

Mindfulness in Measurement: Reconsidering the Measurable in Mindfulness Practice

Sharon G. Solloway

Bloomsburg University

Bloomsburg, PA, USA

William P. Fisher, Jr.¹

Avatar International, Inc.

Sanford, FL, USA

Can an organic partnership of qualitative and quantitative data confirm the value of mindfulness practice as an assignment in undergraduate education? Working from qualitative evidence suggesting the existence of potentially measurable mindfulness effects expressed in ruler measures, a previous study calibrated a mathematically invariant scale of mindfulness practice effects with substantively and statistically significant differences in the measures before and after the assignment. Current efforts replicated these results. The quantitative model is described in measurement terms defined at an introductory level. Detailed figures and appendices are provided, and a program of future research is proposed.

The value of mindfulness practice as contributing to psychological strength has a long history of supporting anecdotal evidence. A rich legacy of such research exists in Buddhist literature as far back as the seventh century BCE. Buddhist practitioners today in both the East and West are actively engaged in broadening this legacy via a scientific research agenda. This agenda seeks to document the physiological effects of meditation and mindfulness practice using methods that meet the technical standards expected of precision measurement and experimental design. The activities of the Dalai Lama's Mind and Life Institute (<http://www.mindandlife.org>), among others, demonstrate the current vigor of this interest.

Mindfulness practice has been described as non-judgmental awareness of both internal and external experience, moment to moment, "...an open, undivided observation of what is occurring both internally and externally rather than a particular cognitive approach to external stimuli" (Brown & Ryan, 2000, p. 823). One of the psychological strengths of mindfulness is the capacity to maintain an emotional balance within any particular life moment, whatever that happens to be. Novice mindfulness practitioners (Solloway, 1999, 2000, 2001, 2004) were asked to describe their experience of mindfulness practice as a non-judgmental focus of attention in the

present moment. These journal entry responses link themselves to a number of important self-care issues: the quality of the inner-life suggested by Seligman and Csikszentmihalyi (2000), self-determination (Ryback, 2006), emotional balance (Goleman, 1995), stress-reduction, and empathy (Kabat-Zinn, 2005) to name a few. Solloway (the first author) teaches in higher education, and holds both a meditation practice and an orientation to mindfulness practice when not meditating. Her daily experience of witnessing the debilitating effects of emotional imbalances, stress, and prejudicial orientations to present moment experience in the lives of university students awakened her compassion. Offering assignments in mindfulness practice became her compassionate intervention. Developing documentation of the effects strengthened the argument for such assignments.

The use of mindful awareness as a method of immersion (Moustakas, 1990) for reading and responding to students' journal entries across several semesters gave Solloway insight into recurring themes associated with powerful individual transformations across the assignment's duration. The students were different each semester but the effects of mindfulness practice emerged through similar themes and ranges each time. The journal entries were anecdotal self-reports of those effects for each student and were in themselves powerful voices

for the value of this compassionate intervention. Growth was palpable...like noticing that the worn patch on your son's jeans no longer matches where his knee was a few months ago. You don't have to measure his height to know he has grown, but the availability of an instrument to provide that measure certainly brings valuable information to bear when selecting a pair of jeans with a better fit. The journal entries, like the jeans, showed evidence of individual growth, but the question arose as to whether it was possible to calibrate a ruler to provide more specific information about each individual's growth.

The most well-known mindfulness instruments are the Mindfulness Attention Awareness Scale (Brown & Ryan, 2003), the Kentucky Inventory of Mindfulness Skills (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; Baer, Smith, & Allen, 2004), and the Toronto Mindfulness Scale (Lau, Bishop, Segal, Buis, Anderson, Carlson, Shapiro, & Carmody, 2006). Solloway's (1999, 2000, 2001, 2004) roots as a qualitative researcher influenced her desire to develop a scale directly out of her students' journal entries rather than select a scale developed from other sources. Could the cumulative voices of her students be translated into a scale that would corroborate their journal entries retaining the individuality of experience just as the journal entries did? Fisher's (2000, 2003a, 2003b, 2004) experience with developing instruments from qualitative data takes advantage of Rasch models to give ruler measures of the qualitative construct without compromising the integrity of the individual measured, thus opening the door to collaboration toward an answer.

The Present Research

The first study (Solloway & Fisher, 2007) grew out of Solloway's seven-semester experience of coaching novice mindfulness practitioners (students in a pre-service undergraduate teacher education course) through an eight-week introduction to mindfulness practice. These students used the breath as an anchor for attention in the present moment all day one day a week for eight weeks. At the end of each day of practice, the student submitted an email journal entry describing the experience of mindfulness practice that day. Solloway, a vipassana practitioner since 1996, mindfully read each journal entry. Out of this deep listening, she responded to each journal entry within 24-hours of receiving it, providing encouragement that seemed appropriate to the individual entry. Across the seven semesters, obvious

patterns emerged regarding students' depths of engagement in the project (see Appendix A). The journal entries suggested a range of depth of engagement in the practice; consistent reports of specific categories of experience began to suggest patterns of "Beginning," "Intermediate," and "Advanced" engagement. These labels only refer to an accumulation of patterns among the self-reported experiences of these novice practitioners. But the accumulation of journal entries seemed to indicate that the participants in this project semester to semester "grew," some more than others.

Could an instrument be constructed that reflected the common themes in the journals and also created a ruler measuring growth across the themes? In other words, could these patterns be corroborated by a quantitative measure requiring experimental tests of the hypothesis that the variable of interest is in fact quantitative, that is, that the variable is divisible into the additive magnitudes necessary for meaningful numeric representations? This would require a model that pitted the difficulty of each item against the ability of the participant without any other influences. This is the same problem Rasch (1960) saw when he contemplated the problem of statistical methods most often used in psychometric methods that are group-centered rather than ones

in which each individual is characterized separately and from which, given adequate data, the individual parameters can be estimated. It is further essential that comparisons between individuals become independent of which particular instruments – tests or items or other stimuli – within the class considered have been used. Symmetrically, it ought to be possible to compare stimuli belonging to the same class – "measuring the same thing" – independent of which particular individuals within a class considered were instrumental for the comparison. This is a huge challenge, but once the problem has been formulated it does seem possible to meet it. (Rasch, 1960, p. xx)

Rasch models enable one to imagine a methodology that embraces both the contemplative and compassionate found in qualitative work describing the experiential without sacrificing the rigor of measurement required in experimental science. Yet Rasch models have their opponents as well. The following section will describe what happened when Solloway's mindfulness practice entered the Present Moment of Fisher's tutelage on the subject.

Fisher's Two-Year Mentorship of Solloway

Rasch measurement practitioners are sometimes accused of an over-zealous advocacy of their methods, as a kind of method idolatry. Sometimes, however, such accusations have less to say about the accused than they do about quick judgments foreclosing prematurely on the opportunity to see something new. Instead of dismissing what seems on the face of it to be an unreasonable position—strong advocacy of either (1) one method among many equivalent methods, or (2) mathematical invariance requirements that can seem unrealistically rigid to those unfamiliar with them—perhaps a more sympathetic attitude, or one more sensitive to the ambiguities of interpretation, as outlined by Kuhn (1977, pp. xi-xii), would lead to insights as to why and how reasonable people might take an apparently unreasonable position.

For instance, there are those who contend that Rasch models are fine to apply when they happen to fit data, but they often do not, and so other, more flexible models are then required (van der Linden & Hambleton, 1997). But generality in the measurement of a construct requires the identification of patterns of invariance that hold up across data sets (Rogosa, 1987; Michell, 1990, 2000). As Embretson (1996, p. 211) puts it,

It is sometimes maintained that the Rasch model is too restrictive and does not fit real test data sufficiently well. However, even if a more complex IRT model is required to fit the data, the total score scale would not provide a relatively better metric. In fact, if item discrimination parameters are required to obtain fit, total score is not even monotonically related to the IRT theta parameters. The IRT trait score, even for equal total scores, would depend on which items were answered correctly.

These kinds of confoundings can occur because multi-parameter IRT models are internally inconsistent, asserting unidimensionality even while allowing item characteristic curves to cross (Lumsden, 1978; Andrich, 1988; Wright, 1984).

Rasch (1960, pp. 37-8) was certainly aware of the problems of interactions, and wrote, “models are not meant to be true,” since no data ever fit a model exactly. Models are meant to be useful and meaningful, however, and abstract heuristic ideals, such as Plato’s redefinition of the elements of geometry, Galileo’s frictionless plane, or Carnot’s perfectly reversible heat engine, have

repeatedly proven themselves essential to science over the course of its history. The identification of anomalies is fundamental to allowing exceptions to prove (in the sense of testing) rules. It is said that nature reveals herself by her exceptions, but when mathematical models incorporate interaction terms and do not require invariantly separable parameters, as do many IRT and statistical models, these exceptions are hidden within summary statistics, where they are either ignored or very difficult to find. Rasch models, in contrast, have been associated from their inception with a variety of graphical and statistical methods for identifying and evaluating anomalies (Smith, 2000). For more information on this controversy, see Wright (1977a, 1984), Fisher (1994), or Andrich (1988, 2002, 2004).

Taking another tack on this issue, there are others who contend that methods such as Confirmatory Factor Analysis (CFA) can be as informative as a Rasch model in the identification of unidimensional constructs. Though this is true in limited applications (Reise, Widaman, Pugh, 1993), (1) CFA lacks a stochastic frame of reference, meaning that there are no error terms for the factor loadings; (2) secondary factors can be completely dependent on the particular error distribution that just happens to be present in one data set, but not in others; (3) CFA does not provide the desired additive unit of measurement, since the raw scores are usually assumed to provide it (and though a logistic regression of the scores on the loadings might come close), and (4) CFA does not provide any means of identifying or evaluating anomalous individual responses. These four shortcomings of CFA as a measurement model mean that multimodal data will produce multifactorial results, even if the data analyzed are a subset of a larger data matrix previously shown by CFA to be a single unidimensional factor (Smith, 1996; Wright, 1988, 1991).

Finally, raw scores from tests and surveys are typically interpreted as though they are meaningful representations of quantitative amounts, when they demonstrably are not. Scores summed from two sets of items drawn from different agreeability or difficulty ranges of the same survey, test, or assessment do not and cannot plot in a straight line. Centimeter and inch measures of the same object lengths do plot in a straight line, as the relation between the two number systems is dominated by the invariance of the objects’ amounts of length.

If nonarbitrary, invariant measures of constant amounts could be obtained from tests and surveys,

would not these be worth obtaining? Might it be that those who dismiss Rasch's models for measurement as just one approach among many equivalent approaches are missing something important, perhaps even something essential?

The fact is that data scaled via fit to a Rasch model can plot linearly, in close approximations to the way quantitative amounts dominate the relation between centimeters and inches, or grams and ounces. Furthermore, this kind of a plot is defined as the hallmark of quantitative meaningfulness by philosophers and theoreticians who are unconcerned with and not informed about Rasch's models. Finally, it has been shown that, insofar as a score from a test or survey provides a useful basis for measurement, the model that it must fit is a Rasch model.

