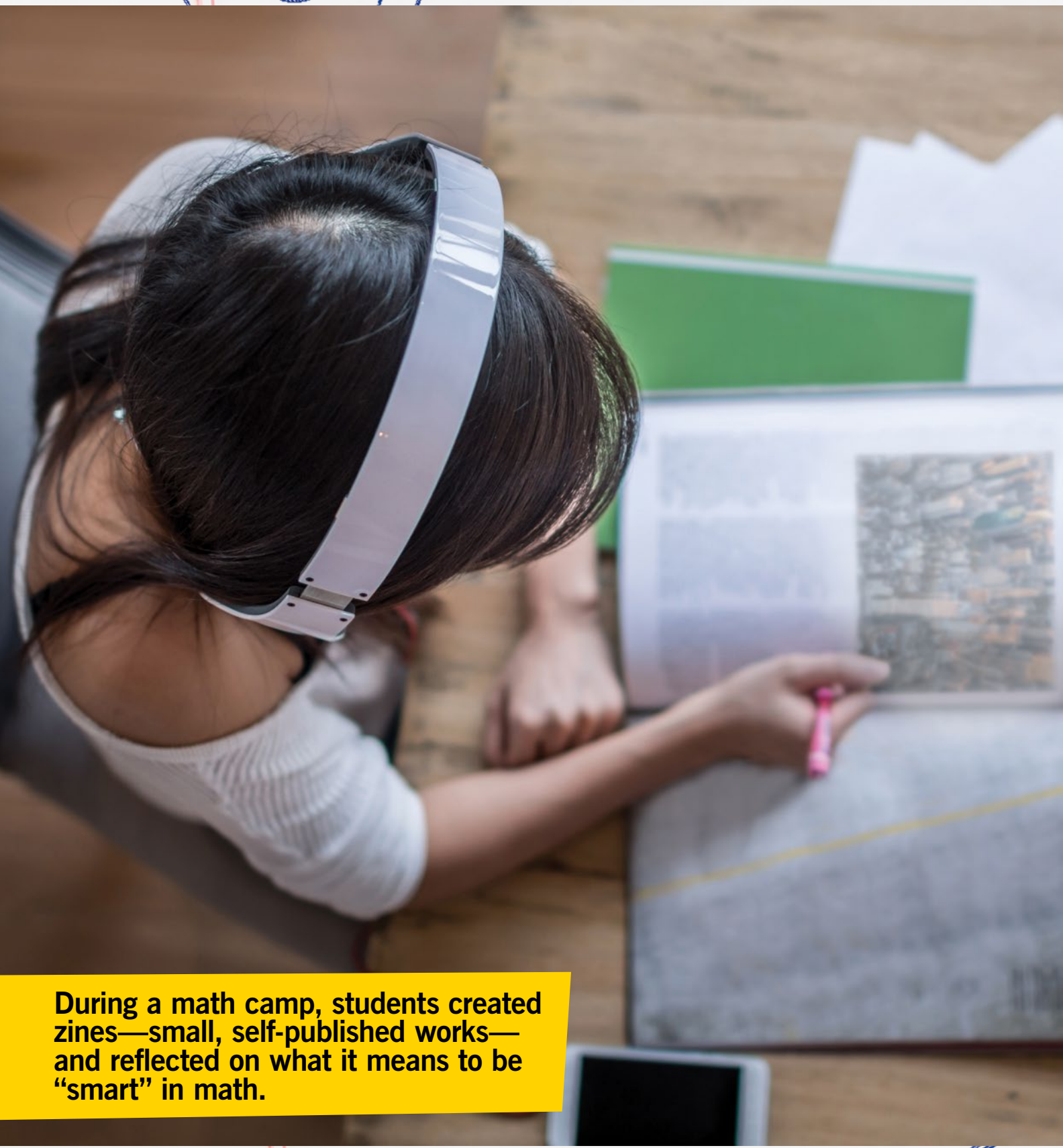

During a math camp, students created zines—small, self-published works—and reflected on what it means to be "smart" in math.

