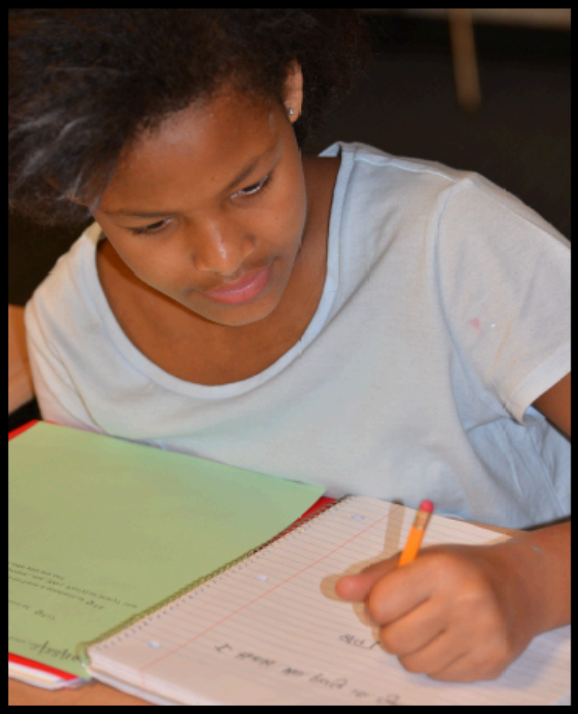
# Types of and Purposes for Elementary Mathematical Writing: Task Force Recommendations



mathematical WRITING

## Disclaimer

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"At its best, writing is learning."[1] But what types of writing have the potential to further elementary students' learning of *mathematics*?

The Elementary Mathematical Writing Task Force outlines in this document recommendations for four types of mathematical writing and the multiple purposes of each type. Importantly, the task force distinguishes *mathematical writing* from writing *about* mathematics. That is, while mathematics content knowledge was at the forefront of the task force's discussions, writing was seen as a means through which students can develop and express their mathematical reasoning.

## Mathematical Writing: Important, But Undefined

Teachers long have been encouraged to engage students in communication as a crucial component of learning mathematics. Writing in mathematics is considered beneficial for students because, through writing, "they communicate to learn mathematics, and they learn to communicate mathematically."[2] Having students write about their ideas helps them learn content[3,4,5] and develops their problem-solving abilities.[6] The process of writing also allows students to reason immediately and visually about the correctness of their solution.[7]

The National Council of Teachers of Mathematics has established that "writing is another important component of the discourse."[8] However, until now, descriptions of the types of and purposes for mathematical writing have fallen short in adequately informing instructional practices. For example, national documents suggest that students use "written communication"[9] and "express themselves increasingly clearly and coherently."[10] The National Research Council states that students should "justify and explain ideas in order to make their reasoning clear,"[11] while the Common Core State Standards call for students to "construct viable arguments and critique the reasoning of others."[12]

Given this rather limited clarity as to the purposes for mathematical writing, it is not surprising that writing has been implemented in a variety of ways in mathematics instruction.[13] Students have been asked, for example, to develop creative pieces,[14,15] engage in expository writing,[16,17] record one's feelings about mathematics,[18] compose a biography of a famous mathematician,[19] reflect on an activity,[20,21,22] and take notes.[23] Although these types of writing may benefit students' literacy, what types of writing are recommended for elementary

students, starting in kindergarten,[24] to lay the foundation for future reasoning and proof writing? Providing a framework for the types of and purposes for mathematical writing enables elementary teachers to leverage writing for students' learning of mathematics, coaches to support teachers with its implementation, assessment developers to design and score such items, and curriculum developers to provide more opportunities for students to engage in this practice.

## Clarifying Elementary Mathematical Writing

The Elementary Mathematical Writing Task Force convened in Fall 2015 to address the lack of clarity about the types of and purposes for mathematical writing. This meeting brought together a diverse group of school- and university-based experts to ensure a comprehensive perspective and offer recommendations that would attend to the needs of various stakeholder groups and students.

Task force members collectively represented the fields of mathematics education, mathematics, and writing education; had expertise across the elementary grades (K-6); were knowledgeable about particular student groups, including English language learners (ELLs), students who have learning difficulties, and/or those students identified as gifted; and had experience teaching writing and authoring assessments and curricula that include mathematical writing.

The primary goals for the Elementary Mathematical Writing Task Force were to:

- Consider various purposes for which students might be asked to write in their mathematics class;
- Reach a consensus about the types of elementary mathematical writing that are reflective of these multiple purposes and recommend the types that leverage students' mathematical learning; and
- Account for perspectives from multiple stakeholders, evidence of students' potential for writing productively in mathematics, and multiple sets of curriculum standards.

Task force members first identified a mathematical writing artifact that represented their original views on mathematical writing and shared it with the task force. Next, they worked collaboratively in small groups — initially with fellow members who had similar professional backgrounds and then with

members specializing in other areas of expertise — to analyze writing-related items. These items included national standards from mathematics education and writing education, as well as samples of students' mathematical writing. Each small group developed working descriptions for the types of and purposes for mathematical writing and then refined them throughout the meeting. Each iteration of the descriptions of the types of and purposes for elementary mathematical writing were presented to the entire task force to facilitate discussions that ultimately led to the recommendations described herein.

## Overarching Goals for Elementary Mathematical Writing

Two overarching goals for elementary mathematical writing were central to the task force's recommendations: for students *to reason* mathematically and *to communicate ideas*. Reasoning and communication have long been emphasized in the teaching and learning of mathematics.[25,26,27,28,29] Together, these overarching goals have the potential to provide students with an authentic way to engage with mathematics.

Students who reason mathematically "tend to note patterns, structure, or regularities in both real-world situations and symbolic objects; they ask if those patterns are accidental or if they occur for a reason; and they conjecture and prove."[30] All recommended types of and purposes for elementary mathematical writing should ultimately serve to engage students in reasoning. (Note: Some purposes for mathematical writing that minimize mathematical reasoning, such as composing a mathematical biography or a narrative describing one's feelings about math, are not addressed in this document.)

Students who communicate mathematically in writing can go beyond using words, phrases, and sentences because "mathematics is so often conveyed in symbols."[31] Like symbols, other representations, such as drawings, tables, and graphs, can serve to communicate mathematical ideas.[32] It is important that any symbols and representations used in mathematical writing should support students' mathematical ideas.

## Types of and Purposes for Elementary Mathematical Writing

The Elementary Mathematical Writing Task Force recommends four types of mathematical writing. These types of writing serve different purposes within the

overarching goals of having students reason and communicate mathematically (Figure 1). Each *type* of writing (highlighted in dark red) defines an overall category that comprises similar purposes. The *purpose(s)* (bulleted in black text) provide specific reason(s) for engaging students in mathematical writing.

