

## **Life in the Mindful Classroom: Nurturing the Disposition of Mindfulness**

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*In this article, we review the appropriateness of “mindfulness” as an educational goal and explore what it means to cultivate mindfulness as a disposition, that is, as an enduring trait, rather than a temporary state. We identify three high-leverage instructional practices for enculturating mindfulness: looking closely, exploring possibilities and perspectives, and introducing ambiguity. We conclude by exploring what it might look like to cultivate the trait of mindfulness within individual classrooms. This report includes a review of an experimental study of “conditional instruction,” which explores mindfulness as a state, and then draws on a series of qualitative case studies of “thoughtful” classrooms to provide an example of conditional instruction as it might serve to develop a disposition of mindfulness.*

Over the past 2 decades, a wealth of experimental research has accumulated to provide the foundation for the theory of mindfulness (Langer, 1989). Ellen Langer and her colleagues have been particularly inventive at designing studies that demonstrate the conditions under which mindfulness is more likely to flourish. For the most part, these studies have consisted of limited, short-term interventions in which individuals practice drawing distinctions, receive alternative

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forms of instruction, consider different perspectives, or engage in making more choices. These experiments have shown that often rather easily manipulable features of a situation can be altered to produce greater mindfulness. For example: After reading a text from different perspectives, individuals have greater recall of details (Lieberman & Langer, 1995); after being given choices in a nursing home, patients experience increased physical and mental engagement (Langer & Rodin, 1976); after exploring different possibilities for handicapped individuals, children are more open and less prejudiced (Langer, Bashner, & Chanowitz, 1985).

Although these studies show that an open and creative *state* of consciousness can be induced in the short term, they do not tell us as much about the development of mindfulness as a *trait*. What does it take to inculcate mindfulness for the long haul, to nurture what might be called a personal disposition toward mindfulness, if this is possible at all? And is it even a worthwhile goal of schooling? In this article, we direct our attention first to a theoretical exploration of these two questions. In doing so, we examine what mindfulness can contribute to education, propose a theory of dispositions to serve as a guide in developing mindfulness as a trait, and identify three high-leverage practices for enculturating mindfulness. Next, we report on our research into one of these high-leverage practices, introducing ambiguity, to explore what it might look like to cultivate the trait of mindfulness within individual classrooms. This report includes a review of an experimental study of what is called “conditional instruction,” which explores mindfulness as a state, and then draws on a series of qualitative case studies of “thoughtful” classrooms to provide an example of conditional instruction as it might serve to develop a disposition of mindfulness.

### **Is Mindfulness a Worthwhile Educational Goal?**

For generations, educational philosophers, policy makers, and practitioners have decried the mindlessness of schools and their tendency to stifle creativity, curiosity, and enthusiasm while nurturing passivity and superficial learning. In 1933, John Dewey criticized “schools where the chief aim is to establish mechanical habit and instill uniformity of conduct, [and] the conditions that stimulate wonder and keep it energetic and vital are necessarily ruled out” (p. 53). His contemporary Alfred North Whitehead warned that schools were too dominated by a slavish addiction to routine and the presentation of “inert ideas—ideas that are merely received into the mind without being utilized, or tested, or thrown into fresh combinations” (Whitehead, 1929, p. 1). A generation ago Charles Silberman (1970) wrote that “what is mostly wrong with schools and colleges [is] mindlessness” (p. 36).

Today, as in the past, schools and classrooms can be inhospitable places for mindfulness. In *The Unschooled Mind*, Howard Gardner (1991) recounted the failure of even “good” schools to go beyond the rote and superficial teaching of knowledge. In a classic example of how traditional didactic instruction can lead to mindlessness, Constance Kamii and Barbara Ann Lewis (1991) gave second graders the following problem: There are 26 sheep and 10 goats on a ship. How old is the captain? 88% of students from traditional classroom settings answered 36, and not a single student commented that the problem didn’t make sense, despite the fact that these were students scoring above the 85th percentile on average on standardized tests. In comparison, nearly a third of the students in the more mindful “constructivist” classroom questioned the sense of the problem.

With the current standards movement’s focus on what students “know and are able to do” in each discrete subject area and the growing interest in a “core knowledge” curriculum, there seems to be little room for an agenda that appears to take time and energy away from the acquisition of skills and knowledge. Although a persuasive argument can be made that employing principles of mindful instruction aids retention, this sells the power of mindfulness short. Mindfulness is a facilitative state that promotes increased creativity, flexibility, and use of information, as well as memory and retention. It is an enabling state in which individuals tend to feel more in control of their lives (Langer, 1989). Consequently, the real educational potential of mindfulness lies not in raising test scores but in addressing some of the other intractable problems of education such as the flexible transfer of skills and knowledge to new contexts, the development of deep understanding, student motivation and engagement, the ability to think critically and creatively, and the development of more self-directed learners.

To the extent that these aims of education are embraced, so is the goal of mindfulness. It is unlikely that one can succeed without the other. There can be no deep understanding without the exploration and testing of ideas from various perspectives. There can be no transfer without the constant refinement and reorganization of one’s conceptual categories. Critical and creative thinking depend on an openness to new ideas and the ability to break out of one’s mind-set. Intrinsic motivation for learning and the ability to be self-directed are both predicated on a sense of personal control and investment.