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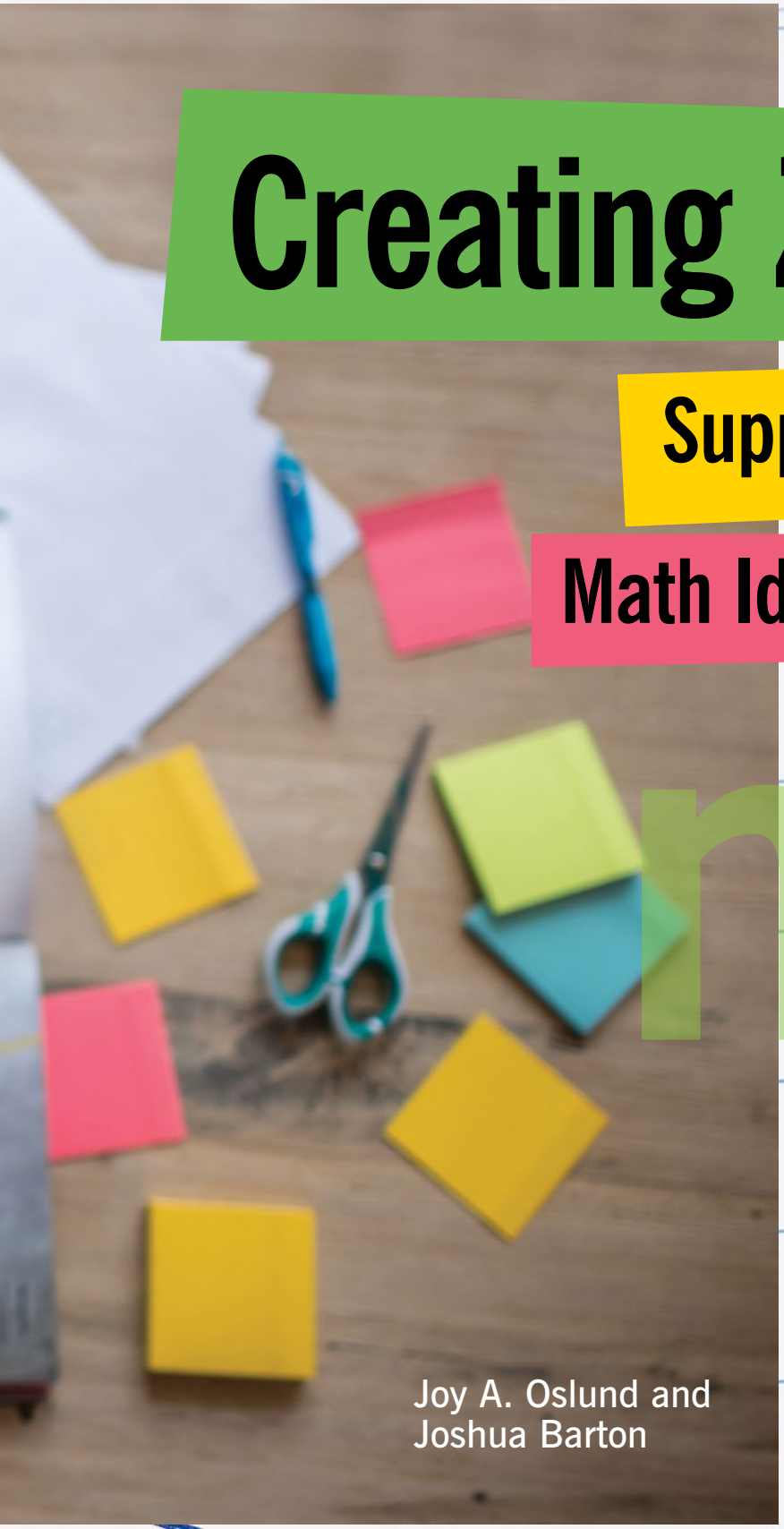
Creating Zines:

Supporting Powerful Math Identities



Joy A. Oslund and Joshua Barton

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Mathematics educators understand the importance of engaging students in mathematical writing to deepen their mathematical knowledge (e.g., Fello and Paquette 2009). Teachers often engage students in writing about mathematics to support students' understanding by assigning math journals (e.g., Kostos and Shin 2010), exchanging pen-pal letters (e.g., Crespo 2003; Lynch and Bolyard 2012), or providing written explanations (e.g., Goldsby and Cozza 2002; Parker and Breyfogle 2011). Another crucial goal of mathematics educators is to help students develop positive dispositions and beliefs toward mathematics (Kilpatrick, Swafford, and Findell 2001). Students often believe that there are two kinds of people in math class: Those who are "math people" and those who are not. It is difficult but important for mathematics teachers to help students see themselves as capable mathematics learners, that is, to help each student develop a positive

Zines' history as a way for people who feel marginalized to push the boundaries of what is acceptable makes this genre appropriate for engaging students in discovering what it means to be "smart" in mathematics.

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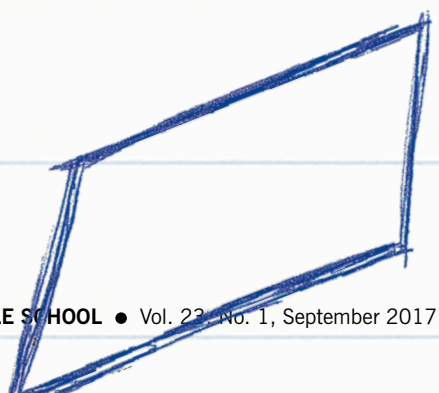
mathematics identity. A student's mathematics identity is a powerful influence on his or her engagement and participation in mathematics (Bishop 2012). Students act in ways that are consistent with how they see themselves as capable (or incapable) in mathematics—in other words, they *perform* mathematics identities. When students see themselves as capable and engage productively in challenging mathematics, they are illustrating *powerful mathematics identities*.

One way that teachers help students develop powerful mathematics identities is to help students understand the abilities beyond computation that they can leverage to solve problems. This raises the chance that students will have an opportunity to experience success and to see themselves (and be seen by others) as capable in mathematics, thereby influencing them to engage and participate in mathematical problem solving (Featherstone et al. 2011). However, this is not easily accomplished. We engaged students in the creation and exchange of zines to develop students' reflection on their mathematics experiences, abilities, and ideas about what it means to do mathematics.

WHAT IS A ZINE?

An abbreviation of fanzine or magazine, a *zine* is a hand-made, small-circulation, self-published work. Zines come in a variety of formats, such as hand-written text, typed text, drawings, or collages. They also come in a variety of genres, including comics, poetry, artwork, recipes, opinion pieces, or accounts of personal experience. Because of these features, zines have a long history of use as a critique of social conditions and a vehicle for prompting change. The first zine may have been Thomas Paine's *Common Sense*, which influenced the American Revolution (Duncombe 2008). We argue that because zines have this long history of use as acts of resistance and revolution, zines provide a way for critiquing narrow understandings of what it means to be "math people" and changing classroom culture and the way mathematics is viewed. Creators of zines, or *zinesters*, make their work available in a variety of ways, including selling them online, at "zine fests," or giving them away.

Zines have a number of benefits for writing in math classrooms. Because mathematics classrooms have traditionally focused on the abilities of computational speed and accuracy, students without those abilities may feel marginalized, even though they have abilities they can leverage for problem solving. Zines' history as a way for people who feel marginalized to push the boundaries of what is acceptable makes this genre appropriate for engaging students in discovering what it means to be "smart" in mathematics. Zines are an unmediated form of communication in that they do not undergo review by a publisher (or in this case, the teacher). Therefore, they may provide a more organic look into how students are thinking about mathematics and themselves, without the barrier to participation that academic genres of writing may impose. Because any genre can be in a zine—from written essays to free-hand art—there is much potential for students to imagine, create, and engage on a personal level using talents that may not be recognized in other classroom activities. Therefore, zine making allows students to present a diverse range of positive mathematics identities, with the power to motivate their continued mathematics engagement.