Thus we have measurement theoreticians and philosophers (Falmagne & Narens, 1983; Narens, 2002; Roberts, 1985, 1999) investigating the meaningfulness of quantitative statements, and arriving at the essential importance of invariance as a fundamental criterion for telling sense from nonsense. Mundy (1986), for instance, summarizes this work in terms applicable to the difference between curved raw score plots and linear length plots, saying,

The hallmark of a meaningless proposition is that its truth-value depends on what scale or coordinate system is employed, whereas meaningful propositions have truth-value independent of the choice of representation, within certain limits. The formal analysis of this distinction leads, in all three areas [measurement theory, geometry, and relativity], to a rather involved technical apparatus focusing upon invariance under changes of scale or changes of coordinate system. (p. 392)

Hall, Wijsman, and Ghosh (1965) show "that the set of invariant rules based on a sufficient statistic is an essentially complete subclass of the class of invariant rules" (Arnold, 1985, p. 275). Rasch models are valued for the fact that counts of correct responses or sums of ratings are minimally sufficient statistics (Andersen, 1977; van der Linden, 1992). Rasch learned of sufficient statistics from their inventor, Ronald Fisher (1922), and considered this work the high mark of Fisher's accomplishments (Andrich, 1997; Wright, 1980). In a Rasch model, ordinal scores are minimally sufficient, and thus necessary, since they are functions of all the other statis-

tics that are sufficient in the sense of summarizing data with no loss of information.

What this means is that, "if there exists a minimal sufficient statistic for the individual parameter Theta which is independent of the item parameters, then the raw score is the minimal sufficient statistic and the model is the Rasch model" (Andersen 1977, p. 72). As Wright (1977b) pointed out, it then follows that

Unweighted scores are appropriate for person measurement if and only if what happens when a person responds to an item can be usefully approximated by a Rasch model.... Ironically, for anyone who claims skepticism about 'the assumptions' of the Rasch model, those who use unweighted scores are, however unwittingly, counting on the Rasch model to see them through. Whether this is useful in practice is a question not for more theorizing, but for empirical study. (p. 114)

In other words, if a count of correct answers or a sum of ratings can provide a meaningful basis for invariant, additive quantification, then a Rasch model holds.

Even when data are not evaluated for fit to a Rasch model, even when the invariance and additivity properties of quantitative measurement are ignored, use of test, survey, or assessment scores as though they are measures inherently implies acceptance of Rasch's separability theorem. This is because the parameter separation theorem is nothing more or less than a formal representation of the rigorous independence of figure and meaning, or of name and concept, that must be assumed in any honest effort at communication (Fisher, 2003a, 2003b, 2004), even in the discourses of deconstruction (Ricoeur, 1977, p. 293; Derrida, 1982, p. 229; Derrida, 1989, p. 218; Gasché, 1987, p. 5). Rasch's mathematics make tests of the qualitative hypothesis of quantitative meaningfulness (Michell, 1990; Narens, 2002) more accessible and practical than most work in this area. And in so doing, Rasch taps deeply into the history of measurement and deploys rich possibilities for mathematical thinking that remain largely unexplored (Wright, 1988, 1997a).

Solloway's Study

This study operationalizes mindfulness as a construct, evaluates stability over time and across groups receiving and not receiving mindfulness training, and establishes a metric for measuring change in amounts of mindfulness. The experience of novice mindfulness

practitioners is taken as a basis for the nurturing of an organically integrated conceptualization of the measured construct.

Method

Instrument

Fundamental measurement-based guidelines for developing high quality survey items (Fisher, 2006) were followed in the development of the instrument. A bank of thirty assessment items were constructed from the students' journal entries (a database of over 350 sets of journal entries). Three more items were added to the instrument after the completion of the original study, in the Fall, 2006, administration. The items were grouped in three categories of hypothesized mindfulness practice development: Beginning, Intermediate, and Advanced (Appendix B). Items were randomized for the final draft of the instrument (Appendix C).

Eight response options (Absolutely Disagree, Very Strongly Disagree, Strongly Disagree, Disagree, Agree, Strongly Agree, Very Strongly Agree, Absolutely Agree) were provided.

Measurement Theory

Criteria for obtaining objectivity in measurement comparisons include conjoint additivity (Luce & Tukey, 1964), statistical sufficiency (Arnold, 1985; Hall, Wijsman, & Ghosh, 1965), invariance (Krantz, Luce, Suppes, & Tversky, 1971), conditional independence (Kolmogorov, 1950), and infinite divisibility (Levy, 1937). All of these are embodied in the criterion of parameter separation (Rasch, 1960), as has been shown over the course of number of analyses and proofs (Andersen, 1977; Andrich, 1988; Fischer, 1995; Perline, Wright, & Wainer, 1979; Wright, 1985, 1997b, 1999). These criteria for objectivity in measurement have been found useful in the study of a wide variety of applications in education, health care, and psychology (Bezruczko, 2005; Bond & Fox, 2007; Fisher & Wright, 1994; Wilson, 2005).

In general, psychologists do not test or even state the hypothesis that the variable of interest in a study is quantitative (Cliff, 1992; Guttman, 1985; Michell, 1990, 1997a, 1997b, 1999, 2000; Wilson, 1971; Wright, 1984). In so doing, their research results remain tied to arbitrary, local, idiosyncratic, sample- and scale-dependent, ordinal comparisons, and are cut off from the benefits that would accrue from nonarbitrary, general, universal, uniform, and invariant linear comparisons. These benefits

include the possibility of unifying research communities via a consensus focus on experimentally demonstrated common objects of investigation that are furthermore measured in the common mathematical language of instruments all traceable to reference standard metrics (Fisher, 2004).

This research tests for the separability of a parameter associated with student mindfulness measures from two parameters associated with mindfulness item and rating scale calibrations. In other words, the substantive hypothesis tested in this research can be expressed as

$$\ln(P_{nij}/P_{nij-1}) = S_n - M_i - R_j$$

that is, that the natural logarithm of the response odds (the probability P for any student n on any item i in response category j relative to category $j-1$) of any student n 's response to any item i on the self-assessment is due only to the difference between that student n 's measure S of the effects of mindfulness practice and the calibration M of the mindfulness practice effects item i and the agreeability calibration R of the response category j (Andrich, 1978; Wright & Masters, 1982; Wright & Mok, 2000).

In short, the model tests the hypothesis that mindfulness is the primary construct dominating the question and answer exchange. Analysis of the model residuals then aids in identifying individual responses, students, and items as influenced by something different other than the primary construct.

Research Participants

Study participants were 338 unique preservice education students enrolled in several different teacher education courses over a four-semester period extending from the Fall of 2005 through the Spring of 2007 (see Table 1). Though the vast majority of students provided both pre- and post-instruction measures every semester, not all did, resulting in a total of 647 measures for the two time points across semesters.

In the first semester of the study, in the Fall of 2005, and only in this semester, two different instructors taught three of these courses. The class lists were cross checked for participants who had previously taken the first instructor's course or who were simultaneously enrolled in both the first and second instructors' courses; these students were removed from the second instructor's list. Therefore, none of the participants had previous

Table 1
Demographics
338 Total Student Participants
(Due to missing data, not all category groups sum to 338)

	Fall 2005	Spring 2006	Fall 2006	Spring 2007	Total	Valid Percent
Sex						
Male	16	5	14	16	51	15.2%
Female	155	35	41	54	285	84.8%
Age						
17-21	106	27	38	53	224	68.7%
22-31	44	11	16	11	82	25.2%
32-41	6	1	0	2	9	2.8%
42-51	5	1	0	4	10	3.1%
Other	1	0	0	0	1	.3%
Ethnic Group						
Caucasian American	151	39	53	68	311	98.4%
African American	0	1	0	2	3	.9%
Asian American	1	0	0	0	1	.3%
Hispanic American	1	0	0	0	1	.3%
Curriculum						
Mindfulness	87	40	55	70	252	74.6%
Non-Mindfulness	86				86	25.4%
Pre- or Post-Instruction * Semester and Year Cross Tabulation						
	Fall 2005	Spring 2006	Fall 2006	Spring 2007	Total	
Pre-Instruction Count	171	37	56	71	335	
Post-Instruction Count	153	38	53	68	312	
Total	324	75	109	139	647	

instruction in mindfulness practice or assignments in mindfulness practice within their teacher education programs prior to the study.

Students in the mindfulness instructor's course were assured every semester that credit for the assignment would be awarded simply by participation. In other words, any level of participation would receive full credit. The students in the second instructor's courses acted as a control group.

Procedure

The mindfulness project opted for mindfulness practice one day a week following Thich Nhat Hahn's (1967) projected potential benefits of one day a week

practice. About half of the students (88) participated in mindfulness training as described in Appendix D, and about half (83) served as a control. The experimental group received positive feedback for each journal entry submitted during the eight weeks. Both groups responded to the survey items twice, using an eight-point rating scale, once before the experimental group underwent eight weeks of mindfulness practice (T1=Pre), and again at the end of those eight weeks (T2=Post).

Analyses

All scaling and fit analyses were performed using the Winsteps software (Linacre, 2006), implementing a probabilistic conjoint model of fundamental measurement for rating scales (Andrich, 1978, 1988; Wright & Mok, 2000), and testing for the invariant internal consistency of the data using information-weighted and outlier-sensitive mean square model fit statistics (Smith, R. M., 2000; Wright & Masters, 1982), and principal components factor analysis of the model residuals (Smith, R. M., 1996; Linacre, 1998; Smith, E., 2002). Measures are reported in "logits."

"Logit" is a contraction of "Log-Odds Unit". It is no more obscure a measurement unit of an underlying and invisible variable than an "Ampère" is of invisible electric current. The essential ingredient of Amps and logits is that they be additive.

Real apples are not additive. One Apple + One Apple = Two Apples. But Two Apples are twice as much as One Apple only when the Two Apples are perfectly identical. Real apples are not perfectly identical. When we say One Amp + One Amp = Two Amps, we say "all Amps are identical," wherever they appear on the Ammeter. Logits form an equal interval linear scale, just like Amps. When any pair of logit measurements have been made with respect to the same origin on the same scale, the difference between them is obtained merely by subtraction and is also in Logits. (Wright, 1997c, p. 288)

Measures and calibrations from Winsteps were then studied statistically and graphically using SPSS v. 14 (2005).

Results

The data from the later three semesters reproduced the same rating scale structure as the initial first semester's study. The optimization of the rating scale based on the first semester's results was thus retained.

