on each form are unique. Pre-post comparisons

are possible because the two forms are equated using item response theory (IRT). IRT involves the calculation of item-level statistics that are used to estimate the probability of an individual correctly responding to an item based on their ability and several important dimensions. Most commonly these dimensions include item difficulty and discrimination (i.e. the item's ability to differentiate accurately among high- and low-ability test takers).

Item characteristic curves (ICCs) illustrate these dimensions. For example, the horizontal position of the two ICCs depicted in Figure 1 shows the difficulty levels of two test items (represented by Curve 1 and Curve 2) and the slope of each curve depicts the item's ability to differentiate among test takers of varying ability levels. The further to the right the ICC, the more difficult the item. Likewise, the steeper the item curve, the better its ability to differentiate among test takers. A flat ICC would represent an item for which the probability of a correct response was not dependent at all on test taker ability.

In this example the difficulty level of the first item (Curve 1) is 0; and the difficulty for the second item (Curve 2) is 1. Figure 1 also visualizes the relationships between probability, item difficulty, and ability. Curve 1 is an item that individuals with average ability have an equal chance of providing a correct response. Curve 2, with a higher difficulty level, would require an individual to have above average ability for an equal chance to provide a correct response. As indicated by their slopes, both items discriminate similarly among test takers of different ability levels.

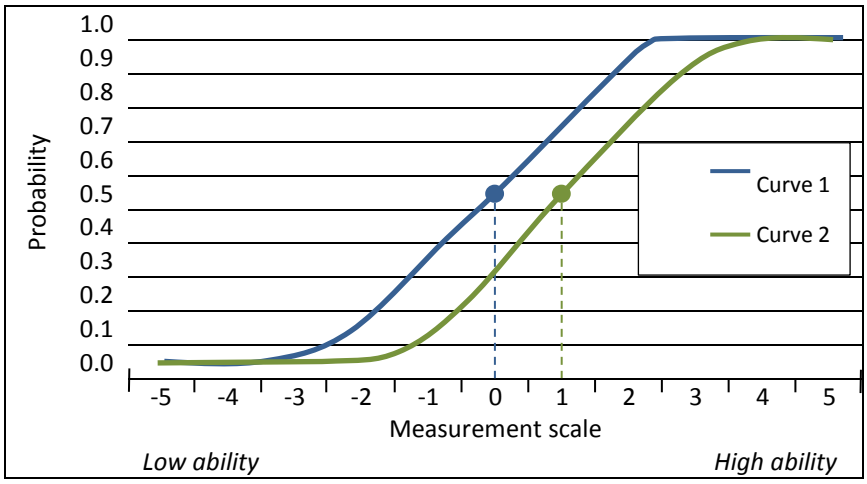


Figure 1. Item Characteristic Curves (ICCs)

This figure, adopted from a State Collaborative on Assessment and Student Standards publication, *A Practitioner's Introduction to Equating* (http://www.ccsso.org), depicts the difficulty level of 2 items (Curve 1 and Curve 2) at the 0.5 (or 50/50) probability rate. Curve 1 has a difficulty level of 0; Curve 2 a difficulty level of 1.

To ensure proper interpretation and use of LMT results, the University of Michigan requires individuals to attend training prior to administering the assessments. In 2011, a small group of staff members from WVDE and local education agencies attended this training.

Results

Cohort 1 results are organized by year; first results from Year 1 will be discussed followed by Year 2 results. To provide a way to compare and contrast, several items on the post-PD and end-of-year surveys are the same or similar. This process allowed us to collect feedback from participants at the onset of the academy and then again at the conclusion of the academy year. Learning Mathematics for Teaching assessment (LMT) results will also be presented by year.

While most results are confined to a specific academy year, some survey items appeared in the end-of-year surveys only. These items, mostly centered on mathematical attitudes and beliefs, provide some interesting findings across the 2-year period.

Year 1–Proportional Reasoning

Post-PD survey and end-of-year survey

Of the 119 participants in the 1st year of the Mathematics Academies Initiative, nearly 80% (n = 95) responded to the post-PD survey, and approximately 65% (n = 77) responded to the end-of-year survey. Those responding to at least one of the academy surveys represented 35 counties across the state (see Figure 2). Additionally, in some cases these counties were represented by more than one teacher. While matching individual responses was not possible from the post-PD survey to the end-of-year survey, examining results from the two surveys revealed substantially similar characteristics from both groups of respondents. Therefore, with alike demographic traits, it is reasonable to draw general inferences when comparing results from the post-PD survey to the end-of-year survey.

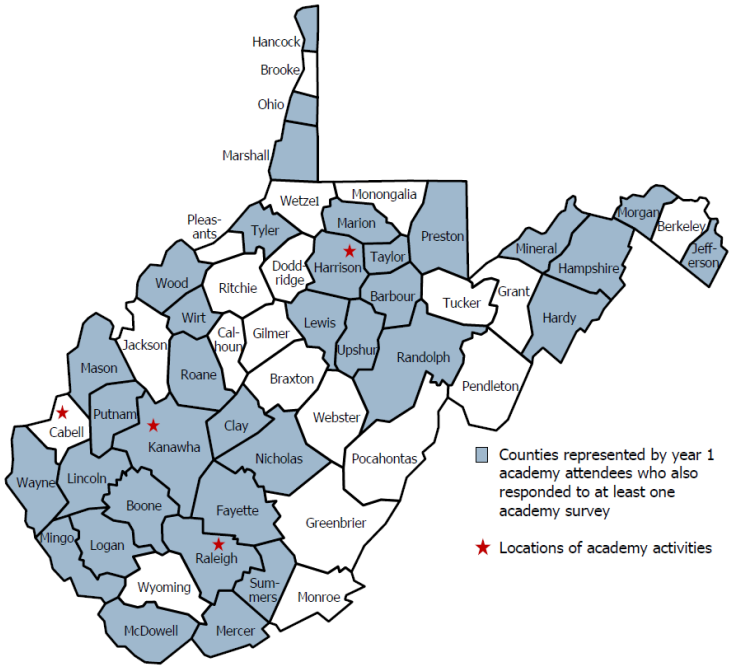


Figure 2. Counties Represented by Cohort 1, Year 1 Academy Attendees

Math academy attendees (responding to at least one academy survey) represented 35 counties across West Virginia. Put another way, teachers from more than 60% of the counties in the state attended Year 1 of the Math Academy.

As depicted in Figure 3, those participating in each of the academy surveys shared similar percentages in the grades they taught (the majority of teachers reported instructing at the middle- and high-school program-

matic levels). Further, they exhibited comparable years of experience in their current teaching positions (most reporting 1–5 years), as well as similar years of experience in the field of education (the majority of responding teachers had over 16 years of experience, but many also reported 1–5 years of experience as well as 6–10). Finally, the four locations of the initial summer academies were represented relatively equally from one survey to the other. These results indicate not only comparable characteristics from the post-PD to the end-of-year surveys, but also a relatively good mixture of teachers representing various programmatic levels, years of experience, and locales. All descriptive statistics for Cohort 1, Year 1 surveys can be found in Appendix A, starting on page 41.

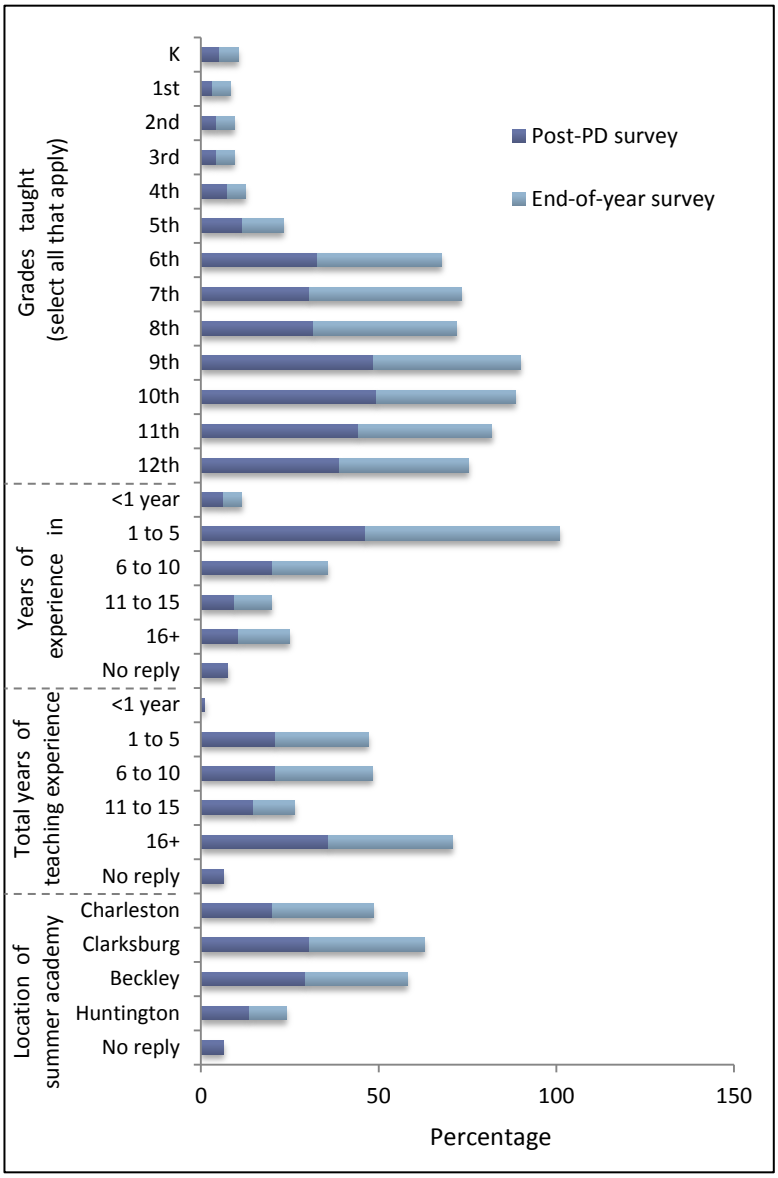


Figure 3. Academy Participant Characteristics by Survey, 2011-2012

This figure shows participants responding to the post-PD (*n* = 95) and end-of-year (*n* = 77) surveys shared similar demographics, including grades taught, total years of teaching and years of experience in current position, as well as representing similar percentages of academy locations.

Both the post-PD and end-of-year surveys asked academy participants several series of questions relating to the usefulness and quality of the Mathematics Academy. This type of survey design allows us to evaluate participants opinions after the initial 5-day summer academy and then again at the conclusion of the academy nearly 1 year later. As is evidenced in the following pages, results of these pre-/post-items remained notably consistent from the post-PD to end-of-year surveys.

When asked about the usefulness of the academy, the majority of respondents indicated the PD was a *good start* and that they *look forward to using* what they have learned (approximately 54% in the post-PD results, and slightly more than 57% in the end-of-year survey). The next most common response with nearly 16% and 25% of the responses, respectfully, was *it was a good start*. The least common response was *I don't think that these ideas will work very well*, representing just over 1% in both the surveys. See Figure 4 to view all response results.

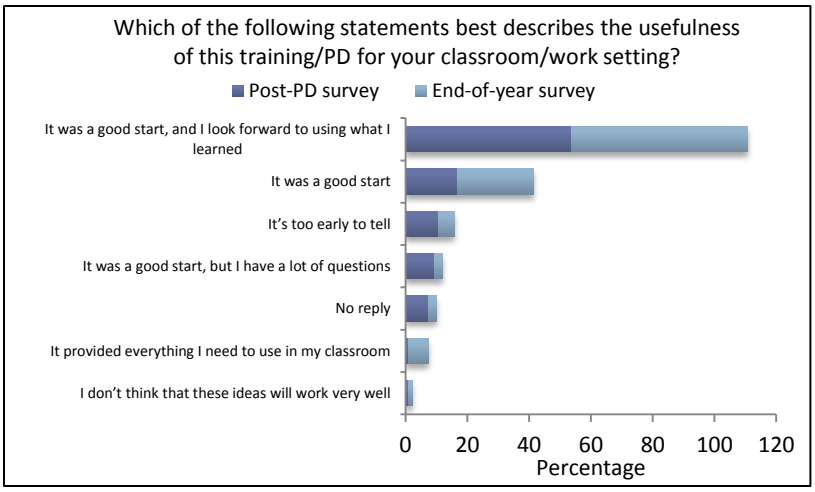


Figure 4. Usefulness of Math Academy PD, 2011-2012
Post PD survey *n* = 95 and end-of-year survey *n* = 77

Next respondents were asked to indicate the extent to which the PD met their professional needs (see Figure 5). With nearly 77% in the post-PD survey and over 71% in the end-of-year survey, the predominant response was *it addressed some of my professional learning needs*. Only 1% in the post-PD and less than 3% in the end-of-year surveys stated that *it did not address my professional learning needs*.

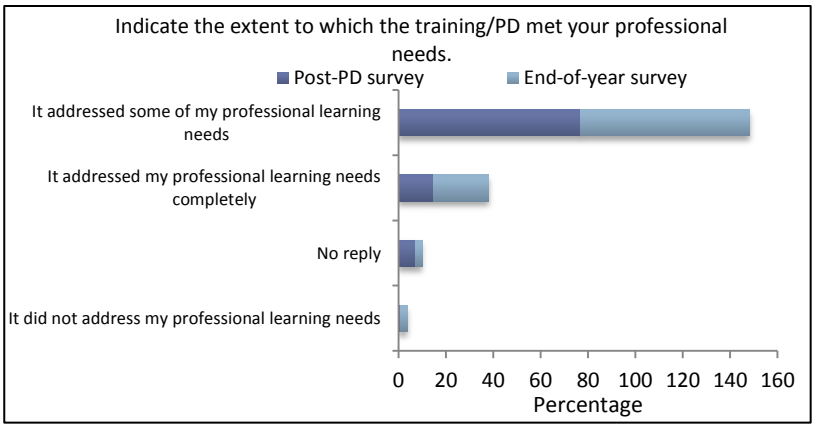


Figure 5. Meeting Teachers' Professional Needs, 2011-2012
Post PD survey *n* = 95 and end-of-year survey *n* = 77

The next survey item asked teachers to compare the PD they received in the math academy to any other PD experiences from the past 3 years (see Figure 6). Approximately 59% of respondents in the post-PD survey and over 66% in the end-of-year survey said the math academy

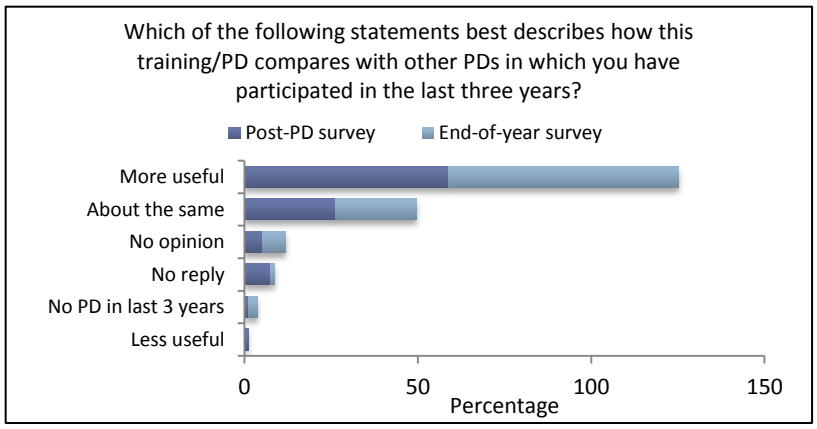
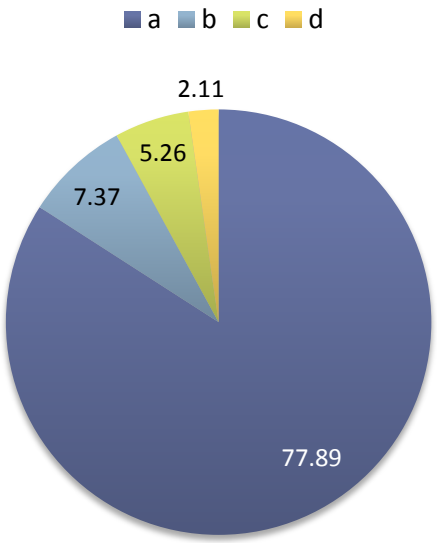


Figure 6. Comparing the Math Academy to Other PD, 2011-2012
Post-PD survey *n* = 95 and end-of-year survey *n* = 77

was *more useful*. Additionally, only 1% in the post-PD survey and zero teachers in the end-of-year survey indicated the PD was *less useful*.

Both surveys also asked teachers the likelihood of applying what they learned in the math academy in their classrooms/work settings. The post-PD survey offered four response choices; they are listed in the key under Figure 7. The predominant response, with close to 78% of all responses, was (a) *I look forward to practicing/applying the knowledge/skills in my classroom during the upcoming school year*.



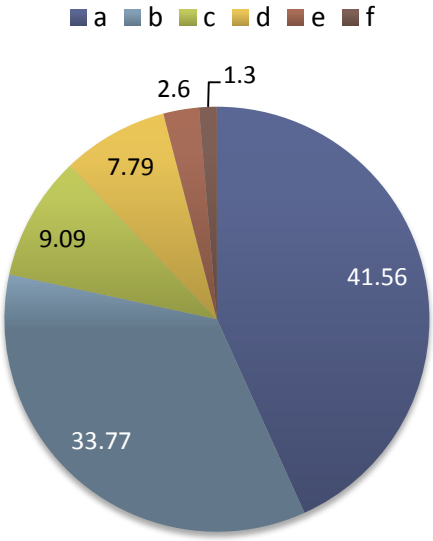
n = 95

Figure 7. Post-PD Survey: Applying Math Academy Knowledge/Skills, 2011-2012

Figure 7 key

a. I look forward to practicing/applying the knowledge/skills in my classroom during the upcoming school year
b. I already practice/apply the knowledge/skills this training provided in my classroom, and it seems to work well
c. I have already practiced/applied the knowledge/skills this training provided in my classroom, but it is not appropriate for my students
d. I don't think what I learned here will work for my students so I don't envision applying the knowledge/skills

Note: Total % ≠ 100 (percent of no response was excluded)



n = 77

Figure 8. End-Of-Year Survey: Applying Math Academy Knowledge/Skills, 2011-2012

Figure 8 key

a. I now practice/apply the knowledge/skills the academy provided in my classroom
b. I previously practiced/applied the knowledge/skills the academy provided in my classroom AND I continue to do so
c. I have not practiced/applied what I learned BUT I plan to practice/apply the knowledge/skills in my classroom soon
d. I do not practice/apply what I learned at the math academy because it is not appropriate for my students
e. I do not practice/apply what I learned at the math academy because of other reasons
f. I previously practiced/applied the knowledge/skills the academy provided in my classroom BUT I no longer do so

Note: Total % ≠ 100 (percent of no response was excluded)

The corresponding end-of-year survey item offered six response choices. The six options may be viewed in the key under Figure 8. At just under 34%, (b) *I previously practiced/applied the knowledge/skills the academy provided in my classroom AND I continue to do so*, was the second most common response. These results indicate that many of the teachers who intended to implement knowledge and skills gained in the math academy did so within the 2011-2012 school year.

The next survey item asked teachers how closely the math academy PD was related to their schools' or programs' goals for improving instruction. Among both the post-PD and end-of-year surveys more than 50% of teachers said the math academy was *very closely aligned* with their school's/program's goals. Just under 30% in the post-PD survey and slightly less than 40% in the end-of-year survey said the PD was *somewhat aligned*. Eight percent and 5%, respectively, reported *I do not know*; and approximately 1% of responses to both surveys stated the PD was *not aligned*.