The research on mindfulness reveals many promising practices for addressing these broader agendas and improving education. However, it is not enough to simply overlay a series of discrete instructional practices on teachers’ existing repertoires. For mindfulness to be embraced by the educational establishment as a worthwhile goal, these practices must have a meaningful and long-term effect on students’ learning. This means that mindfulness must be more than a set of instructional techniques. It must take hold in classrooms in ways that permeate the lives of both students and teachers. Only by developing a disposition toward mindfulness can we alter substantially the educational landscape of students.

### The Nature of Mindfulness as a Disposition

What does it mean to cultivate mindfulness as a disposition? The notion of dispositions addresses the gap between one's abilities and one's actions, between a temporary facilitative state and a consistently enabling trait. Dewey (1933) recognized this gap when he said, "Knowledge of methods alone will not suffice: there must be the desire, the will, to employ them. This desire is an affair of personal disposition" (p. 30). Through our dispositions we engage our abilities and direct our mental resources. Dispositions are the mainspring that activates our behavior.

Elsewhere we have proposed a theory of dispositions that honors this motivational aspect and projective role of dispositions but also includes attention to sensitivities and even abilities (Perkins, Jay, & Tishman, 1993a, 1993b; Ritchhart, 1997; Tishman, Perkins, & Jay, 1993). Specifically, we define a disposition as a psychological element consisting of three components: sensitivity, inclination, and ability. Sensitivity is an awareness of and alertness to occasions for engaging in certain behavior. Inclination is the motivation or habit toward carrying out a particular behavior. Ability is the capability of carrying out that behavior. This conception broadens the definition of dispositions traditionally used by philosophers, which tends to take an inherent-properties conception of dispositions rooted in the physical world of objects, such as the "disposition" of glass toward brittleness, for example (see, for example, Ennis, 1987; Ryle, 1949; Siegel, 1997). Though it is arguable whether it is appropriate to refer to the attributes or properties of objects as dispositions, the physical world provides a poor metaphor for understanding the psychological aspects of dispositions, including the role of voluntary action, internal control, regulation, and acquisition. Our definition also goes beyond that used by some in personality and social psychology, which treats dispositions as a purely descriptive category used to characterize behavior (see, for example, Buss & Craik, 1983).

Why is it important to include ability and sensitivity in addition to inclination as components of thinking dispositions? Standard conceptions of dispositions often implicitly assume ability while focusing attention on the role of inclination in bridging the ability-action gap. First of all, we want to make the presence of ability explicit rather than implicit. Second, we suggest that this still leaves out an important component of behavior, sensitivity. Before activating an ability, you must first recognize the occasion as one appropriate for bringing that ability into play. For example, you must see reading this article as a good occasion to reflect, challenge ideas, or seek alternative explanations before marshaling those abilities. We argue that this sensitivity to occasions is distinct from general inclination and provides an important construct in explaining behavior. Indeed, our research on the assessment of dispositions suggests that sensitivity rather than inclination is often the principal bottleneck (Perkins & Tishman, 1997; Tishman, Perkins, Andrade, Ritchhart, & Donis, 1997).

It is easy to see how in day-to-day operation these three components work together. We must first notice an occasion, either intuitively or consciously, where we might engage in a certain behavior. Then, if we are so inclined, we get ready to carry out that behavior. Finally, we can proceed with that behavior to the extent that our ability permits. Thus, all three components are necessary for a behavior to be exhibited. When we say one person is more disposed to a behavior such as mindfulness than another, we do not necessarily mean that this individual has more ability, nor does it necessarily mean that one person is more motivated than the other. It may instead mean that the individual is recognizing more occasions for being mindful and is thus able to act on them.

Consequently, nurturing the dispositions of mindfulness in schools requires attention to the development of students' abilities, inclinations, and sensitivities with respect to mindfulness. This means developing certain abilities such as the ability to look at the world from more than one perspective. It means helping students to become aware of the value of mindfulness and the consequences of mindlessness. Finally, it means helping students to be alert to occasions for mindfulness as well as to occasions when one is likely to engage in mindless behavior.

### **Three High-Leverage Practices for Nurturing the Disposition of Mindfulness**

In this section, we examine three high-leverage practices that can be useful in developing students' sensitivity, inclination, and ability with regard to mindfulness: looking closely, exploring possibilities and perspectives, and introducing ambiguity. These practices are grounded both in Langer's key qualities of a mindful state—the creation of new categories, openness to new information, and an awareness of more than one perspective (Langer, 1989)—and in models of exemplary classroom practices that already have a rich presence in some school settings.

#### *Looking Closely*

Although we would all like to believe that we are open to new information, the fact is that we often screen out much of our environment, filling in the gaps with previously learned information. For efficiency's sake, we have trained ourselves to be insensitive to much of our environment. Although this lets us speed through certain routines and attend to other issues of our choosing, there is a cost. Seeing the world in new ways is one of the greatest avenues for creativity and personal engagement with the world (Csikszentmihalyi, 1996).

Cultivating an openness to new information is principally a matter of cultivating sensitivity rather than ability. This is exactly what John Stilgoe, a professor of landscape history at Harvard University, attempts to do in his courses. Although ostensibly they are classes about landscape, Stilgoe stresses that his classes are

really about exploring. He does not teach “a mass of facts and figures, but a technique that produces surprise and delight, that enlivens otherwise dull days, that frees them [students] from the ordinariness of so much learning” (Stilgoe, 1998, p. 4). Stilgoe encourages his students to go outside and examine the built environment as if it were a manuscript that has been continuously overwritten by human history to provide a living record of past generations. In this case, developing sensitivity means giving students both the time to explore and the assurance that something valuable exists to be found.