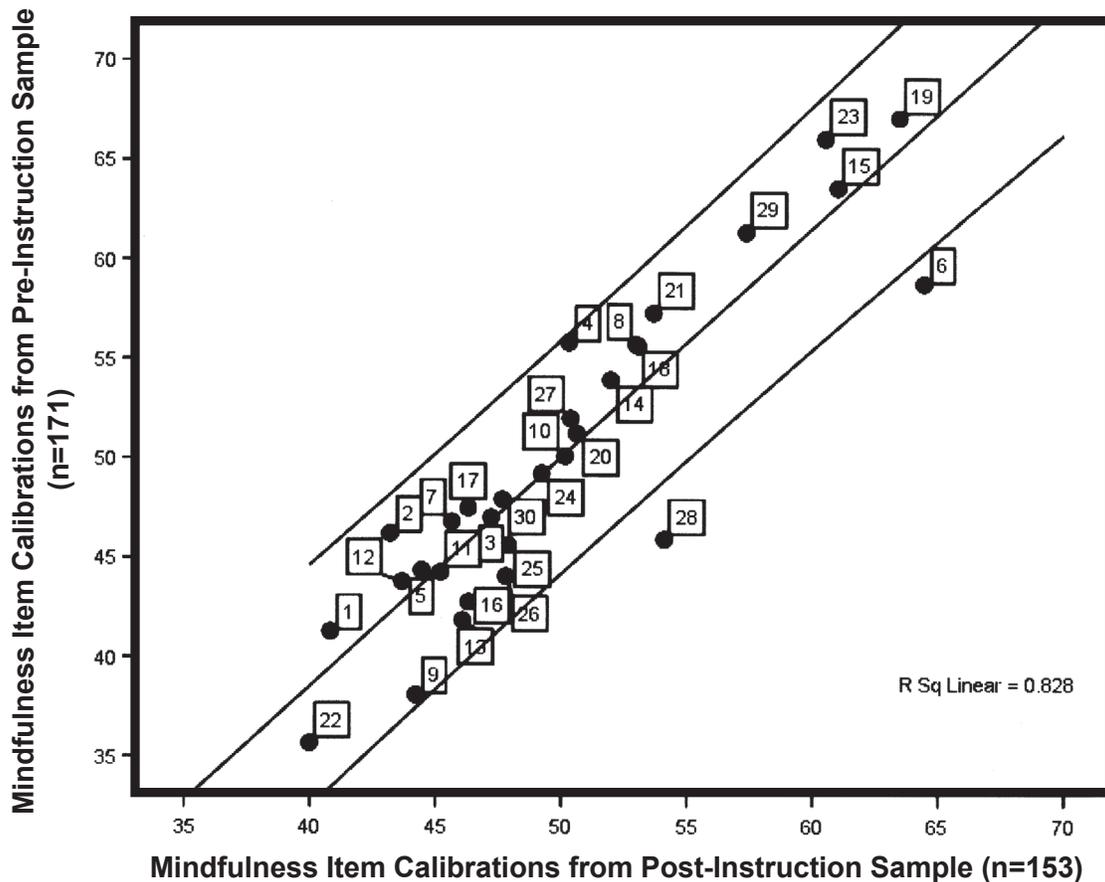


Figure 1. Scatter Plot of Fall 2005 Pre-Instruction and Post-Instruction Item Calibrations

Scaling

The 8-point rating scale was optimized (Andrich, 1996; Linacre, 1999, 2002) to three categories, with all of the disagree categories (25% of the responses) combined together, the Agree category (37% of the responses) left intact, and three most extreme Agree categories (37%) also combined. The transition from category 1 (All disagree categories) to category 2 (Agree) calibrated to 6.9 rescaled units (0.69 logits) below matching measures and calibrations, while the threshold between categories 2 and 3 (all other agree categories) calibrated to 6.9 units above matching measures and calibrations.

Overall respondent measurement separation reliability ranged from 0.90 to 0.93, depending on how error is estimated, and item calibration separation reliability was 0.99. Logits were transformed to a roughly 0-100 scale from their default values by multiplying by 10 and adding 50. The same scale was produced when the items were separately calibrated on the T1 and T2 groups ($R = 0.91$), as shown in Figure 1. The model fit statistics do not falsify the hypothesis that the thirty items measure a single construct of mindfulness practice. Construct validity was

supported by the meaningfulness of the item order on the variable.

Due to an error in survey production, item 29 was rephrased in late 2006, resulting in exceptionally high calibrations and mean square outlier-sensitive fit statistics in the Fall 2006 and Spring 2007 semesters. It is the only item to fall repeatedly outside the 95% confidence intervals in scatter plots of item calibrations by semester and year. The rephrasing resulted in the item's calibration changing by about two logits. Since the item was already near the top of the scale, the new text changed its position on the scale to a level far above all other items. This large effect size resulted in all unexpected responses becoming statistically significant.

The Fall 2006 and Spring 2007 data for item 29 were therefore removed from the calibration database. New data will be added in the future, and the item will be restored to its original phrasing.

The items were calibrated on multiple separate subsamples of the data, determined by curriculum type, pre- or post-intervention time points, the semester and year, or simply the first half of the respondent data entered

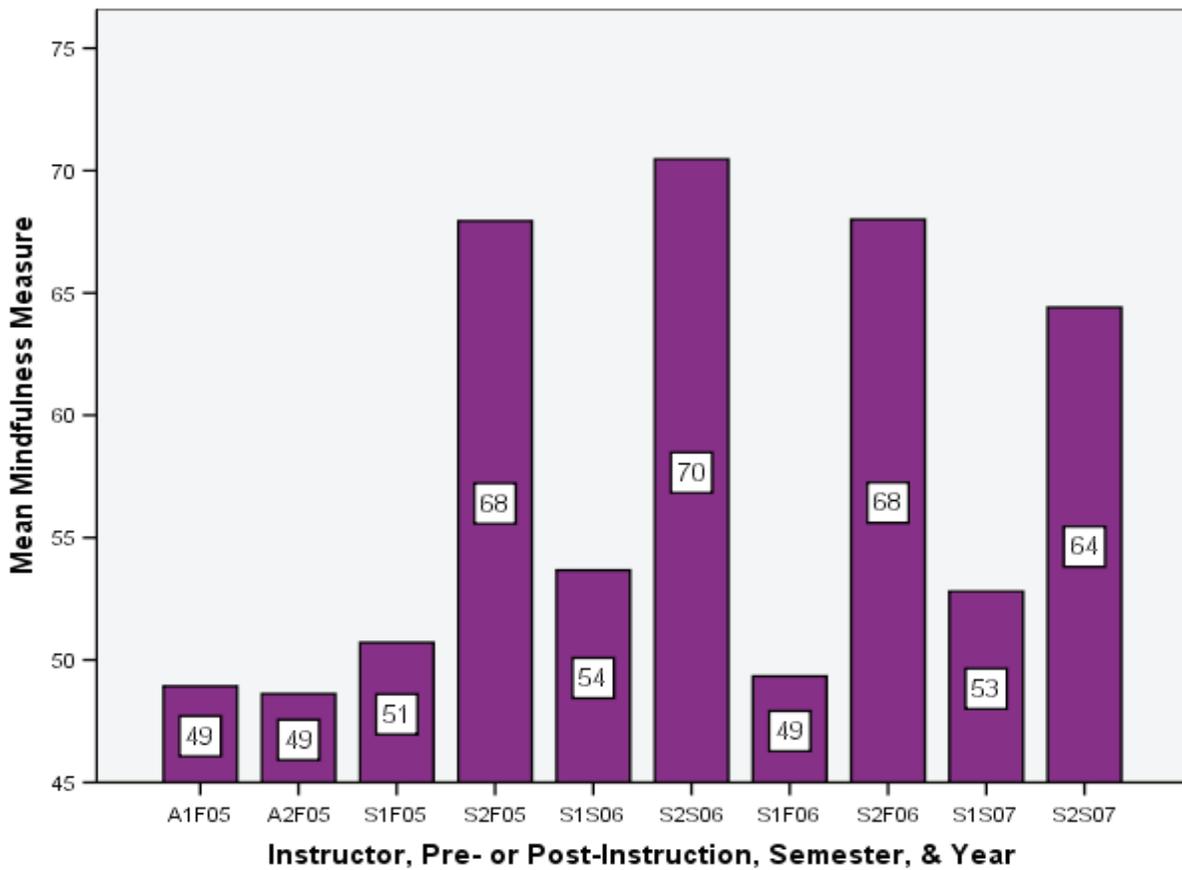
vs. the second half. Correlations of the resulting 41 pairs of separate-sample calibrations range from 0.85 to 0.99.

In contrast with item 29's two-semester explainable aberration, items 28 and 6 were repeatedly identified by the model fit statistics, the graphical scatter plots of separate-sample item calibrations (see Figure 1), and the principal components analysis of the residuals as provoking responses inconsistent with the overall common construct. These two items changed positions on the scale to a statistically significant degree, depending primarily on whether the response was made at T1 (Time 1 or Pre Test) or T2 (Time 2 or Post Test). Omitting the items from the scale makes virtually no difference in the

resulting measures, suggesting that there is no substantive significance to the items' statistically significant changes in position.

Experimental

In the initial Fall 2005 study of the mindfulness measures (Solloway & Fisher, 2007), the control group (receiving no mindfulness instruction) had nearly identical average measures at the beginning and end of the semester (about 50, with an error of 4). The treatment group (receiving mindfulness instruction) had an average T1 measure of 51, with an error of 4, but finished the semester with an average T2 measure of 68, 17 units, or



- Key:
- A1F05: Non-mindfulness Curriculum, Pre-Instruction, Fall, 2005
 - A2F05: Non-mindfulness Curriculum, Post-Instruction, Fall, 2005
 - S1F05: Mindfulness Curriculum, Pre-Instruction, Fall, 2005
 - S2F05: Mindfulness Curriculum, Post-Instruction, Fall, 2005
 - S1S06: Mindfulness Curriculum, Pre-Instruction, Spring, 2006
 - S2S06: Mindfulness Curriculum, Post-Instruction, Spring, 2006
 - S1F06: Mindfulness Curriculum, Pre-Instruction, Fall, 2006
 - S2F06: Mindfulness Curriculum, Post-Instruction, Fall, 2006
 - S1S07: Mindfulness Curriculum, Pre-Instruction, Spring, 2007
 - S2S07: Mindfulness Curriculum, Post-Instruction, Spring, 2007

Figure 2. Pre- and Post-Mindfulness Instruction Measures

more than four errors of measurement, higher on the scale. As previously reported, the T2 measures were different from the T1 measures to a statistically significant degree for the treatment group, but not for the control group.

Replicating the previously reported Fall 2005 results, the pre- and post-mindfulness instruction measures differ by 16, 19, and 11 units, respectively, for the Spring 2006, Fall 2006, and Spring 2007 semesters (see Figure 2). The average T2 measures across the four semesters were consistent over the first three semesters, at 68, 68, and 70.

The average gain from T1 to T2 dropped markedly in the Spring of 2007, though students started with about the same average measure as in the previous semesters. Spring 2007 was unusual in that, due to the sudden departure of a colleague, Solloway was asked to teach his four sections of Language Arts in addition to her usual responsibilities. It was a difficult time and the strain is reflected, we believe, in the drop in mindfulness measures that semester.