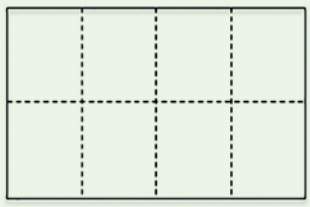
COLLABORATING ON COMMUNITY-BASED MATH PROBLEMS

We used the zine activity in a multiage math camp, taking place on four consecutive mornings during the last week of the students' summer vacation. Students ages 8–14 attended each three-hour session and were taught by Joy A. Oslund, with assistance from a preservice teacher. The camp met in a community building in an urban neighborhood. Neighborhood students were recruited through signs, flyers, and word-of-mouth and were able to attend free of charge.

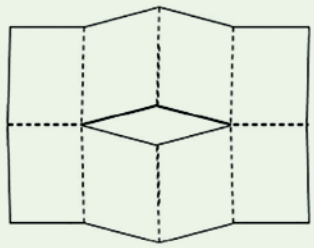
The camp began with group-work tasks that engaged students in learning to collaborate productively to solve problems. For example, we assigned norms and roles for group work and used "skill builders" designed to promote collaboration (Cohen 1994; Featherstone et al. 2011). Then we engaged students in collaboratively studying mathematics problems situated in the context of students' interests and community. Students used logic and spatial reasoning to design square-foot gardens (a type of garden designed to grow a maximum amount of food in small spaces, which are often used in the urban neighborhood where the math camp took place) (Sandborn 2012). They also used recorded measurement data by studying the projectile distances of foam darts from various toy blasters.

During every activity, we foregrounded with the question, "How are you smart in math?" as students reflected on the abilities they used to contribute to each problem-solving situation. At least once per day, we asked all students to write one way that they were "smart in math." We then posted these comments on our "smartness wall" to encourage the building of powerful math identities

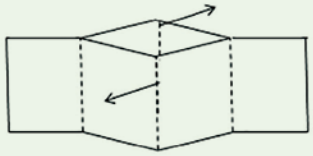
Fig. 1 Students are shown how to make a zine from one piece of paper.



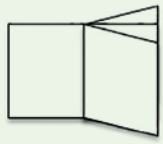
1. Fold any size paper into eighths.



2. Cut along the horizontal center fold line so that the paper appears as shown. (This is most easily accomplished by folding the paper along the center vertical fold, cutting the horizontal fold to the next vertical fold.)



3. Fold paper in half along the horizontal line. Open the cut sections so as to push the vertical center folds away from each other and to push the far right and far left sections together.



4. Pinch or rub the folds to make them sharp and to allow the booklet to lie flat.

(Featherstone et al. 2011). At the beginning of the camp, students generally posted computational skills ("I can multiply") and memorization skills ("I know my addition facts" and "PEMDAS," referring to the order of operations for computation: Parentheses, Exponents, Multiplication and Division, Addition and Subtraction). However, as students engaged in tasks that required them to collect data, create representations, and analyze situations, they added other abilities to their lists: "visualizing," "drawing 3D objects," and "making conjectures." In addition, students were asked to think about the mathematical abilities they use in their favorite out-of-school activities and to add these to the wall.

As they collaboratively solved problems, students sometimes disagreed. One group's difficult argument resulted in hurt feelings. To respond, we asked students to reflect about dis-

agreement and arguing. We showed a short video clip in which arguing was framed as "struggling together" toward a solution (Maio and Rosen 2014). Together, students in the camp then brainstormed ways to deal with conflict. Some of these ideas were added to the smartness wall: "dividing tasks [among group members]," "deciding between two solutions," and "struggling together."

Because of the changing nature of the abilities that students were adding to the wall, as well as group conversations, we believe that the math

camp activities and discussions allowed students to broaden their ideas about what it means to be smart in math. These developing ideas about mathematical competence were the context for the zines activity.