*The Private Eye* is a program developed by Kerry Ruef for getting school-aged children to look closely at the world (Ruef, 1992). Through the use of simple magnifying glass called a jewelers’ loupe, students explore everyday objects and engage in answering the question: What *else* does this remind you of? While the program stresses “loupe looking” as a way of creating analogies and new insights into the world, it also develops students’ sensitivity to occasions for openness. The loupe reveals to both children and adults that the everyday world is a fascinating place full of wonders to explore. Once again we see that this sensitivity is built by providing time for exploration. Both Ruef and Stilgoe help open the world up to their students by encouraging them to look closely. These experiences breed an increased sensitivity to the openness that mindfulness requires. At the same time, the rewards offered by such experiences help build an inclination to engage in more of the same.

### *Exploring Possibilities and Perspectives*

Exploring the world may be rather natural to children, but this is certainly not the case for perspective taking. Adopting another’s perspective and considering different perspectives is an ability that must be explicitly nurtured. The egocentrism of young children, and some grown ones for that matter, often makes this a challenging undertaking. How can this ability be cultivated in schools?

Natural opportunities for exploring perspectives exist in the study of literature and history. Susan McCray, a middle school humanities teacher, begins the school year by asking her students to look around the room and take in the view from their seats. Then, she asks them to stand on their chairs and notice how the view has changed. From this simple starting point, the class begins to discuss how age, gender, temperament, feelings, and ultimately culture affect how people view the world. These activities lay the groundwork for students reading *A Light in the Forest*, in which Native American and European cultures collide in an unusual way. In order to understand the actions of the characters in the book, students must consider the perspectives of each of the characters.

A project called Art Works for Schools treats experiencing works of visual art and drama as an occasion to develop powerful patterns of thinking, including perspective taking. Harvard researchers Tina Grotzer and Shari Tishman, working in

collaboration with the De Cordova Museum of Lincoln, Massachusetts, and the Underground Railway Theater, a performance company based in Arlington, Massachusetts, introduce teachers to innovative ways of helping children interact with works of art (Tishman & Grotzer, 1998). For instance, teachers encourage elementary school children to examine paintings and imagine what it would be like to be inside the painting, as a participant, versus outside as a viewer. The idea of physical versus attitudinal perspective is introduced, physical as a matter of where you stand and attitudinal as a matter of your attitudes. Then teachers seek occasions to stimulate application of these same ideas to other disciplines. For example, what different perspectives can be taken on a historical event? How might perspectives today differ systematically from those of various groups or individuals living at the time? What new or neglected possibilities does that suggest?

### *Introducing Ambiguity*

Ambiguous situations naturally make us more mindful than familiar situations because they demand much more processing. However, ambiguous situations do not necessarily serve learning or nurture a general disposition toward mindfulness. For example, when teachers are unclear about course objectives or fail to explicate criteria for their assignments, an ambiguous situation is created. To be sure, this tends to cause students to “mindfully” deal with this situation: What does this instructor want? What am I supposed to be learning? How will I know if I’ve done it right? However, such puzzlement takes energy away from engagement with the subject matter, isolates the learner from the instructor, and increases students’ anxiety. Few students are apt to persist for long in such a situation, and, if such ambiguity is the norm, students are likely to become either hostile or apathetic.

So how can the introduction of ambiguity serve learning? A study by Langer and Piper (1987) introduced the idea of “conditional,” as opposed to absolute, instruction. In this form of instruction, participants encounter information in an open rather than absolute format, for example, by saying that this “could be” a dog’s chew toy or this “may be” the cause of the evolution of city neighborhoods. In these studies, participants demonstrated equal retention of information but more flexibility and creativity in using that information to solve problems (Langer, Hatem, Joss, & Howell, 1989; Langer & Piper, 1987). When ambiguity is introduced in this way, the learner is prompted to shift from a passive to an active role. The student becomes engaged not in memorizing information but in making sense of the situation. As the student takes charge to fill in the gaps, the student’s authority and autonomy as a learner are strengthened. In the process of making sense, alternatives get explored because the learner isn’t just striving for a correct answer but rather building a series of connections and abstractions that will facilitate later transfer to new situations (Salomon & Perkins, 1989). When learners take a single correct answer as the goal, they are likely to narrow quickly

their examination of possibilities, resulting in less flexible use of their knowledge (Langer & Piper, 1987).

It would be easy to see conditional instruction as nothing more than a cosmetic change in wording, a substitution of “could be” for “is,” that somehow achieves magnificent results. However, looking behind the surface features of the instruction, it is important to examine what actually takes place in conditional instruction to encourage mindfulness. In all of the experiments on conditional instruction, foundational characteristics of instruction are evident: the open presentation of information and the active engagement of the learner in making decisions and coming to conclusions within what is perceived as a somewhat ambiguous situation. These foundational elements also can be seen in a series of experiments on transfer conducted by Gick and Holyoak. The authors found that when participants were helped in forming *their own* abstractions in one learning situation, their transfer of principles to a new situation was greater than when participants were provided with ready-made abstractions (Gick & Holyoak, 1987). The hallmark of this kind of transfer is the active role the learner must assume. In these experiments, the learners were engaged in making mindful abstractions, coping with a somewhat ambiguous situation by decontextualizing principles and generating new possibilities. In contrast, when the situation does not appear to be at least somewhat ambiguous or problematic, the learner may not be inclined to engage in this level of processing and may rely on direct memorization of the material. Thus, the introduction of ambiguity helps to cultivate both sensitivity and inclination.