Even with this exception, however, every semester's differences in the mindfulness effects measures are highly significant, in both substantive and statistical terms. The overall average pre-instruction measure for students enrolled in the mindfulness curriculum is 51, and the overall average post-instruction measure for those students is 67. ANOVA shows this difference of 16 units (4 errors of measurement) to be statistically significant ($F(1,495)=184.06, p < .001$). The Pre- and Post-Instruction differences shown in Figure 2 are similarly all statistically significant, ranging from the low of the Spring 2007 11-unit difference ($F(1,137)=24.63, p < .001$) to the high of the Fall 2006 19-unit difference ($F(1,107)=75.26, p < .001$).

The statistical power of the design for all the mindfulness curriculum comparisons was 1.00, since all of the statistically significant differences are most of, all of, or more than the pooled standard deviations in size, with one degree of freedom and $p < .01$.

Substantive Interpretation

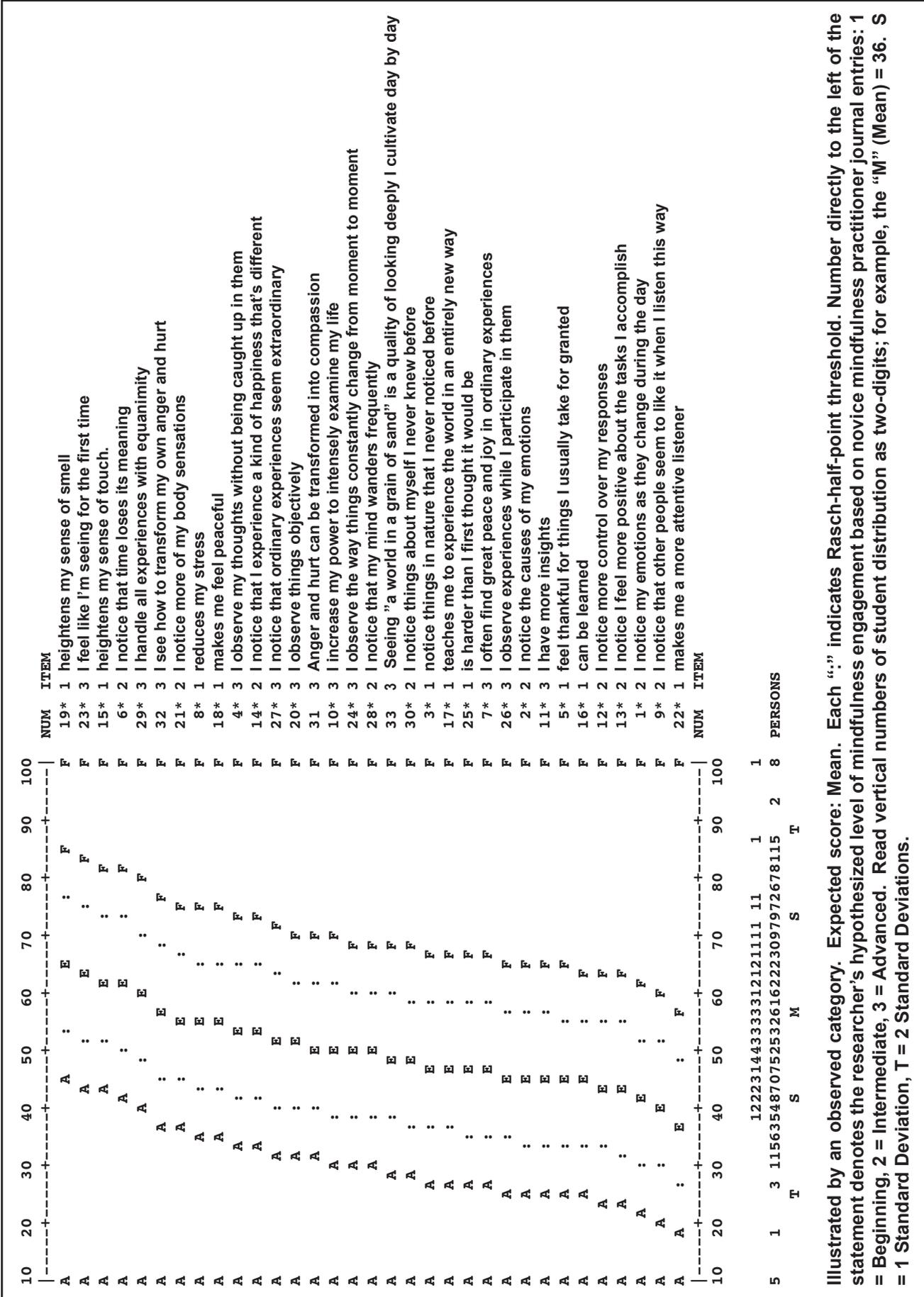
Figures 3 and 4 show the order of the items on the variable relative to the optimized rating categories and measures. The item hierarchy exhibits a meaningful progression ranging from simple noticing to more intensely understanding and experiencing, and then to heightened awareness and sensation.

The distribution of measures relative to the item hierarchy and optimized rating categories is shown horizontally across the bottom of Figure 3, with the mean, and first and second standard deviations, indicated by M, S, and T, respectively. The counts of students at each measure are read vertically; i.e., there are 36 students with measures at the mean. The same information is conveyed in Figure 4, but with both the measures and the response category-level item calibrations plotted vertically.

The average T1 measure for the students in the mindfulness curriculum over the four semesters is 51. Drawing a vertical line through Figure 3 at 50 on the horizontal scale shows what the expected responses to the items are for a student with that measure. Students with these initial, uninformed experiences of mindfulness practice's effects strongly acknowledge that mindfulness makes for more attentive listening, and more mildly acknowledge a wide range of other effects, from positive effects on others to more self control to a new kind of happiness, with a decreasing likelihood of agreement as one reads up the scale. Three items involving sensations (smell, touch, and sight) are more likely to elicit disagreeable responses than agreeable ones, for T1 measures, on average. Using the Pre/Post measures for Students A, B, and C given at the end of Appendix A, the expected responses for individuals may be seen in the same way in Figure 3.

The average T2 measure for the students in the mindfulness curriculum over the four semesters is 67. Again imagining a vertical line drawn through Figure 3, this time at 67 on the scale, we now expect strong agreement with all but the top six of the mindfulness practice effects, and mild agreement is expected for these.

The substantive meaning of the experimental intervention of training in mindfulness practice is expressed in terms of the difference between these expected response patterns. The difference between the overall T1 measures and the experimental group's T2 measures is about 16. At T1, with an average measure of 50, the item with the highest calibration with which all students typically strongly agree is item 22, mindfulness makes me a more attentive listener, which calibrates at 38. At T2, with an average measure of 67, the item with the highest calibration with which the experimental group typically strongly agrees with is item 8, reduces my stress, which calibrates at 55.



Illustrated by an observed category. Expected score: Mean. Each “:” indicates Rasch-half-point threshold. Number directly to the left of the statement denotes the researcher’s hypothesized level of mindfulness engagement based on novice mindfulness practitioner journal entries: 1 = Beginning, 2 = Intermediate, 3 = Advanced. Read vertical numbers of student distribution as two-digits; for example, the “M” (Mean) = 36. S = 1 Standard Deviation, T = 2 Standard Deviations.

Figure 3. Mindfulness Practice Wright Construct Map

Notice that item 8, at 55, is 17 units higher up the scale than item 22, at 38. After taking the 4-unit error of measurement into account, we see that the same unit difference distinguishing the T1 from the T2 measures also distinguishes the differences between the two groups' response likelihoods, respective to any pair of items on the scale. These relationships constitute the substantive meaning of the quantitative comparisons facilitated by the scale. Any unit difference between any two points on the scale will translate into substantively meaningful contrasts illustrated by the content of the items and optimized rating scale. The constancy of this relationship is itself substantiated by the fit to the measurement model, and the high correlations and linear plots of the items' scale values across sub sample calibrations.

Theory-Data Convergence

The numbers 1, 2, and 3 in the first column of the item names in Figure 3 indicate the pre-experimental theoretically predicted calibration ranges. These predicted calibration ranges correlate 0.03 to 0.10 with the multiple independent subsample recalibrations of the 30 items. The respondents' ordering of the items thus differs from the researcher's original conceptualization of that hierarchy, offering an opportunity for rethinking theory and possibly establishing closer theory-data congruence.

The theoretical order was derived from several years' experience reading students' mindfulness journals. It seemed evident that the empirical frequency with which students mentioned or described various effects of mindfulness practice in their journals followed the pattern described by the three assigned categories, with 1 emerging earliest, and 3, latest.

But does the empirical order of emergence necessarily imply a hierarchy of effects? Perhaps the effects initially noticed are landmarks or a general structure within which the experience of later effects are categorized. The group 1 items in fact span the entire calibration range, and seem to be marking out significantly different ranges in the items, with the content of the group 1 item signifying a theme common to the group 2 and 3 items falling in that range.

That is, if a student is experiencing enhanced listening ability as an effect (item 22, at the bottom of the scale), then it becomes possible to do the "noticing" (category 2) items right above it, each of which may be in some degree entailed by the first item.

If then the student acknowledges that mindfulness can be learned (item 16), and experiences some gratification in noticing what is usually taken for granted (item 5), then she or he is ready and able to experience the "taken for granted things" in the group 2 and 3 items right above these. When the student in due course breaks through the next group of category 1 items, a new level of critical awareness or attunement is obtained, which supports receptivity to the following group of largely group 3 items. Sticking with that critical attunement then leads to the next group 1 transition into reduced stress (item 8), and the associated group 2 and 3 new balance, centering, and enhanced physical sensations.

Discussion

Our replication of the first study offer further scientific evidence and theory supporting the substantive conjecture that the effects of mindfulness practice are teachable, learnable, and amenable to measurement. Making "non-arbitrary measures" possible in psychometrics was Rasch's "outstanding contribution," according to Jane Loevinger (1965, p. 151). Loevinger further observed that, "When his (Rasch's) model fits, the results are independent of the sample of persons and of the particular items within some broad limits. Within these limits, generality is, one might say, complete" (p. 151). This specific generality makes successful applications of science possible and is crucial to meaningful, linked conversations among the interested parties.

In this context, the historian of science, Bruno Latour, remarked, "Everytime you hear about a successful application of science, look for the progressive extension of a network" (Latour, 1987, p. 249). The extension of metrological networks in psychosocial science has been effectively blocked by instrument-dependent and arbitrary numerical representations of its measured constructs. The non-arbitrary measures calibrated in this study begin the work of investigating the possibility that mindfulness may be characterized by lawful regularities in its patterns of presence and absence. Insofar as those lawful regularities are not found to be dependent on the particulars of this study, a common language for interpreting and reading qualitatively-informed amounts of mindfulness presence and absence will emerge.