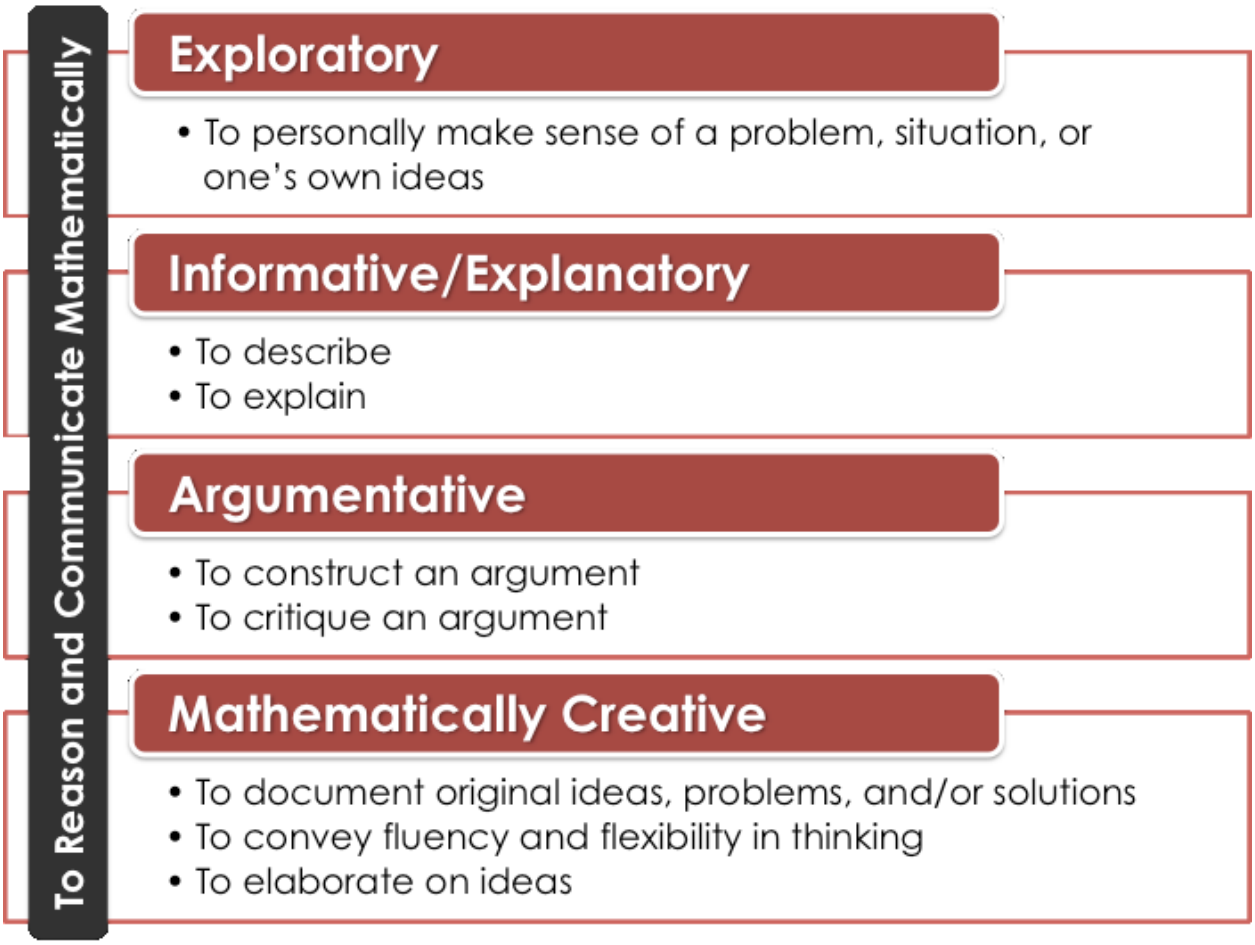



*Figure 1. Overview of the overarching goals and the types of and purposes for elementary mathematical writing*

The types of and purposes for elementary mathematical writing are further described in the remainder of this report. Several considerations guided the task force's recommendations. First and foremost, all elementary students should write mathematically and "reasonable and appropriate accommodations [should] be made as needed to promote access and attainment for all students,"[33] including those with learning difficulties and those who are English language learners. Additional considerations include the following:

- *Writing develops across multiple continua*. First, it is reasonable to assume that younger students' writing would be less sophisticated than that of older students. For example, kindergarteners may use invented spelling, or

teachers may transcribe ideas conveyed in students' notations and representations for others to read. Second, it would be expected that students' writing would develop over the course of any given year through multiple experiences with a given writing type and purpose. Third, some writing may develop using writing processes (plans, drafts, revisions, final product). However, with mathematical writing, the goal for writing may not require the full trajectory of the complete writing process, and the end result may not be a final published piece.

- *The audience influences students' mathematical writing.* Often, the teacher serves as the students' audience, albeit not explicitly. Students can write to an outside or authentic audience, such as their peers, family members, and community members. In some cases, students might serve as their own audience. Particular expectations may be present when writing to an outside audience, as on assessments.
- *Mathematical writing may take multiple forms.* The types of and purposes for writing can be captured in a variety of forms, such as students' notations, a paragraph, or a letter (see the appendix). However, these forms may be more formal and imply that students conform to literacy conventions. The forms that teachers or students decide to utilize, if any, should not override the overarching goals or the types of and purposes for elementary mathematical writing.

## Notes About the Student Writing Samples

- The student writing samples we include here generally illustrate the types of and purposes for mathematical writing. The samples are not meant to be exemplars.
- The samples were gathered across various projects, districts, and grades resulting from task force members' work. Most samples were created prior to the identification of the task force recommendations.
- The samples represent writing from across the school year. The amount of instructional guidance and support within the writing prompt for the development of student writing also varied.
- The set was selected, in part, to signify characteristics of mathematical writing, such as the use of symbols, representations, and vocabulary.

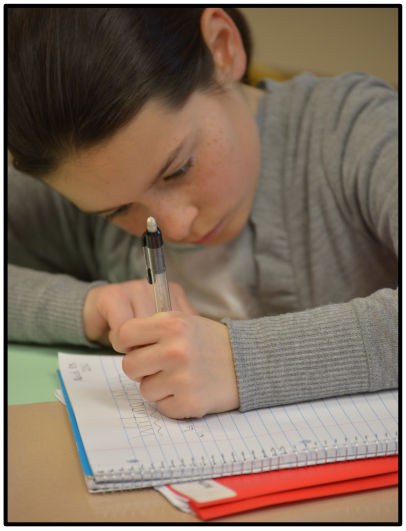
# Type of Mathematical Writing: Exploratory

**Exploratory writing** serves to have elementary students use writing as a way to make sense of their thoughts about mathematical concepts, problems, and their own mathematical ideas. This type of writing provides students with another modality in addition to, for example, participating in discussions and using manipulatives, to grapple with their mathematical ideas.

Exploratory writing is student-initiated. Students serve as their own audience; thus, the writing can take on any form and might include ideas represented in words, pictures, and mathematical symbols and representations. Students may choose to share their exploratory writing with others and, therefore, this type may lead to other types of writing, including informative/explanatory, argumentative, and mathematically creative.

***Purpose—Writing mathematically to personally make sense of a problem, situation, or one's own ideas***

Students may use mathematical writing to reason about and communicate their explorations. Although students can engage in such writing at any time, they might utilize exploratory writing more frequently when first starting to work on a mathematical task in an effort to brainstorm ideas, make sense of the problem, or express early thinking about mathematical ideas. They also might write to develop their ideas about a problem's solution(s), work out their confusion, record their insights, ask or formulate questions, and clarify their thinking.



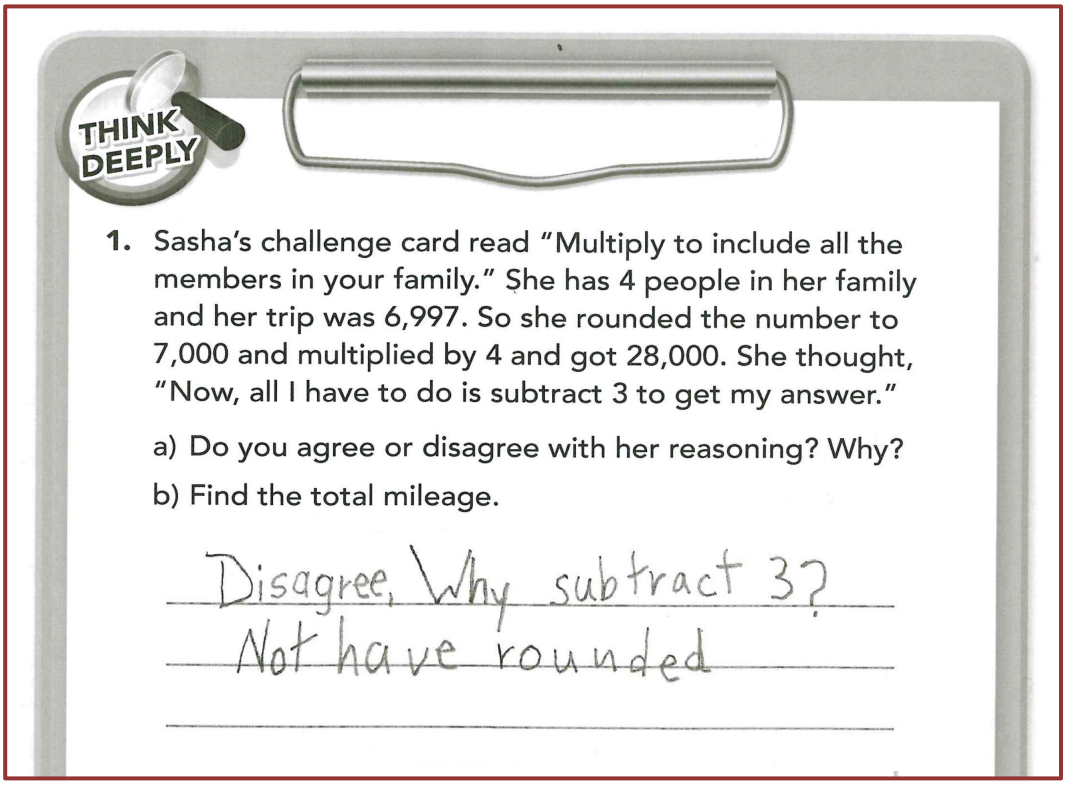



*Figure 2. Grade 3 sample of exploratory writing for the purpose of personally making sense of a problem, situation, and one's own ideas. This student decided to write notes for herself before responding to the question that she later shared with her teacher.*

Adapted from Gavin, M. K., Chapin, S.C., & Dailey, J. (2014). *How big is big? Understanding and using large numbers.* Dubuque, IA: Kendall Hunt, p. 33. Reprinted with permission.