The cumulative effect of such open and active instruction is to make students more aware of or sensitive to the ambiguous or conditional nature of the world—that knowledge and understanding are always in flux. In addition, such instruction draws on our natural inclination to fill in the gaps and make sense of the world. Honoring this natural inclination in the classroom by creating situations that are both engaging and ambiguous helps students develop a sense of their own agency as learners. In the next section, we report on an experiment applying the principles of conditional instruction to mathematics. Following this, we examine a case study of a middle school math teacher whose instruction embodies the three high-leverage principles of mindful instruction we have discussed.

### **An Experiment in Conditional Instruction**

To investigate the effects of conditional instruction in learning mathematical procedures, a mathematical “operation” called “pairwise” was invented. The pairwise *concept* was introduced to all participants through the following written instruction:

When you *Pairwise* a number, you figure out how many pairs can be made from that number of objects and how many singles are left remaining. For example, to pairwise the number 6, you would ask yourself how many pairs can be made from 6 objects? The answer would



be 3. You then ask yourself how many singles are remaining? The answer would be 0. You would write your answer to *Pairwise 6* as  $3/0$ .  $P/S 6 = 3/0$ .

As an invented operation, pairwise represented new content for all participants, making it possible to assess the effects of different forms of instruction rather than participants' prior knowledge or understanding of mathematics. At the same time, the underlying mathematics is simple enough so that people can create their own understanding and not be completely dependent on instruction in order to understand or use the procedure; one might even say the pairwise concept and operation are "easy" to grasp and apply. The experiment was designed to test how conditional and absolute instruction would affect participants' understanding, skill, and use of the operation. The hypothesis was that absolute instruction would interfere with participants' natural sense making and lead to greater mindlessness, whereas participants receiving conditional instruction would demonstrate greater mindfulness, as evidenced by facility and flexibility with the procedure.

The instruction focused on learning a procedural algorithm for applying the pairwise procedure to two 2-digit numbers. This mirrors traditional mathematics instruction, in which conceptual understanding of an operation is often followed by instruction in procedures for carrying out that operation on larger quantities. Four instructional conditions were devised: absolute instruction, no instruction, and two different forms of conditional instruction. Having two types of conditional instructional allowed us to explore the most effective aspects of conditional instruction in mathematics.

Although an invented operation may not capture the contextual nature of "real" mathematics, the many ways the pairwise operation and instructional sequence are used is representative of much of traditional mathematics and mathematics instruction. In mathematics instruction, learners frequently encounter "invented" procedures in the form of formulas or functions that they must seek to understand and master. Like these procedures, the pairwise operation builds on previously learned mathematics and can be contextualized, allowing participants to draw on their prior mathematical knowledge in learning or devising a pairwise algorithm.

## Method

### *Participants and Procedure*

Fifty-three female undergraduates from a small private college in the Northeast participated in the experiment as part of their mathematics classes. Three classes, taught by the same instructor, were used. Two thirds of the participants were enrolled in a basic math course focusing on numeration, graphing, and logic. The remaining students were enrolled in a general geometry course. The content of both courses was comparable to prealgebra and sought to provide a basic level of mathematical proficiency for math-phobic students majoring in the social sciences.

Participants were told they were participating in a study of the effects of different types of instruction in mathematics. In each class, participants were randomly assigned to one of four conditions: no instruction ( $n = 14$ ), absolute instruction ( $n = 13$ ), one-example conditional instruction ( $n = 13$ ), and two-example conditional instruction ( $n = 13$ ). All instruction was provided in written form, and the instructional packets were collected prior to giving participants four problems to solve.

*No-instruction and absolute-instruction conditions.* All participants received the same introduction to the pairwise concept (stated above). Participants in the no-instruction condition received no further instruction. In the absolute-instruction condition, participants were provided with a four-step procedure and accompanying example for applying the pairwise operation to two 2-digit numbers. The algorithm involved (1) arranging the two numbers vertically, (2) multiplying the sum of the tens column by 5 to determine “the number of pairs so far,” (3) adding the ones column and “figuring out” the number of pairs and singles in this sum, and (4) adding the pairs and singles from steps 2 and 3. This algorithm was introduced in absolute terms with the statement: “Mathematicians have invented *a method* to allow them to quickly find the answer to these pairwise problems. This method contains four steps.”

*Conditional-instruction conditions.* In the one-example conditional group, participants were provided with the exact same four-step algorithm and example as in the absolute condition but with a conditional introduction: “Mathematicians have invented *several ways* to quickly find the answer to these pairwise problems. *One possible method* contains four steps.” In the two-example conditional group, participants were provided with the four-step algorithm, introduced with conditional language, as well as a second five-step procedure. (The presentation of more than one model is conditional instruction because it breaks the set of a single correct method, solution, or answer.)