The first requirement for any network of relations is a medium or a common language. The mindfulness ruler calibrated in this study is a first step in establishing a non-arbitrary common language and

an invitation for further meaningfully linked conversations. Such common languages are in various stages of emergence in different areas of psychology, education, and health care (Dawson, 2002a, 2002b; Fisher, 1997a, 1997b; Stenner, 1994).

What these studies have in common is that scatter plots illustrating the measured relationships are linear. A plot illustrating one-to-one relationships between amounts of length measured in centimeters and amounts of length measured in inches is linear because amounts of length remain invariant across the numerical representations of it. Measures exhibiting the properties of conjoint additivity, invariance, sufficiency, parameter separation, and others which accordingly emerge from data fitting a Rasch model, are linear in the same way.

A scatter plot illustrating a typical correlation of about 0.91 between separate sample calibrations of the mindfulness self-assessment is shown in Figure 1. The constant amounts of mindfulness practice's effects across the samples measured are illustrated in the way the pairs of item calibrations fall together in a consistently orderly pattern roughly along the identity line (an imaginary line extending from the lower left corner to the upper right). Though the item order is constant from T1 to T2, the calibrations are somewhat skewed away from the identity line because, at T1, the students are inexperienced with the construct and unable to distinguish among the effects of mindfulness practice as well as they can after training. This gain in construct definition has been documented in other research, with the suggestion that the items be anchored at their outcome values in practical applications (Bezruczko, 2005).

The pattern is, in addition, not as narrow and linear as a plot of centimeter vs. inch measures of the same objects would be, but it still provides us with a precision of more than four statistically distinct ranges (when reliability is greater than 0.94). These ranges are sections of the measurement continuum that have centers three errors apart (Wright & Masters, 1982, p. 96), and so establish the precision of the calibrations that can be expected to be reliably reproduced for this instrument by samples of about these sizes from the population.

The nature of the population remains an issue for further investigation. Is it the population of all possible students in preservice teacher education programs? Or is it only students in one particular preservice teacher education program? Or will the population studied in this project turn out to be just students in one

program at one particular time? The population might be expanded to include college students in general, or adults in general, but this will be determined only by additional research that focuses specifically on these issues.

Establishing a common language of mindfulness practice effects that researchers can think in together requires more than having different samples of respondents reproduce the calibrations of the items from one instrument. It must also be possible for different samples of items from the infinite universe of all possible mindfulness practice effects items—that is, different mindfulness practice effects instruments—to produce linearly comparable measures that could be expressed in a common metric. Scientific research, properly understood, makes a fundamental priority of this kind of collectively distributed care for the unity and sameness of what is studied.

Human beings, like any form of life, exist in ecological webs of relations. Physical, emotional, social, and spiritual forms of well-being are experienced as projected from networked webs of relations. Susser and Susser (1996) called the future of epidemiology eco-epidemiology, acknowledging the necessity of meaningful communication across molecular, individual, and societal levels of organization.

Similarly, our findings point to the convergence of mindfulness effects across all three ecological levels of relations in positive psychology (Figure 5), and so acknowledge and incorporate the ecological implications of mindfulness practice. Substantial growth in psychological strengths was demonstrated with only one day a week of intentional practice. These effects converge simultaneously with several of The Five Basic Postulates of Humanistic Psychology (Greening, n.d.) and are reflected as well in Figure 5. This strengthening of emotional balance integrated itself positively across the subjective, individual, and social levels. That our calibrated ruler now offers non-arbitrary measures of this growth opens the possibility for testing the efficacy of methods of mindfulness instruction in developing psychological strengths within and between individuals, ecologically. Might one future of the exploration of mindfulness practice be defined by developments in the direction of an eco-positive psychology facilitated by non-arbitrary measures?

Indeed, we have dedicated much space to the details of the quantitative aspects of the study. As the

Positive Psychology/Subjective Level—Valued Subjective Experiences:

Well-being, contentment, satisfaction, happiness

- Notice I feel more positive about the tasks I accomplish (Postulates 3, 5)
- Feel thankful for things I usually take for granted (Postulates 3, 4, 5)
- I often find great peace and joy in ordinary experiences (Postulates 3, 5)
- Notice that I experience a kind of happiness that's different (Postulate 3)
- Makes me feel peaceful (Postulate 3)

Positive Psychology/Individual Level—Positive Individual Traits:

Capacity for Vocation

- Notice I feel more positive about the tasks I accomplish (Postulates 3, 5)
- Reduces my stress (Postulate 3)

Interpersonal skill

- Makes me a more attentive listener (Postulates 3, 4)
- Notice that other people like it when I listen to them this way (Postulates 3, 4, 5)
- Notice more control over my responses (Postulates 3, 4, 5)
- Notice the causes of my emotions (Postulate 3)

Aesthetic Sensibility

- Notice things in nature I never noticed before (Postulate 3)
- Feel thankful for things I usually take for granted (Postulates 3, 4, 5)

Wisdom

- I have more insights (Postulate 3)
- Increases my power to intensely examine my life (Postulates, 3, 5)
- Can observe my thoughts without being caught up in them (Postulates 3, 4, 5)
- Feel thankful for things I usually take for granted (Postulates 3, 4, 5)

Positive Psychology/Group Level—Civic Virtues and the Institutions Toward Better Citizenship:

Responsibility, Nurturance, Moderation, Tolerance, Civility, Work Ethic

- Notice more control over my responses (Postulates 3, 4, 5)
- Notice I feel more positive about the tasks I accomplish (Postulates 3, 5)

Correlations between Seligman & Csikszentmihalyi's (2000) Positive Psychology Definition, Five Postulates of Humanistic Psychology (Greening, n.d.), and Novice Practitioners' Descriptions of Effects of Mindfulness Practice

Figure 5. Positive Psychology and Five Basic Postulates of Humanistic Psychology Link to Effects of Mindfulness Practice for Novice Practitioners

value of qualitative work in the history of mindfulness practice is well established, it seemed more important to deeply describe our quantitative process. As a qualitative researcher, Solloway is well aware of the initial prejudice she herself brought to Fisher's early introduction of the idea that a quantitative corroboration could enhance this work. It was her meditation practice in support of her mindfulness practice that brought her face to face with that prejudice. Solloway's commitment to truly and openly entering the present moment with curiosity dismantled that prejudice in order to more non-judgmentally investigate Rasch models as possibilities for discovering the organic partnership between her qualitative data and the quantitative ruler that data were ready to construct with Fisher's help. We have worked to make that process as transparent as possible.

Issues for Future Research

Several issues present themselves for further study. First, can the effects measured here be reproduced elsewhere by others? Second, can the revised substantive theory of the variable be used to improve the instrument? Third, DIF analysis shows that items 25 and 28 differ significantly by sex; this contrast is confounded a bit by the repetition of the same people across two time points. This issue should be addressed in a later study. Fourth, the participants' overall growth in mindfulness practice as defined by the survey items demonstrates the growth predicted in several sections of the operational definition of mindfulness proposed by Bishop, Lau, Shapiro, Anderson, Carmody, Segal, Abbey, Speca, Velting, & Devins (2004). Follow-up studies can further corroborate this finding. Fifth, what is the nature of the gap separating the five items at the top of the scale from those lower down? Sixth, the suggestive connections between novice practitioners' interest in positive and humanistic psychologies might be further investigated with other studies providing different mindfulness instructions but comparable with non-arbitrary measures. Seventh, the corroboration of the journal entries and the mindfulness ruler to show growth by university students in their ability to mediate the debilitating effects of emotional imbalances, stress, and prejudicial orientations to present moment experience provides important validation for the inclusion of mindfulness assignments at the university. Future research should address these corroborations and analyze the differences using rigorous measurement models.

Conclusions

The study is innovative in at least three ways. First, it demonstrates mindfulness practice as measurable, as teachable and learnable, and as an object of experimental research. Second, it does so through a rich hermeneutic integration of qualitative and quantitative processes (Fisher, 2003a, 2003b, 2004). One of Rasch's probabilistic conjoint models of fundamental measurement is shown to entertain uncertainty and chance in conversation, in order for what is known to converge with differences that make a difference across ecological webs of relations. Third, the study is innovative in its qualitative evidence corroborated by quantitative evidence of the value of mindfulness practice as an assignment in the university classroom. Future research will seek to generalize these findings to other mindfulness settings and measures.

The way has never been more open for researchers to work back and forth between qualitative evidence and more fully mathematical, quantitative measures. To do so with integrity, care must be taken to retain the contemplative and compassionate in the best qualitative work while at the same time holding quantitative methodologies to the rigorous requirements of fundamental measurement. Important obstacles to meaningful conversations have been removed; the way has opened for the proliferation of invitations for meaningful conversations and the means for sustaining those conversations is at hand. We suggest that this work supports not a "type of scientism [which] can be termed methodolatry, the undue elevation of a method to a sacred artifact" (Friedman, 2003), but rather a research/living stance of a curiosity open to the present moment.

Endnotes

1. Portions of this paper were presented at the International Objective Measurement Workshop, April, 2006, Berkeley, CA; American Association for the Advancement of Curriculum Studies, April, 2006, Berkeley, CA; and the American Educational Research Association Conference, April, 2006, San Francisco, CA.

We thank the reviewers for their helpful insights.

Appendix A:

Journal Entry Samples with Instructor Responses and Pre/Post Measures for Students A, B, C

Week 1

Student A—

Usually when I awake in the morning, my mind is racing with thoughts of everything I need to get done.

Taking deep breaths and trying to clear my mind proved a bit difficult. Lying in bed, trying to be in the now, I could hear my heart beating, and my ears ringing. I could feel that my eyes were itchy, my teeth were throbbing (I grind them in my sleep), and my throat was sore. I thought that I must be doing this wrong, this wasn't fun. Relax more, take another breath, concentrate. Now I noticed that everything has a rhythm, and as I listened and felt that rhythm, I was soothed. Eating my bowl of Kashi, I had to slow down, put my spoon down between bites, and concentrate on each mouthful. I could feel and enjoy the coolness of the milk, the taste and texture of the cereal, the weight and smoothness of the spoon. This was challenging and unnatural for me as I am usually not that aware of eating breakfast. The day continued to be a challenge. Many times I had to stop, breathe, and pay attention to the rhythm to clear my mind. What stands out for me is how easily distracted I am from the moment. Interruptions from my son, my dogs, the phone, but mostly from my own mind, seem a huge obstacle. I need to incorporate all of these into "happenings of the now" instead of intrusions. Being in the moment seemed easier in the evening. Perhaps my mind was tired, or I was less distracted now that the day was near an end. Playing cards with my husband, it was simpler to enjoy just doing what I was doing, and not thinking about anything else. For some reason, this day seemed longer than most. Maybe it was because I became disappointed with myself every time my mind wandered, which was often. I hope, as the mindful days progress, that "being in the now" will become more natural for me.