The final three sets of survey items directly comparable from post-PD to end-of-year responses focused on the quality of math academy materials, trainers, and overall PD. Each set of survey items was based on a 5-point Likert-type scale of agreement (*strongly agree*, *agree*, *neutral*, *disagree*, and *strongly disagree*). The three sets of items were analyzed in two different ways. First, looking at the individual items in each set, frequencies (represented as percentages) were determined for each response on the 5-point scale. Second, we averaged the individual items (where 5 = *strongly agree*, 4 = *agree*, 3 = *neutral*, 2 = *disagree*, and 1 = *strongly disagree*) to create an overall composite score for each set.

Four items were used to measure the quality of math academy materials. They were: (a) *adequate amounts* of training materials/resources were provided; (b) materials/resources were *relevant* to my work; (c) the materials/resources provided were of *high quality* (i.e., based on recent research and evidence-based; and (d) the materials/resources provided were *useful* to my work. Figure 9 shows the individual item results stacked by post-PD survey and end-of-year survey. Note the item names in the figure correspond *with italicized* words in the complete description of the 4 items above.

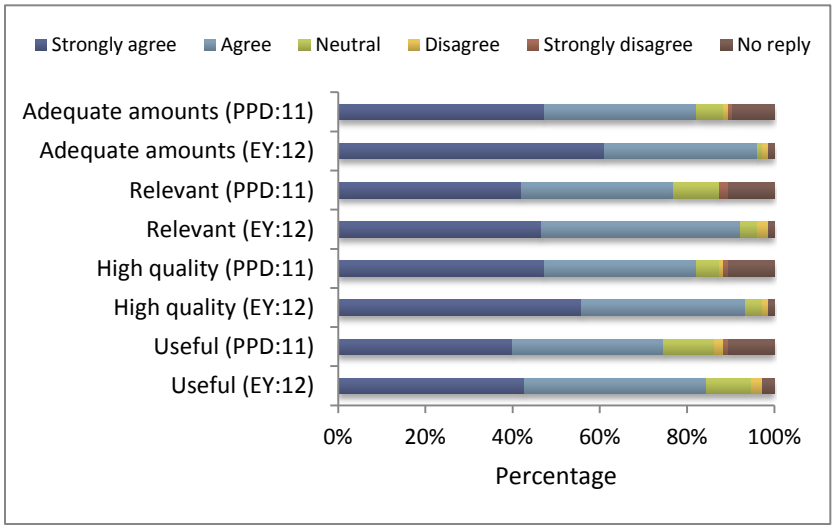


Figure 9. Math Academy Material Quality Ratings, 2011-2012

Note: PPD:11 = Post-PD survey (*n* = 95), 2011 and EY:12 = End-of-year survey (*n* = 77), 2012

While *strongly agree* was the most frequent response across all items and both surveys (ranging from 40% to 61%) it is evident in Figure 9 that more teachers chose *strongly agree* in

the end-of-year survey compared to the post-PD survey. Likewise, among all items, the second most frequent response, *agree* (ranging from 35% to 45%) exhibited an increase from the post-PD to end-of-year surveys. This trend may be attributable to a decrease in those choosing "neutral" or not responding in the end-of-year survey. Typically, "disagree" represented only 1% to 2% of responses among both surveys. There were no *strongly disagree* responses in the end-of-year survey and never more than 2% in the post-PD survey.

Calculating a composite mean of the material items resulted in a post-PD mean of 4.3 (out of a possible 5) and end-of-year mean of 4.4. Overall, teachers attending the math academy gave high quality ratings to the academy materials.

Five items were developed to gauge the quality of the math academy trainers: (a) trainer(s) were *knowledgeable* about the topic; (b) trainer(s) were *well organized*; (c) trainer(s) presented the material *clearly and effectively*; (d) trainer(s) *facilitated discussions* well; and (e) trainer(s) *answered questions* raised during sessions adequately. Figure 10 shows the individual item results stacked by post-PD survey and end-of-year survey. Note the item names in the figure correspond with italicized words in the complete description of the five items above.

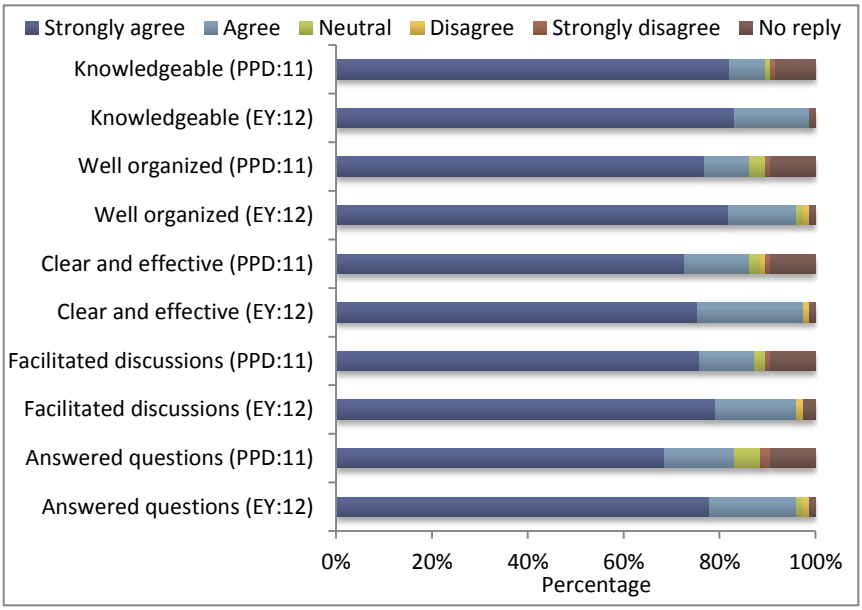


Figure 10. Math Academy Trainer Quality Ratings, 2011-2012

Note: PPD:11 = Post-PD survey, 2011 (*n* = 95) and EY:12 = End-of-year survey, 2012 (*n* = 77)

Teachers gave math academy trainers overwhelmingly high ratings by selecting *strongly agree* most frequently to all items in both surveys. In fact, *strongly agree* accounted for 68% to 83% of the total responses. At a distant second, *agree* represented from 7% to 22% of the responses. Often no teachers selected *disagree* or *strongly disagree*, and the frequencies for these responses did not exceed 2% on either survey. Additionally, fewer respondents opted for *neutral*, *disagree*, *strongly disagree* or provided no response in the end-of-year survey compared to the post-PD survey.

Moreover, the composite mean was 4.8 (on a 5 point scale) for both the post-PD and end-of-year surveys. Clearly, participating teachers were highly satisfied with the quality of the math academy trainers.

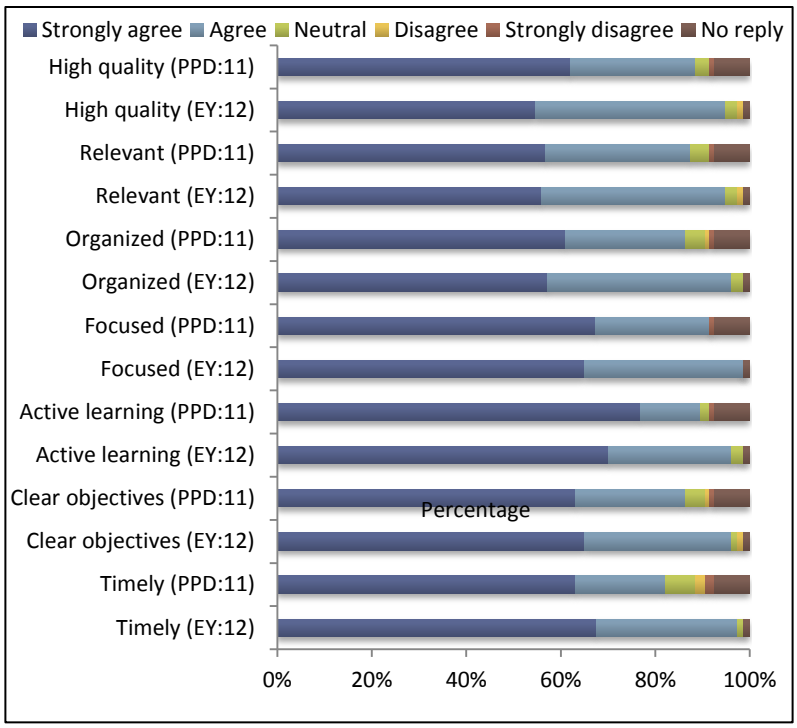


Figure 11. Math Academy PD Quality Ratings, 2011-2012

Note: PPD:11 = Post-PD survey, 2011 (*n* = 95) and EY:12 = End-of-year survey, 2012 (*n* =77)

Seven items were used to determine the quality of the math academy PD: (a) Mathematics Academy initiatives/ activities have been *high quality*; (b) academy initiatives/ activities have been *relevant*; (c) academy initiatives/activeties have been well *organized*; (d) academy initiatives/activeties have been specific and content-*focused*; (e) academy initiatives/activities have been hands-on and included *active learning* opportunities; (f) academy/initiatives' training *objectives* were clearly stated before each session began; and (g) the academy's activity sessions began and ended in a *timely* fashion. Figure 11 shows the individual item results stacked by post-PD survey and end-of-year survey. Note the item names in the figure correspond with italicized words in the complete description of the seven items above. Among all items in both the post-PD and end-of-year surveys, 80% to 98% of respondents either *agreed* or *strongly agreed*. The *neutral* response never exceeded 6%, and both *disagree* and *strongly disagree* did not surpass 2%.

Examining these data by calculating an overall composite mean resulted in a PD quality mean of 4.6 (with 5 as the highest possible mean) for both the post-PD and end-of-year surveys. Taken together, the results clearly indicate participants felt the math academy PD was very high quality.

Results from the three sets of survey items, according to those responding to the surveys, indicate the math academy materials, trainers, and overall PD was high quality. Moreover, qualitative data support this finding. The surveys contained several opportunities for participants to provide comments about the usefulness, materials, trainers, and overall quality of the PD. During analysis, comments were organized into four general categories: positive, negative, mixed and neutral/other.

The majority of comments from Year 1 surveys were positive. Participants most often gave praise and positive feedback about the content, trainers, and overall quality of the PD.

Post-PD survey examples include:

> I liked the idea of tying all the lessons to the Common Core Standards. The whole 5 days were informative, educationally relevant, and interesting, and presented very professionally.
>
> The training was excellent--definitely above the norm.
>
> Very informative....Got good ideas to use in classroom....best PD I have ever attended in 31 years.
>
> The trainer was excellent. She facilitated things very well, and had wonderful classroom management techniques. I liked how she never told anyone outright that they were wrong. She made everyone feel comfortable doing the work and going up and working and explaining problems. She was probably the best trainer I have had in any workshops.
>
> I enjoy getting ideas, manipulatives, strategies, and technology tools to use with my math students.

This PD has help[ed] me to be involved in a learning community. I have teachers that I can talk with and discuss issues that arise during the school year.

This was the most useful and motivating PD I have attended in years.

End-of-year examples include:

> I thoroughly enjoyed the 5 day summer PD with the follow up in fall and spring. I am not a Math major and have found this very helpful to me. It is very organized and the ones who present it are very knowledgeable and organized. I look forward to the next summer program and fall and spring follow ups in 2012 and 2013. This had been very helpful to me. I highly recommend it!
>
> The Academy was a wonderful experience for special educators across the state. It met many needs and helped me to see more about how foreign many math topics must appear without the ability to discover various ways to solve them.
>
> It was very good training. When I do presentations, I tend to bring up the Carnegie Math workshops and cite examples of my experiences as a "student." I feel I am getting stronger in my Math content knowledge which will assist me in my work with special educators in my RESA.
>
> I think this is a great program. Carnegie Learning and the state department have done a nice job.

[The trainer] didn't just show us how to do things or talk to us, she encouraged us to think and do!

Some comments were more critical and therefore categorized as negative. Several comments were concerned with technical issues, materials/techniques for the classroom, and appropriateness of content for special education environments. Post-PD survey examples include:

> I would have like[d] to have more examples and hands on ideas to take back to my classroom.
>
> We didn't get a chance to use/practice the Carnegie application program because of technology issues so I'm not sure exactly how useful it will be to my teaching.
>
> I am still not sure why there was so much emphasis put on Part to whole / Part to part section. I also went away without being sure of a couple of the correct answers to several items contained in the [workbook]. I understand the need to have think/discussion time, but I also want to know what the correct response would be to insure that what I present to my students would be accurate.
>
> I would like to have more real world examples to use in my classroom aligned with the CSO's.

There were few negative comments in the end-of-year survey, a couple of examples include:

> The activities were mostly too difficult for the students I have to work with.
>
> Carnegie Learning's methods do not work with MM/MI students. Research has shown that project based learning works with the general student and maybe the LD student. NOT the MM/MI student. Connecting all of the CSO's at one time is too confusing and overwhelming for most of these students.

Finally, some of the comments categorized as mixed or neutral/other may be helpful when considering areas for improvement in the math academies. The following are examples from both the post-PD and end-of-year surveys:

> I really enjoyed the training, however, if WVDE wants special educators to learn the content knowledge in order to meet the needs of the students they also need to have sessions that teach strategies to teach the concepts to our students.
>
> I love the summer training and even a few meetings throughout the year, but the additional course work required was not made clear before the training began. This additional work is taking away the one thing that educators do not have enough of already- TIME.
>
> I wish the training had been more content specific, but it was a very good start.
>
> Having student access [to MATHia] would make application more effective and if the school used this approach instead of the "standard" teaching to help students who have skill gaps.
>
> The training was well-organized and had useful information, however, the math classes I teach do not do any proportional reasoning. I would like to have a training that focuses more on Algebra or Geometry concepts. This would be more relevant and better meet my needs.
>
> It would be nice to have follow-up in years 2013-2014 (another academy) to keep the incentive going and to keep current as we transfer to the common core standards.
>
> More opportunities for discussion of what participants have tried; what worked what didn't. Ideas for hands-on projects that correlate with these skills.
>
> MATHia software was not very user friendly and not very interesting to students. The tutorials were helpful but unfortunately most students would not read the lengthy directions and examples.

General math teachers should participate. Some still have "one way" to get the answer. Difficult for someone to go in and try to change that.

Learning Mathematics for Teaching assessment

Among the Year 1, Cohort 1 academy attendees, 42 participated in the proportional reasoning LMT assessment. The pre-/post-assessments were designed to measure any changes in mathematical knowledge and pedagogical skills in the area of proportional reasoning. A paired *t* test of the pre- and post-scores yielded a *p* value of 0.046 (see Table 3). Therefore, we can state with 95% confidence that math academy teachers who took the LMT increased their proportional reasoning knowledge and pedagogical skills. With a Cohen's *d* value of 0.4, the effect size substantiates this finding, indicating a medium effect from pre- to post-LMT assessment scores.

Table 3. Proportional Reasoning LMT Results, 2011-2012

Year	Academy content	*n*	*df*	*t* score	*p* value	Interpretation
2011-2012	proportional reasoning	42	41	2.054	0.046	Statistically significant difference from pre to post test scores

Year 2–Developing Algebraic Thinking

Post-PD survey and end-of-year survey

The 2nd year of the Mathematics Academies Initiative hosted 77 Cohort 1 participants. Participation decreased by 42 individuals; this attrition was caused by several different factors including but not limited to certification transfers (i.e. teachers transferring from special to general education), location transfers (both in-state and out-of-state), retirement, health constraints, time and commitment barriers, and loss of interest. Of the returning 77 participants, over 85% (n = 66) responded to the post-PD survey and all 77 (100%) responded to the end-of-year survey. Those responding to at least one of the academy surveys represented 26 counties across the state (see Figure 12). While in some cases multiple teachers came from the same county, overall, nine fewer counties were represented in Year 2 compared to Year 1. Although matching survey responses was possible due to a revision in the study research design, we decided to present findings unmatched because (a) Year 1 results were presented unmatched; (b) matching would require excluding 11 end-of-year survey records, diminishing the richness of the data; and most importantly (c) demographic results yielded similar participant characteristics. Thus it is still reasonable to draw general inferences when comparing results from the post-PD survey to the end-of-year survey.

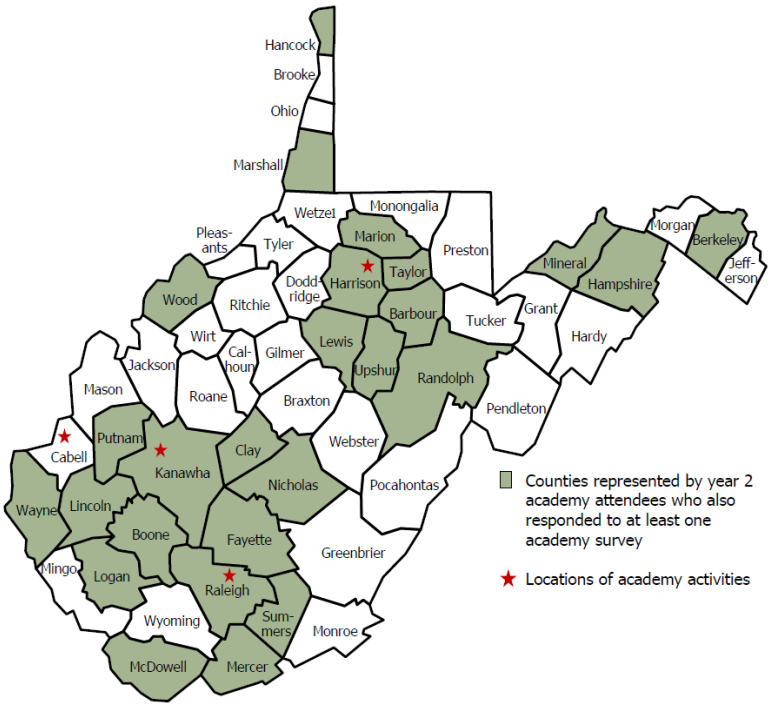


Figure 12. Counties Represented by Cohort 1, Year 2 Academy Attendees

Math Academy attendees (responding to at least one academy survey) represented 26 counties across WV. This is nine fewer counties than were represented in year 1 of the Math Academy.

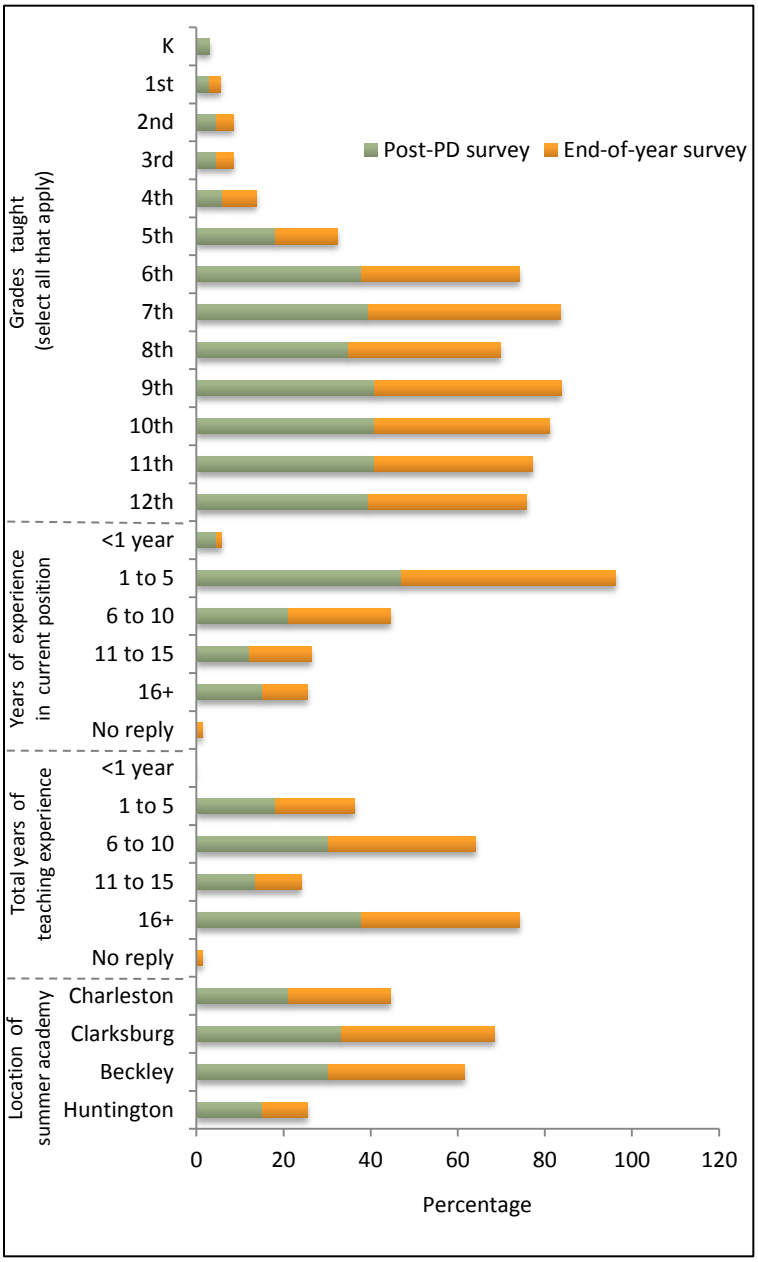


Figure 13. Academy Participant Characteristics by Survey, 2012-2013

Post-PD survey *n* = 66 and end-of-year survey *n* = 77

As depicted in Figure 13, those participating in each of the academy surveys shared similar percentages in the grades they taught (the majority of teachers reported instructing at the middle- and high-school programmatic levels). Further, they exhibited comparable years of experience in their current teaching positions (most reporting 1–5 years), as well as similar years of experience in the field of education (the majority of responding teachers had over 16 years of experience, but many also reported 1–5 years of experience as well as 6–10). Finally, although attendance at the four locations of the initial summer academies differed from location to location, attendance was comparable from one survey to the other. These results indicate not only comparable characteristics from the post-PD to end-of-year surveys, but also a relatively good mixture of teachers from various programmatic levels, years of experience, and localities. All descriptive statistics for Cohort 1, Year 2 surveys can be found in Appendix B, starting on page 53.