### *Measures*

*Accuracy, procedural workability, understanding, and creative use of instruction.* Following instruction, participants were given four problems to solve. The first two were 2-digit pairwise problems similar to the instructional example. Participants were asked to solve the problems, describe their solution method, and provide an explanation for why their method works. Participants’ solutions were evaluated for accuracy, their procedures were judged on workability, and understanding of the method employed was evaluated. The third problem was designed to measure the creative use of instruction. In this problem, participants were asked to solve another 2-digit pairwise problem using a method of their own that was different from any they had been shown.

*Mindless misapplication.* Participants' potential for the mindless misapplication of the pairwise procedure was assessed in the fourth problem. This problem involved a description of an optometrist who sold single and pairs of contact lenses and information on two shipments of contact lenses. This problem looked like it might have involved application of the pairwise procedure, but the actual question only asked how many contact lenses were available. Participants' solutions were evaluated for accuracy.

### *Analysis*

Initial descriptive analysis led us to question whether the instruction received by our one-example group actually represented a form of conditional instruction. Although previous research had shown the effectiveness of written conditional language (Langer et al., 1989), we speculated that in mathematics learners may have a tendency to absolutize instruction. A follow-up study was designed to test this hypothesis. Ten students, enrolled in another of the same instructor's sections, were asked to read and then paraphrase the one-example conditional-instruction information. Only 2 of the 10 used conditional language—"there are a *number of ways*" and "mathematicians have invented *methods*." The remaining students stated they did not read the introductory statement or that it introduced a single method, procedure, or formula. Therefore, the one-example conditional group received essentially the same instruction as the absolute group. In our subsequent analysis, we combined the one-example and absolute groups into a single absolute-instruction group to obtain more statistical power.

## **Results**

Given the small sample size, a normal distribution of scores could not be assumed. Therefore, a nonparametric test, the Wilcoxon Rank Sum test, was chosen to compare group means. All  $p$  values reported are for one-tailed tests. Only  $z$  scores that approach at least the .10 level of statistical significance are reported.

### *Accuracy*

The first two pairwise problems were scored together. *Accurate* solutions (= 2) provided the correct number of pairs and singles for both problems. *Partially accurate* solutions (= 1) either solved only one of the two problems correctly or provided the number of pairs and singles for each number as opposed to a single, combined total (i.e., P/S 18 and 12 = 9/0 and 6/0 rather than 15/0). Inaccurate solutions to both problems were scored as 0.

The conditional-instruction group demonstrated greater accuracy than either the absolute ( $M_{\text{con}} = 1.53$ ,  $M_{\text{abs}} = .96$ ;  $z = 1.72$ ,  $p < .05$ ) or the no-instruction group

( $M_{\text{con}} = 1.53, M_{\text{no}} = .64; z = 2.57, p < .01$ ). One hypothesis for this finding is that the second procedure provided to the conditional group was easier to understand and use, providing them with an advantage. However, analysis of the methods used revealed that only 2 out of 13 participants used the second method.

### *Procedural Workability*

Participants' solution methods were evaluated as either *workable* (= 1) or *unworkable/limited workability* (= 0). Workable methods were those that had the potential for yielding a correct solution. Methods of limited workability worked in this particular instance but lacked generalizability. For example, in the problem P/S 25 and 36, some participants said to add the tens column and square it. Unworkable solutions were those that could not possibly yield a correct answer. For example, for P/S 18 and 12 a participant wrote, "Take 18 and divide it by 12, [then] put it [6] over 12." Only 65% (17/26) of the absolute group produced workable solutions compared to 85% (11/13) of the conditional group ( $M_{\text{con}} = .85, M_{\text{abs}} = .65; t = 1.40, p < .10$ ) and 86% (12/14) of the no-instruction group ( $M_{\text{no}} = .86, M_{\text{abs}} = .65; t = 1.50, p < .10$ ).<sup>1</sup>

### *Understanding*

Participants' explanations of the method they employed to solve the pairwise problems was assessed to determine their level of understanding. Explanations were rated as *acceptable* (= 2), *weak* (= 1), or *no understanding* (= 0). Acceptable explanations provided a mathematical rationale for some aspect of a workable procedure. For example, "this works because dividing a number by two will 'pair' any number." Weak explanations often reiterated the method in new language without actually justifying it. Explanations for procedures that were unworkable or stated that "I followed the steps" were rated as no understanding.

The no-instruction group showed understanding superior to both the conditional group ( $M_{\text{no}} = 1.29, M_{\text{con}} = .31; z = -2.67, p < .01$ ) and the absolute group ( $M_{\text{no}} = 1.29, M_{\text{abs}} = .19; z = 3.81, p < .0001$ ). Since the no-instruction group members had to invent their own procedure, they were unlikely to invent something that they didn't understand or could not explain. Thus, it makes sense for this group to demonstrate a higher level of understanding.

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<sup>1</sup> An arcsine transformation was performed on these data to permit the use of a more powerful *t* test.

### *Creative Use of Instruction*

The ability of participants to go beyond the instruction given to creatively produce a novel and workable procedure for solving pairwise problems was assessed in the third problem. Participants' solutions methods were coded as either *novel and workable* (= 1) or *the same and/or unworkable* (= 0). 82% (9/11) of the conditional group and 64% (9/14) of the no-instruction group produced novel solutions compared to only 46% (11/24) of the absolute group ( $M_{\text{con}} = .82$ ,  $M_{\text{abs}} = .46$ ;  $z = 1.95$ ,  $p < .05$ ). Even though showing the conditional group a second example eliminated one possible response from their potential repertoire of responses, the instruction appears to have had the effect of increasing flexibility and creative thinking.