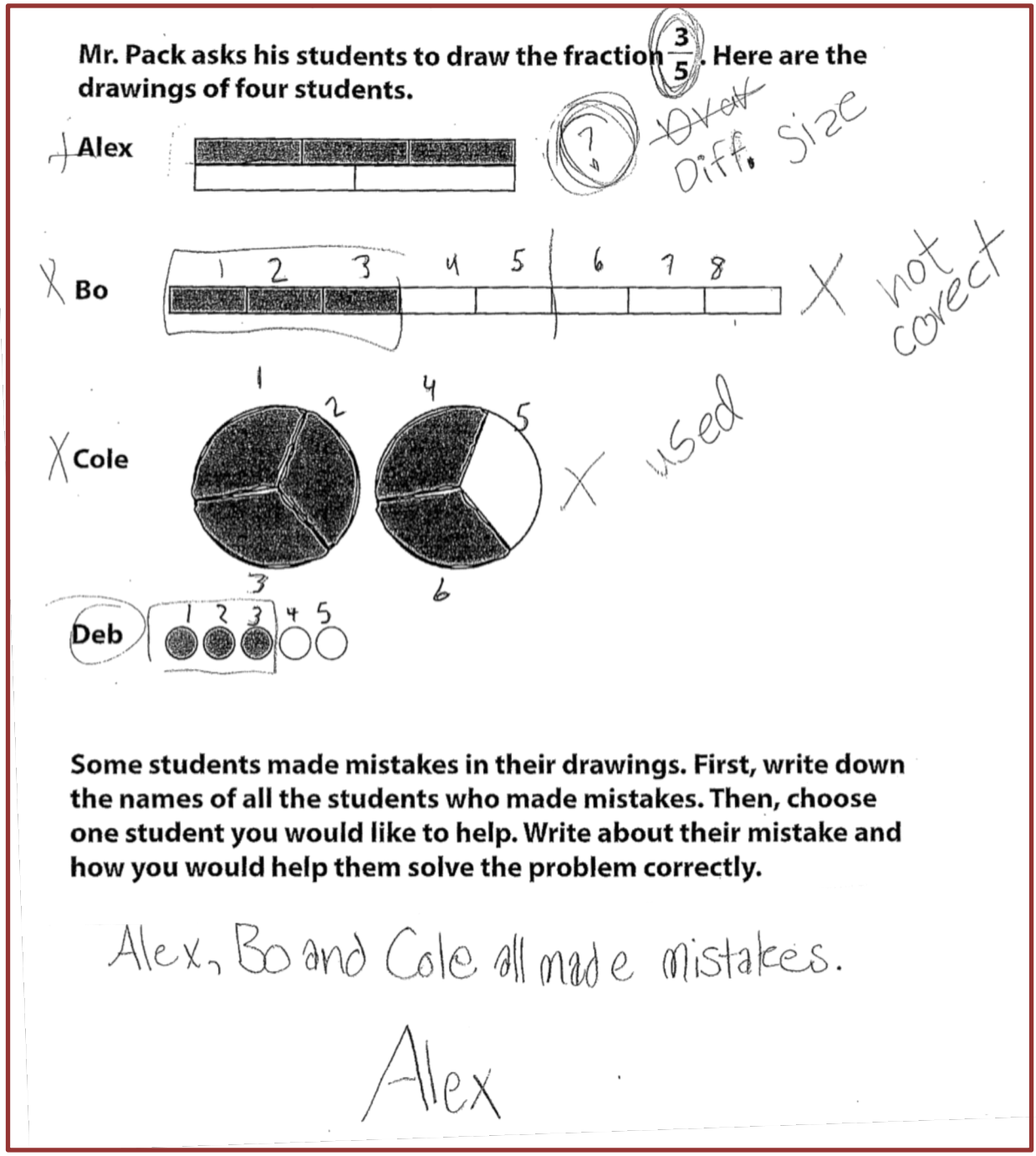



*Figure 3. Grade 4 sample of exploratory writing for the purpose of writing mathematically to personally make sense of a problem, situation, or one's own ideas. This student decided to write notes to himself before answering the problem addressing the role of the whole as it relates to a fraction.*

Sample adapted from Powell, S. R., & Hebert, M. A. (in press). Influence of writing ability and computational skill on mathematics writing. *The Elementary School Journal.*

# Type of Mathematical Writing: Informative/Explanatory

**Informative/explanatory writing** serves to have elementary students provide information or explanations related to mathematical concepts. Specifically, students reason about concepts and communicate descriptions and explanations through mathematical writing. Typically, the teacher and other students serve as the audience for this type of writing.

***Purpose—Writing mathematically to describe***

Descriptions of attributes, observations, definitions, and representations, among others, can serve to help students identify features and ideas using a mathematical lens. Writing descriptions can further students' mathematical reasoning by having them clarify ideas, precisely communicate them, and give them permanence for ongoing analysis or to create a record of ideas. In particular, this writing may involve precise mathematical language as well as students' own terms that can make the mathematics more accessible.

***Purpose—Writing mathematically to explain***

Students may be asked to use writing to explain mathematical concepts, strategies used to solve problems, reasoning about processes and procedures, and mathematical connections and comparisons (e.g., representations, real-world applications, other content areas, or mathematical concepts).