PRODUCING MATH ZINES

The zines activity occurred on the last day of math camp for about ninety minutes. Joshua Barton began by introducing students to the genres of zines by providing examples for students to read and by pointing out genre features. (Visit http://www.quimbys.com or other online sources for zines or see http://www.stolensharpierevolution.org to find local zine fests. Teachers should use judgment to select classroom-appropriate zines.) We then engaged students in brainstorming topics by asking them to remember and list various activities, conversations, abilities, and moments during math camp that were important to them. After posting a list of possible topics, we demonstrated one way to construct the physical pages of the zine by folding and cutting one piece of paper (see **fig. 1**). We also pointed out the various sizes, bindings, and other physical features of the sample zines (e.g., zines constructed by folding several sheets of paper in half and stapling, sewing, or tying along the center fold; zines created by fastening full or quarter sheets of paper).

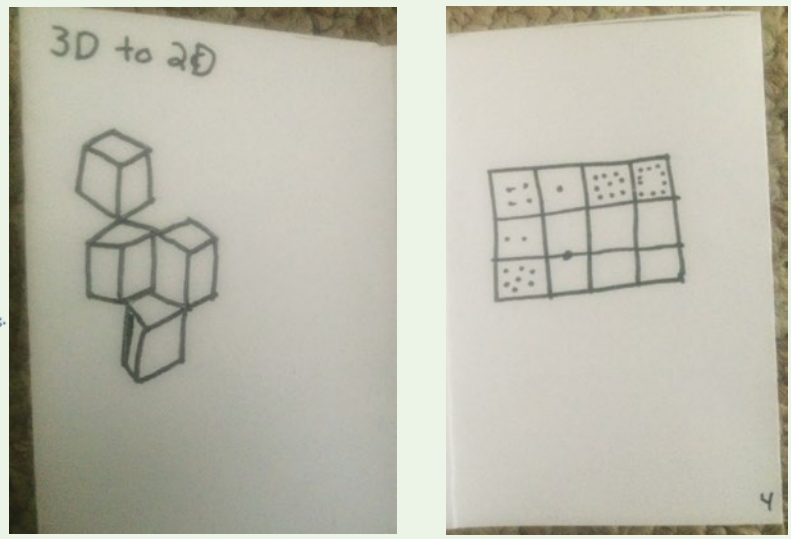
From then on, we allowed students to work on zines individually or collaboratively. Students were allowed to share their zines or keep them private. (An important consideration when using zines in the classroom is that their personal nature affords the possibility to anonymously write comments that are not acceptable in other places.) Most (but not all) students chose to share their zines by reading them aloud and by distributing photocopies to camp participants and their families.

STUDENTS' ZINES

The zines demonstrated students' engagement in the focal idea of the math camp: what it means to be smart in math. The zines varied in genre from stories and expository writing to lists and pen-and-ink drawings. Some included both graphics and text; others included one or the other. All students chose to use marker or pencil on paper, but with more time and materials they may have chosen to use a collage or a multimedia format. Although the camp included students ages 8–14 and students of all ages successfully created zines, we focus here on examples created by middle-grades students because they were able to produce finished zines within our limited time frame. Our examples demonstrate some of the different types of reflective thinking that students demonstrated in their zines. These examples were chosen to illustrate three ways in which making zines allowed students to engage in demonstrating positive and powerful mathematics identities. This project allowed students to—

1. use their strengths to communicate about mathematical experiences (and avoid areas of perceived weakness or discomfort);
2. perform identities as people who have something to teach others about mathematics; and
3. legitimize mathematical abilities that are not always recognized in math class.

Fig. 2 These excerpts from a zine called *Math Smartness* were created by a fourteen-year-old to reflect on math activities.



USING STRENGTHS AND AVOIDING PERCEIVED WEAKNESSES

One strength of using zines is that there is no requirement to stick to the conventions of any genre. In other words, anything goes in zine making. This barrier-free entry to the activity is beneficial for students who perceive themselves to be less capable in the conventional academic tasks of essay writing or representing calculations symbolically. It is also beneficial for students who have been very successful at academic tasks because it can push them to think of

Fig. 3 A thirteen-year-old girl added an interactive feature to her zine, asking readers to answer the question, "How are you smart in math?"

new ways to represent their experiences, prompting them to realize that although they may identify as "math people," they still have things to learn.