Designed nearly identically to Year 1 surveys, both the post-PD and end-of-year surveys asked academy participants several series of questions relating to the usefulness and quality of the math academy. Again, this type of survey design allows us to evaluate participants' opinions after the initial 5-day summer academy and then once more at the conclusion of the academy. Akin to Year 1 findings, results for Year 2 surveys tended to remain relatively consistent from the post-PD to end-of-year surveys.

Even though Year 2 surveys are similar to Year 1 surveys, a few items differ. Our discussion begins with one of those items. When asked about the usefulness of the academy, the

post-PD response choices were the same as Year 1, see key under Figure 14. Nearly 70% of respondents indicated the PD was a *good start* and that they *look forward to using* what they have learned. The least common response was *I don't think that these ideas will work very well* representing a little more than 1%.

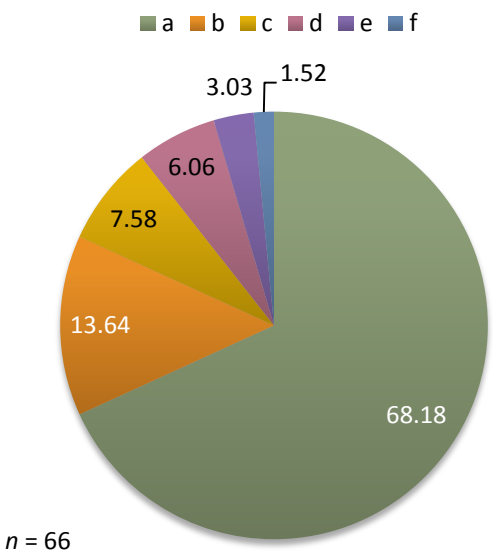


Figure 14. Post-PD Survey: Usefulness of Math Academy PD, 2012-2013

Figure 14 key

a. It was a good start, and I look forward to using what I learned in my classroom
b. It was a good start
c. It provided everything I need to use what I learned in my classroom
d. It's too early to tell
e. It was a good start, but I have a lot of questions
f. I don't think that these ideas will work very well in my classroom

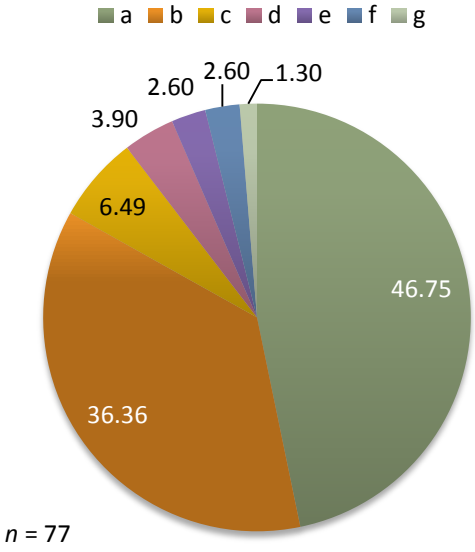


Figure 15. End-Of-Year Survey: Usefulness of Math Academy PD, 2012-2013

Figure 15 key

a. Both years were equally useful, and I look forward to using what I learned in my classroom
b. Both years were equally useful
c. The second year was more useful
d. Overall, the academy provided everything I need to use in my classroom
e. The first year was more useful
f. I don't think that these ideas will work very well in my classroom
g. Both years were equally useful, but I have a lot of questions

Reflective of not only the completion of the academy year, but also the conclusion of 2 years of Cohort 1 activities, the corresponding end-of-year survey item included some response options that differed from Year 1. They are listed in the key under Figure 15. Nearly 47% of teachers chose option (a) and about 36% selected option (b); this indicates that approximately 83% of participants believe both years of academy activities were *equally useful*. Roughly 6% stated the 2nd *year was more useful*, and less than 3% felt the 1st *year was more useful*.

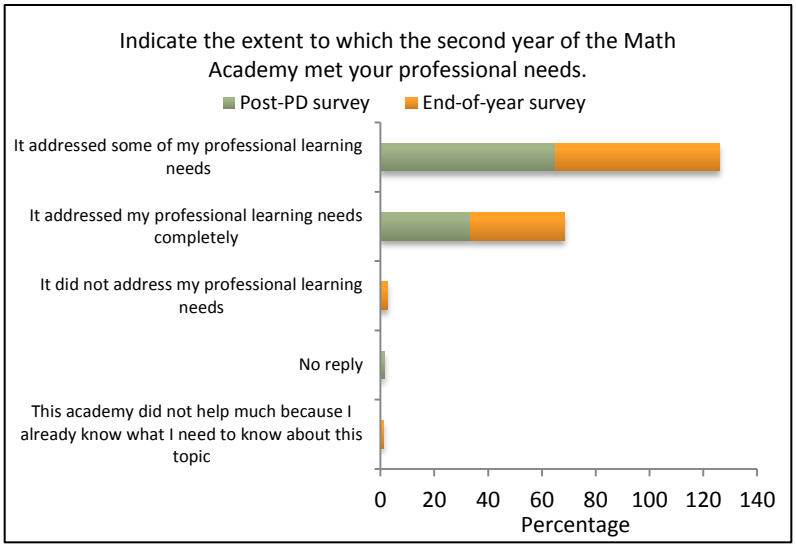


Figure 16. Meeting Teachers' Professional Needs, 2012-2013
Post-PD survey *n* = 66 and end-of-year survey *n* = 77

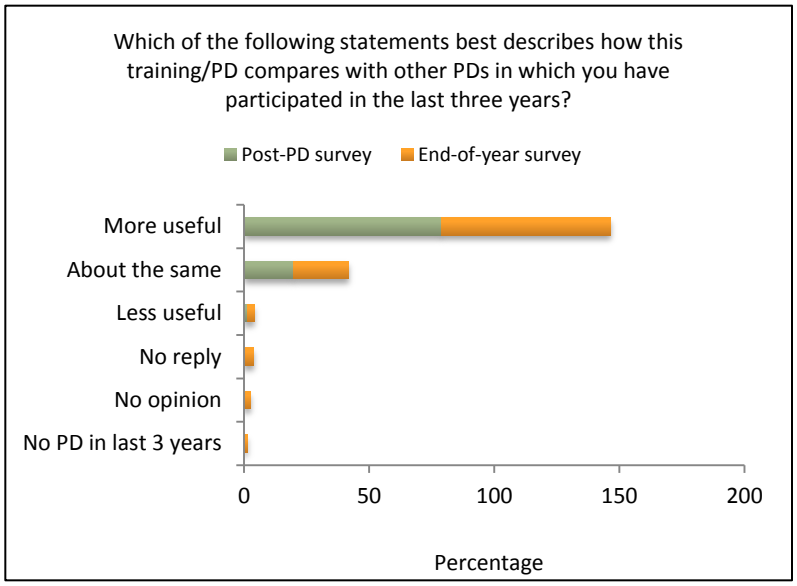


Figure 17. Comparing the Math Academy to Other PD, 2012-2013
Post-PD survey *n* = 66 and end-of-year survey *n* = 77

Next the surveys asked respondents to indicate at what level the PD met their professional needs (see Figure 16). With 65% in the post-PD survey and 61% in the end-of-year survey, the predominant response was *it addressed some of my professional learning needs*. Perhaps more notably, 33% and 35%, respectively, stated *it addressed my professional learning needs completely*. No participants in the post-PD survey chose either of the two unfavorable response options. Slightly over 1% of end-of-year survey respondents indicated that the PD *did not address their professional learning needs*; and fewer than 3% felt they *already know what they need to know about the topic* and the academy would not help them.

The next survey item asked teachers to compare the PD they received in the math academy to any other PD experiences from the past 3 years (see Figure 17). Nearly 79% of respondents in the post-PD survey and close to 68% in the end-of-year survey replied that the math academy was *more useful*. Fewer than 2% in the post-PD survey and not quite 3% of teachers in the end-of-year survey indicated the PD was *less useful*.

As with the Year 1 surveys, both Year 2 surveys asked teachers about the likelihood of applying what they learned at the math academy in their classrooms/work settings. The post-PD survey offered four response choices, see Figure 18. The most prevalent response, at 62%, was (a), followed by (b) with 24% of all responses. Fewer than 2% of responding teachers felt the techniques they learned would not *work for my students*.

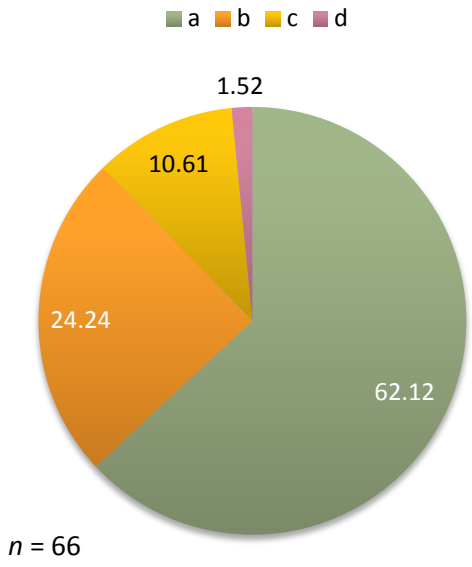


Figure 18. Post-PD Survey: Applying Math Academy Knowledge/Skills, 2012-2013

Figure 18 key

a. I look forward to practicing/applying the knowledge/skills in my classroom during the upcoming school year
b. I already practice/apply the knowledge/ skills this training provided in my classroom, and it seems to work well
c. I have already practiced/applied the knowledge skills this training provided in my classroom, but it is not appropriate for my students
d. I don't think what I learned here will work for my students so I don't envision applying the knowledge/skills

Note: Total % ≠ 100 (percent of no response was excluded)

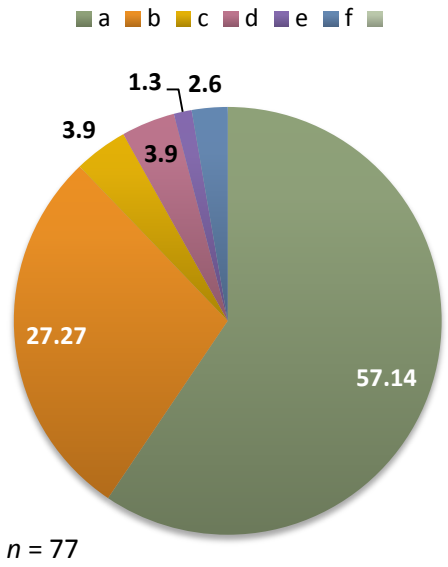


Figure 19. End-Of-Year Survey: Applying Math Academy Knowledge/Skills, 2012-2013

Figure 19 key

a. I now practice/apply the knowledge/skills the academy provided in my classroom
b. I previously practiced/applied the knowledge/ skills the academy provided in my classroom AND I continue to do so
c. I have not practiced/applied what I learned BUT I plan to practice/apply the knowledge/ skills in my classroom soon
d. I do not practice/apply what I learned at the math academy because it is not appropriate for my students
e. I do not practice/apply what I learned at the math academy because of other reasons
f. I previously practiced/applied the knowledge/skills the academy provided in my classroom BUT I no longer do so

Note: Total % ≠ 100 (percent of no response was excluded)

The corresponding item on the end-of-year survey offered six response choices, see key under Figure 19. At 57%, the most frequent response was (a) with 27%, (b) was the second most common response. Approximately 8% of the participants are not utilizing and do not plan to utilize academy techniques—responses (d), (e), and (f). Nevertheless, when comparing post-PD results to those from the end-of-year, findings suggest many of the teachers who intended to implement knowledge and skills gained in the math academy did so within the 2012-2013 school year.

The next survey item asked teachers how closely the math academy PD was related to their schools' or programs' goals for improving instruction. This particular survey item appeared only in the post-PD survey; it was excluded from the end-of-year survey as academy stakeholders deemed it no longer integral to the study. Results from the post-PD survey indicated solid alignment between the math academy and school goals for instructional improvement as 62% of respondents stated they were *very closely aligned* and 35% reported they were *somewhat* aligned. The remaining 3% said they *did not know*. No teachers reported that the academy and school goals were not aligned.

Unchanged from Year 1 surveys,[7] the final three sets of survey items comparable between post-PD and end-of-year survey responses are focused on the quality of math academy materials, trainers, and overall PD. As before, each set of survey items were based on a 5-point Likert type scale of agreement (where 5 = *strongly agree*, 4 = *agree*, 3 = *neutral*, 2 = *disagree*, and 1 = *strongly disagree*). Also, the items were analyzed in the same manner; first frequencies were calculated for individual items (represented as a percentage) and then an overall composite score (with a maximum point value of 5) was determined for each set of items.

Generally, academy materials continued to receive high ratings. With only one exception, (see Figure 20) at least 90% or more of respondents chose *agree* or *strongly agree* for each of the math academy material statements. Further, *disagree* and *strongly disagree* were seldom chosen, especially in the post-PD survey. Of note, the percentage of *strongly agree* responses

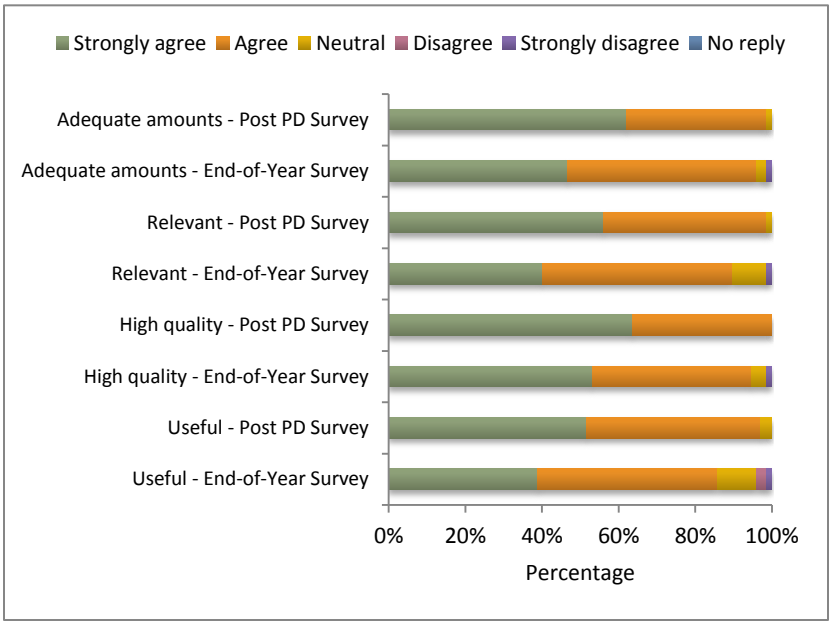


Figure 20. Math Academy Material Quality Ratings, 2012-2013
Note: PPD:12 = Post-PD survey, 2012 (*n* = 66) and EY:13 = End-of-year survey, 2013 (*n* = 77)

[7] Refer to page 13 of Year 1–Proportional Reasoning for complete item descriptions.

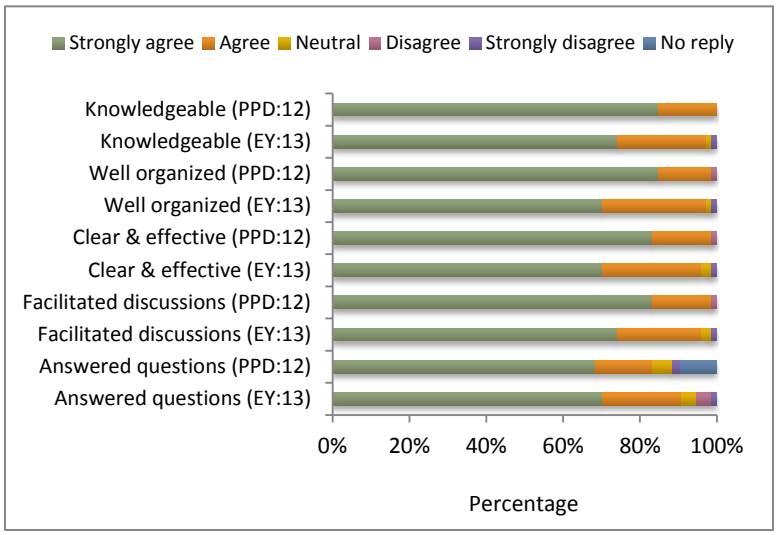


Figure 22. Math Academy Trainer Quality Ratings, 2012-2013

Note: PPD:12 = Post-PD survey, 2012 (*n* = 66) and EY:13 = End-of-year survey, 2013 (*n* = 77)

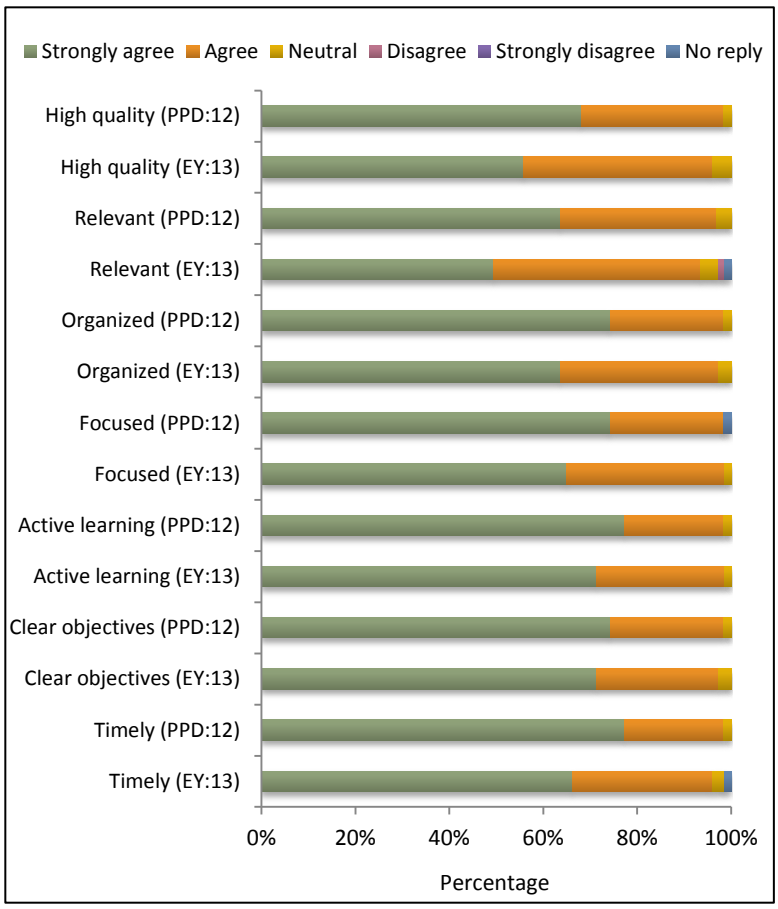


Figure 21. Math Academy PD Quality Ratings, 2012-2013

Note: PPD:12 = Post-PD survey, 2012 (*n* = 66) and EY:13 = End-of-year survey, 2013 (*n* = 77)

did drop somewhat in the end-of-year survey as compared to the post-PD survey. This trend is also reflected in the composite scores for this set of items; the post-PD mean was 4.6 and the end-of-year was 4.3. Nevertheless, these results remain quite high, suggesting academy participants were satisfied with the quality of the materials.