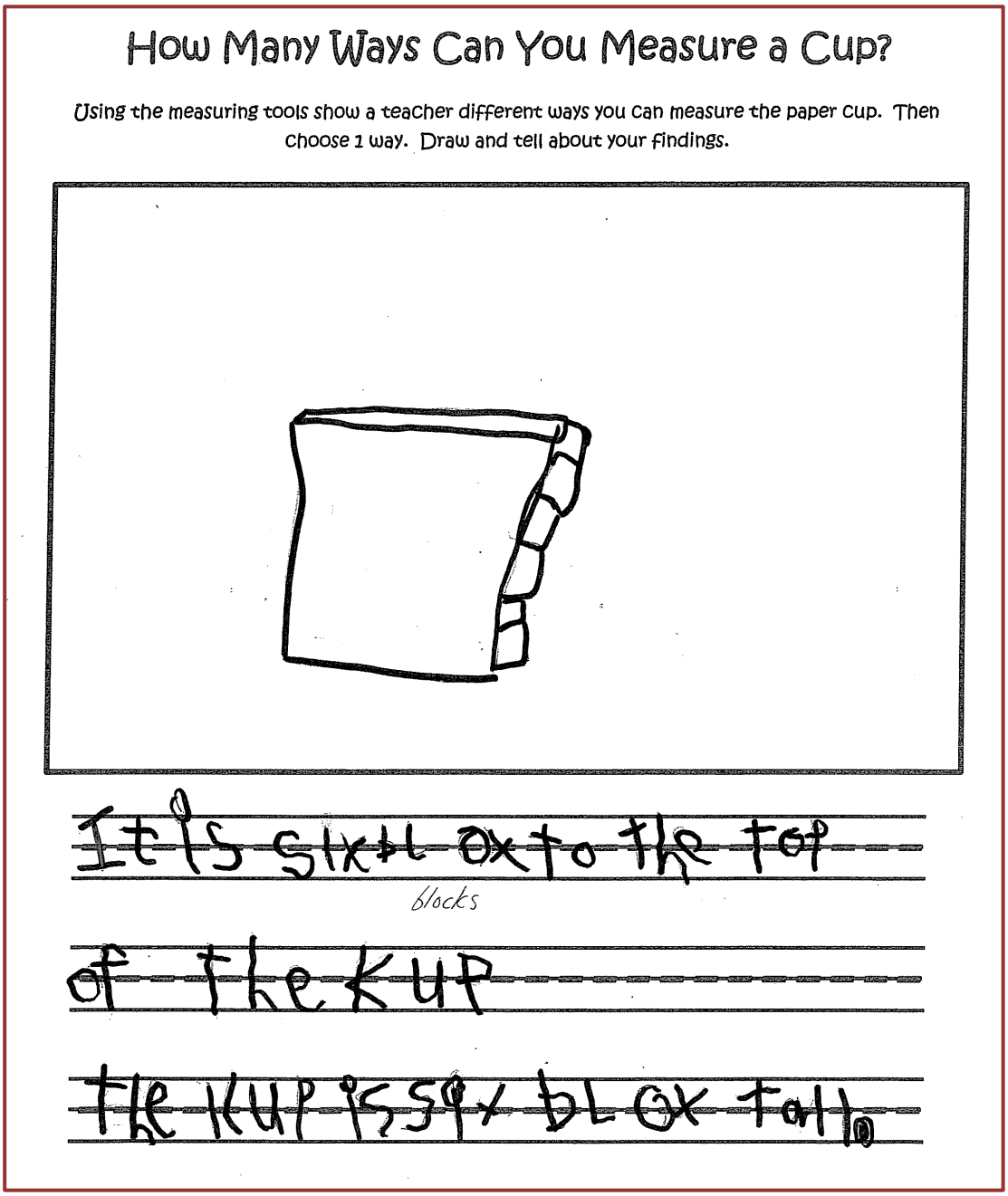



*Figure 4. Kindergarten sample of informative/explanatory writing for the purpose of writing mathematically to describe. Here is the transcription of the writing: "It is six blocks to the top of the cup. The cup is six blocks tall."*

Sample contributed by Erika LaBella.

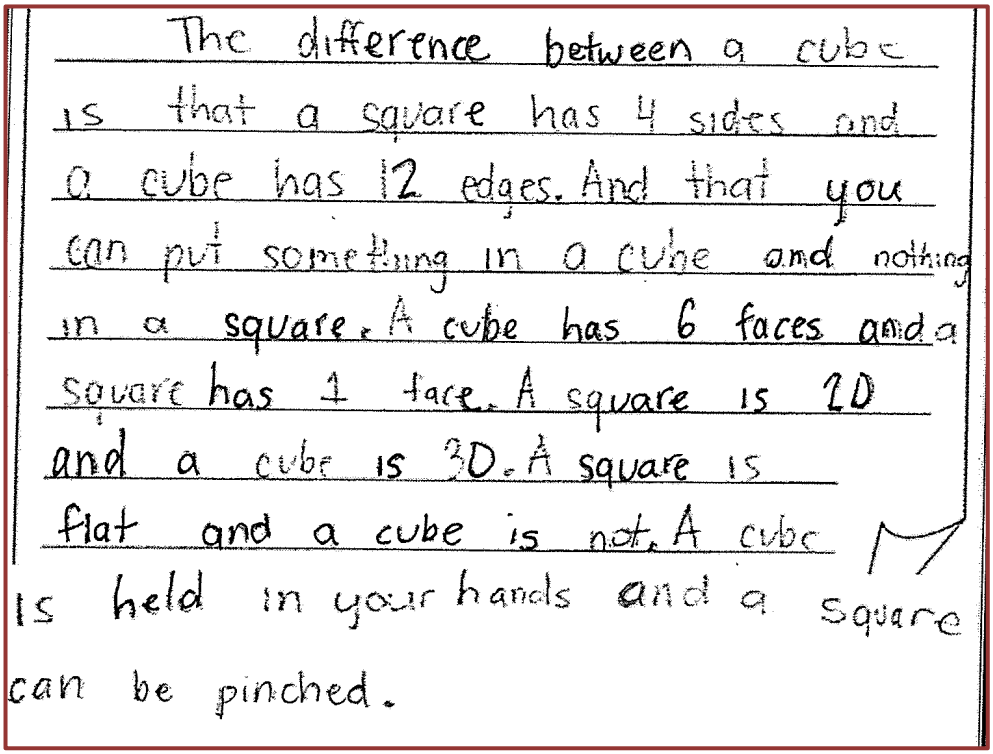



*Figure 5. Grade 2 sample of informative/explanatory writing for the purpose of writing mathematically to explain*

From the Project M²: Mentoring Young Mathematicians field test of Gavin, M. K., Casa, T. M., Chapin, S. H., & Sheffield, L. J. (2010). *Designing a shape gallery: Geometry with the meerkats.* Dubuque, IA: Kendall Hunt.

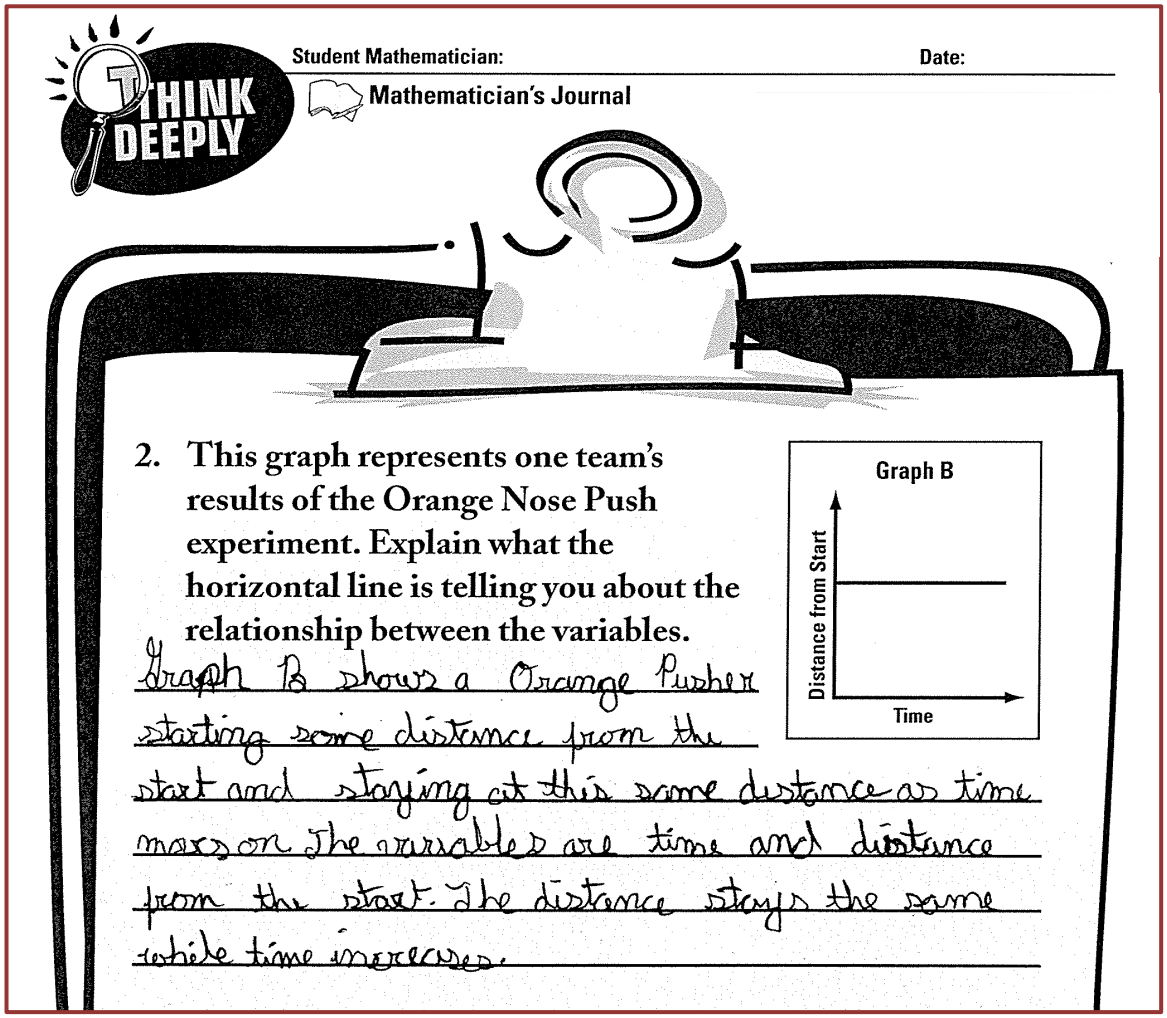



*Figure 6. Grade 5 sample of informative/explanatory writing for the purpose of writing mathematically to describe*

From Gavin, M. K., Sheffield, L. J., Chapin, S. H., & Dailey, J. (2008). *Record makers and breakers: Using algebra to analyze change*. Dubuque, IA: Kendall Hunt, p. 12. Reprinted with permission.