In the zine that is excerpted in **figure 2**, a student reflected by drawing simple illustrations of math camp activities. Each page featured a different task done during the camp. The first page represents a skill builder that required students to engage in deductive reasoning to build figures with cubes and draw them on paper (Erickson 1989). The second page represents a task involving the design of square gardens; each dot represents the position of a plant in the garden.

Fig. 4 This student's reflection described a skill required to successfully complete group work and problem-solving tasks: persistence.

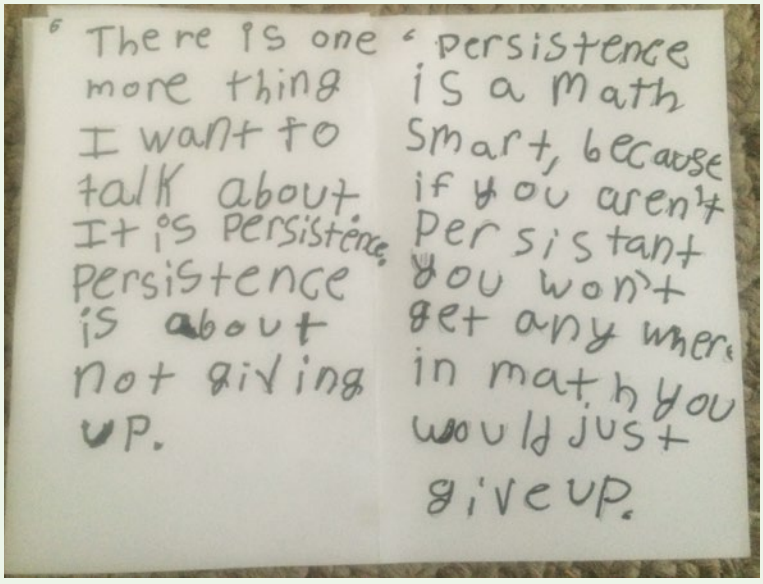


Fig. 5 Good arguing was the focus of this reflections.