Good Afternoon, _____,

You wrote: "Maybe it was because I became disappointed with myself every time my mind wandered, which was often." Remember that it is NORMAL for the mind to wander. Mindfulness practice is about NOTICING that. If you notice it OFTEN, that means that you are practicing mindfulness...try to just notice without judging yourself or anything else in the moment...let me know what happens..... Best wishes for your next mindfulness day...ss

Student B—

The first mindfulness day didn't go as well as I would have liked. I didn't stop and pull myself back as much as I would have liked. The one time I really did experience it was after work and classes. I came home and lay down to take a nap. As I lay there, I thought about being mindful and was able to bring myself back into the moment. It was nice to just lay there and hear myself breathe and feel the breeze come in though my open window and fall asleep.

Good Morning, _____!

Best wishes for your next mindfulness day. Be sure to put something close to your bed to remind you as soon as you awake that it is your mindfulness day. Take that first conscious breath of the morning and begin your mindfulness day. Be gentle with yourself. Be happy at whatever number of times you remember during the day to use your breath as an anchor for your attention. In your journal entry, describe at least one mindful moment and analyze how it was different from ordinary moments...I look forward to what you learn...ss

Student C—

Today while trying to be mindful I realized it could be harder than I thought. It was hard at first because I usually daydream and aren't very attentive to what is going on around me. As I paid closer attention to breathing and clearing my head of the daydreaming, I was more attentive to what was actually going on around me. I noticed the bird's chirping, I noticed other people talking as they walked by me, I noticed the construction worker's noise, and in class I was more attentive to the professor and fellow classmates. I was more mindful of what they said and of what I said when talking to them. When talking to my friends I paid more attention to what they were saying instead of half listening and half daydreaming at the same time. It was a clear feeling being mindful all day. It was a nice feeling to actually be in the present when I needed to be.

Good Evening, _____,

Yes, the practice of keeping attention focused in the present moment seems simple. But as you discovered, the mind constantly dashes out of the moment taking our thoughts elsewhere. Best wishes for your next mindfulness day...ss

Week 4

Student A—

Thanks to your input from last week, and the revelation that what was really driving my busy mind was a need for approval, I have found it much easier to focus on the now. It's funny that once I was aware of this, I find being mindful, and my entire day, less stressful. I think I was just seeking exterior goals, the shell as it were, when really, inside I was seeking control of my day. But by keeping my mind on what I am presently doing, instead of what also needs to be done later, each undertaking has become so much more enjoyable and freeing. Do you believe you can actually enjoy a task as mundane as folding laundry? When you're in the moment, you can feel the warmth, feel the textures, smell the fresh scents. Meals taste better, are more plea-

surable, and I think you actually eat less because you realize when you've had your fill.

Listening during conversations is gratifying, because you are no longer obsessed with your own agendas, or what you'd rather be doing. It's not that I no longer seek approval, but from my new viewpoint, I no longer need to chase after it. My mind still wanders from the moment, but I can relax, cleanse my mind with a breath, and bring it back. Or, if I am thinking about something, I become aware and allow myself to think. I have to do this every day now, not just one day a week. It's not that this is a radical change, but my patterns of thinking are changing, and you can't just turn that on once a week.

Good Evening, _____,

You wrote, "Do you believe you can actually enjoy a task as mundane as folding laundry? When you're in the moment, you can feel the warmth, feel the textures, smell the fresh scents." YES! One of the most lovely benefits of mindfulness practice is the way it lets you experience the AWE and WONDER of ordinary tasks or experiences! This nourishes the soul and we feel more energy for our lives!... Best wishes for your next mindfulness day...ss

Student B—

I was actually very pleased with my mindfulness this week. Before leaving the house I caught myself at least twice and was able to bring myself back into the moment. The rest of the day I forgot to do it.

Good Morning, _____!

In your next journal entry, try to describe one mindful moment in your day and analyze how it was different from ordinary moments....ss

Student C—

This week my mindfulness brought me back to the senses of walking around campus. Since being sick it is hard to keep focus but I have since recovered and while walking to class this week I was happy that I was finally feeling better and therefore had a better outlook on things. I once again noticed the chatter of people talking and the leaves blowing and rustling and the clatter of high heels clicking along and the construction going on. It is nice being able to walk and listen with a clear head!!

Good Morning, _____,

Glad you are feeling better. Best wishes for your next mindfulness day...ss

Week 8

Student A—

With the holidays approaching, I was afraid I might backslide, start to panic about what needs to be done before family arrives. My need for approval, my old mental habit, might rear its ugly head. But that hasn't happened. This mindfulness is like a natural tranquilizer. It's not that I'm numb or blasé. I'm excited and looking forward to sharing the holidays. It's more like I am at ease, aware of my own mental connections with what's around me. Life is touching me, and I'm allowing it. With the "approval monster" banished, I am free to be sensitive to a whole new realm, and enjoy each experience and mindful moment as it comes. From past experience, I had connected family gatherings with a certain amount of stress; trying to make sure everything was perfect (nothing is ever perfect, so that was unrealistic to begin with). And what for? Approval. And why was approval important? Because it made me feel good, like I should be admired or something. Once I realized how egotistical this really was, and how it was cutting me off, I could clear my mind and end the pursuit. While I was chasing self-satisfaction, life was passing by unnoticed. And like I said before, nothing in life is perfect—but that is okay. Something doesn't have to be perfect to be enjoyed. You just have to ignore your old impulse to fix everything, and instead become comfortable with the reality. No matter what reality brings, it can be beautiful. You don't have to analyze it, manage it, or improve upon it - just be part of it. This holiday season is going to be the best one since childhood.

Good Morning, _____,

Well, this is your last mindfulness journal entry. Thank you for letting me share in this journey with you. It has been a joy...Best wishes for your CONTINUED mindfulness practice...ss

Student B—

My last mindfulness day was very successful. I have come such a long way since the first day of this project. On this day, I was able to successfully catch myself at least ten times and bring myself back. It was an amazing feeling!

Good Afternoon, _____!

Yes, what we cannot change is that you can only live ONE moment at a time AND that the mind constantly wanders! And mindfulness practice empowers you to NOTICE that the mind has wandered, bring it back, and then live that moment with crystal clear energy and wisdom! Best wishes for your continued use of mindfulness practice with ever more expertise beyond this assignment...ss

Student C—

This week's mindfulness journal brought new senses. It got VERY cold this week and as I was standing outside waiting for someone I took a deep breath and although I got a tad colder by doing that I noticed the slight wind blowing the leaves around and smelled the rain in the air that was to come. I love the smell of rain, usually more so in the spring time with the scent of flowers also in the air but I like it nonetheless. I noticed people walking more briskly and shivering loudly as they were disgruntled over the rain and the cold. It was interesting, I never really noticed people that way before because I am usually concentrating on my own wanting to get warm.

Good Morning, _____,

As you discovered, one of the benefits of mindfulness practice is our heightened awareness of others and of the pleasures of the ordinary—like the smell of rain. Best wishes for your continued mindfulness practice...ss

Results

Student A—Pre (50.6) Post (103.3) +52.7

Student B—Pre (38.2) Post (48.5) +10.3

Student C—Pre (34.0) Post (54.3) +20.3

Student A—Pre (50.6) Post (103.3) +52.7

Deep inner work—success measured by the satisfaction of the ordinary made extraordinary and satisfaction of discovering your own complicity in your unhappiness and then using mindfulness practice as a tool to change that

Student B—Pre (38.2) Post (48.5) +10.3

Couldn't remember to do it—success measured by counting how many times you noticed the mind wandering

Student C—Pre (34.0) Post (54.3) +20.3

Joy in heightened awareness of sensory input

Appendix B

Developmental Mindfulness Survey Items

(09-04-05)

Sharon G. Solloway, Ph.D.

Beginning Understandings/Knowing/Impressions

I am learning that paying attention to what is happening right now:

- 1) ...can be learned.
- 2) ...is harder than I first thought it would be.
- 3) ...makes me a more attentive listener.
- 4) ...heightens my sense of smell.
- 5) ...heightens my sense of touch.
- 6) ...makes me notice things in nature that I never noticed before.
- 7) ...makes me feel peaceful.
- 8) ...reduces my stress.
- 9) ...makes me feel thankful for things I usually take for granted.
- 10) ...teaches me to experience the world in an entirely new way.

Intermediate Understandings/Knowing/Impressions

As I practice paying attention to what is happening right now, I notice:

- 11) ...that my mind wanders frequently.
- 12) ...more of my body sensations.
- 13) ...things about myself I never knew before.
- 14) ...that other people seem to like it when I listen to them this way.
- 15) ...more control over my responses.
- 16) ...I feel more positive about the tasks I accomplish.
- 17) ...that I experience a kind of happiness that's different.
- 18) ...the causes of my emotions.
- 19) ...my emotions as they change during the day.
- 20) ...that time loses its meaning.

Advanced Understandings/Knowing/Impressions

When I practice paying attention to what is happening right now, I:

- 21) ...observe my thoughts without being caught up in them.
- 22) ...observe experiences while I participate in them.
- 23) ...often find great peace and joy in ordinary experiences.
- 24) ...feel like I'm seeing for the first time.
- 25) ...have more insights.
- 26) ...notice that ordinary experiences seem extraordinary.
- 27) ...observe things objectively.
- 28) ...increase my power to intensely examine my life.
- 29) ...observe the way things constantly change from moment to moment.
- 30) ...handle all experiences with equanimity.

Appendix C
Developmental Mindfulness Survey Items--Randomized
(9-06-05)
Sharon G. Solloway, Ph.D.

- 1) As I practice paying attention to what is happening right now, I notice my emotions as they change during the day.
- 2) As I practice paying attention to what is happening right now, I notice the causes of my emotions.
- 3) I am learning that paying attention to what is happening right now makes me notice things in nature that I never noticed before.
- 4) When I practice paying attention to what is happening right now, I observe my thoughts without being caught up in them.
- 5) I am learning that paying attention to what is happening right now makes me feel thankful for things I usually take for granted.
- 6) As I practice paying attention to what is happening right now, I notice that time loses its meaning.
- 7) When I practice paying attention to what is happening right now, I often find great peace and joy in ordinary experiences.
- 8) I am learning that paying attention to what is happening right now reduces my stress.
- 9) As I practice paying attention to what is happening right now, I notice that other people seem to like it when I listen to them this way.
- 10) When I practice paying attention to what is happening right now, I increase my power to intensely examine my life.
- 11) When I practice paying attention to what is happening right now, I have more insights.
- 12) As I practice paying attention to what is happening right now, I notice more control over my responses.
- 13) As I practice paying attention to what is happening right now, I notice I feel more positive about the tasks I accomplish.
- 14) As I practice paying attention to what is happening right now, I notice that I experience a kind of happiness that's different.
- 15) I am learning that paying attention to what is happening right now heightens my sense of touch.
- 16) I am learning that paying attention to what is happening right now can be learned.
- 17) I am learning that paying attention to what is happening right now teaches me to experience the world in an entirely new way.
- 18) I am learning that paying attention to what is happening right now makes me feel peaceful.