# Type of Mathematical Writing: Argumentative

**Argumentative writing** serves to have elementary students use writing to "construct viable arguments and critique the reasoning of others."[34] Because the audience for this type of writing is others, students should keep in mind precision and clarity when constructing an argument or a critique to ensure it is understood by the targeted audience. Sophistication of an argument or critique may vary depending on the grade level and classroom norms.

***Purpose—Writing mathematically to construct an argument***

Students may engage in mathematical writing to communicate their reasoning and support their arguments. Writing to construct an argument considers both the *process* of developing an argument and the final product. An argument is a sequence of statements and reasons presented with the aim of demonstrating that a claim is true or false[35] rather than just describing a series of procedural steps taken to arrive at an answer. An argument includes a claim, justification of the claim with evidence, and warrants, which connect the evidence to the claim. Students may incorporate pictorial, symbolic, and empirical evidence to support their mathematical claim.

***Purpose—Writing mathematically to critique an argument***

Students may use mathematical writing to reason about and communicate critiques of others' arguments. Students do so by reviewing, analyzing, and evaluating others' mathematical ideas, approaches, or strategies. Students may provide further evidence to strengthen an argument or counterexamples to disprove a claim. Writing a critique also may help students further their understanding of a mathematical concept by considering ideas other than their own.

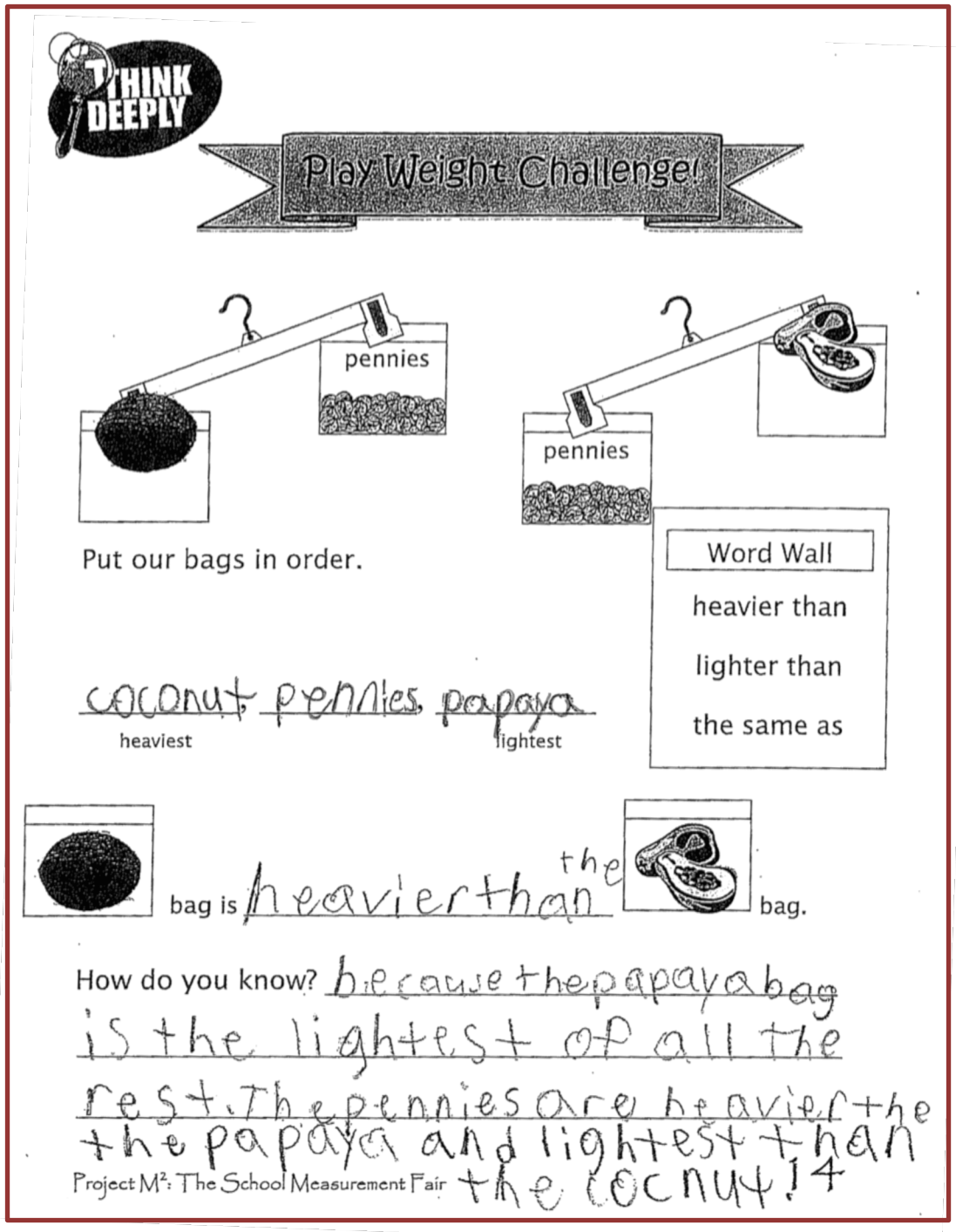



*Figure 7. Grade 1 sample of argumentative writing for the purpose of writing mathematically to construct an argument*

From the Project M²: Mentoring Young Mathematicians field test of Gavin, M. K., Casa, T. M., Chapin, S. H., & Sheffield, L. J. (2012). *Creating the school measurement fair: Measuring with Imi and Zani.* Dubuque, IA: Kendall Hunt.