Throughout Year 2, academy participants maintained high regard for their trainers. Again, with one exception, (see Figure 22) 90% or more of the responses for all trainer quality statements were *agree* or *strongly agree*. The trainers received the highest ratings in the post-PD survey—especially for items centered on *knowledge*, *organization*, *clear and effective presentations*, and successfully *facilitating discussions*. The item with the lowest ratings (consisting of 70% *strongly agree* and 15%–20% *agree*) was about trainers adequately addressing questions raised during academy activities.

When composite scores were calculated for the trainer items, the post-PD mean was 4.8 and the end-of-year mean was 4.6. The results clearly suggest math academy participants believe the trainers from Carnegie Learning deliver high quality and effective professional development.

The final set of quality items, measuring the overall PD quality, were also highly rated by both post-PD and end-of-year survey respondents. Among all items, 93% to 95% of responses were *strongly agree* or *agree*. Moreover, *disagree* represented 1% of the responses for one end-of-year item and *strongly disagree* was never chosen as a response in this set of items. Accordingly, the composite scores were also high; the post-PD mean was 4.7 and the end-of-year mean was 4.6. Large percentages of those responding *strongly agree* and *agree* to the quality PD survey items along with the high composite mean scores signify the math academy was successful in delivering high quality professional development.

Altogether, results from the three sets of survey items demonstrate participants felt the materials, trainers, and overall quality of the PD was very high. In alignment with Year 1 results, Year 2 qualitative data also supports this finding. Year 2 surveys provided participants several opportunities to submit comments about the usefulness, materials, trainers, and overall quality of the PD. During analysis, comments were organized into four general categories: positive, negative, mixed and neutral/other. Comments classified as positive were most common among Year 2 survey results. Below, we provide examples of positive comments.

Post-PD survey examples include:

I appreciate being able to review the skills for the content. Most trainings say they will teach strategies and concepts, but as special educators we are expected to be able to teach such a variety of subjects it's wonderful to be able to go to a training that actually improves my knowledge to teach my students the math.

All PD should be done in this format!

[The trainer] very helpful and knowledgeable and had our success in mind as she trained us. I think she really challenged us to think like our students what a great challenge it was

I believe this is one of the best classes I have ever participated in and it has helped me gain confidence in the classroom.

Instructors have been top-notch. . . .I wish I would have had [them] in high school. For once in my life, math was actually enjoyable.

I really appreciate that our trainer was a WV Math teacher -- not just a trainer but an actual teacher who has been in the classroom.

I really enjoyed this academy. The math was on my level and on the level in which my students need to be.

I am interested in additional training. These sessions have been the best professional developments for obtaining hands-on strategies to use in the classroom.

End-of-year examples include:

This is the absolute best training I have ever had as a teacher. I hope this continues in the future for other teachers. I have found no other source that is better at preparing teachers for the new state standards.

At first, I wasn't crazy about giving up a week in the summer BUT I loved both years of the academy!! I think everyone should attend one of the academies!!!

The amount of useful information given is outstanding. Before the academies; math was my most absolute dreaded class to participate in and teach, but now I feel

The instructors were demanding but helpful. The work was challenging but with support, an understanding was accomplished. The work was extremely time consuming but well worth the effort.

more confident and able to really understand my students frustration and offer many ways of helping them to better understand the material.

I enjoyed the setting. It was nice to be able to meet with so many educators from around the state to discuss what works for them. I was able to get some great ideas and make lifelong friends. Thank you!

At first, I felt lost, but I gained more confidence during the 2 year program.

There were not too many negative comments in either the post-PD or end-of-year surveys. Most were concerned with the desire to have more materials and the use of Cognitive Tutor. Examples from both surveys include:

Sometimes the amount of time provided for a specific activity seemed to be too long. There is a thin line between giving time to think and work while insuring that all students are still working on the task. My group frequently finished and had time to wait while others were working. However at one time we had about 1 1/2 to 2 hours left over.

I think we would all like to have more "take home" activities that we can incorporate into our classrooms. I realize that Carnegie wants everyone to buy their product, but not all counties have the funds to do so.

I wasn't the biggest fan of the Cognitive Tutor. I didn't find it very user friendly

Finally, some of the comments categorized as mixed or neutral/other may be helpful when considering areas for improvement in the math academies. Many comments that were placed in these categories called for considerations for special education environments/ students, appropriateness of difficulty levels, and MATHia/Cognitive Tutor. The following are examples from both the post-PD and end-of-year surveys

I was a bit frustrated in the beginning because of answering a question with a question format but I quickly adjusted and knew I was going to be forced to solve for my own answer. This made me think and was difficult but awesome!

I would have like[d] some specific special education ideas.

I have suggested this academy to my peers, especially those who co-teach or are new to teaching. These courses would help any math teacher get a grasp of the new common core standards and how to best present them. About the Mathia software, I can see how it helps deepen understanding but it is quite frustrating for some of us. Thank you for the opportunity, this was the best PD I have been a part of in 13 years.

I enjoyed this PD and the wealth of math knowledge I gained from it, but a 1 week training with 2 follow up days should not overshadow a Master's Degree, numerous other coursework, and years teaching experience in another content area. This deepened my math knowledge, but a 1 week training in Math I content should not make administrators view me as qualified to teach higher math (Conceptual Math and College Transition Math for example).

The training opportunities have been fantastic. The presenter is a super educator and she provides an immense amount of information. However, my particular classroom situation does not allow me to use a great deal of advanced mathematics. I would really like to learn of methods and materials relating to a less advanced population of students

Learning Mathematics for Teaching assessment

An LMT assessment covering patterns, functions, and algebra was deemed appropriate for middle school teachers in the developing algebraic thinking academy. Of Cohort 1, Year 2 attendees, 34 completed the LMT pre-/post-assessments. The assessment measured changes in knowledge and pedagogy related to patterns, functions, and algebra. A paired *t* test of the pre- and post-scores yielded a *p* value of 0.1025 (*p* values equal to or less than .05 are considered statistically significant) (see Table 4). Therefore, even though the data shows an increase from pre- to post-scores, it is not a significant increase. It is not possible to determine with any level of certainty if a gain in knowledge and pedagogical skills occurred among participants or not. An effect size of 0.05 (interpreted as a negligible effect) further evidences these statistical results.

Table 4. Patterns, Functions and Algebra LMT Results, 2012-2013

Year	Academy content	*n*	*df*	*t* score	*p* value	Interpretation
2012-2013	Algebraic thinking	34	33	1.68	0.1025	Difference from pre- to post-test, but not a significant difference

End-of-Year Survey Items, Years 1 and 2

Besides the comparable items included in both the post-PD and end-of-year surveys, the end-of year surveys also had several others. These items asked participants to consider shifts in their attitudes toward mathematics and teaching mathematics as well as changes in specific math content knowledge (i.e. proportional reasoning, and algebraic thinking). Further, each year, we asked participants to compare their sentiments toward mathematics and mathematics instruction prior to the academy against their viewpoints at the conclusion of the academy. To this end, we asked them to tell us if they agreed *more*, *about the same*, or *less* to a series of statements. Additionally, the end-of-year surveys included items designed to measure the helpfulness of academy components and the levels of support felt by teachers at local, district, and state levels. Since these items are unique to the end-of-year surveys, results from Years 1 and 2 are presented together next (see Appendix C, page 65 for complete results).

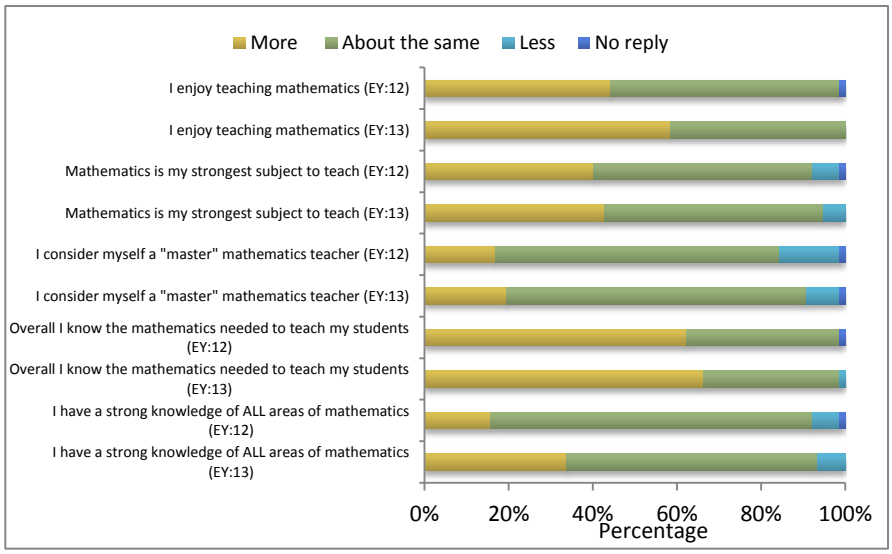


Figure 23. Change In Mathematical Attitudes, 2011-2013

Note: EY:12 = End-of-year survey, 2012 (*n* = 77) and EY:13 = End-of-year survey, 2013 (*n* = 77)

Adjustments in attitudes concerning math and mathematics pedagogy for both academy years can be seen in Figure 23 (above). Compared to their attitudes prior to participating in the Mathematics Academy Initiative, approximately 44% of Year 1 teachers reported they enjoy teaching mathematics *more*. At the conclusion of Year 2, the percentage responding *more* to the same item exceeded 58%; representing a 14% increase from Year 1 to Year 2. Results for the next item, "Mathematics is my strongest subject to teach," remained relatively consistent across both academy years with 40–42% responding *more*. When asked if they considered themselves a "master" mathematics teacher the percentage of those choosing *less* dropped from 14% in Year 1 to less than 8% at the conclusion of Year 2. Sizeable percentages of responders chose *more* to the statement, "Overall I know the mathematics needed to teach my students," across both years of the academy (62% and 66% respectively). Finally, the percentage of those responding *more* to the item "I have a strong knowledge of ALL areas of mathematics," rose from 15% in Year 1 to nearly 34% in Year 2.

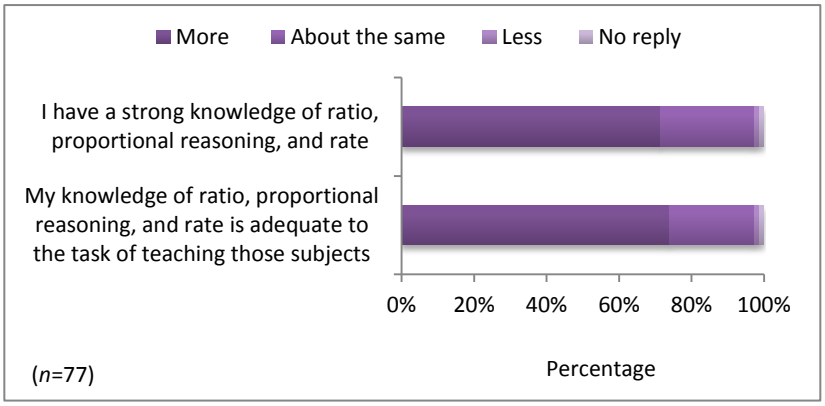


Figure 24. Change in Proportional Reasoning Knowledge, Year 1, 2011-2012

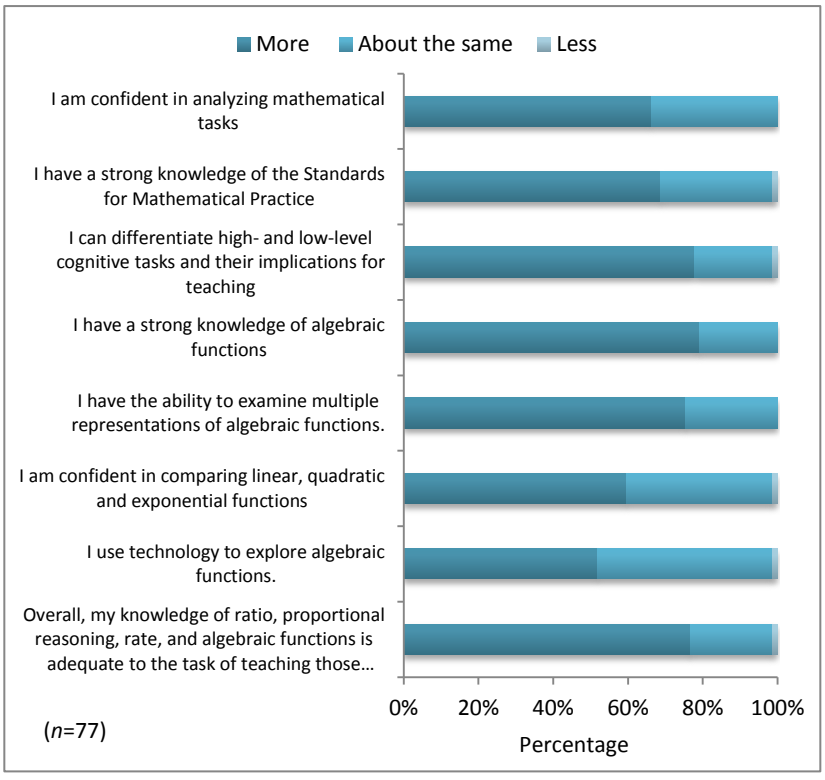


Figure 25. Change in Math Academy Content Knowledge and Attitude, Year 2, 2012-2013

There were two content-specific items in the Year 1 end-of-year survey. Seen in Figure 24, over 70% of responses were *more* for both of the proportional reasoning items. Year 2 end-of-year survey contained eight items pertaining not only to algebraic thinking knowledge and attitudes, but also related to knowledge gained over the 2 years of academy activities.

Depicted in Figure 25, those responding *more* ranged from 52% ("I use technology to explore algebraic functions") to 79% ("I have a strong knowledge of algebraic functions"). Nearly 77% responded *more* to "Overall, my knowledge of ratio, proportional reasoning, rate, and algebraic functions is adequate to the task to teaching those subjects," the item that synthesized knowledge and pedagogy ability gained over the 2 years of the initiative.

Next, participants were asked to rate how helpful they felt the different components of the Mathematics Academy Initiative were. Response options were based on a 5-point Likert-type scale of agreement ranging from *strongly agree* to *strongly disagree*. Results seen in Figure 26 indicate participants viewed the 5-day summer academy as the most helpful component; approximately 95% of responses were *strongly agree* and *agree* across both years. Again, combining the *strongly agree* and *agree* responses, participants felt the fall and spring follow-up meetings were about equally helpful (75%–85%). Finally, while about 80% reported Cognitive Tutor/MATHia as being helpful, 15-17% indicated their feelings were neutral. Notably, the percentage of those strongly agreeing with each of the statements was greater in Year 2 than in Year 1. Mean scores calculated for the items further support these findings (see Appendix C Table C 9). The summer academy had the highest mean (4.55 in Year 1 and 4.65 in Year 2; with 5 as the highest possible result) and Cognitive Tutor/MATHia received the lowest mean scores (4.24 in Year 1 and 4.19 in Year 2). The Year 2 survey contained an additional Cognitive Tutor/MATHia item, which asked participants if using Cognitive Tutor/MATHia had deepened their understanding of mathematics; approximately 75% of responses were *strongly agree* or *agree*.

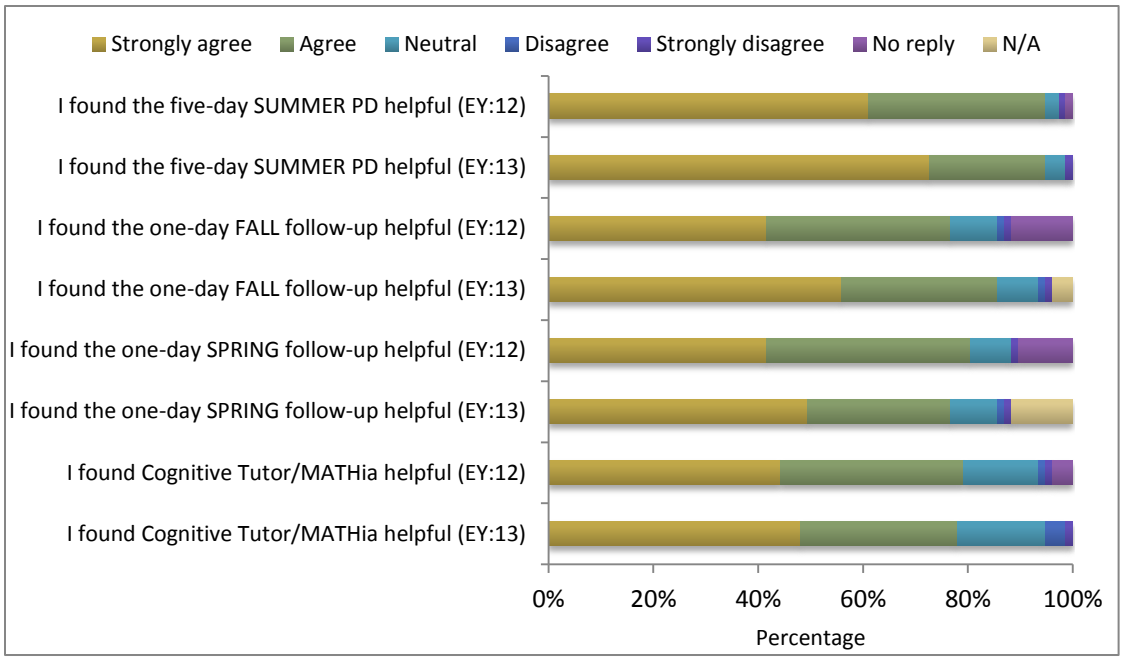


Figure 26. Helpfulness of Math Academy Components, 2011-2013

Notes: EY:12 = End-of-year survey, 2012 (*n* = 77) and EY:13 = End-of-year survey, 2013 (*n* = 77); response of N/A may indicate individual did not attend a specific academy activity