- 19) I am learning that paying attention to what is happening right now heightens my sense of smell.
- 20) When I practice paying attention to what is happening right now, I observe things objectively.
- 21) As I practice paying attention to what is happening right now, I notice more of my body sensations.
- 22) I am learning that paying attention to what is happening right now makes me a more attentive listener.
- 23) When I practice paying attention to what is happening right now, I feel like I'm seeing for the first time.
- 24) When I practice paying attention to what is happening right now, I observe the way things constantly change from moment to moment.
- 25) I am learning that paying attention to what is happening right now is harder than I first thought it would be.
- 26) When I practice paying attention to what is happening right now, I observe experiences while I participate in them.
- 27) When I practice paying attention to what is happening right now, I notice that ordinary experiences seem extraordinary.
- 28) As I practice paying attention to what is happening right now, I notice that my mind wanders frequently.
- 29) When I practice paying attention to what is happening right now, I handle all experiences with equanimity.
- 30) As I practice paying attention to what is happening right now, I notice things about myself I never knew before.

Appendix D
Individual Research Project Instructions

The research option for this assignment reflects the teacher's need for ongoing inquiries into the "being" of the profession. Teaching is as much "being" as it is "doing."

- "Being" focuses on inquiries in the inner-life of the teacher; constantly developing more refined capacities for heightened awareness in classroom practice.
- "Doing" includes inquiries, which focus on constantly developing more effective content, processes, and structures in the classroom.

Individual Research Project--Being: Study of Personal Efficacy of Mindfulness for Teachers

Mindfulness: Being fully conscious that you are doing whatever you are doing. When walking, be conscious that you are walking. When sitting, be conscious you are sitting. No matter what you are doing, your thoughts are only thinking

about what is happening in the moment. There is no room left in consciousness for thoughts about anything that is not present in the moment...when you are brushing your teeth you are concentrating on the feeling of the brush in your hand, the movement across your teeth, the taste of the toothpaste... etc. (You may also be aware that while you are brushing your teeth—fully aware of the movements /sensations involved—you are also aware that you are planning what you will wear, or what you will do that day.) Mindfulness practice is about being fully conscious of what IS happening RIGHT NOW.

When you discover that your thoughts have strayed away from what is happening RIGHT NOW—for example, you might suddenly realize that your thoughts drifted off into worry about some future event or anxiety over something that happened in the past and this will happen frequently during your “Mindfulness Day”—you take a long, slow breath and let that breath be a reminder to get your thoughts back to what is happening in the present moment.

Mindfulness practice is not a competition to see how few times you have to bring your attention back. You are not “doing it wrong” when you discover that your thoughts have wandered away from what is happening RIGHT NOW. This is NORMAL. Mindfulness practice is about NOTICING that your attention has wandered and then bringing it back with your breath as an anchor or signal to your body/mind that you are bringing all your attention back to the present moment.

No matter how many times your thoughts stray during the day, each time you recognize that they have strayed, just take a breath and bring yourself back to the moment. Your breath will become the anchor that brings you back to what’s happening RIGHT NOW. Just as the ship’s anchor keeps the ship from straying too far from the anchored spot, so your breath will constantly bring your thoughts back to what is happening in the moment. Keeping your thoughts anchored to the present moment is also known as being “fully present”. There are many benefits to this practice, as you will discover during your eight weeks of research.

Beginning with the week of Sept. 26-30 and continuing through the week of Nov. 14-18, you will set aside one day out of each set of five days for your “Mindfulness Day.” You may choose any MTWTHF (no weekends) to set up a day of mindfulness (You do not have to use the same (M-F) day each week. Use whatever M-F day is most convenient in any week.) You will figure out a way to remind yourself at the moment of waking that this day is your day of mindfulness. You might hang something on the ceiling or on the wall, a paper with the word “mindfulness” or a twig—anything that

will suggest to you as you open your eyes and see it that today is your day of mindfulness—“Today is your day. Remembering that, perhaps you can feel a your own breath inhaling/exhaling, which affirms that you are in complete mindfulness.”

While lying in bed, begin to slowly to follow your breath—slow, long, and conscious breaths. Then slowly rise from bed, nourishing mindfulness by keeping your thoughts on each motion as you rise. Once up, then practice keeping your thoughts on each movement you make as you go through your regular routine of getting ready for the events of your day (and this might include being aware that at the same time you are aware of the movements/events necessary for getting ready, you are also aware of planning your day). *Whatever you do, do it with intentional attention all day.* Consistently bring your attention back to the present moment each time you discover that your attention has strayed by feeling your breath inhaling and exhaling and using that breath as a reminder, an anchor to hold your thoughts in the present moment.

At the end of each of your “Mindfulness Days” or by midnight of the Friday of that week, create an email journal entry. *This journal entry will include your thoughts about your experience of being intentionally mindful for this day...what insights do you have, what stands out to you about the experience, list the ways this day was different for you than your regular days, what body sensations did you experience...what did you notice that you usually don’t notice...etc. This journal entry is not to be a list of the events of your day, but rather, a reflection on the way being mindful affected each event of your day.* You will email your entry to xxxx@xxxx.com

In the subject heading of your email journal entry, provide the week, day, and your name (See the Revised Individual Research Timeline for the weeks and dates). For example:

1st Journal Entry—Sept. 30—Jane Doe

You will provide eight journal entries, one for each of the eight weeks.

By class time, Wednesday, Nov. 23, you will submit to xxxx@xxxx.com for my review, a one-page, font 12, single-spaced reflection on your eight “Mindfulness Days.”

References

- Andersen, E. B. (1977). Sufficient statistics and latent trait models. *Psychometrika*, 42(1), 69-81.
- Andrich, D. A. (1978). A rating formulation for ordered response categories. *Psychometrika*, 43(4), 561-574.

- Andrich, D. A. (1988). *Rasch models for measurement*. (Vols. series no. 07-068, Sage University Paper Series on Quantitative Applications in the Social Sciences). Beverly Hills, CA: Sage Publications.
- Andrich, D. A. (1996). Measurement criteria for choosing among models with graded responses. In A. von Eye & C. Clogg (Eds.), *Categorical variables in developmental research: Methods of analysis* (pp. 3-35). New York: Academic Press, Inc.
- Andrich, D. (1997). Georg Rasch in his own words [excerpt from a 1979 interview]. *Rasch Measurement Transactions*, 11(1), 542-3. [<http://www.rasch.org/rmt/rmt111.htm#Georgl>].
- Andrich, D. (2002). Understanding resistance to the data-model relationship in Rasch's paradigm: A reflection for the next generation. *Journal of Applied Measurement*, 3(3), 325-59.
- Andrich, D. (2004, January). Controversy and the Rasch model: A characteristic of incompatible paradigms? *Medical Care*, 42(1), I-7-I-16.
- Arnold, S. F. (1985, September). Sufficiency and invariance. *Statistics & Probability Letters*, 3, 275-279.
- Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006). Using self-report assessment methods to explore facets of mindfulness. *Assessment*, 13(1), 27-45.
- Baer, R. A., Smith, G. T., & Allen, K. B. (2004). Assessment of mindfulness by self-report. *Assessment*, 11(3), 191-206.
- Bezruczko, N. (Ed.). (2005). *Rasch measurement in health sciences*. Maple Grove, MN: JAM Press.
- Bishop, S. R., Lau, M., Shapiro, S., Carlson, L., Anderson, N. D., Carmody, J., Segal, Z. V., Abbey, S., Speca, M., Velting, D., & Devins, G. (2004). Mindfulness: A proposed operational definition. *Clinical Psychology: Science and Practice*, 11(3), 230-241.
- Bond, T., & Fox, C. (2007). *Applying the Rasch model: Fundamental measurement in the human sciences* (2nd ed.). Mahwah, New Jersey: Lawrence Erlbaum Associates [<http://homes.jcu.edu.au/~edtg/b/book/>].
- Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in Psychological well-being. *Journal of Personality and Social Psychology*, 84(4), 822-848.
- Cliff, N. (1992). Abstract measurement theory and the revolution that never happened. *Psychological Science*, 3, 186-190.
- Dawson, T. L. (2002a, Summer). A comparison of three developmental stage scoring systems. *Journal of Applied Measurement*, 3(2), 146-89.
- Dawson, T. L. (2002b, March). New tools, new insights: Kohlberg's moral reasoning stages revisited. *International Journal of Behavioral Development*, 26(2), 154-66.
- Derrida, J. (1982). *Margins of philosophy*. Chicago: University of Chicago Press.
- Derrida, J. (1989). On colleges and philosophy: An interview conducted by Geoffrey Bennington. In L. Appignanesi (Ed.), *Postmodernism: ICA documents* (pp. 209-28). London: Free Association Books.
- Embretson, S. E. (1996, September). Item Response Theory models and spurious interaction effects in factorial ANOVA designs. *Applied Psychological Measurement*, 20(3), 201-212.
- Falmagne, J.-C., & Narens, L. (1983). Scales and meaningfulness of quantitative laws. *Synthese*, 55, 287-325.
- Fischer, G. H. (1995). Derivations of the Rasch model. In G. Fischer & I. Molenaar (Eds.), *Rasch models: Foundations, recent developments, and applications* (pp. 15-38). New York: Springer-Verlag
- Fisher, R. A. (1922). On the mathematical foundations of theoretical statistics. *Philosophical Transactions of the Royal Society of London, A*, 222, 309-68.
- Fisher, W. P., Jr. (1994). The Rasch debate: Validity and revolution in educational measurement. In M. Wilson (Ed.), *Objective measurement: Theory into practice*. Vol. 2 (pp. 36-72). Norwood, NJ: Ablex Publishing Corporation.
- Fisher, W. P., Jr. (1997a). Physical disability construct convergence across instruments: Towards a universal metric. *Journal of Outcome Measurement*, 1(2), 87-113.
- Fisher, W. P., Jr. (1997b). What scale-free measurement means to health outcomes research. *Physical Medicine & Rehabilitation State of the Art Reviews*, 11(2), 357-373.
- Fisher, W. P., Jr. (2003a, December). Mathematics, measurement, metaphor, metaphysics: Part I. Implications for method in postmodern science. *Theory & Psychology*, 13(6), 753-90.
- Fisher, W. P., Jr. (2003b, December). Mathematics, measurement, metaphor, metaphysics: Part II. Accounting for Galileo's "fateful omission." *Theory & Psychology*, 13(6), 790-828.
- Fisher, W. P., Jr. (2004). Meaning and method in the human sciences. *Human Studies: A Journal for Philosophy and the Social Sciences*, 27(4), 429-54.
- Fisher, W. P., Jr. (2006). Survey design recommendations. *Rasch Measurement Transactions*, 20(3), 1072-4 [<http://www.rasch.org/rmt/rmt203f.htm>].
- Fisher, W. P., Jr., & Wright, B. D. (Eds.). (1994). Applications of probabilistic conjoint measurement. *International Journal of Educational Research*, 21(6), 557-664.