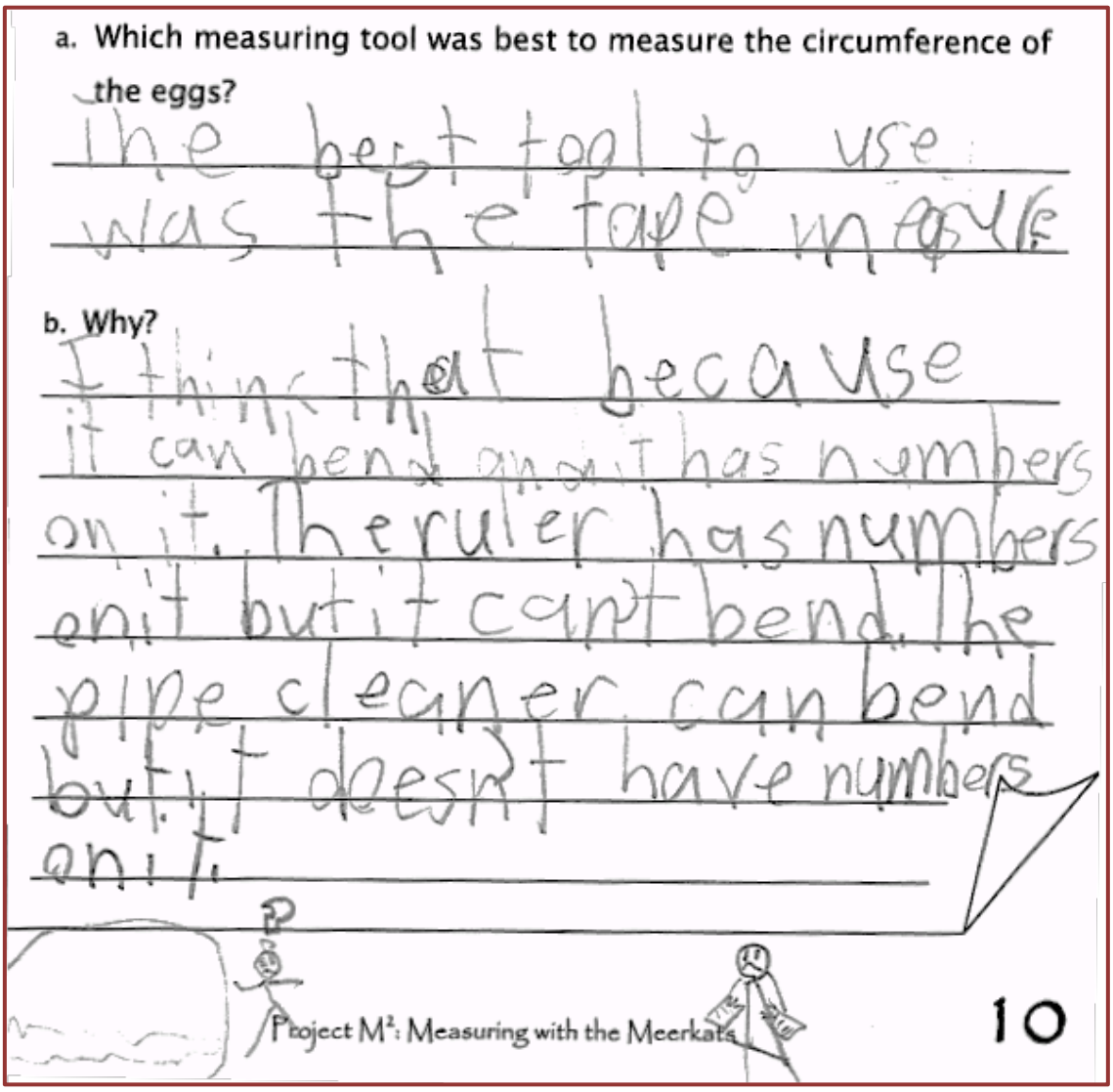



*Figure 8. Grade 2 sample of argumentative writing for the purpose of writing mathematically to construct an argument*

From the Project M²: Mentoring Young Mathematicians field test of Gavin, M. K., Casa, T. M., Chapin, S. H., & Sheffield, L. J. (2011). *Using everyday measures: Measuring with the meerkats*. Dubuque, IA: Kendall Hunt.

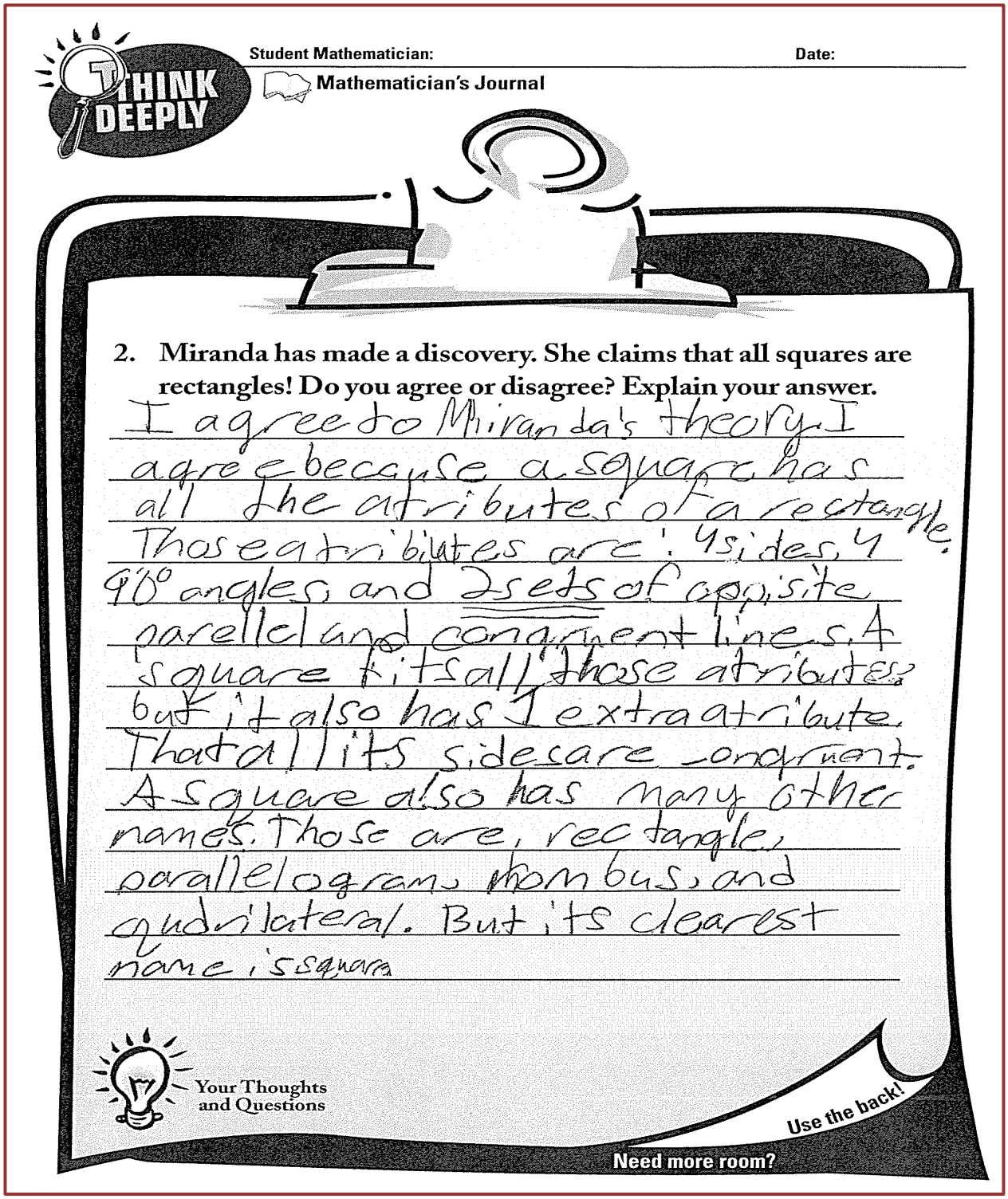



*Figure 9. Grade 4 sample of argumentative writing for the purpose of writing mathematically to critique an argument*

From Gavin, M. K., Dailey, J., Chapin, S.C., & Sheffield, L. J. (2007). *Getting into shapes.* Dubuque, IA: Kendall Hunt, p. 20. Reprinted with permission.

# Type of Mathematical Writing: Mathematically Creative

**Mathematically creative writing** serves to encourage elementary students to think creatively and document their mathematical ideas that extend beyond the expected or intended outcome of a task, situation, or problem. Within the context of elementary mathematical writing, the purposes of mathematically creative writing are to engage students in reasoning about and communicating originality, fluency, flexibility, and elaboration of ideas, problems, and/or solutions. Students' mathematically creative ideas may be expressed in formal or informal ways and for a wider or authentic audience. This type of writing requires an allotment of time for students to generate multiple ideas and a classroom context in which they come to see mathematics as an ongoing and dynamic process.

***Purpose—Writing mathematically to document original ideas, problems, and/or solutions***

Originality refers to the novelty of an idea. Within the context of elementary school mathematics, it is not necessary that students generate ideas that are original or novel to the field of mathematics. Instead, ideas can be considered original if students develop them for themselves through experiences prior to formal instruction. In this way, insights that are novel to students themselves or to the class can be considered original. Writing mathematically about original ideas would include students posing problems or questions, generating novel or original solutions to problems, and writing about mathematical structures or patterns they have discovered.

***Purpose—Writing mathematically to convey fluency and flexibility in thinking***

Being able to look at a problem or situation from multiple perspectives, or to approach problems in unique ways, demonstrates flexibility in thinking. Additionally, fluency refers to the ability to generate many or multiple ideas. Students can write about connecting mathematical ideas in innovative ways both within and beyond mathematics, solving

problems in flexible or multiple ways, contextualizing abstractions (e.g., creating a situation to match an expression, equation, or inequality), and evaluating strategies for efficiency or effectiveness.