### *Mindless Misapplication*

The tendency to misapply the pairwise procedure based on surface features of a situation was assessed in the fourth problem. Participants' solutions were judged as either providing a *correct* answer (= 1) or providing only an *incorrect* answer (= 0). Many of the participants provided both the requested solution and a pairwise answer. These were judged as being correct solutions. 73% (16/22) of the absolute group mindlessly misapplied the pairwise procedure compared to only 55% (6/11) of the conditional group ( $M_{\text{con}} = .45$ ,  $M_{\text{abs}} = .27$ ;  $t = 1.71$ ,  $p < .05$ )<sup>2</sup> and 38% (5/13) of the no-instruction group ( $M_{\text{no}} = .62$ ,  $M_{\text{abs}} = .27$ ;  $z = 1.95$ ,  $p < .05$ ).

## **Discussion**

The greater facility and creativity, and decreased mindlessness of the conditional- instruction group in this study supports previous findings about the power of conditional learning to promote mindfulness. Thus, conditional instruction may be useful in reframing traditional didactic, including textbook, instruction in mathematics. However, this research found that the use of conditional language alone was insufficient to produce effects in the mathematics learning of this population, leading us to conclude that individuals' past experiences in mathematics may lead them to absolutize their instruction. Therefore, to be effective, conditional instruction must be made more salient to the learner in mathematics in a way that prompts the learner to engage actively in making sense of the information at hand. In addition, the performance of the no-instruction group indicates that building on the learners' intuitive understanding and encouraging personal agency are also important attributes of mindful instruction.

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<sup>2</sup> An arcsine transformation was performed on these data to permit the use of a more powerful  $t$  test.

## A Case Study of Mindful Instruction

The foregoing experiment illustrates how variables with a potential impact on mindfulness can be isolated and manipulated to gauge their influence. It does less to convey the flavor of teaching that in multiple ways appears to foster the development of mindfulness. To that end, we offer a case study of a teacher who proceeds fully in the spirit of mindful instruction.

There is a distinct lack of formality as John Threlkeld prepares to begin the first algebra class of the school year. He quickly introduces himself for the benefit of those students who don't know him and then calls out students' names. As he says each name, he looks around the room to locate the student and then points to him or her. Many of the faces are familiar to him. Throughout this process, John appears a bit disorganized, says he is having trouble with names and faces, comments on not being able to find his overhead projector and in general breaks just about every rule the experts dictate for an effective start of the school year. Matter-of-factly, John presents a problem culled from the newspaper—a bit of a puzzle in which you move only one digit in the false equality  $62 - 63 = 1$  in order to make it true. Without much discussion, he says that the problem is “out there.” “There's something for you to ponder. Something interesting to think about,” he remarks. He encourages students to bring in other interesting problems for the class, noting that this one was given to him by a student. He tells the class that he likes problems such as these, that he is eccentric and an unabashed geek.

In just this brief exchange, John has set the tone. While he appears to be disorganized, prone to fits of coughing, and rather lax in attending to details, he also comes across as affable, good natured, trusting, and approachable. Perhaps more importantly, he gives the impression of being on top of the content, eager to pursue mathematics with students, and ready to push their thinking. John finds mathematics engaging and he becomes animated just talking about a problem. It is clear that he is in charge of the class and not a slave to the textbook (it is never even mentioned or asked about during the hour). John is self-effacing and well aware of his own eccentricities. Since his reputation as a mathematician is well known at the school, there is a sense that he doesn't need to prove himself, but his passion comes through loud and clear.

John tells the class that he would like to begin with a problem from *The Phantom Tollbooth*, a book many of the students remember reading in sixth grade. John flashes a page of the book on the overhead projector and reads it quickly. In the story the main character, Milo, explains how mathematics can make things disappear and, by way of example, presents the following problem:  $4 + 9 - 2 \times 16 + 1 \div 3 \times 6 - 67 + 8 \times 2 - 3 + 26 - 1 \div 34 + 3 \div 7 + 2 - 5 =$ . Upon seeing the problem, another character, described as always first to shout out a wrong answer, says the answer is 17. John asks if anyone in the class is like that. A few giggles and John adds, “Don't ever be afraid to give a wrong answer. Never be afraid to give a wrong answer that

you have thought about.” Returning to the problem, John asks the class, “What does this equal? Work in pairs to come up with an answer?” Under his breath he adds, “I suppose that I should figure this out myself” and heads to the board.

After a few minutes, John calls out, “I want to hear what you got.” A student says that she may be wrong. John says that he doesn’t care, he wants to hear it. “I really am quite serious. I want you to tell me what you get. Yeah, the bottom line is that one is right and one is wrong, at least in algebra, but I want you to try out your ideas and not be the least hesitant to say, ‘Here is what I got.’ And by the way, maybe we are all wrong.” He writes down her solution and then quickly gets other answers up on the board. There are soon as many answers as student pairs. Before delving into a discussion of the problem, John interjects, “I might as well add my answer to the list as well.” A few students moan and John adds, “Not that it’s right, but because I think it’s wrong.” In this gesture, John both joins the community of learners as a coparticipant and ratifies the task as an authentic problem, one in which the answer is not known and being kept hidden from the class. John comments that most of the answers are different, but hastens to add, “Math is not a democracy, and whatever gets the most votes doesn’t win. There has to be a proven answer.”