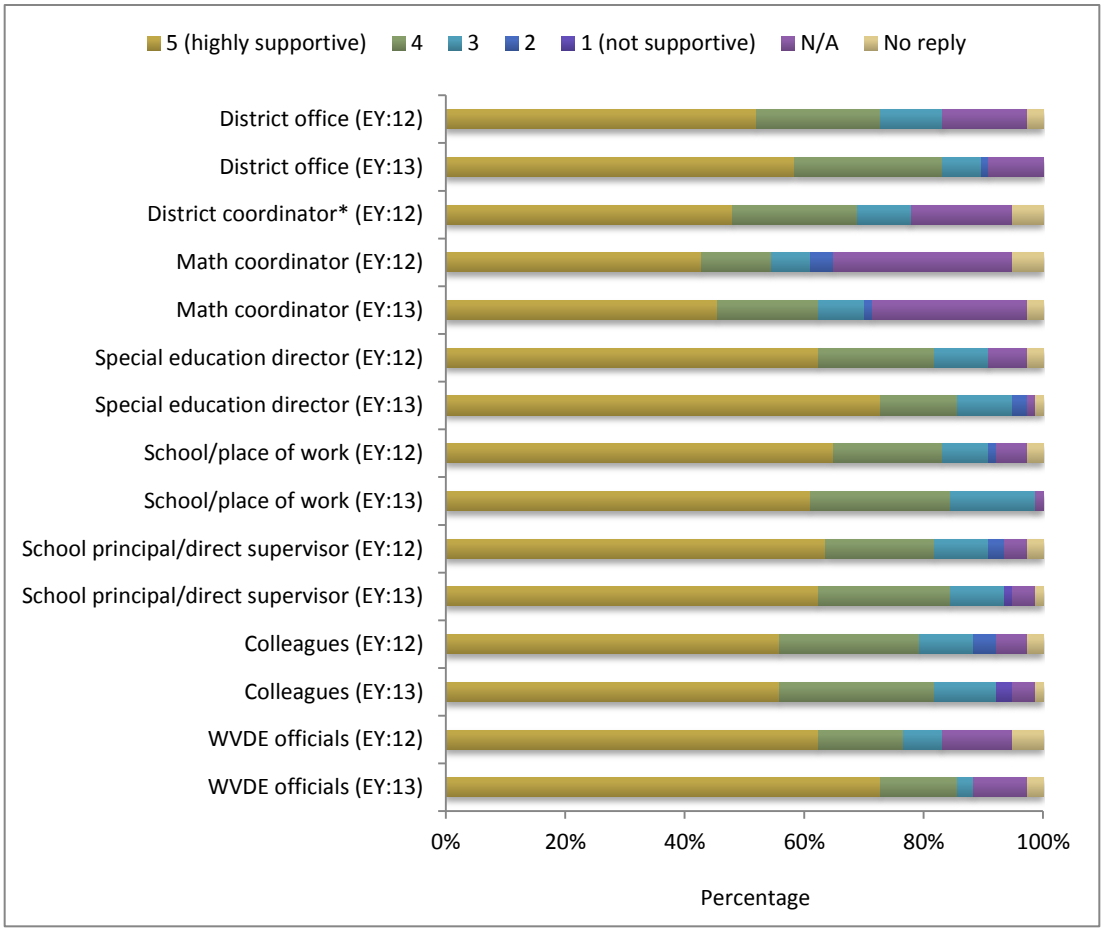


Figure 27. Levels of Support for Math Academy Participants, 2011-2013

Notes: EY:12 = End-of-year Survey, 2012 (*n* = 77) and EY:13 = End-of-year survey, 2013 (*n* = 77); district coordinator item was excluded from EY:13; response of N/A may indicate the absence of an office or individual

The last set of survey items in this section pertain to academy attendees' perceptions of how supportive different offices or role groups were regarding attendees' participation in the Mathematics Academy Initiatives. Offices and role groups were listed for the school, county, RESA, and state levels. Responses for these items were based on a 5-point scale ranging from 1 (*not supportive*) to 5 (*highly supportive*). Generally, participants reported relatively high levels of support across all offices and role groups throughout both years of their participation. The highest ratings for supportiveness were observed in 2012-2013 with 73% of special education directors and 73% of WVDE officials receiving the rating of 5 (*highly supportive*). Figure 27 displays results for all offices and role groups.

Discussion

The purpose of the Mathematics Academy Initiative research study is to determine the effectiveness and impact of the math academies in three areas: (a) the quality of academy elements (i.e. instruction, materials, overall PD); (b) teacher attitude and disposition toward mathematics instruction; and (c) teacher content knowledge in specific mathematics focus areas. We will discuss the evaluation results for each of these areas followed by an examination of how the math academy compares to current research findings on the elements of effective professional development.

Quality of Math Academy Elements

Participants responding to the four evaluation surveys (a post-PD survey and end-of-year survey for each year) clearly felt the academy elements were high quality. Among academy materials, trainers, and overall PD and across both years of Cohort 1, Carnegie Learning trainers received the highest 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. Further, an examination of individual trainer items revealed participants most strongly agreed with the statement, "Trainer(s) were knowledgeable about the topic." Finally, reaffirming these findings, the vast majority of additional comments about trainers were positive in nature.

Those responding to our surveys also gave the overall quality of the PD excellent ratings. Again, calculating composite scores by averaging the seven items in this set, we see scores with a small span, 4.6 to 4.7 (note, the 4.6 composite score occurred in three of the four surveys). While Year 1 ratings were somewhat higher than those in Year 2, across all items at least 83% and up to 100% of responses were *strongly agree* and *agree*.

Of the academy quality items, academy materials received the lowest ratings. Composite scores for the set of four items ranged from 4.3 to 4.6. The composite scores reflect the fact that these items received fewer *strongly agree* ratings than any of the other PD quality items. However, the percentages of those choosing *strongly agree* or *agree* remained remarkably high (from 75% to 100%).

Notably, very few survey participants chose *strongly disagree* among any of the PD quality items discussed above. This finding along with the large percentages of *strongly agree* and *agree* responses as well as high composite mean scores suggest the Mathematics Academy 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 Mathematics Instruction

Impacts on attitudes and disposition toward mathematics and mathematics instruction were measured by several survey items. First, participants consistently reported that the math academy was useful. When asked to describe the usefulness of the PD, over 50% of Year 1 (for both surveys) and nearly 70% of Year 2 post-PD responses indicated participants felt the academy was a good start and that they looked forward to implementing what they learned into their classrooms or work settings. At the conclusion of Year 2, nearly 85% of participants reported both years of academy activities were equally useful. Furthermore, when asked to compare the math academy to other PD at least 60% and up to 80% of participants stated the math academy was more useful.

Second, when the post-PD survey asked about the likelihood of applying what they learned at the math academy into their classrooms or work settings, 78% of Year 1 and 62% of Year 2 participants said they looked forward to practicing new skills in their classrooms/work settings within the school year. In the corresponding end-of-year survey item, 42% of Year 1 and 57% of Year 2 participants reported that they now practice the skills the math academy taught them in their classrooms or work settings. This suggests many of the attendees implemented the skills and knowledge they gained as a direct result of the math academies.

Third, the end-of-year surveys contained a series of items asking participants about their attitudes concerning mathematics and teaching mathematics. When asked to compare their sentiments prior to the academy against their viewpoints at the conclusion of the academy year, 44% of Year 1 and 58% of Year 2 participants reported enjoying teaching more after attending the math academy. Between 40% (Year 1) and 43% (Year 2) reported "Mathematics is my strongest subject to teach" as *more* the case after attending the academies. Perhaps most telling, 62% (Year 1) and 66% (Year 2) of respondents indicated *more* agreement after participation in the academies, with the item "Overall I know the mathematics needed to teach my students."

Finally, shifts in mathematics attitudes and dispositions are demonstrated by some of the additional comments. Several participants wrote 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 imply the Mathematics Academies Initiatives have made a positive impact on the attitudes and dispositions of teachers concerning mathematics and mathematics instruction.

Content Knowledge in Mathematics 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. Change in knowledge was measured using both self-reported survey items and the LMT pre-/post-assessments. While the LMT is an evidence-based tool with established reliability, we felt it was also important to collect self-reported data. This twofold approach gave all

academy attendees the opportunity to participate (the LMT is appropriate for elementary and middle school teachers only) and allowed us to capture both subjective perceptual information and more objective assessment data concerning shifts in content knowledge.

The Year 1 end-of-year survey included two proportional reasoning content items. Again, instructing teachers to consider how they felt prior to attending the math academy to their current perceptions, over 71% of participants said they have a stronger knowledge of ratio, proportional reasoning, and rate. Further, 74% stated their knowledge of ratio, proportional reasoning, and rate is more adequate to the task of teaching those subjects.

The Year 2 end-of-year survey included content-specific items as well as items pertaining to changes in knowledge throughout Cohort 1's 2-year timespan. Of the algebraic thinking items, nearly 80% of participants reported having stronger knowledge of algebraic functions and 75% said they have an increased ability to examine multiple representations of algebraic functions. Among the items covering the entirety of Cohort 1, nearly 77% of participants reported their knowledge of ratio, proportional reasoning, rate, and algebraic functions is now more adequate to the task of teaching those subjects; 78% said they are better able to differentiate high- and low-level cognitive tasks; 69% indicated stronger knowledge of the Standards for Mathematical Practice; and 66% reported an increase in their confidence in analyzing mathematical tasks.

Based on LMT results for Year 1, participants realized statistically significant gains in proportional reasoning from pre- to post-assessments. This allows us to report with 95% confidence that there was an increase in teacher content knowledge and pedagogical capacity. Further, the magnitude of the increase in LMT scores was measured by calculating the effect size. The resulting effect size of 0.4 indicates a medium effect, further corroborating a measurable positive impact in the knowledge and pedagogy skills among those who took the proportional reasoning LMT assessments.

Even though Year 2 findings for algebraic thinking on the LMT showed an increase from pre- to post-assessments, it was not statistically significant. Therefore, it is not possible to report with any certainty that an observable change in algebraic functions knowledge and/or pedagogy took place. Additionally, calculation of the effect size yielded only a negligible effect. While these data are reliable, there are other possible explanations as to why we did not observe statistically significant results. One possible explanation is that the special education teachers in the group had not previously taught algebra and may need further support to increase their content and instructional knowledge. Another possibility relates to statistical power, or the ability to detect differences that are real (i.e. avoiding a false negative result). Power may be influenced by sample size (larger samples typically increase the statistical power of a test); the variance of the distribution of results (it is easier to detect change among distributions that exhibit greater variance); the magnitude of the true difference being tested (measured by the effect size); and stringency of significance establishment, most commonly statistical significance is established with a minimum of a p value equaling 0.05 (more stringent significance criteria are p values of 0.01 and 0.001).

According to the self-reported data, academy participants experienced content specific increases in knowledge, pedagogical capacity, and confidence during the 2 years of academy activities. Year 1 proportional reasoning LMT results substantiate these findings.

However, Year 2's algebraic thinking LMT did not yield statistically significant results and any changes in knowledge or pedagogy cannot be objectively verified.

Elements of Effective PD Present in the Mathematics Academies Initiatives

Results from the evaluation tools used in this study (post-PD surveys, end-of-year surveys, and LMT assessments) indicate Cohort 1 of the Mathematics Academies Initiatives has been successful. Participants reported satisfaction with academy materials, trainers, and overall PD; findings also suggest improvements concerning mathematics attitudes and disposition toward mathematics instruction. Further, self-reported survey data and Year 1 LMT results show increases in content knowledge and pedagogical abilities. Yet, without linking student outcomes to math academy participants (see Limitations), what other evidence do we have that this PD has been effective?

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 (Hammer, 2013), there are five common elements to effective PD. These include: (1) content and pedagogy focus; (2) coherence; (3) active learning; (4) collective participation; and (5) duration.

Arguably, Cohort 1 of the Mathematics Academies Initiatives practiced four of the five elements (see Table 5). Below we describe how the math academy implemented (and plans to implement) these elements:

1. Each year of the math academies explored a different content focus (proportional reasoning in Year 1 and developing algebraic thinking in Year 2) and was designed to increase teacher knowledge as well as their pedagogical abilities.
2. Math academies exhibited coherence; the PD activities progressively built upon each other and were in alignment with school goals for instructional improvement, the Standards for Mathematical Practice and the Common Core/WV Next Generation Mathematics Standards and Objectives.
3. Academies incorporated active learning into all face-to-face sessions; participants took the role of students while trainers modeled appropriate and successful teaching techniques.
4. Collective participation refers to participation of a group of teachers/personnel from the same school or the same specialization within a district. While Cohort 1 did not involve collective participation, beginning with Cohort 3 (2013-2014), the OSP actively encouraged coteaching pairs (special and general education 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.
5. Research differs on the exact number of hours required for effective PD, ranging from 30 to 180 hours. Further, some studies suggest duration is a crucial component, and others indicate content focus impacts the number of contact hours needed. Generally, however, effective PD should include at minimum 30 contact hours distributed across a timespan of at least a year. Cohort 1 lasted for 2 years and involved 100 hours of direct contact and on average 34 hours of Cognitive Tutor/MATHia interaction.

Table 5. Comparison of Effective PD Elements to Math Academy Cohort 1 (2011-2013)

Element	High quality PD	Math academy Cohort 1 (2011-2013)
Content/content pedagogy focus	✓	✓
Coherence	✓	✓
Active learning	✓	✓
Collective participation	✓	✗
Sufficient duration and timespan	✓	✓

Therefore, using these criteria, Cohort 1 of the Mathematics Academies Initiatives was mostly successful in delivering PD that has a high potential of improving instructional practice.

Limitations

While sound research methods are an integral component of quality studies, eliminating all potential risks of bias is impossible. The limitations of this evaluation study are typical of other studies with similar designs. Surveys (such as the post-PD and end-of-year surveys) that rely upon self-reported information always contain a risk of response bias. Respondents may exaggerate or underestimate, may have recall difficulties, and/or may report information they perceive as socially acceptable.

Furthermore, less than 100% of academy attendees participated in each of the surveys, and the academy lost more than 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. Individuals opting to participate in the surveys may have stronger opinions (either negative or positive) and there is a chance these viewpoints could skew the results. Considering demographic characteristics were comparable between post-PD and end-of-year surveys, we can presume but not guarantee survey results accurately represent the opinions of academy attendees. Additionally, the LMT was appropriate for measuring changes in knowledge and pedagogical capacity among elementary and middle school programmatic levels only. 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 Mathematics Academy Initiative and student outcomes. Currently, our data system lacks the capacity to reliably match teachers to their students. However, 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.

Recommendations

Continue offering academy activities that include elements of effective professional development (PD). Maintain academies that: (a) are focused on specific content and content pedagogy; (b) exhibit coherence with alignment to school goals, state standards, curriculum, and assessments; (c) engage in active learning, such as the current method of participants learning as students and trainers modeling as classroom teachers; (d) have collective participation of groups of teachers from the same school or specialization within the same district; and (e) maintain the level of contact time and timespan (at least 1 year) provided to Cohort 1 participants.

Encourage special education directors to recruit participants from counties that were not represented in Cohort 1. As a program with longevity and new content focus areas offered each year, the math academies are appropriate for many math teachers across the state. The West Virginia Department of Education Office of Special Programs and special education directors should encourage each school district to send at least one teacher to an academy. This will help ensure increased math knowledge and pedagogical capacity throughout WV.

Review academy content and classroom examples to ensure their application is appropriate for special education students/environments. Some Cohort 1 participants stated they felt the content and examples were not at an appropriate level for their students and therefore not applicable in their classrooms. While these sentiments may be a reflection of teachers not expecting or requiring enough from their students, academy designers should 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 specialization within the same district. One element of effective PD not incorporated into Cohort 1 activities was collective participation. While this practice was not implemented until the 2013-2014 (Cohort 3) Mathematics Academy Initiative, we encourage the continuation of this practice. Collective participation may be especially beneficial among coteaching teams, enhancing both general and special education teachers' mathematics content and pedagogical capacity.

Continue to develop the algebra content knowledge and instructional skills of middle school special educators. Beginning in 2014–2015, NxGen standards call for middle school special education teachers to teach algebra for the first time. Their success in teaching this content will have a strong bearing on the success of their students in math courses throughout high school and in closing the mathematics achievement for students with disabilities.

Consider the feasibility of determining if any correlation exists between the Mathematics Academies Initiative and gains in mathematics performance and/or proficiency among special education students. Currently, we do not have a method to study the exist-

ence of any linkage between math academy PD and student outcomes. Further research is required to (a) determine if it is possible to link special education teachers to their students, and (b) determine if there are other reliable ways to measure changes in student outcomes attributable to math academy activities.

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Appendix A.

Cohort 1 Year 1–Post-PD and End-of-Year Survey Results

Table A 1. County of Employment (2011-2012)

	Post-PD survey				End-of-year survey			
Response	Frequency	Percent	Cumulative frequency	Cumulative percent	Frequency	Percent	Cumulative frequency	Cumulative percent
No reply	33	34.74	33	34.74	0	0	NA	NA
Barbour	2	2.11	35	36.84	4	5.19	4	5.19
Boone	6	6.32	41	43.16	6	7.79	10	12.99
Clay	0	0	NA	NA	5	6.49	15	19.48
Fayette	2	2.11	43	45.26	3	3.90	18	23.38
Hampshire	1	1.05	44	46.32	1	1.30	19	24.68
Hancock	1	1.05	45	47.37	2	2.60	21	27.27
Hardy	3	3.16	48	50.53	0	0	NA	NA
Harrison	0	0	NA	NA	1	1.30	22	28.57
Jefferson	4	4.21	52	54.74	0	0	NA	NA
Kanawha	2	2.11	54	56.84	8	10.39	30	38.96
Lewis	3	3.16	57	60.00	3	3.90	33	42.86
Lincoln	2	2.11	59	62.11	3	3.90	36	46.75
Logan	3	3.16	62	65.26	2	2.60	38	49.35
McDowell	2	2.11	64	67.37	1	1.30	39	50.65
Marion	1	1.05	65	68.42	4	5.19	43	55.84
Marshall/Mason*	2	2.11	67	70.53	1	1.30	44	57.14
Mercer	2	2.11	69	72.63	3	3.90	47	61.04
Mineral	1	1.05	70	73.68	2	2.60	49	63.64
Mingo	0	0	NA	NA	1	1.30	50	64.94
Morgan	3	3.16	73	76.84	0	0	NA	NA
Nicholas	0	0	NA	NA	3	3.90	53	68.83
Ohio	0	0	NA	NA	1	1.30	54	70.13
Preston	9	9.47	82	86.32	0	0	NA	NA
Putnam/Raleigh*	1	1.05	83	87.37	11	14.29	65	84.42
Randolph	0	0	NA	NA	2	2.60	67	87.01
Roane	3	3.16	86	90.53	0	0	NA	NA
Summers	1	1.05	87	91.58	3	3.90	70	90.91
Taylor	0	0	NA	NA	2	2.60	72	93.51
Tyler	3	3.16	90	94.74	0	0	NA	NA
Upshur	1	1.05	91	95.79	2	2.60	74	96.10
Wayne	0	0	NA	NA	1	1.30	75	97.40
Wirt	4	4.21	95	100.00	0	0	NA	NA
Wood	0	0	NA	NA	2	2.60	77	100.00

*An error in the design of the online surveys resulted in Marshall and Mason, and Putnam and Raleigh counties appearing in pairs as one response option

Table A 2. Grade Levels Taught (2011-2012)