***Purpose—Writing mathematically to elaborate on ideas***

Elaboration refers to the ability to extend ideas, provide more detailed explanations, and develop ideas over an extended period of time. Students write creatively in mathematics and demonstrate elaboration when they write extensions of their understanding, notice repeated reasoning, and create or develop generalizations with their explanations. This purpose is fulfilled when the elaboration is student-initiated as opposed to teacher-prompted.

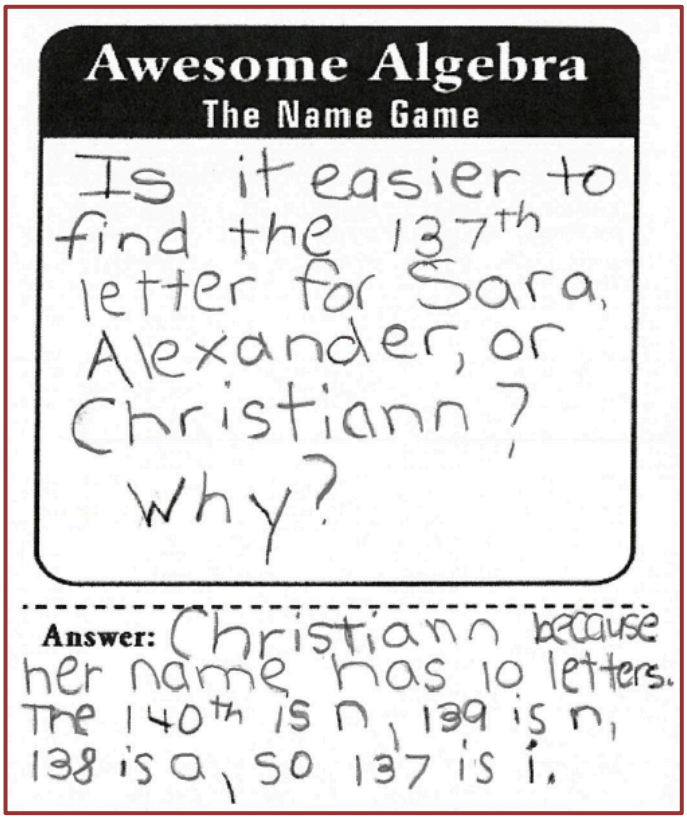



*Figure 10. Grade 3 sample of mathematically creative writing for the purpose of writing mathematically to elaborate on ideas. Students first engaged with problems asking them to identify the letter, such as the 82nd letter, resulting from the scribbling of Sarah's name over and over again. They were positioned to look for patterns rather than writing the name repeatedly. This student expanded on these activities.*

From the Project M3: Mentoring Mathematical Minds field test of Gavin, M. K., Chapin, S.C., Dailey, J., & Sheffield, L. J. (2006). *Awesome algebra: Looking for patterns and generalizations.* Dubuque, IA: Kendall Hunt.

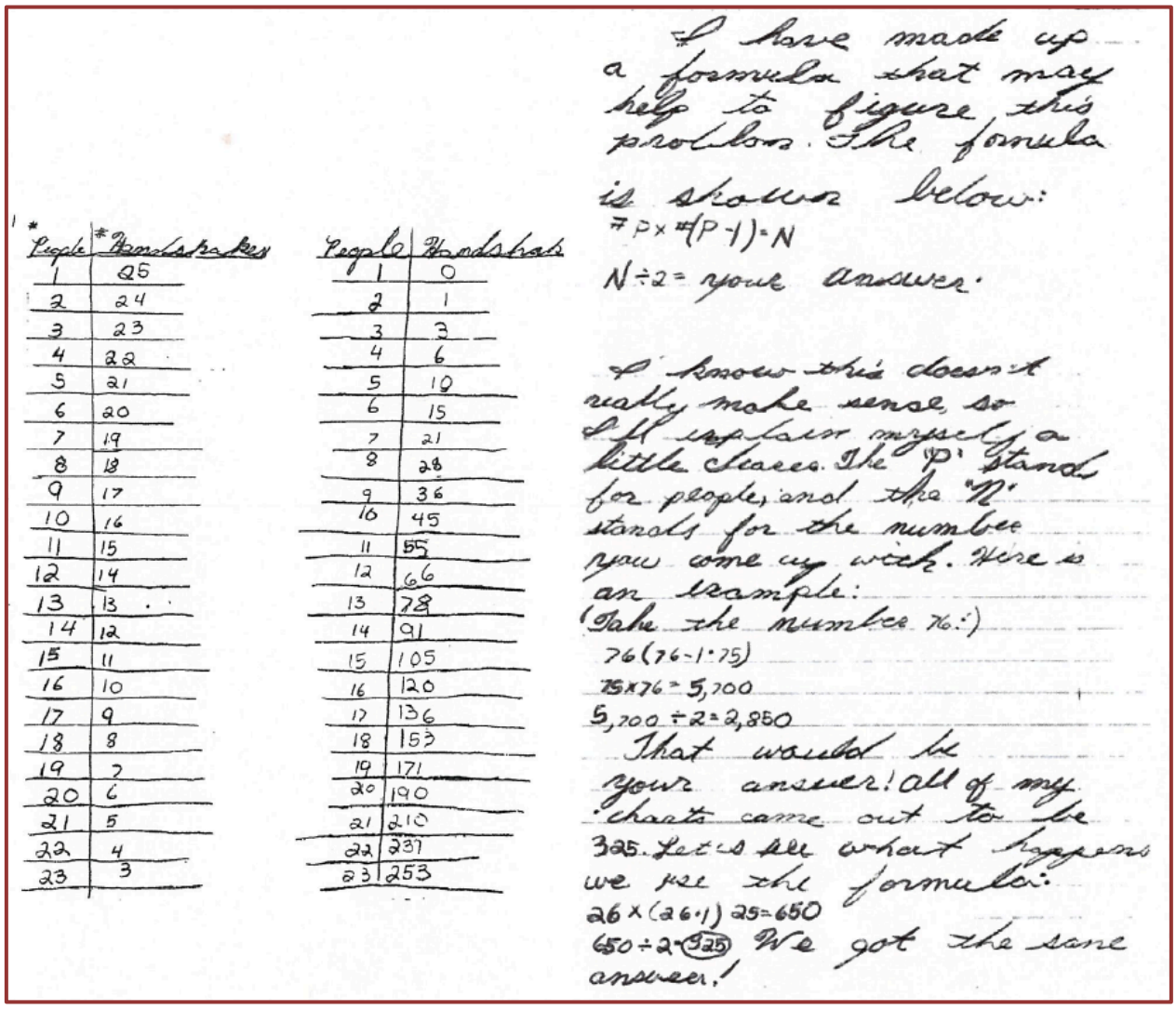



*Figure 11. Grade 4 sample of mathematically creative writing for the purposes of writing mathematically to document original ideas, problems, and/or solutions and to convey fluency and flexibility in thinking. This student wrote a response to the following problem: How many handshakes will there be if everyone in our class of 26 shakes hands once with everyone else? Although students were expected to solve the problem only one way, she solved it multiple ways because she "needed to look at it differently." She made two tables or charts, drew a bar graph, and composed a formula, something the class had not yet learned. This figure showcases a portion of her writing, including her charts and use of a formula.*

Sample contributed by Linda J. Sheffield.

# Appendix: Possible Forms and Audiences

The **form** and **audience** are secondary to the types of and purposes for elementary mathematical writing to ensure that the purpose of writing is to reason and communicate mathematically. The following lists are not intended to be exhaustive but rather to provide some ideas for how teachers may engage their students in mathematical writing. For example, if students are reasoning about shapes and their attributes, they may write an informational piece to explain their understanding of a square. This may be in the form of a self-created dictionary and the students would be their own audience.