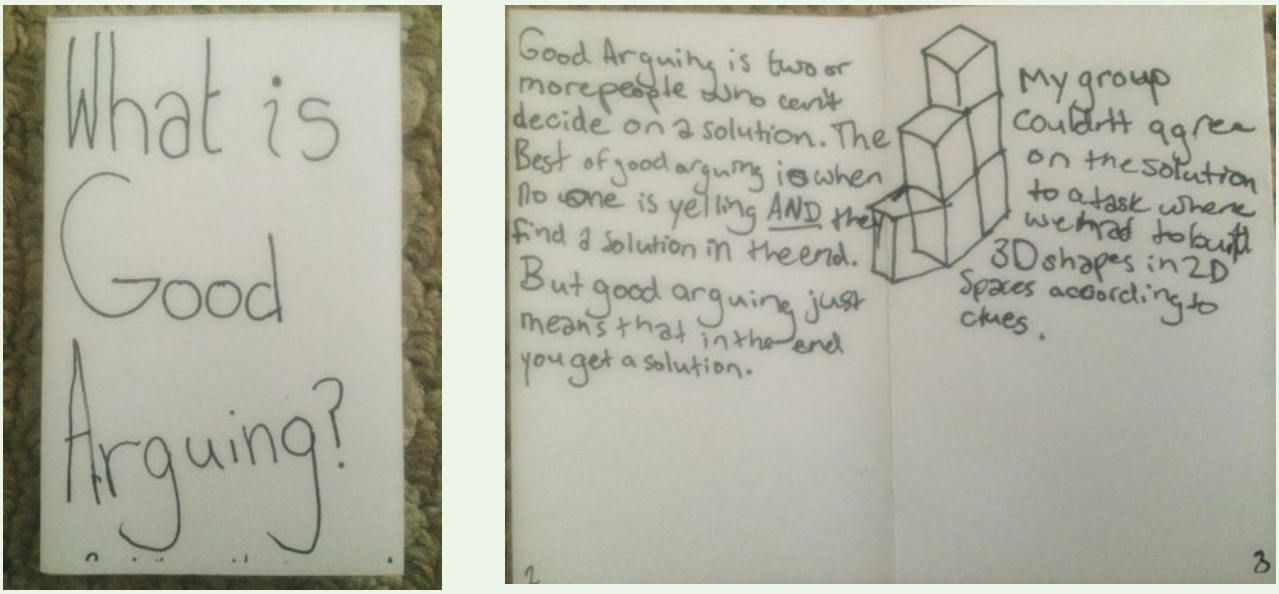
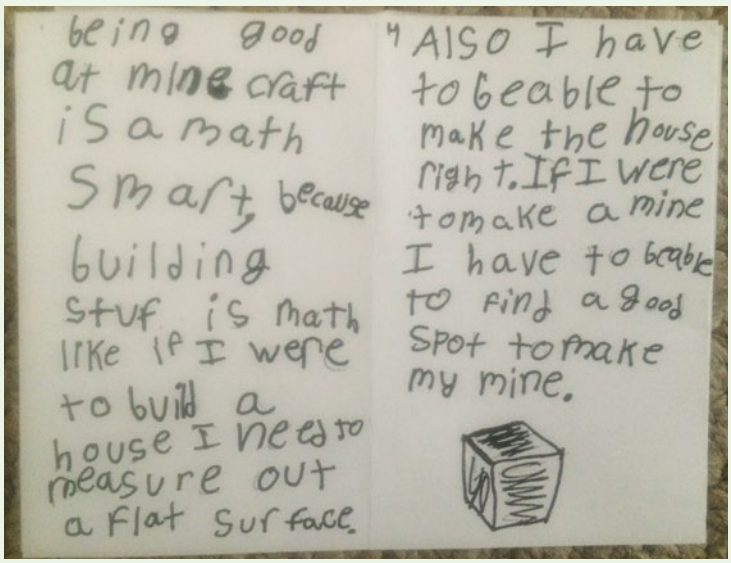


Fig. 6 Math is used outside of school, according to this eleven-year-old who described work with the Minecraft video game.



Obviously, this zine does not conform to the usual ways that students are asked to summarize or explain their mathematical work; very few words and numbers are used. However, even without those conventions, the zine showed us which activities the student found meaningful and how she viewed what it means to be smart in math. Not only that, students demonstrated ideas about mathematical representations that had surfaced during discussions, including the use of white space and contrast.

The zine in **figure 3** lacks the conventional prose often used to demonstrate students' mathematical ideas. In this case, the student lists mathematical abilities. Being free from the conventions of essay writing prompted this student to fill the pages of the zine with various mathematical abilities.

SOMETHING TO TEACH OTHERS ABOUT MATH

In some math classes, students are expected to be consumers of the supplied textbook and its social and cultural ideas. Students are not often invited to be the producers of texts or contribute to changes in the classroom culture. The audience for students' writing in math class is limited to teachers and classmates. Therefore, students are generally producing work for an audience that is already familiar with the ideas in the writing. Because zines are written for broad audiences, zines provide students with opportunities to write for people who may not be familiar with the ideas being communicated. This prompts students to construct ways to teach others about their