		Post-PD survey				End-of-year survey			
Grade*	Response	Frequency	Percent	Cumulative frequency	Cumulative percent	Frequency	Percent	Cumulative frequency	Cumulative percent
K	No reply	6	6.32	6	6.32	0	0	NA	NA
	N	84	88.42	90	94.74	73	94.81	73	94.81
	Yes	5	5.26	95	100.00	4	5.19	77	100.00
1st	No reply	6	6.32	6	6.32	0	0	NA	NA
	No	86	90.53	92	96.84	73	94.81	73	94.81
	Yes	3	3.16	95	100.00	4	5.19	77	100.00
2nd	No reply	6	6.32	6	6.32	0	0	NA	NA
	No	85	89.47	91	95.79	73	94.81	73	94.81
	Yes	4	4.21	95	100.00	4	5.19	77	100.00
3rd	No reply	6	6.32	6	6.32	0	0	NA	NA
	No	85	89.47	91	95.79	73	94.81	73	94.81
	Yes	4	4.21	95	100.00	4	5.19	77	100.00
4th	No reply	6	6.32	6	6.32	0	0	NA	NA
	No	82	86.32	88	92.63	73	94.81	73	94.81
	Yes	7	7.37	95	100.00	4	5.19	77	100.00
5th	No reply	6	6.32	6	6.32	0	0	NA	NA
	No	78	82.11	84	88.42	68	88.31	68	88.31
	Yes	11	11.58	95	100.00	9	11.69	77	100.00
6th	No reply	6	6.32	6	6.32	0	0	NA	NA
	No	58	61.05	64	67.37	50	64.94	50	64.94
	Yes	31	32.63	95	100.00	27	35.06	77	100.00
7th	No reply	6	6.32	6	6.32	0	0	NA	NA
	No	60	63.16	66	69.47	44	57.14	44	57.14
	Yes	29	30.53	95	100.00	33	42.86	77	100.00
8th	No reply	6	6.32	6	6.32	0	0	NA	NA
	No	59	62.11	65	68.42	46	59.74	46	59.74
	Yes	30	31.58	95	100.00	31	40.26	77	100.00
9th	No reply	6	6.32	6	6.32	0	0	NA	NA
	No	43	45.26	49	51.58	45	58.44	45	58.44
	Yes	46	48.42	95	100.00	32	41.56	77	100.00
10th	No reply	6	6.32	6	6.32	0	0	NA	NA
	No	42	44.21	48	50.53	47	61.04	47	61.04
	Yes	47	49.47	95	100.00	30	38.96	77	100.00
11th	No reply	6	6.32	6	6.32	0	0	NA	NA
	No	47	49.47	53	55.79	48	62.34	48	62.34
	Yes	42	44.21	95	100.00	29	37.66	77	100.00
12th	No reply	6	6.32	6	6.32	0	0	NA	NA
	No	52	54.74	58	61.05	49	63.64	49	63.64
	Yes	37	38.95	95	100.00	28	36.36	77	100.00

*Respondents were instructed to select all grades that apply

Table A 3. Years of Experience in Current Position (2011-2012)

	Post-PD survey				End-of-year survey			
Response	Frequency	Percent	Cumulative frequency	Cumulative percent	Frequency	Percent	Cumulative frequency	Cumulative percent
No reply	7	7.37	7	7.37	4	5.19	4	5.19
<1 year	6	6.32	13	13.68	42	54.55	46	59.74
1-5 years	44	46.32	57	60	12	15.58	58	75.32
6-10 years	19	20	76	80	8	10.39	66	85.71
11-15 years	9	9.47	85	89.47	11	14.29	77	100.00
16+ years	10	10.53	95	100.00	4	5.19	4	5.19

Table A 4. Years of Experience in Education (2011-2012)

	Post-PD survey				End-of-year survey			
Response	Frequency	Percent	Cumulative frequency	Cumulative percent	Frequency	Percent	Cumulative frequency	Cumulative percent
No reply	6	6.32	6	6.32	20	25.97	20	25.97
<1 year	1	1.05	7	7.37	21	27.27	41	53.25
1-5 years	20	21.05	27	28.42	9	11.69	50	64.94
6-10 years	20	21.05	47	49.47	27	35.06	77	100.00
11-15 years	14	14.74	61	64.21	20	25.97	20	25.97
16+ years	34	35.79	95	100.00	21	27.27	41	53.25

Table A 5. Academy Activities Attendance (2011-2012)

Survey and activity	Response	Frequency	Percent	Cumulative frequency	Cumulative percent
Post-PD survey Summer 2011 academy	No reply	6	6.32	6	6.32
	Charleston	19	20	25	26.32
	Clarksburg	29	30.53	54	56.84
	Beckley	28	29.47	82	86.32
	Huntington	13	13.68	95	100.00
End-of-year survey Summer 2011 academy	Charleston	22	28.57	22	28.57
	Clarksburg	25	32.47	47	61.04
	Beckley	22	28.57	69	89.61
	Huntington	8	10.39	77	100.00
End-of-Year survey Fall 2011 follow-up	Beckley	17	22.08	17	22.08
	Huntington	8	10.39	25	32.47
	Bridgeport	25	32.47	50	64.94
	Nitro	17	22.08	67	87.01
	None	10	12.99	77	100.00
End-of-Year survey Spring 2012 follow-up	Bridgeport	25	32.47	25	32.47
	Huntington	7	9.09	32	41.56
	Nitro	21	27.27	53	68.83
	Beckley	19	24.68	72	93.51
	None	5	6.49	77	100.00

Table A 6. Usefulness of the Math Academy (2011-2012)

	Post-PD survey				End-of-year survey			
Response	Frequency	Percent	Cumulative frequency	Cumulative percent	Frequency	Percent	Cumulative frequency	Cumulative percent
No reply	7	7.37	7	7.37	2	2.60	2	2.60
It was a good start	16	16.84	23	24.21	19	24.68	21	27.28
It was a good start, but I have a lot of questions	9	9.47	32	33.68	2	2.60	23	29.88
It was a good start, and I look forward to using what I learned in my classroom (or work setting)	51	53.68	83	87.37	44	57.14	67	87.02
It provided everything I need to use what I learned in my classroom (or work setting)	1	1.05	84	88.42	5	6.49	72	93.51
I don't think that these ideas will work very well in my classroom (or work setting)	1	1.05	85	89.47	1	1.30	73	94.81
It's too early to tell	10	10.53	95	100.00	4	5.19	77	100.00

Table A 7. Meeting Teachers' Professional Needs (2011-2012)

	Post-PD survey				End-of-year survey			
Response	Frequency	Percent	Cumulative frequency	Cumulative percent	Frequency	Percent	Cumulative frequency	Cumulative percent
No reply	7	7.37	7	7.37	2	2.60	2	2.60
It addressed my professional learning needs completely	14	14.74	21	22.11	18	23.38	20	25.97
It addressed some of my professional learning needs	73	76.84	94	98.95	55	71.43	75	97.4
It did not address my professional learning needs	1	1.05	95	100.00	2	2.60	77	100.00

Table A 8. Applying/Practicing Math Academy Skills (2011-2012)

Survey	Response	Frequency	Percent	Cumulative frequency	Cumulative percent
Post-PD	No reply	7	7.37	7	7.37
	I already practice/apply the knowledge/skills this training provided in my classroom (or work setting), and it seems to work well	7	7.37	14	14.74
	I have already practiced/applied the knowledge/skills this training provided in my classroom (or work setting), but it is not appropriate for my students	5	5.26	19	20.00
	I look forward to practicing/applying the knowledge/skills in my classroom (or work setting) during the upcoming school year	74	77.89	93	97.89
	I don't think what I learned here will work for my students so I don't envision applying the knowledge/skill	2	2.11	95	100.00
End-of-year	No reply	3	3.90	3	3.90
	I now practice/apply the knowledge/skills the academy provided in my classroom (or work setting)	32	41.56	35	45.45
	I previously practiced/applied the knowledge/skills the academy provided in my classroom (or work setting) AND I continue to do so	26	33.77	61	79.22
	I have not practiced/applied what I learned BUT I plan to practice/apply the knowledge/skills in my classroom (or work setting) soon	7	9.09	68	88.31
	I previously practiced/applied the knowledge/skills the academy provided in my classroom (or work setting) BUT I no longer do so	1	1.30	69	89.61
	I do not practice/apply what I learned at the math academy because it is not appropriate for my students	6	7.79	75	97.40
	I do not practice/apply what I learned at the math academy because of other reasons	2	2.60	77	100.00

Table A 9. Alignment With Goals for Instructional Improvement (2011-2012)

	Post-PD survey				End-of-year survey			
Response	Frequency	Percent	Cumulative frequency	Cumulative percent	Frequency	Percent	Cumulative frequency	Cumulative percent
No reply	8	8.42	8	8.42	2	2.60	2	2.60
The PD was VERY CLOSELY aligned with school's/program's goals for instructional improvement*	50	52.63	58	61.05	40	51.95	42	54.55
The PD was SOMEWHAT aligned with school's/program's goals for instructional improvement*	28	29.47	86	90.53	30	38.96	72	93.51
The PD was NOT ALIGNED with school's/program's goals for instructional improvement*	1	1.05	87	91.58	0	0	NA	NA
The PD was INCONSISTENT with school's/program's goals for instructional improvement*	0	0	NA	NA	1	1.30	73	94.81
I don't know	8	8.42	95	100.00	4	5.19	77	100.00

* End-of-year survey wording slightly altered; "The PD" was replaced with "The objectives of the initiatives"

Table A 10. Comparison of the Math Academy to Other PD (2011-2012)

	Post-PD survey				End-of-year survey			
Response	Frequency	Percent	Cumulative frequency	Cumulative percent	Frequency	Percent	Cumulative frequency	Cumulative percent
No reply	7	7.37	7	7.37	1	1.30	1	1.30
This professional development was MORE USEFUL than other professional development that I have participated in*	56	58.95	63	66.32	51	66.23	52	67.53
This professional development was ABOUT THE SAME AS other professional development that I have participated in**	25	26.32	88	92.63	18	23.38	70	90.91
This professional development was LESS USEFUL than other professional development that I have participated in**	1	1.05	89	93.68	0	0	NA	NA
I don't have an opinion	5	5.26	94	98.95	5	6.49	75	97.40
I haven't participated in any other professional development in the last three years	1	1.05	95	100.00	2	2.60	77	100.00

* End-of-year survey wording slightly altered; "This professional development" was replaced with "The math academy"

** End-of-year survey wording slightly altered; "This professional development" was replaced with "This academy"

Table A 11. Participant Evaluation of Math Academy PD (2011-2012)

		Post-PD survey				End-of-year survey			
Survey item*	Response	Frequency	Percent	Cumulative frequency	Cumulative percent	Frequency	Percent	Cumulative frequency	Cumulative percent
The training was high quality	No reply	7	7.37	7	7.37	1	1.30	1	1.30
	Strongly disagree	1	1.05	8	8.42	0	0	NA	NA
	Disagree	0	0	NA	NA	1	1.30	2	2.60
	Neutral	3	3.16	11	11.58	2	2.60	4	5.19
	Agree	25	26.32	36	37.89	31	40.26	35	45.45
	Strongly agree	59	62.11	95	100.00	42	54.55	77	100.00
The training was relevant	No reply	7	7.37	7	7.37	1	1.30	1	1.30
	Strongly disagree	1	1.05	8	8.42	0	0	NA	NA
	Disagree	0	0	NA	NA	1	1.30	2	2.60
	Neutral	4	4.21	12	12.63	2	2.60	4	5.19
	Agree	29	30.53	41	43.16	30	38.96	34	44.16
	Strongly agree	54	56.84	95	100.00	43	55.84	77	100.00
The training was well organized	No reply	7	7.37	7	7.37	1	1.30	1	1.30
	Strongly disagree	1	1.05	8	8.42	0	0	NA	NA
	Disagree	1	1.05	9	9.47	0	0	NA	NA
	Neutral	4	4.21	13	13.68	2	2.60	3	3.90
	Agree	24	25.26	37	38.95	30	38.96	33	42.86
	Strongly agree	58	61.05	95	100.00	44	57.14	77	100.00
The training was specific and content focused	No reply	7	7.37	7	7.37	1	1.30	1	1.30
	Strongly disagree	1	1.05	8	8.42	0	0	NA	NA
	Disagree	0	0	NA	NA	0	0	NA	NA
	Neutral	0	0	NA	NA	0	0	NA	NA
	Agree	23	24.21	31	32.63	26	33.77	27	35.06
	Strongly agree	64	67.37	95	100.00	50	64.94	77	100.00
The training was hands-on and included active learning opportunities	No reply	7	7.37	7	7.37	1	1.30	1	1.30
	Strongly disagree	1	1.05	8	8.42	0	0	NA	NA
	Disagree	0	0	NA	NA	0	0	NA	NA
	Neutral	2	2.11	10	10.53	2	2.60	3	3.90
	Agree	12	12.63	22	23.16	20	25.97	23	29.87
	Strongly agree	73	76.84	95	100.00	54	70.13	77	100.00
Training objectives were clearly stated before sessions began	No reply	7	7.37	7	7.37	1	1.30	1	1.30
	Strongly disagree	1	1.05	8	8.42	0	0	NA	NA
	Disagree	1	1.05	9	9.47	1	1.30	2	2.60
	Neutral	4	4.21	13	13.68	1	1.30	3	3.90
	Agree	22	23.16	35	36.84	24	31.17	27	35.06
	Strongly agree	60	63.16	95	100.00	50	64.94	77	100.00
Training sessions began and ended in a timely fashion	No reply	7	7.37	7	7.37	1	1.30	1	1.30
	Strongly disagree	2	2.11	9	9.47	0	0	NA	NA
	Disagree	2	2.11	11	11.58	0	0	NA	NA
	Neutral	6	6.32	17	17.89	1	1.30	2	2.60
	Agree	18	18.95	35	36.84	23	29.87	25	32.47
	Strongly agree	60	63.16	95	100.00	52	67.53	77	100.00

* End-of-year survey wording slightly altered; “Training” was replaced with “The initiatives”

Table A 12. Participant Evaluation of Math Academy Materials (2011-2012)

		Post-PD survey				End-of-year survey			
Survey item	Response	Frequency	Percent	Cumulative frequency	Cumulative percent	Frequency	Percent	Cumulative frequency	Cumulative percent
Adequate amounts of training materials/resources were provided	No reply	9	9.47	9	9.47	1	1.30	1	1.30
	Strongly disagree	1	1.05	10	10.53	0	0	NA	NA
	Disagree	1	1.05	11	11.58	1	1.30	2	2.60
	Neutral	6	6.32	17	17.89	1	1.30	3	3.90
	Agree	33	34.74	50	52.63	27	35.06	30	38.96
	Strongly agree	45	47.37	95	100.00	47	61.04	77	100.00
Materials/resources were relevant to my work	No reply	10	10.53	10	10.53	1	1.30	1	1.30
	Strongly disagree	2	2.11	12	12.63	0	0	NA	NA
	Disagree	0	0	NA	NA	2	2.60	3	3.90
	Neutral	10	10.53	22	23.16	3	3.90	6	7.79
	Agree	33	34.74	55	57.89	35	45.45	41	53.25
	Strongly agree	40	42.11	95	100.00	36	46.75	77	100.00
The materials/ resources provided were of high quality (i.e., based on recent research and evidence-based)	No reply	10	10.53	10	10.53	1	1.30	1	1.30
	Strongly disagree	1	1.05	11	11.58	0	0	NA	NA
	Disagree	1	1.05	12	12.63	1	1.30	2	2.60
	Neutral	5	5.26	17	17.89	3	3.90	5	6.49
	Agree	33	34.74	50	52.63	29	37.66	34	44.16
	Strongly agree	45	47.37	95	100.00	43	55.84	77	100.00
The materials/ resources provided were useful to my work	No reply	10	10.53	10	10.53	2	2.60	2	2.60
	Strongly disagree	1	1.05	11	11.58	0	0	NA	NA
	Disagree	2	2.11	13	13.68	2	2.60	4	5.19
	Neutral	11	11.58	24	25.26	8	10.39	12	15.58
	Agree	33	34.74	57	60	32	41.56	44	57.14
	Strongly agree	38	40	95	100.00	33	42.86	77	100.00

Table A 13. Participant Evaluation of Math Academy Trainers (2011-2012)

		Post-PD survey				End-of-year survey			
Survey item	Response	Frequency	Percent	Cumulative frequency	Cumulative percent	Frequency	Percent	Cumulative frequency	Cumulative percent
Trainer(s) were knowledge-able about the topic	No reply	8	8.42	8	8.42	1	1.30	1	1.30
	Strongly disagree	1	1.05	9	9.47	0	0	NA	NA
	Disagree	0	0	NA	NA	0	0	NA	NA
	Neutral	1	1.05	10	10.53	0	0	NA	NA
	Agree	7	7.37	17	17.89	12	15.58	13	16.88
	Strongly agree	78	82.11	95	100.00	64	83.12	77	100.00
Trainer(s) were well organized	No reply	9	9.47	9	9.47	1	1.30	1	1.30
	Strongly disagree	1	1.05	10	10.53	0	0	NA	NA
	Disagree	0	0	NA	NA	1	1.30	2	2.60
	Neutral	3	3.16	13	13.68	1	1.30	3	3.90
	Agree	9	9.47	22	23.16	11	14.29	14	18.18
	Strongly agree	73	76.84	95	100.00	63	81.82	77	100.00
Trainer(s) presented the material clearly and effectively	No reply	9	9.47	9	9.47	1	1.30	1	1.30
	Strongly disagree	1	1.05	10	10.53	0	0	NA	NA
	Disagree	1	1.05	11	11.58	1	1.30	2	2.60
	Neutral	2	2.11	13	13.68	0	0	NA	NA
	Agree	13	13.68	26	27.37	17	22.08	19	24.68
	Strongly agree	69	72.63	95	100.00	58	75.32	77	100.00
Trainer(s) facilitated discussions well	No reply	9	9.47	9	9.47	2	2.60	2	2.60
	Strongly disagree	1	1.05	10	10.53	0	0	NA	NA
	Disagree	0	0	NA	NA	1	1.30	3	3.90
	Neutral	2	2.11	12	12.63	0	0	NA	NA
	Agree	11	11.58	23	24.21	13	16.88	16	20.78
	Strongly agree	72	75.79	95	100.00	61	79.22	77	100.00
Trainer(s) answered questions raised during sessions adequately	No reply	9	9.47	9	9.47	1	1.30	1	1.30
	Strongly disagree	2	2.11	11	11.58	0	0	NA	NA
	Disagree	0	0	NA	NA	1	1.30	2	2.60
	Neutral	5	5.26	16	16.84	1	1.30	3	3.90
	Agree	14	14.74	30	31.58	14	18.18	17	22.08
	Strongly agree	65	68.42	95	100.00	60	77.92	77	100.00

Table A 14. Average Evaluation of Math Academy PD (2011-2012)

	Post-PD survey			End-of-year survey		
Survey item*	*n*	mean**	*sd*	*n*	mean**	*sd*
The training was high quality	88	4.60	6.29	76	4.50	5.42
The training was relevant	88	4.53	6.51	76	4.51	5.42
The training was well organized	88	4.56	6.95	76	4.55	4.81
The training was specific and content-focused	88	4.69	5.57	76	4.66	4.16
The training was hands-on and included active learning opportunities	88	4.77	5.64	76	4.68	4.55
Training objectives were clearly stated before sessions began	88	4.58	6.93	76	4.62	5.13
Training sessions began and ended in a timely fashion	88	4.50	8.41	76	4.67	4.36
Composite academy PD mean		4.61			4.61	

* End-of-year survey wording slightly altered; "Training" was replaced with "The initiatives"
** Means are based on 5-point Likert type scale of agreement, where 1 = *strongly disagree* and 5 = *strongly agree*

Table A 15. Average Evaluation of Math Academy Materials (2011-2012)

	Post-PD survey			End-of-year survey		
Survey item	*n*	mean*	*sd*	*n*	mean*	*sd*
Adequate amounts of training materials/resources were provided	86	4.40	7.15	76	4.58	5.18
Materials/resources were relevant to my work	85	4.28	7.87	76	4.38	6.03
The materials/resources provided were of high quality (i.e., based on recent research and evidence-based)	85	4.41	7.01	76	4.50	5.60
The materials/resources provided were useful to my work	85	4.24	7.88	75	4.28	6.61
Composite academy materials mean		4.33			4.44	

* Means are based on 5-point Likert type scale of agreement, where 1 = *strongly disagree* and 5 = *strongly agree*

Table A 16. Average Evaluation of Math Academy Trainers (2011-2012)

	Post-PD survey			End-of-year survey		
Survey item	*n*	mean*	*sd*	*n*	mean*	*sd*
Trainer(s) were knowledgeable about the topic	87	4.85	5.03	76	4.84	3.20
Trainer(s) were well organized	86	4.78	5.76	76	4.79	4.57
Trainer(s) presented the material clearly and effectively	86	4.72	6.31	76	4.74	4.58
Trainer(s) facilitated discussions well	86	4.78	5.58	75	4.79	4.34
Trainer(s) answered questions raised during sessions adequately	86	4.63	7.40	76	4.75	4.75
Composite academy trainer(s) mean		4.75			4.78	

* Means are based on 5-point Likert type scale of agreement, where 1 = *strongly disagree* and 5 = *strongly agree*

Appendix B.