## Possible Forms

- Books
- Concept map
- Data files
- Diagrams
- Drawings
- Essay
- Informational texts
- Journal
- Lists
- Math fair/displays
- Notes
- Photos
- Quick writes
- Self-created dictionary
- Social media
- Tables
- Technological representations
- Videos
- Word problems

## Possible Audiences

- Community members (e.g., town, city, state)
- Fictional characters
- Group of peers
- Older/younger peers
- Other teachers
- Own teacher
- Parents
- Researchers
- School administrators
- Self
- Test assessors

## Notes

[1] The National Commission on Writing for America's Families, Schools, and Colleges, "The Neglected 'R': The Need for a Writing Revolution," *National Commission on Writing and College Board*, April 2003, http://www.collegeboard.com/prod_downloads/writingcom/writing-school-reform-natl-comm-writing.pdf, 51.

[2] National Council of Teachers of Mathematics, *Principles and Standards for School Mathematics* (Reston, VA: National Council of Teachers of Mathematics, 2000), 60.

[3] Robert L. Bangert-Drowns, Marlene M. Hurley, and Barbara Wilkinson, "The Effects of School-Based Writing-to-Learn Interventions on Academic Achievement: A Meta-Analysis," *Review of Educational Research* 74, no. 1 (2004): 29-58.

[4] Perry D. Klein, "Elementary Students' Strategies for Writing-to-Learn in Science." *Cognition and Instruction* 18, no. 3 (2000): 317-348.

[5] Perry D. Klein and Mary A. Rose, "Teaching Argument and Explanation to Prepare Junior Students for Writing to Learn," *Reading Research Quarterly* 45, no. 4 (2010): 433-461.

[6] David K. Pugalee, *Writing to Develop Mathematical Understanding* (Norwood, MA: Christopher-Gordon, 2005).

[7] Mark Freitag, "Reading and Writing in the Mathematics Classroom," *The Mathematics Educator* 8, no. 1 (1997): 16-21.

[8] National Council of Teachers of Mathematics, *Professional Standards for Teaching Mathematics* (Reston, VA: National Council of Teachers of Mathematics, 1991), 34.

[9] National Council of Teachers of Mathematics, *Principles to Actions: Ensuring Mathematical Success for All* (Reston, VA: National Council of Teachers of Mathematics, 2014), 29.

[10] National Council of Teachers of Mathematics, *Principles and Standards*, 62.

[11] National Research Council, *Adding It Up: Helping Children Learn Mathematics*. (Washington, DC: National Academy Press, 2001),130.

[12] National Governors Association Center for Best Practices & Council of Chief State School Officers, *Common Core State Standards for Mathematics* (Washington, DC: Authors, 2010), http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf, 6.

[13] Debra L. Johanning, "An Analysis of Writing and Postwriting Group Collaboration in Middle School Pre-Algebra," *School Science and Mathematics* 100, no. 3 (2000): 151-160.

[14] Donna E. Alvermann and David W. Moore, "Secondary School Reading," in *Handbook of Reading Research*, Vol. II, ed. Rebecca Barr, Michael L. Kamil, Peter B. Mosenthal, P. David Pearson (New York: Longman, 1991), 951-983.

[15] Robert J. Quinn and Mary M. Wilson, "Writing in the Mathematics Classroom: Teacher Beliefs and Practices," *The Clearing House* 71, no. 1 (1997): 14-20.

[16] Ibid.

[17] Greg Venne, "High-School Students Write About Math," *The English Journal* 78, no. 1 (1989): 64-66.

[18] Murad Jurdak and Rihab Abu Zein, "The Effect of Journal Writing on Achievement in and Attitudes Toward Mathematics," *School Science and Mathematics* 98, no. 8 (1998): 412-419.

[19] Carla Tayeh and Patricia A. Pokay, "The Time-Line Project," *Mathematics Teaching in the Middle School* 4, no. 7 (1999): 468-469.

[20] Marilyn Burns and Robyn Silbey, "Math Journals Boost Real Learning," *Instructor* 110, no. 7 (2001): 18-20.

[21] Marilyn Burns, "Writing in Math." *Educational Leadership* 62, no. 2 (2004): 30-33.

[22] Kathleen Kostos and Eui-kyung Shin, "Using Math Journals to Enhance Second Graders' Communication of Mathematical Thinking," *Early Childhood Education Journal* 38, no. 3 (2010): 223-231.

[23] Burns and Silbey, "Math Journals."

[24] National Council of Teachers of Mathematics, *Principles and Standards*.

[25] National Council of Teachers of Mathematics, *Professional Standards.*

[26] National Council of Teachers of Mathematics, *Principles and Standards.*

[27] National Council of Teachers of Mathematics, *Principles to Actions.*

[28] National Governors Association Center for Best Practices & Council of Chief State School Officers, "Common Core State Standards."

[29] National Research Council, *Adding It Up.*

[30] National Council of Teachers of Mathematics, *Principles and Standards*, 56.

[31] Ibid., 60.

[32] Ibid.

[33] Ibid., 12.

[34] National Governors Association Center for Best Practices & Council of Chief State School Officers, *Common Core State Standards*, 6.

[35] Ibid.

## Bibliography


Alvermann, Donna E., and David W. Moore. "Secondary School Reading." In *Handbook of Reading Research*, Vol. II, edited by Rebecca Barr, Michael L. Kamil, Peter B. Mosenthal, and P. David Pearson, 951-983. New York: Longman, 1991.

Bangert-Drowns, Robert L., Marlene M. Hurley, and Barbara Wilkinson. "The Effects of School-Based Writing-to-Learn Interventions on Academic Achievement: A Meta-Analysis." *Review of Educational Research* 74, no. 1 (2004): 29-58.

Burns, Marilyn and Robyn Silbey. "Math Journals Boost Real Learning." *Instructor* 110, no. 7 (2001): 18-20.

Burns, Marilyn. "Writing In Math." *Educational Leadership* 62, no. 2 (2004): 30-33.

Freitag, Mark. "Reading and Writing in the Mathematics Classroom." *The Mathematics Educator* 8, no. 1 (1997): 16-21.

Johanning, Debra L. "An Analysis of Writing and Postwriting Group Collaboration in Middle School Pre-Algebra." *School Science and Mathematics* 100, no. 3 (2000): 151-160.

Jurdak, Murad and Rihab Abu Zein. "The Effect of Journal Writing on Achievement in and Attitudes Toward Mathematics." *School Science and Mathematics* 98, no. 8 (1998): 412-419.

Klein, Perry D. "Elementary Students' Strategies for Writing-to-Learn in Science." *Cognition and Instruction* 18, no. 3 (2000): 317-348.

Klein, Perry D. and Mary A. Rose. "Teaching Argument and Explanation to Prepare Junior Students for Writing to Learn." *Reading Research Quarterly* 45, no. 4 (2010): 433-461.

Kostos, Kathleen and Eui-kyung Shin. "Using Math Journals to Enhance Second Graders' Communication of Mathematical Thinking." *Early Childhood Education Journal* 38, no. 3 (2010): 223-231.

National Council of Teachers of Mathematics. *Professional Standards for Teaching Mathematics*. Reston, VA: National Council of Teachers of Mathematics, 1991.

___. *Principles and Standards for School Mathematics*. Reston, VA: National Council of Teachers of Mathematics, 2000.

___. *Principles to Actions: Ensuring Mathematical Success for All*. Reston, VA: National Council of Teachers of Mathematics, 2014.

National Governors Association Center for Best Practices & Council of Chief State School Officers. *Common Core State Standards for Mathematics* (Washington, DC: Authors, 2010), http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf.

National Research Council. *Adding It Up: Helping Children Learn Mathematics*. Washington, DC: National Academy Press, 2001.

The National Commission on Writing for America's Families, Schools, and Colleges. "The Neglected 'R': The Need for a Writing Revolution." *National Commission on Writing and College Board*. April 2003. http://www.collegeboard.com/prod_downloads/writingcom/writing-school-reform-natl-comm-writing.pdf.

Pugalee, David K. *Writing to Develop Mathematical Understanding*. Norwood, MA: Christopher-Gordon, 2005.

Quinn, Robert J. and Mary M. Wilson. "Writing in the Mathematics Classroom: Teacher Beliefs and Practices." *The Clearing House* 71, no. 1 (1997): 14-20.

Tayeh, Carla and Patricia A. Pokay. "The Time-Line Project." *Mathematics Teaching in the Middle School* 4, no. 7 (1999): 468 -469.

Venne, Greg. "High-School Students Write About Math." *The English Journal* 78, no. 1 (1989): 64-66.