John leads the class in working through the arithmetic of the problem together and immediately there is a discussion of order of operations, a topic the class has already recognized as the key to the problem. John reviews the mnemonic device, PEMDAS, used for remembering order of operations, and recounts the first time he was introduced to this now familiar memory tool, thus placing himself once again as a learner. Before long the class has discovered many of their errors, and it seems clear that the answer is  $-48 + 95/238$ . But at this point, students are confused. “Okay, that’s what I want you to think about, what does *that* equal? The confusion is understandable and that is what we want to talk about.” There is a discussion about how to handle the problem and various positions are stated. Ultimately, the class agrees that adding  $95/238$  to  $-48$  will bring it back toward zero and thus the answer is  $-47$  and  $143/238$ .

The students use their calculators to check their answer, and soon a new problem emerges when a student points out that not all calculators do the problem the same way. Others have noticed that it makes a difference when and if you press the “enter” key as you are typing in the problem. “Details,” John interjects, “but details are important.”

John starts the class down this new path. “It is interesting to notice something. Someone programmed your calculator. We have at least a dozen different kinds of calculators in here, and almost all did the same thing. Did they have to do that? Did they have to?” The students quickly shake their heads in disagreement, and John continues, “Mathematicians have generally adopted this agreement among themselves, scientists too, about what is meant by order of operations. If not what would happen?”

“You’d get different answers.”

“Right, so there is a general agreement. In math it is pretty important that two people doing the same problem can arrive at the same answer, so we have order of operations. We talked about those rules. What were they?”

“PEMDAS: Parentheses, exponents, multiplication and division, and then addition and subtraction.”

John pauses and then turns to the class and asks quietly, “Who thought of those rules? Why all that instead of doing it Milo’s way, from left to right?” There is silence and then John begins again, “I don’t know the answer to that. I don’t know the answer to that and I haven’t been able to find out. But I have some places that I might look. I think that at some time in the evolution of math, Milo’s way was right. I have a hunch that it had something to do with computers. I have a place where we might look on the Internet, but the real question is: Could we do it another way? Could we do things in a different order?”

A student volunteers a tentative answer, “Well, it depends.”

“It depends on what?”

“If we could get everyone to agree.”

“Okay, it’s called a grassroots effort,” John adds as he expands on the student’s idea. “We would have to convince others that our way is better or we could treat ourselves as a closed society. The real point I suppose here is that that set of rules is an incredibly arbitrary thing? What does *arbitrary* mean?”

“No good reason for it.”

“That right,” John reiterates. “*Arbitrary* means that it doesn’t really matter as long as everybody agrees on it.”

From the side of the room a student offers his evaluation of the order of operations rule. “I think that parentheses have to come first because that is the only reason to have them. It just gets too confusing otherwise.”

John writes the student’s assertion on the board and adds to the class, “Think about what he is saying.”

The student continues with his argument, “Well, if you had another rule, like do multiplication first, and you had the problem . . . well, something like,  $2 + 4(6 + 4 \times 2)$ . If multiplication had to come first, you’d be confused because you’re supposed to multiply 4 times the quantity  $(6 + 4 \times 2)$  but you don’t know what that is?”

“Think about what he is saying. His declaration was, hypothetically, multiplication first, but unless you know what *this* is, what do you do? You’ve got two multiplications, but which one do you do first and how? You see the dilemma I hope. I’ve thought about this, and I don’t see any way around having parentheses first.”

Another student chimes in, “I think that parentheses only exist because we have order of operations, you wouldn’t need them otherwise, that’s the whole point.”

“Yeah,” a girl sitting in the back row adds, “they just group things for you. Like, sometimes you need to think of a group of numbers going together. If you



look back at the original problem, there weren't actually any parentheses but you could put them in to show how you grouped the operations in your head."

Still another student enters the debate, "Well, what about exponents? It seems like exponents could come first."

John tosses the student's comments back to the group, "Let's think about that. It's a good question." He then writes  $2 + 4(6 + 4 \times 2)^3$  and asks, "How would you do that?"

The student examines the problem and gathers her thoughts, "Oh, I guess you would still have to do the parentheses first or just not have them at all."

Another student enters the conversation by picking up on this comment expressing tentatively, "Well, this is only an idea but. . ."

"That's what this is about. It is all about ideas. Go on," John encourages.

"Well," the student continues, "you could say the same thing about why have any operation—like multiplication. Why have multiplication? It's all about what it allows us to do. Multiplication speeds things up so you don't have to add, so that's why we use it."

A student brings the conversation back around to the main point, "But the argument is why have order of operations at all, why not just go right to left and just forget about parentheses?"

"Just do it Milo's way you mean?" John clarifies and then begins to sum up the discussion, "Great stuff. You're all causing me to think about this more. I'll have to go home and see what I can come up with. That was good stuff. What I am going to ask you to do tonight is to go home and play with this some more. One of the things that you are going to play with is this kind of idea about order of operation. Instead of PEMDAS, why not PESMAD? What you are going to be doing tonight is experimenting with different configurations of order of operations to see what you come up with. This was a great class. I love these kinds of discussions."