Cohort 1 Year 2–Post-PD and End-of-Year Survey Results

Table B 1. County of Employment (2012-2013)

	Post-PD survey				End-of-year survey			
Response	Frequency	Percent	Cumulative frequency	Cumulative percent	Frequency	Percent	Cumulative frequency	Cumulative percent
No reply	22	33.33	22	33.33	29	37.66	29	37.66
Barbour	4	6.06	26	39.39	2	2.60	31	40.26
Berkeley	0	0	NA	NA	1	1.30	32	41.56
Boone	3	4.55	29	43.94	2	2.60	34	44.16
Clay	2	3.03	31	46.97	2	2.60	36	46.75
Fayette	1	1.52	32	48.49	0	0	NA	NA
Hampshire	1	1.52	33	50.01	2	2.60	38	49.35
Hancock	1	1.52	34	51.53	1	1.30	39	50.65
Harrison	2	3.03	36	54.56	1	1.30	40	51.95
Kanawha	4	6.06	40	60.62	8	10.39	48	62.34
Lewis	1	1.52	41	62.14	1	1.30	49	63.64
Lincoln	1	1.52	42	63.66	1	1.30	50	64.94
Logan	2	3.03	44	66.69	1	1.30	51	66.23
McDowell	1	1.52	45	68.21	1	1.30	52	67.53
Marion	4	6.06	49	74.27	3	3.90	55	71.43
Marshall	1	1.52	50	75.79	0	0	NA	NA
Mercer	0	0	NA	NA	2	2.60	57	74.03
Mineral	0	0	NA	NA	2	2.60	59	76.62
Nicholas	2	3.03	52	78.82	1	1.30	60	77.92
Putnam	3	4.55	55	83.37	1	1.30	61	79.22
Raleigh	0	0	NA	NA	8	10.39	69	89.61
Randolph	0	0	NA	NA	1	1.30	70	90.91
Summers	4	6.06	59	89.43	1	1.30	71	92.21
Taylor	1	1.52	60	90.95	1	1.30	72	93.51
Upshur	2	3.03	62	93.98	1	1.30	73	94.81
Wayne	2	3.03	64	97.01	2	2.60	75	97.4
Wood	2	3.03	66	100.00	2	2.60	77	100.00

Table B 2. Grade Levels Taught (2012-2013)

		Post-PD survey				End-of-year survey			
Grade*	Response	Frequency	Percent	Cumulative frequency	Cumulative percent	Frequency	Percent	Cumulative frequency	Cumulative percent
K**	No	64	96.97	64	96.97	NA	NA	NA	NA
	Yes	2	3.03	66	100.00	NA	NA	NA	NA
1st	No	64	96.97	64	96.97	75	97.4	75	97.40
	Yes	2	3.03	66	100.00	2	2.60	77	100.00
2nd	No	63	95.45	63	95.45	74	96.1	74	96.10
	Yes	3	4.55	66	100.00	3	3.90	77	100.00
3rd	No	63	95.45	63	95.45	74	96.1	74	96.10
	Yes	3	4.55	66	100.00	3	3.90	77	100.00
4th	No	62	93.94	62	93.94	71	92.21	71	92.21
	Yes	4	6.06	66	100.00	6	7.79	77	100.00
5th	No	54	81.82	54	81.82	66	85.71	66	85.71
	Yes	12	18.18	66	100.00	11	14.29	77	100.00
6th	No	41	62.12	41	62.12	49	63.64	49	63.64
	Yes	25	37.88	66	100.00	28	36.36	77	100.00
7th	No	40	60.61	40	60.61	43	55.84	43	55.84
	Yes	26	39.39	66	100.00	34	44.16	77	100.00
8th	No	43	65.15	43	65.15	50	64.94	50	64.94
	Yes	23	34.85	66	100.00	27	35.06	77	100.00
9th	No	39	59.09	39	59.09	44	57.14	44	57.14
	Yes	27	40.91	66	100.00	33	42.86	77	100.00
10th	No	39	59.09	39	59.09	46	59.74	46	59.74
	Yes	27	40.91	66	100.00	31	40.26	77	100.00
11th	No	39	59.09	39	59.09	49	63.64	49	63.64
	Yes	27	40.91	66	100.00	28	36.36	77	100.00
12th	No	40	60.61	40	60.61	49	63.64	49	63.64
	Yes	26	39.39	66	100.00	28	36.36	77	100.00

*Respondents were instructed to select all grades that apply
**Kindergarten was not an option on the End-of-Year Survey

Table B 3. Years of Experience in Current Position (2012-2013)

	Post-PD survey				End-of-year survey			
Response	Frequency	Percent	Cumulative frequency	Cumulative percent	Frequency	Percent	Cumulative frequency	Cumulative percent
No reply	0	0	NA	NA	1	1.30	1	1.30
<1 year	3	4.55	3	4.55	1	1.30	2	2.60
1-5 years	31	46.97	34	51.52	38	49.35	40	51.95
6-10 years	14	21.21	48	72.73	18	23.38	58	75.32
11-15 years	8	12.12	56	84.85	11	14.29	69	89.61
16+ years	10	15.15	66	100.00	8	10.39	77	100.00

Table B 4. Years of Experience in Education (2012-2013)

	Post-PD survey				End-of-year survey			
Response	Frequency	Percent	Cumulative frequency	Cumulative percent	Frequency	Percent	Cumulative frequency	Cumulative percent
No reply	0	0	NA	NA	1	1.30	1	1.30
<1 year	0	0	NA	NA	0	0	NA	NA
1-5 years	12	18.18	12	18.18	14	18.18	15	19.48
6-10 years	20	30.30	32	48.48	26	33.77	41	53.25
11-15 years	9	13.64	41	62.12	8	10.39	49	63.64
16+ years	25	37.88	66	100.00	28	36.36	77	100.00

Table B 5. Academy Activities Attendance (2012-2013)

Survey and activity	Response	Frequency	Percent	Cumulative frequency	Cumulative percent
Post-PD survey Summer 2012 academy	Charleston	14	21.21	14	21.21
	Clarksburg	22	33.33	36	54.55
	Beckley	20	30.30	56	84.85
	Huntington	10	15.15	66	100.00
End-of-year survey Summer 2012 academy	Charleston	18	23.37	18	23.37
	Clarksburg	27	35.06	45	58.43
	Beckley	24	31.17	69	89.60
	Huntington	8	10.39	77	100.00
End-of-year survey Fall 2012 follow-up	Nitro (previously Charleston)	22	28.57	22	28.57
	Clarksburg/Bridgeport	26	33.77	48	62.34
	Beckley	19	24.68	67	87.01
	Nitro (previously Huntington)	6	7.79	73	94.81
	None of the above	4	5.19	77	100.00
End-of-year survey Spring 2013 follow-up	Nitro (previously Charleston)	18	23.38	18	23.38
	Clarksburg/Bridgeport	22	28.57	40	51.95
	Beckley	17	22.08	57	74.03
	Nitro (previously Huntington)	5	6.49	62	80.52
	None of the above	15	19.48	77	100.00

Table B 6. Usefulness of the Math Academy (2012-2013)

Survey	Response	Frequency	Percent	Cumulative frequency	Cumulative percent
Post-PD	It was a good start	9	13.64	9	13.64
	It was a good start, but I have a lot of questions	2	3.03	11	16.67
	It was a good start, and I look forward to using what I learned in my classroom (or work setting)	45	68.18	56	84.85
	It provided everything I need to use what I learned in my classroom (or work setting)	5	7.58	61	92.42
	I don't think that these ideas will work very well in my classroom (or work setting)	1	1.52	62	93.94
	It's too early to tell	4	6.06	66	100.00
End-of-year	The first year was more useful	2	2.60	2	2.60
	The second year was more useful	5	6.49	7	9.09
	Both years were equally useful	28	36.36	35	45.45
	Both years were equally useful, and I look forward to using what I learned in my classroom (or work setting)	36	46.75	71	92.21
	Overall, the academy provided everything I need to use in my classroom (or work setting)	3	3.90	74	96.10
	Both years were equally useful, but I have a lot of questions	1	1.30	75	97.40
	I don't think that these ideas will work very well in my classroom (or work setting)	2	2.60	77	100.00

Table B 7. Meeting Teachers' Professional Needs (2012-2013)

	Post-PD survey				End-of-year survey			
Response	Frequency	Percent	Cumulative frequency	Cumulative percent	Frequency	Percent	Cumulative frequency	Cumulative percent
No reply	1	1.52	1	1.52	0	0	NA	NA
It addressed my professional learning needs completely	22	33.33	23	34.85	27	35.06	27	35.06
It addressed some of my professional learning needs	43	65.15	66	100.00	47	61.04	74	96.10
It did not address my professional learning needs	0	0	NA	NA	2	2.60	76	98.70
This professional development did not help much because I already know what I need to know about this topic*	0	0	NA	NA	1	1.30	77	100.00

* End-of-year survey wording slightly altered; "This professional development" was replaced with "This academy"

Table B 8. Applying/Practicing Math Academy Skills (2012-2013)

Survey	Response	Frequency	Percent	Cumulative frequency	Cumulative percent
Post-PD	No reply	1	1.52	1	1.52
	I already practice/apply the knowledge/skills this training provided in my classroom (or work setting), and it seems to work well	16	24.24	17	25.76
	I have already practiced/applied the knowledge/skills this training provided in my classroom (or work setting), but it is not appropriate for my students	7	10.61	24	36.36
	I look forward to practicing/applying the knowledge/skills in my classroom (or work setting) during the upcoming school year	41	62.12	65	98.48
	I don't think what I learned here will work for my students so I don't envision applying the knowledge/skills	1	1.52	66	100.00
End-of-year	No reply	3	3.90	3	3.90
	I now practice/apply the knowledge/skills the academy provided in my classroom (or work setting)	44	57.14	47	61.04
	I previously practiced/applied the knowledge/skills the academy provided in my classroom (or work setting) AND I continue to do so	21	27.27	68	88.31
	I have not practiced/applied what I learned BUT I plan to practice/apply the knowledge/skills in my classroom (or work setting) soon	3	3.90	71	92.21
	I previously practiced/applied the knowledge/skills the academy provided in my classroom (or work setting) BUT I no longer do so	2	2.60	73	94.81
	I do not practice/apply what I learned at the math academy because it is not appropriate for my students	3	3.90	76	98.70
	I do not practice/apply what I learned at the math academy because of other reasons	1	1.30	77	100.00

Table B 9. Alignment With Goals for Instructional Improvement (2012-2013)

	Post-PD survey*			
Response	Frequency	Percent	Cumulative frequency	Cumulative percent
The PD was VERY CLOSELY aligned with school's/program's goals for instructional improvement	41	62.12	41	62.12
The PD was SOMEWHAT aligned with school's/program's goals for instructional improvement	23	34.85	64	96.97
The PD was NOT ALIGNED with school's/program's goals for instructional improvement	0	0	NA	NA
The PD was INCONSISTENT with school's/program's goals for instructional improvement	0	0	NA	NA
I don't know	2	3.03	66	100.00

*This survey item was not included in the End-of-year survey

Table B 10. Comparison of the Math Academy to Other PD (2012-2013)

	Post-PD survey				End-of-year survey			
Response	Frequency	Percent	Cumulative frequency	Cumulative percent	Frequency	Percent	Cumulative frequency	Cumulative percent
No reply	0	0	NA	NA	3	3.90	3	3.90
This professional development was MORE USEFUL than other professional development that I have participated in*	52	78.79	52	78.79	52	67.53	55	71.43
This professional development was ABOUT THE SAME AS other professional development that I have participated in**	13	19.70	65	98.48	17	22.08	72	93.51
This professional development was LESS USEFUL than other professional development that I have participated in**	1	1.52	66	100.00	2	2.60	74	96.10
I don't have an opinion	0	0	NA	NA	2	2.60	76	98.70
I haven't participated in any other professional development in the last three years	0	0	NA	NA	1	1.30	77	100.00

* End-of-year survey wording slightly altered; "This professional development" was replaced with "The math academy"

** End-of-year survey wording slightly altered; "This professional development" was replaced with "This academy"

Table B 11. Participant Evaluation of Math Academy PD (2012-2013)

		Post-PD survey				End-of-year survey			
Survey item*	Response	Frequency	Percent	Cumulative frequency	Cumulative percent	Frequency	Percent	Cumulative frequency	Cumulative percent
The training was high quality	No reply	0	0	NA	NA	0	0	NA	NA
	Strongly disagree	0	0	NA	NA	0	0	NA	NA
	Disagree	0	0	NA	NA	0	0	NA	NA
	Neutral	1	1.52	1	1.52	3	3.90	3	3.90
	Agree	20	30.30	21	31.82	31	40.26	34	44.16
	Strongly agree	45	68.18	66	100.00	43	55.84	77	100.00
The training was relevant	No reply	0	0	NA	NA	1	1.30	1	1.30
	Strongly disagree	0	0	NA	NA	0	0	NA	NA
	Disagree	0	0	NA	NA	1	1.30	2	2.60
	Neutral	2	3.03	2	3.03	3	3.90	5	6.49
	Agree	22	33.33	24	36.36	34	44.16	39	50.65
	Strongly agree	42	63.64	66	100.00	38	49.35	77	100.00
The training was well organized	No reply	0	0	NA	NA	0	0	NA	NA
	Strongly disagree	0	0	NA	NA	0	0	NA	NA
	Disagree	0	0	NA	NA	0	0	NA	NA
	Neutral	1	1.52	1	1.52	2	2.60	2	2.60
	Agree	16	24.24	17	25.76	26	33.77	28	36.36
	Strongly agree	49	74.24	66	100.00	49	63.64	77	100.00
The training was specific and content focused	No reply	1	1.52	1	1.52	0	0	NA	NA
	Strongly disagree	0	0	NA	NA	0	0	NA	NA
	Disagree	0	0	NA	NA	0	0	NA	NA
	Neutral	0	0	NA	NA	1	1.30	1	1.30
	Agree	16	24.24	17	25.76	26	33.77	27	35.06
	Strongly agree	49	74.24	66	100.00	50	64.94	77	100.00
The training was hands-on and included active learning opportunities	No reply	0	0	NA	NA	0	0	NA	NA
	Strongly disagree	0	0	NA	NA	0	0	NA	NA
	Disagree	0	0	NA	NA	0	0	NA	NA
	Neutral	1	1.52	1	1.52	1	1.30	1	1.30
	Agree	14	21.21	15	22.73	21	27.27	22	28.57
	Strongly agree	51	77.27	66	100.00	55	71.43	77	100.00
Training objectives were clearly stated before sessions began	No reply	0	0	NA	NA	0	0	NA	NA
	Strongly disagree	0	0	NA	NA	0	0	NA	NA
	Disagree	0	0	NA	NA	0	0	NA	NA
	Neutral	1	1.52	1	1.52	2	2.60	2	2.60
	Agree	16	24.24	17	25.76	20	25.97	22	28.57
	Strongly agree	49	74.24	66	100.00	55	71.43	77	100.00
Training sessions began and ended in a timely fashion	No reply	0	0	NA	NA	1	1.30	1	1.30
	Strongly disagree	0	0	NA	NA	0	0	NA	NA
	Disagree	0	0	NA	NA	0	0	NA	NA
	Neutral	1	1.52	1	1.52	2	2.60	3	3.90
	Agree	14	21.21	15	22.73	23	29.87	26	33.77
	Strongly agree	51	77.27	66	100.00	51	66.23	77	100.00

* End-of-year survey wording slightly altered; “Training” was replaced with “Academy activities”

Table B 12. Participant Evaluation of Math Academy Materials (2012-2013)

		Post-PD survey				End-of-year survey			
Survey item	Response	Fre-quency	Percent	Cumulative frequency	Cumulative percent	Fre-quency	Percent	Cumulative frequency	Cumulative percent
Adequate amounts of training materials/ resources were provided	No reply	0	0	NA	NA	0	0	NA	NA
	Strongly disagree	0	0	NA	NA	1	1.30	1	1.30
	Disagree	0	0	NA	NA	0	0	NA	NA
	Neutral	1	1.52	1	1.52	2	2.60	3	3.90
	Agree	24	36.36	25	37.88	38	49.35	41	53.25
	Strongly agree	41	62.12	66	100.00	36	46.75	77	100.00
Materials/ resources were relevant to my work	No reply	0	0	NA	NA	0	0	NA	NA
	Strongly disagree	0	0	NA	NA	1	1.30	1	1.30
	Disagree	0	0	NA	NA	0	0	NA	NA
	Neutral	1	1.52	1	1.52	7	9.09	8	10.39
	Agree	28	42.42	29	43.94	38	49.35	46	59.74
	Strongly agree	37	56.06	66	100.00	31	40.26	77	100.00
The materials/ resources provided were of high quality (i.e., based on recent research and evidence-based)	No reply	0	0	NA	NA	0	0	NA	NA
	Strongly disagree	0	0	NA	NA	1	1.30	1	1.30
	Disagree	0	0	NA	NA	0	0	NA	NA
	Neutral	0	0	NA	NA	3	3.90	4	5.19
	Agree	24	36.36	24	36.36	32	41.56	36	46.75
	Strongly agree	42	63.64	66	100.00	41	53.25	77	100.00
The materials/ resources provided were useful to my work	No reply	0	0	NA	NA	0	0	NA	NA
	Strongly disagree	0	0	NA	NA	1	1.30	1	1.30
	Disagree	0	0	NA	NA	2	2.60	3	3.90
	Neutral	2	3.03	2	3.03	8	10.39	11	14.29
	Agree	30	45.45	32	48.48	36	46.75	47	61.04
	Strongly agree	34	51.52	66	100.00	30	38.96	77	100.00

Table B 13. Participant Evaluation of Math Academy Trainers (2012-2013)

		Post-PD survey				End-of-year survey			
Survey item	Response	Fre-quency	Percent	Cumulative frequency	Cumulative percent	Fre-quency	Percent	Cumulative frequency	Cumulative percent
Trainer(s) were knowledgeable about the topic	No reply	0	0	NA	NA	0	0	NA	NA
	Strongly disagree	0	0	NA	NA	1	1.30	1	1.30
	Disagree	0	0	NA	NA	0	0	NA	NA
	Neutral	0	0	NA	NA	1	1.30	2	2.60
	Agree	10	15.15	10	15.15	18	23.38	20	25.97
	Strongly agree	56	84.85	66	100.00	57	74.03	77	100.00
Trainer(s) were well organized	No reply	0	0	NA	NA	0	0	NA	NA
	Strongly disagree	0	0	NA	NA	1	1.30	1	1.30
	Disagree	1	1.52	1	1.52	0	0	NA	NA
	Neutral	0	0	NA	NA	1	1.30	2	2.60
	Agree	9	13.64	10	15.15	21	27.27	23	29.87
	Strongly agree	56	84.85	66	100.00	54	70.13	77	100.00
Trainer(s) presented the material clearly and effectively	No reply	0	0	NA	NA	0	0	NA	NA
	Strongly disagree	0	0	NA	NA	1	1.30	1	1.30
	Disagree	1	1.52	1	1.52	0	0	NA	NA
	Neutral	0	0	NA	NA	2	2.60	3	3.90
	Agree	10	15.15	11	16.67	20	25.97	23	29.87
	Strongly agree	55	83.33	66	100.00	54	70.13	77	100.00
Trainer(s) facilitated discussions well	No reply	0	0	NA	NA	0	0	NA	NA
	Strongly disagree	0	0	NA	NA	1	1.30	1	1.30
	Disagree	1	1.52	1	1.52	0	0	NA	NA
	Neutral	0	0	NA	NA	2	2.60	3	3.90
	Agree	10	15.15	11	16.67	17	22.08	20	25.97
	Strongly agree	55	83.33	66	100.00	57	74.03	77	100.00
Trainer(s) answered questions raised during sessions adequately	No reply	9	9.47	9	9.47	0	0	NA	NA
	Strongly disagree	2	2.11	11	11.58	1	1.30	1	1.30
	Disagree	0	0	NA	NA	3	3.90	4	5.19
	Neutral	5	5.26	16	16.84	3	3.90	7	9.09
	Agree	14	14.74	30	31.58	16	20.78	23	29.87
	Strongly agree	65	68.42	95	100.00	54	70.13	77	100.00