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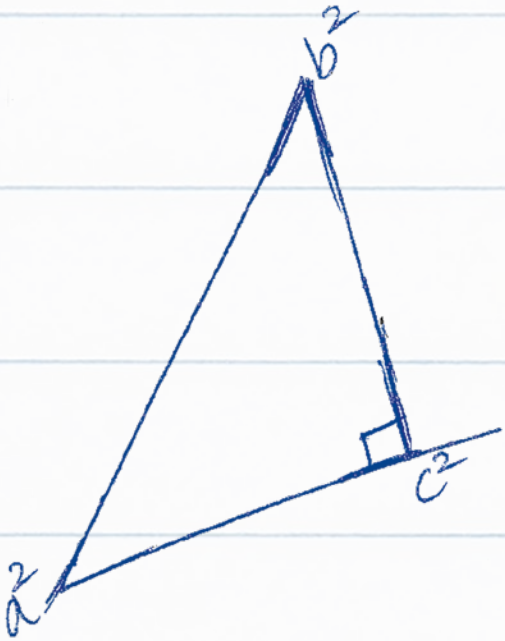
ideas. Distributing zines to families, or making them available at zine fairs or online, allows students an authentic audience for writing about their mathematical experiences.

In addition, some of the students' zines had interactive features, usually in the form of questions for the reader, sometimes with a space for the reader to draw or write a response, as shown in **figure 3**. The space for readers to respond demonstrates the creator's conception of math as a conversational topic, her identity as someone who can start mathematics conversations, and her view of her readers as people with mathematical abilities.

Math educators have come to appreciate the importance of understanding the mathematics that students use outside school to draw on students' informal mathematics abilities.

LEGITIMIZING MATH ABILITIES NOT ALWAYS RECOGNIZED

Because the nature of the problem-solving tasks required work that was collaborative, challenging, and messy, students needed to sustain their attention and cognitive work for significant periods of time. Students engaged in many different mathematical practices and processes, depending on their group's decisions. This is the opposite of the speed and accuracy that are sometimes the focus of mathematics instruction. The zines excerpted in **figures 4** and **5** show students' reflections on the abilities and skills required for success in these tasks. Although there are conventional genres for communicating about math ideas, fewer venues exist in which students write about the practices and dispositions that we have come to recognize as so important in math. The nature of the zine activity—asking students to reflect on any aspect of their experience—opened a space for students to communicate their ideas. As an assessment of the math camp instruction, these zines show that students experienced the tasks as being about more than just mathematical content.



In addition to providing students with opportunities to engage in problem solving in the classroom, math educators have come to appreciate the importance of understanding the mathematics that students use outside school to draw on students' informal mathematics abilities (Civil and Khan 2001; Simic-Muller, Turner, and Varley 2009). Students in the math camp spent time daily connecting their new conceptions of mathematics to out-of-school activities that they enjoyed and cared about. During the camp, students had completed a task that required them to construct a three-dimensional structure, draw it on paper, and discuss the abilities it required. **Figure 6** shows a zine in which a student connected her experience with that task to the video game Minecraft®. The zine shows a cube drawn in the way students had drawn cubes in the math task, along with sentences describing the game. Illuminating to students the way that they use math in their favorite activities will help them develop a sense of themselves as users of mathematics.

After the zines were completed, copies were produced so that students who chose to do so could share their zines with group mates, friends, and families. Additionally, the zines were archived in the university

library, and the link to the library record was forwarded to students.

REFLECTING ON MATH IDENTITIES

Zine making fosters mathematical reflection, allows collaborative problem solving, promotes productive dispositions, and illustrates mathematics identities. The activity—along with the collaborative, context-based, high-level problems—created a space for students to voice powerful conceptions of mathematics and themselves. The range of genres allowed students to demonstrate multiple ways of knowing mathematics and provided a barrier-free entry to the activity. Additionally, the project allowed students to connect with a long history of resistance and revolution and critique prevalent understandings of what it means to do mathematics and be smart at mathematics.

The project gave students the opportunities to demonstrate diverse mathematical abilities and be recognized as people who have mathematical knowledge to share with others. In other words, students exhibited powerful mathematics identities.

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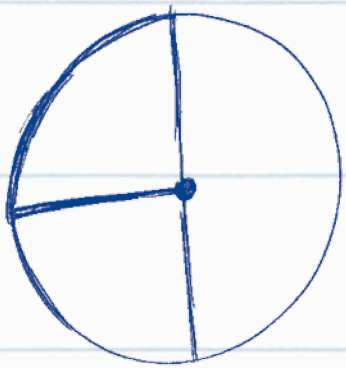

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