## Discussion

What makes this a mindful classroom? John's class is a big departure from the way most of us learned algebra—as a set of rules to be practiced and memorized. Furthermore, his first day of class begins without the usual review of rules and procedures. Instead he jumps right in to the middle of a big disciplinary issue: Where does knowledge and truth come from in mathematics? In this way, John puts a human face on mathematics: Yes there are rules, but the rules have a history and an origin rooted in the lives of real people. How does he get students to this point? By *looking closely* at a long but fairly straightforward arithmetic problem presented in a children's book. This book does not deal with the source of knowledge and truth in mathematics, or even order of operations rules for that matter, but by looking closely one can find these issues lurking beneath the surface. This ability to uncover the curriculum is a hallmark of good teachers. They see below the

surface of the prescribed curriculum to the hidden and deeper issues buried below the surface and then lead their students on an expedition to mine these gems.

Presenting math in this way, as a constructed reality, is a most mindful place to start. Mindfulness rests on the assumption that through our thoughts and ideas we can create new realities (Langer, 1989). John gets his students playing with ideas and thinking about a familiar concept in a new way. Rather than memorizing procedures, John has his students explore a math problem through *perspectives*: from the perspective of a character in a book, from the perspective of different calculators, and then from their own perspective as diligent math students. Finally, he asks them to break free of that information and to continue to explore both this problem and arithmetic in general from a whole new perspective: How might things be different if . . . ?

How has John let in *ambiguity* to help his students to be more mindful? John begins this class by presenting students with a problem and a solution and then asking them how it might be different: Milo, the character in the book, says that the answer is zero; how might it be different? Once a solution is generated, he pushes yet again to ask how it might be different still. Soon students are at the point of recognizing that the rules they are assuming are arbitrary and that mathematicians frequently find themselves in ambiguous situations from which they must extract themselves: How do we decide what  $2 + 4(6 + 4 \times 2)^3$  is? Thus, an ambiguous problem space has been presented for the class to explore. What are the possibilities? What are the givens? What are the constraints we are working under? To what extent can we use logic to guide us and at what point will it fail? In exploring this ambiguous situation, we contend that John's students come away with a far better understanding of both order of operations and mathematics than their counterparts in more traditional didactic classrooms. Furthermore, we suspect that John has laid the foundation for students' mindful and creative use of these procedures.

How does this kind of classroom conduct foster sensitivity and inclination and therefore build mindfulness as a trait, not just a state? As an instructor, John serves as a model of mindful sensitivity and inclination for his students. He is constantly pointing out good places to head to explore mathematics in a mindful manner as well as highlighting the pitfalls of mindless thinking along the way. Likewise, he demonstrates an inclination toward mindfulness. He closes this particular class, and most of the others we have observed, by stating how he is going to have to rethink some issue or question. Thus, he is modeling his own openness to new information and the mindful creation of new categories.

In addition to modeling mindfulness, John also actively encourages it in his students. It doesn't take long for an observer to John's class to recognize that his most commonly spoken refrain to students is "Good question!" He is enthusiastic about ideas and delights in questions that push, probe, challenge, and extend the meaning of ideas. Throughout his instruction and interaction with students, John welcomes, scaffolds, and rewards the detection of interesting features and ideas

that might be explored, thus supporting students' own sensitivity. Through his enthusiasm for students' ideas and the subsequent follow-through in exploring them, John nurtures students' inclination toward mindfulness. In this classroom, John has succeeded in creating what we have called a "hot cognitive economy" in which the cost of high-level thinking, risk taking, and mindfulness are low and the rewards are high (Perkins, 1992). Over time, a disposition toward mindfulness begins to develop as students continuously find their sensitivity, inclination, and ability with regard to mindfulness supported and encouraged.

### Overall Summary and Implications

The research on mindfulness has resulted in the identification of various means of configuring the environment and constraining situations to make individuals more mindful (Langer, 1997). These manipulations help us to understand both how the mind works and the role of the environment in facilitating more mindful states. However, teaching and schooling are much more than the clever, effective, or even mindful presentation of material. In its best incarnation, schooling strives to cultivate the dispositions that lead to a lifetime of learning and enjoyment. Mindfulness is surely one of those dispositions.

In reaching for this goal, we must keep in mind that the trait of mindfulness, and not merely the conditions that promote it, is our ultimate goal. Toward this end, it is important that teachers develop in students both an awareness of situations where it is important to be mindful and a sensitivity to mindlessness traps. By necessity, this means that schools must focus more on developing understanding than imparting knowledge and skills through mere practice and repetition. Teachers must also guide their students in understanding the value of mindfulness and the costs of mindlessness so that they will have the inclination to be mindful. The mind has a tendency to fall back into the familiar and the routine, to stick within its well-worn grooves. Mindfulness means stepping outside of those grooves to explore new territory, and that can be difficult to do at times. We need to show students that the risk is worth it. Finally, there are certain abilities that must be nurtured, such as perspective taking.

As we have seen in our case study, the mindful classroom is a place where mindfulness is cultivated on many levels and over time. Through the introduction of ambiguity into the classroom, a form of "conditional instruction" can be applied that extends beyond the narrow presentation of material to the broader exploration of ideas and problems as well. Looking closely, at both ideas and objects, opens up the curriculum and the world for students. The ongoing examination of the disciplines—mathematics, history, art, science, and so on—from various perspectives encourages students to see the world as a place in which they are active agents in constructing meaning and building understanding. Practices such as these support the development of students' sensitivity, inclination, and ability and nurture the disposition of mindfulness.

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