Table B 14. Average Evaluation of Math Academy PD (2012-2013)

	Post-PD survey			End-of-year survey		
Survey item*	*n*	mean**	*sd*	*n*	mean**	*sd*
The training was high quality	66	4.67	4.11	77	4.52	5.05
The training was relevant	66	4.61	4.48	76	4.43	5.57
The training was well organized	66	4.73	3.91	77	4.61	4.75
The training was specific and content-focused	65	4.75	3.50	77	4.64	4.48
The training was hands-on and included active learning opportunities	66	4.76	3.79	77	4.70	4.29
Training objectives were clearly stated before sessions began	66	4.73	3.91	77	4.69	4.56
Training sessions began and ended in a timely fashion	66	4.76	3.79	76	4.64	4.66
Composite academy PD mean		4.71			4.60	

* End-of-year survey wording slightly altered; "Training" was replaced with "The initiatives"

** Means are based on 5-point Likert type scale of agreement, where 1 = *strongly disagree* and 5 = *strongly agree*

Table B 15. Average Evaluation of Math Academy Materials (2012-2013)

	Post-PD survey			End-of-year survey		
Survey item	*n*	mean*	*sd*	*n*	mean*	*sd*
Adequate amounts of training materials/resources were provided	66	4.61	4.25	77	4.40	5.91
Materials/resources were relevant to my work	66	4.55	4.32	77	4.27	6.47
The materials/resources provided were of high quality (i.e., based on recent research and evidence-based)	66	4.64	3.94	77	4.45	6.13
The materials/resources provided were useful to my work	66	4.48	4.56	77	4.19	7.26
Composite academy materials mean		4.57			4.33	

* Means are based on 5-point Likert type scale of agreement, where 1 = *strongly disagree* and 5 = *strongly agree*

Table B 16. Average Evaluation of Math Academy Trainers (2012-2013)

	Post-PD survey			End-of-year survey		
Survey item	*n*	mean*	*sd*	*n*	mean*	*sd*
Trainer(s) were knowledgeable about the topic	66	4.85	2.94	77	4.69	5.56
Trainer(s) were well organized	66	4.82	4.01	77	4.65	5.65
Trainer(s) presented the material clearly and effectively	66	4.80	4.09	77	4.64	5.85
Trainer(s) facilitated discussions well	66	4.80	4.09	77	4.68	5.77
Trainer(s) answered questions raised during sessions adequately	66	4.79	3.91	77	4.55	7.47
Composite academy trainer(s) mean		4.81			4.64	

* Means are based on 5-point Likert type scale of agreement, where 1 = *strongly disagree* and 5 = *strongly agree*

Appendix C.

Cohort 1 Years 1 and 2–Items Unique to the End-of-Year Surveys

Table C 1. Mathematical and Pedagogical Attitudes at the Conclusion of the Proportional Reasoning Academy; Year 1 (2011-2012)

Survey item	Response	Frequency	Percent	Cumulative frequency	Cumulative percent
I enjoy teaching mathematics	No reply	1	1.30	1	1.30
	Less	0	0	NA	NA
	About the same	42	54.55	43	55.84
	More	34	44.16	77	100.00
Mathematics is my strongest subject to teach	No reply	1	1.30	1	1.30
	Less	5	6.49	6	7.79
	About the same	40	51.95	46	59.74
	More	31	40.26	77	100.00
I consider myself a "master" mathematics teacher	No reply	1	1.30	1	1.30
	Less	11	14.29	12	15.58
	About the same	52	67.53	64	83.12
	More	13	16.88	77	100.00
Overall I know the mathematics needed to teach my students	No reply	1	1.30	1	1.30
	Less	0	0	NA	NA
	About the same	28	36.36	29	37.66
	More	48	62.34	77	100.00
I have strong knowledge of ratio, proportional reasoning, and rate	No reply	1	1.30	1	1.30
	Less	1	1.30	2	2.60
	About the same	20	25.97	22	28.57
	More	55	71.43	77	100.00
I have strong knowledge of ALL areas of mathematics	No reply	1	1.30	1	1.30
	Less	5	6.49	6	7.79
	About the same	59	76.62	65	84.42
	More	12	15.58	77	100.00
My knowledge of ratio, proportional reasoning, and rate is adequate to the task of teaching those subjects	No reply	1	1.30	1	1.30
	Less	1	1.30	2	2.60
	About the same	18	23.38	20	25.97
	More	57	74.03	77	100.00

Table C 2. Mathematical and Pedagogical Attitudes at the Conclusion of the Developing Algebraic Thinking Academy; Year 2 (2012-2013)

Survey item	Response	Frequency	Percent	Cumulative frequency	Cumulative percent
I enjoy teaching mathematics	No reply	0	0	NA	NA
	Less	0	0	NA	NA
	About the same	32	41.56	32	41.56
	More	45	58.44	77	100.00
Mathematics is my strongest subject to teach	No reply	0	0	NA	NA
	Less	4	5.19	4	5.19
	About the same	40	51.95	44	57.14
	More	33	42.86	77	100.00
I consider myself a "master" mathematics teacher	No reply	1	1.30	1	1.30
	Less	6	7.79	7	9.09
	About the same	55	71.43	62	80.52
	More	15	19.48	77	100.00
Overall I know the mathematics needed to teach my students	No reply	0	0	NA	NA
	Less	1	1.30	1	1.30
	About the same	25	32.47	26	33.77
	More	51	66.23	77	100.00
I have strong knowledge of ALL areas of mathematics	No reply	0	0	NA	NA
	Less	5	6.49	5	6.49
	About the same	46	59.74	51	66.23
	More	26	33.77	77	100.00
I can differentiate high- and low-level cognitive tasks and their implications for teaching	No reply	0	0	NA	NA
	Less	1	1.30	1	1.30
	About the same	16	20.78	17	22.08
	More	60	77.92	77	100.00
I have a strong knowledge of the Standards for Mathematical Practice	No reply	0	0	NA	NA
	Less	1	1.30	1	1.30
	About the same	23	29.87	24	31.17
	More	53	68.83	77	100.00
I am confident in analyzing mathematical tasks	No reply	0	0	NA	NA
	Less	0	0	NA	NA
	About the same	26	33.77	26	33.77
	More	51	66.23	77	100.00

Table C 3. Self-Reported Proportional Reasoning Mathematical Knowledge; Year 1 (2011-2012)

Survey item	Response	Frequency	Percent	Cumulative frequency	Cumulative percent
I have strong knowledge of ratio, proportional reasoning and rate	No reply	1	1.30	1	1.30
	Less	1	1.30	2	2.60
	About the same	20	25.97	22	28.57
	More	55	71.43	77	100.00
My knowledge of ratio, proportional reasoning, and rate is adequate to the task of teaching those subjects	No reply	1	1.30	1	1.30
	Less	1	1.30	2	2.60
	About the same	18	23.38	20	25.97
	More	57	74.03	77	100.00

Table C 4. Self-Reported Developing Algebraic Thinking Mathematical Knowledge; Year 2 (2012-2013)

Survey item	Response	Frequency	Percent	Cumulative frequency	Cumulative percent
I can differentiate high- and low-level cognitive tasks and their implications for teaching	Less	1	1.30	1	1.30
	About the same	16	20.78	17	22.08
	More	60	77.92	77	100.00
I have a strong knowledge of the Standards for Mathematical Practice	Less	1	1.30	1	1.30
	About the same	23	29.87	24	31.17
	More	53	68.83	77	100.00
I am confident in analyzing mathematical tasks	Less	0	0	NA	NA
	About the same	26	33.77	26	33.77
	More	51	66.23	77	100.00
I have a strong knowledge of algebraic functions	Less	0	0	NA	NA
	About the same	16	20.78	16	20.78
	More	61	79.22	77	100.00
I have the ability to examine multiple representations of algebraic functions	Less	0	0	NA	NA
	About the same	19	24.68	19	24.68
	More	58	75.32	77	100.00
I am confident in comparing linear, quadratic and exponential functions	Less	1	1.30	1	1.30
	About the same	30	38.96	31	40.26
	More	46	59.74	77	100.00
I use technology to explore algebraic functions	Less	1	1.30	1	1.30
	About the same	36	46.75	37	48.05
	More	40	51.95	77	100.00
Overall, my knowledge of ratio, proportional reasoning, rate, and algebraic functions is adequate to the task of teaching those subjects	Less	1	1.30	1	1.30
	About the same	17	22.08	18	23.38
	More	59	76.62	77	100.00

Table C 5. Helpfulness and Understandability of Proportional Reasoning Academy Components; Year 1 (2011-2012)

Survey item	Response	Frequency	Percent	Cumulative frequency	Cumulative percent
I found the five-day SUMMER PD provided by Carnegie helpful	No reply	1	1.30	1	1.30
	Strongly disagree	1	1.30	2	2.60
	Disagree	0	0	NA	NA
	Neutral	2	2.60	4	5.19
	Agree	26	33.77	30	38.96
	Strongly Agree	47	61.04	77	100.00
I found the five-day SUMMER PD provided by Carnegie easy to understand	No reply	1	1.30	1	1.30
	Strongly disagree	0	0	NA	NA
	Disagree	1	1.30	2	2.60
	Neutral	7	9.09	9	11.69
	Agree	28	36.36	37	48.05
	Strongly Agree	40	51.95	77	100.00
I found the one-day FALL follow-up helpful	No reply	9	11.69	9	11.69
	Strongly disagree	1	1.30	10	12.99
	Disagree	1	1.30	11	14.29
	Neutral	7	9.09	18	23.38
	Agree	27	35.06	45	58.44
	Strongly Agree	32	41.56	77	100.00
I found the one-day FALL follow-up easy to understand	No reply	9	11.69	9	11.69
	Strongly disagree	0	0	NA	NA
	Disagree	1	1.30	10	12.99
	Neutral	4	5.19	14	18.18
	Agree	28	36.36	42	54.55
	Strongly Agree	35	45.45	77	100.00
I found the one-day SPRING follow-up helpful	No reply	8	10.39	8	10.39
	Strongly disagree	1	1.30	9	11.69
	Disagree	0	0	NA	NA
	Neutral	6	7.79	15	19.48
	Agree	30	38.96	45	58.44
	Strongly Agree	32	41.56	77	100.00
I found the one-day SPRING follow-up easy to understand	No reply	9	11.69	9	11.69
	Strongly disagree	0	0	NA	NA
	Disagree	0	0	NA	NA
	Neutral	3	3.90	12	15.58
	Agree	34	44.16	46	59.74
	Strongly Agree	31	40.26	77	100.00

Table C 5 continues on next page

Table C 5. Helpfulness and Understandability of Proportional Reasoning Academy Components; Year 1 (2011-2012)

Survey item	Response	Frequency	Percent	Cumulative frequency	Cumulative percent
I found MATHia helpful	No reply	3	3.90	3	3.90
	Strongly disagree	1	1.30	4	5.19
	Disagree	1	1.30	5	6.49
	Neutral	11	14.29	16	20.78
	Agree	27	35.06	43	55.84
	Strongly Agree	34	44.16	77	100.00
I found MATHia easy to use	No reply	4	5.19	4	5.19
	Strongly disagree	1	1.30	5	6.49
	Disagree	11	14.29	16	20.78
	Neutral	13	16.88	29	37.66
	Agree	21	27.27	50	64.94
	Strongly Agree	27	35.06	77	100.00

Table C 6. Helpfulness of Developing Algebraic Thinking Academy Components; Year 2 (2012-2013)

Survey item	Response	Frequency	Percent	Cumulative frequency	Cumulative percent
I found the five-day SUMMER PD provided by Carnegie helpful	No reply	0	0	NA	NA
	Strongly disagree	1	1.30	1	1.30
	Disagree	0	0	NA	NA
	Neutral	3	3.9	4	5.19
	Agree	17	22.08	21	27.27
	Strongly Agree	56	72.73	77	100.00
I found the one-day FALL follow-up helpful	No reply	0	0	NA	NA
	Strongly disagree	1	1.30	1	1.30
	Disagree	1	1.30	2	2.60
	Neutral	6	7.79	8	10.39
	Agree	23	29.87	31	40.26
	Strongly Agree	43	55.84	74	96.10
	NA*	3	3.90	77	100.00
I found the one-day SPRING follow-up helpful	No reply	0	0	NA	NA
	Strongly disagree	1	1.30	1	1.30
	Disagree	1	1.30	2	2.60
	Neutral	7	9.09	9	11.69
	Agree	21	27.27	30	38.96
	Strongly Agree	38	49.35	68	88.31
	NA*	9	11.69	77	100.00
I found Cognitive Tutor/MATHia helpful	No reply	0	0	NA	NA
	Strongly disagree	1	1.30	1	1.30
	Disagree	3	3.90	4	5.19
	Neutral	13	16.88	17	22.08
	Agree	23	29.87	40	51.95
	Strongly Agree	37	48.05	77	100.00
Using Cognitive Tutor/MATHia deepened my understanding of mathematics	No reply	2	2.60	2	2.60
	Strongly disagree	1	1.30	3	3.90
	Disagree	3	3.90	6	7.79
	Neutral	13	16.88	19	24.68
	Agree	23	29.87	42	54.55
	Strongly Agree	35	45.45	77	100.00

*NA = Participant responded that they did not attend this academy activity

Table C 7. Reported Support From Offices and/or Individuals Among Proportional Reasoning Participants; Year 1 (2011-2012)

Survey item	Response	Frequency	Percent	Cumulative frequency	Cumulative percent
District office	No reply	2	2.60	2	2.60
	1 – Not supportive	0	0	NA	NA
	2	0	0	NA	NA
	3	8	10.39	10	12.99
	4	16	20.78	26	33.77
	5 – Highly supportive	40	51.95	66	85.71
	NA	11	14.29	77	100.00
District coordinator	No reply	4	5.19	4	5.19
	1 – Not supportive	0	0	NA	NA
	2	0	0	NA	NA
	3	7	9.09	11	14.29
	4	16	20.78	27	35.06
	5 – Highly supportive	37	48.05	64	83.12
	NA	13	16.88	77	100.00
Math coordinator	No reply	4	5.19	4	5.19
	1 – Not supportive	0	0	NA	NA
	2	3	3.90	7	9.09
	3	5	6.49	12	15.58
	4	9	11.69	21	27.27
	5 – Highly supportive	33	42.86	54	70.13
	NA	23	29.87	77	100.00
Special education director	No reply	2	2.60	2	2.60
	1 – Not supportive	0	0	NA	NA
	2	0	0	NA	NA
	3	7	9.09	9	11.69
	4	15	19.48	24	31.17
	5 – Highly supportive	48	62.34	72	93.51
	NA	5	6.49	77	100.00
School/place of work	No reply	2	2.60	2	2.60
	1 – Not supportive	0	0	NA	NA
	2	1	1.30	3	3.90
	3	6	7.79	9	11.69
	4	14	18.18	23	29.87
	5 – Highly supportive	50	64.94	73	94.81
	NA	4	5.19	77	100.00

Table C 7 continues on next page

Table C 7. Reported Support From Offices and/or Individuals Among Proportional Reasoning Participants; Year 1 (2011-2012)

Survey item	Response	Frequency	Percent	Cumulative frequency	Cumulative percent
School principal/direct supervisor	No reply	2	2.60	2	2.60
	1 – Not supportive	0	0	NA	NA
	2	2	2.60	4	5.19
	3	7	9.09	11	14.29
	4	14	18.18	25	32.47
	5 – Highly supportive	49	63.64	74	96.1
	NA	3	3.90	77	100.00
Colleagues	No reply	2	2.60	2	2.60
	1 – Not supportive	0	0	NA	NA
	2	3	3.90	5	6.49
	3	7	9.09	12	15.58
	4	18	23.38	30	38.96
	5 – Highly supportive	43	55.84	73	94.81
	NA	4	5.19	77	100.00
WVDE officials	No reply	4	5.19	4	5.19
	1 – Not supportive	0	0	NA	NA
	2	0	0	NA	NA
	3	5	6.49	9	11.69
	4	11	14.29	20	25.97
	5 – Highly supportive	48	62.34	68	88.31
	NA	9	11.69	77	100.00

Table C 8. Reported Support From Offices and/or Individuals Among Developing Algebraic Thinking Participants; Year 2 (2012-2013)

Survey item	Response	Frequency	Percent	Cumulative frequency	Cumulative percent
District office	No reply	0	0	NA	NA
	1 – Not supportive	0	0	NA	NA
	2	1	1.30	1	1.30
	3	5	6.49	6	7.79
	4	19	24.68	25	32.47
	5 – Highly supportive	45	58.44	70	90.91
	NA	7	9.09	77	100.00
Math coordinator	No reply	2	2.60	2	2.60
	1 – Not supportive	0	0	NA	NA
	2	1	1.30	3	3.90
	3	6	7.79	9	11.69
	4	13	16.88	22	28.57
	5 – Highly supportive	35	45.45	57	74.03
	NA	20	25.97	77	100.00

Table C 8 continues on next page

Special education director	No reply	1	1.30	1	1.30

Table C 8. Reported Support From Offices and/or Individuals Among Developing Algebraic Thinking Participants; Year 2 (2012-2013)

Survey item	Response	Frequency	Percent	Cumulative frequency	Cumulative percent
	1 – Not supportive	0	0	NA	NA
	2	2	2.60	3	3.90
	3	7	9.09	10	12.99
	4	10	12.99	20	25.97
	5 – Highly supportive	56	72.73	76	98.70
	NA	1	1.30	77	100.00
School/place of work	No reply	0	0	NA	NA
	1 – Not supportive	0	0	NA	NA
	2	0	0	NA	NA
	3	11	14.29	11	14.29
	4	18	23.38	29	37.66
	5 – Highly supportive	47	61.04	76	98.70
	NA	1	1.30	77	100.00
School principal/direct supervisor	No reply	1	1.30	1	1.30
	1 – Not supportive	1	1.30	2	2.60
	2	0	0	NA	NA
	3	7	9.09	9	11.69
	4	17	22.08	26	33.77
	5 – Highly supportive	48	62.34	74	96.10
	NA	3	3.90	77	100.00
Colleagues	No reply	1	1.30	1	1.30
	1 – Not supportive	2	2.60	3	3.90
	2	0	0	NA	NA
	3	8	10.39	11	14.29
	4	20	25.97	31	40.26
	5 – Highly supportive	43	55.84	74	96.10
	NA	3	3.90	77	100.00
WVDE officials	No reply	2	2.60	2	2.60
	1 – Not supportive	0	0	NA	NA
	2	0	0	NA	NA
	3	2	2.60	4	5.19
	4	10	12.99	14	18.18
	5 – Highly supportive	56	72.73	70	90.91
	NA	7	9.09	77	100.00

Table C 9. Average Helpfulness of Academy Components (2011-2013)

	Year 1 (2011-2012) proportional reasoning			Year 2 (2012-2013) developing algebraic thinking		
Survey item	*n*	mean*	*sd*	*n*	mean*	*sd*
I found the five-day SUMMER PD provided by Carnegie helpful	76	4.55	5.94	77	4.65	6.00
I found the one-day FALL follow-up helpful	68	4.29	6.84	77	4.49	7.48
I found the one-day SPRING follow-up helpful	69	4.33	6.32	77	4.57	8.35
I found Cognitive Tutor/MATHia helpful	74	4.24	7.37	77	4.19	8.31
Academy components helpfulness mean		4.36			4.48	

* Means are based on 5-point Likert type scale of agreement, where 1 = *strongly disagree* and 5 = *strongly agree*

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