- Friedman, H. (2003). Methodolatry and graphicacy. *The American Psychologist*, 58(10), 817-818.
- Gasché, R. (1987). Infrastructures and systemacity. In J. Sallis (Ed.), *Deconstruction and philosophy: The texts of Jacques Derrida* (pp. 3-20). Chicago: University of Chicago Press.
- Goleman, D. (1995). *Emotional intelligence*. New York: Bantam.
- Greening, T. (n.d.). Tom Greening—International editor, Journal of Humanistic Psychology. Retrieved March 5, 2008 from www.tom.greening.com/tged.html
- Guttman, L. (1985). The illogic of statistical inference for cumulative science. *Applied Stochastic Models and Data Analysis*, 1, 3-10.
- Hahn, T. N. (1976). *The miracle of mindfulness*. Boston: Beacon Press.
- Hall, W. J., Wijsman, R. A., & Ghosh, J. K. (1965). The relationship between sufficiency and invariance with applications in sequential analysis. *Annals of Mathematical Statistics*, 36, 575-614.
- Kabat-Zinn, J. (2005). *Coming to our senses*. New York: Hyperion.
- Kolmogorov, A. N. (1950). *Foundations of the theory of probability*. New York: Chelsea.
- Krantz, D. H., Luce, R. D., Suppes, P., & Tversky, A. (1971). *Foundations of measurement*. Vol. 1. *Additive and polynomial representations*. New York: Academic Press.
- Kuhn, T. S. (1977). *The essential tension: Selected studies in scientific tradition and change*. Chicago: University of Chicago Press.
- Latour, B. (1987). *Science in action: How to follow scientists and engineers through society*. New York: Cambridge University Press.
- Lau, M. A., Bishop, S. R., Segal, Z. V., Buis, T., Anderson, N. D., Carlson, L., Shapiro, S., & Carmody, J. (2006). The Toronto Mindfulness Scale: Development and validation. *Journal of Clinical Psychology*, 62(12), 1445-1467.
- Levy, P. (1937). *Theorie de l'addition des variables aleatoires* [Combination theory of unpredictable variables]. Paris: Wiley.
- Linacre, J. M. (1998). Detecting multidimensionality: Which residual data-type works best? *Journal of Outcome Measurement*, 2(3), 266-83.
- Linacre, J. M. (1999). Investigating rating scale category utility. *Journal of Outcome Measurement*, 3(2), 103-22.
- Linacre, J. M. (2002). Understanding Rasch measurement: Optimizing rating scale category effectiveness. *Journal of Applied Measurement*, 3(1), 85-106.
- Linacre, J. M. (2006). *WINSTEPS Rasch measurement software*. Chicago: WINSTEPS.
- Loevinger, J. (1965). Person and population as psychometric concepts. *Psychological Review*, 72(2), 143-155.
- Luce, R. D., & Tukey, J. W. (1964). Simultaneous conjoint measurement: A new kind of fundamental measurement. *Journal of Mathematical Psychology*, 1(1), 1-27.
- Lumsden, J. (1978). Tests are perfectly reliable. *British Journal of Mathematical and Statistical Psychology*, 31, 19-26.
- Michell, J. (1990). *An introduction to the logic of psychological measurement*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Michell, J. (1997a). Quantitative science and the definition of measurement in psychology. *British Journal of Psychology*, 88, 355-383.
- Michell, J. (1997b). Reply to Kline, Laming, Lovie, Luce, and Morgan. *British Journal of Psychology*, 88, 401-406.
- Michell, J. (1999). *Measurement in psychology: A critical history of a methodological concept*. Cambridge: Cambridge University Press.
- Michell, J. (2000, October). Normal science, pathological science and psychometrics. *Theory & Psychology*, 10(5), 639-667.
- Moustakas, C. (1990). *Heuristic research: Design, methodology, and applications*. Newbury Park, CA: Sage Publishers.
- Mundy, B. (1986). On the general theory of meaningful representation. *Synthese*, 67, 391-437.
- Narens, L. (2002). *Theories of meaningfulness* (S. W. Link & J. T. Townsend, Eds.). Scientific Psychology Series. Mahwah, NJ: Lawrence Erlbaum Associates.
- Perline, R., Wright, B. D., & Wainer, H. (1979, Spring). The Rasch model as additive conjoint measurement. *Applied Psychological Measurement*, 3(2), 237-255.
- Rasch, G. (1960). *Probabilistic models for some intelligence and attainment tests*. Copenhagen: Danmarks Paedagogiske Institut. [Reprinted, 1980, with Foreword and Afterword by B. D. Wright, Chicago: University of Chicago Press.]
- Ricoeur, P. (1977). *The rule of metaphor: Multi-disciplinary studies of the creation of meaning in language* (R. Czerny, Trans.). Toronto: University of Toronto Press.
- Roberts, F. S. (1985). Applications of the theory of meaningfulness to psychology. *Journal of Mathematical Psychology*, 29, 311-32.
- Roberts, F. S. (1999). Meaningless statements. In R. Graham, J. Kratochvil, J. Nesetril & F. Roberts (Eds.), *Contemporary trends in discrete mathematics*, DIMACS Series, Volume 49 (pp. 257-274). Providence, RI: American Mathematical Society.

- Rogosa, D. (1987). Casual models do not support scientific conclusions: A comment in support of Freedman. *Journal of Educational Statistics*, 12(2), 185-95.
- Ryback, D. (2006). Self-determination and the neurology of mindfulness. *Journal of Humanistic Psychology*, 46(4), 474-4934.
- Seligman, M. E. P., & Csikszentmihalyi, M. (2000). Positive psychology: An introduction. *American Psychologist*, 55, 5-14.
- Smith, E. V., Jr. (2002). Understanding Rasch measurement: Detecting and evaluating the impact of multidimensionality using item fit statistics and principal component analysis of residuals. *Journal of Applied Measurement*, 3(2), 205-31.
- Smith, R. M. (1996). A comparison of methods for determining dimensionality in Rasch measurement. *Structural Equation Modeling*, 3(1), 25-40.
- Smith, R. M. (2000). Fit analysis in latent trait measurement models. *Journal of Applied Measurement*, 1(2), 199-218.
- Solloway, S. G. (1999). Teachers as contemplative practitioners: Presence, meditation, and mindfulness as a classroom practice. Unpublished dissertation, Oklahoma State University at Stillwater, Oklahoma.
- Solloway, S. G. (2000). Contemplative practitioners: The project of thinking gaze differently. *Encounter: Education for Meaning and Social Justice*, 13(3), 30-42.
- Solloway, S. G. (2001). Mindfulness, the hermeneutic imagination and jouissance: Action inquiry and transformations in classroom practice. *Journal of Curriculum Theorizing*, 17(4), 155-170.
- Solloway, S. G. (2004). Naked vulnerabilities: Intersections of mindfulness, hermeneutics, and professor/student realities. *American Educational Research Association*, April.
- Solloway, S. G., & Fisher, W. P., Jr. (2007). Mindfulness practice: A Rasch variable construct innovation. *Journal of Applied Measurement*, 8(4), 359-372.
- SPSS for Windows, V. 14. (2005). Chicago: SPSS Inc.
- Stenner, A. J. (1994). Specific objectivity - local and general. *Rasch Measurement Transactions*, 8(3), 374 [http://www.rasch.org/rmt/rmt83e.htm].
- Susser, M., & Susser, E. (1996). Choosing a future for epidemiology: From black box to Chinese boxes and eco-epidemiology. *American Journal of Public Health*, 86(5), 674-7.
- van der Linden, W. J. (1992). Sufficient and necessary statistics. *Rasch Measurement Transactions*, 6(3), 231 [http://rasch.org/rmt/rmt63d.htm].
- van der Linden, W. J., & Hambleton, R. K. (Eds.). (1997). *Handbook of modern Item Response Theory (IRT)*. New York: Springer-Verlag.
- Wilson, M. (2005). *Constructing measures: An item response modeling approach*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Wilson, T. P. (1971). Critique of ordinal variables. *Social Forces*, 49, 432-444.
- Wright, B. D. (1977a). Misunderstanding the Rasch model. *Journal of Educational Measurement*, 14(3), 219-225.
- Wright, B. D. (1977b). Solving measurement problems with the Rasch model. *Journal of Educational Measurement*, 14(2), 97-116 [http://www.rasch.org/memo42.htm].
- Wright, B. D. (1980). Foreword, Afterword. In *Probabilistic models for some intelligence and attainment tests*, by Georg Rasch (pp. ix-xix, 185-199. http://www.rasch.org/memo63.htm) Chicago: University of Chicago Press.
- Wright, B. D. (1984). Despair and hope for educational measurement. *Contemporary Education Review*, 3(1), 281-288.
- Wright, B. D. (1985). Additivity in psychological measurement. In E. Roskam (Ed.), *Measurement and personality assessment*. North Holland: Elsevier Science Ltd.
- Wright, B. D. (1988, Autumn). Georg Rasch and measurement. *Rasch Measurement Transactions*, 2(3), 25-32 [http://www.rasch.org/rmt/rmt23.htm].
- Wright, B. D. (1991). Factor item analysis versus Rasch item analysis. *Rasch Measurement Transactions*, 5(1), 134-135 [http://www.rasch.org/rmt/rmt51.htm].
- Wright, B. D. (1997a, Winter). A history of social science measurement. *Educational Measurement: Issues and Practice*, 16(4), 33-45, 52 [http://209.41.24.153/memo62.htm].
- Wright, B. D. (1997b). Fundamental measurement for outcome evaluation. *Physical Medicine & Rehabilitation State of the Art Reviews*, 11(2), 261-88.
- Wright, B. D. (1997c). "Logits"? *Rasch Measurement Transactions*, 7(2), 288.
- Wright, B. D. (1999). Fundamental measurement for psychology. In S. E. Embretson & S. L. Hershberger (Eds.), *The new rules of measurement: What every educator and psychologist should know* (pp. 65-104 [http://www.rasch.org/memo64.htm]). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Wright, B. D., & Masters, G. N. (1982). *Rating scale analysis*. Chicago: MESA Press.
- Wright, B. D., & Mok, M. (2000). Rasch models overview. *Journal of Applied Measurement*, 1, 83-106.

About the Authors

Sharon G. Solloway, Ph.D., is an Associate Professor in the Department of Developmental Instruction, Bloomsburg University, Bloomsburg, Pennsylvania. Her teaching and research seek to illuminate the value of mindfulness practice in the university classroom using both qualitative and quantitative methodologies. Her work is the first to use Rasch models to measure mindfulness practice effects. She may be contacted at ssollowa@bloomu.edu.

William P. Fisher, Jr., Ph.D., was a Spencer Foundation Dissertation Fellow at the University of Chicago, where he earned A.M. and Ph.D. degrees. He is currently Chief Science Officer at Avatar International, Inc., in Orlando, Florida. Fisher is a student of the history and philosophy of science, and is skilled in the calibration of invariant metrics for a wide variety of constructs in the human sciences.