# A Photograph-Based Measure of Students' Beliefs About Math

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**Abstract:** While there is some consensus on the importance of students' beliefs about mathematics, it can be difficult to measure those beliefs. Thirty-five sixth-graders and 54 undergraduates completed a photo sort task that required them to make judgments about the extent to which activities depicted in a series of photographs "involved math." Results show the measure had some desirable properties, thus providing a proof of concept for non-verbal, photograph-based measures of students' views of mathematics.

## Introduction

Students' beliefs about what is and is not mathematical are associated with a number of important problem-solving and motivational outcomes (Muis, 2004). In particular, studies have shown that the belief that mathematics is largely computational and meaningless outside of the classroom context can be a significant barrier to flexibility in problem solving (e.g., Schoenfeld, 1991). Despite widespread interest in students' beliefs about mathematics, they can be difficult to assess properly. Hammer and Elby (2002) note that, in spite of evidence to the contrary, many researchers tacitly assume that students' beliefs are coherent and consistent across context and across time. This mistaken assumption can lead to an over-reliance on verbal measures of beliefs, such as surveys and questionnaires, which can misrepresent these beliefs. As such, new, non-verbal measures of students' beliefs about mathematics may be particularly valuable to the field.

This paper reports on an exploratory effort to develop such a measure. As a part of a broader design study looking at students' views of mathematics in and out of school, a photo sort task was developed to help assess students' views of mathematics. As Schwartz, Chang, and Martin (2008) note, one of the most important contributions that design research can make is the development of new research instrumentation (i.e., measures) that can be shared with others. The photo sort task and its properties are the focus of the analysis here.

## Method

### Participants

Participants were 35 sixth-grade students (19 girls, 16 boys) from a diverse middle school in an urban area in California. Students participated as part of their math class. In addition, 54 undergraduates enrolled in an education course served as a comparison group.

### Materials and Procedure

The photo sort task made use of a set of 25 photographs depicting everyday activities such as cooking, construction, dancing, and playing videogames (photos are available from the authors on request). Each student sorted the photographs into one of four categories based on whether they thought the activity "involved math": definitely math; probably math; probably not math; and definitely math. Students then categorized the photos based on their experience with the activities: things they had done themselves (personal experience), things they had not done but a family member had done (family experience), and things neither they nor a family member had done (no experience).

Following this initial photo sort, students completed a series of homework and in-class activities that gave them the opportunity to take their own photographs, share those photos with classmates, and participate in online and in-person discussions about what "counts" as mathematics. Students then completed a second set of ratings for the photo sort task.

In addition to the sixth-graders, a group of 54 undergraduates completed a modified version of the photo sort task. The instructions were the same, but they viewed digital projections of the photographs, rather than sorting physical prints. Their data served as an adult baseline.

## Results

We present three pieces of evidence for the value of the photo sort task as a measure of students' beliefs about what "counts" as mathematical. First, sixth-grade students' ratings from the first and second photo sort were moderately highly correlated, $r = .62$. While this correlation is not as high as one would expect for a well-established measure, it is a reasonably good indication that students' responses were not random, but were related to an enduring underlying variable.

Second, students' ratings of activities were predicted by their experiences with those activities. There was a risk that a spurious association between experience and rating could arise from the choice of photographs (e.g., if photos showed only two activities, math class in school – high experience and high math – and writing novels – low experience and low math). To address this potential problem, we treated undergraduate data as an approximately normative guide to how mathematical each photograph was (results remain the same with or without this correction) . For each sixth-grade rating, we computed the deviation from the mean undergraduate rating for that photograph. For example, undergraduates rated the photograph of people playing chess as "probably math" and dancing as "probably not math." A sixth grader who rated both photographs as "probably not math" (as many did) would have deviation scores of -1 and 0, respectively, for those two items.

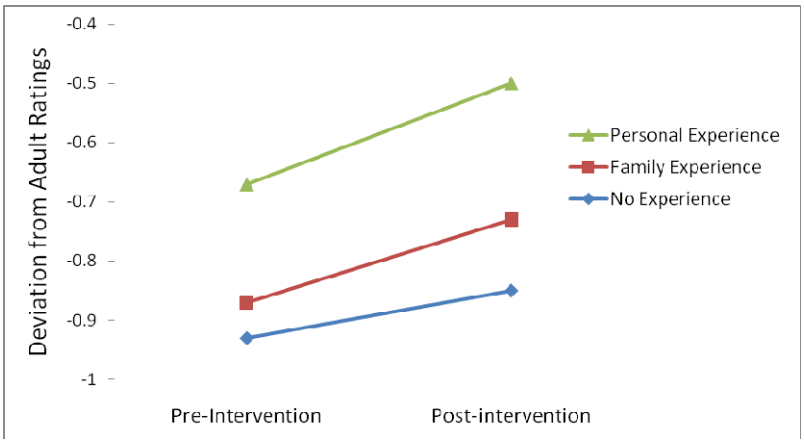


Figure 1. Sixth graders' deviation from adult ratings on the photo sort task.

We found that sixth-graders' personal experience with activities was predictive of their ratings for those activities. That is, students were the most adult-like in their ratings for activities with which they had personal experience, and the least adult like (and the least willing to call things mathematical) for activities with which they had little experience (see Figure 1). This result shows that the photo sort measure was sensitive, on an individual item level, to students' actual, real world experiences. Note that this improves upon measures of beliefs which treat them as independent of experience (Hammer & Elby, 2002).

Finally, as is evident in Figure 1, the measure was responsive to an intervention designed to have students reflect on the nature of what counts as mathematics in and out of school. Across all items, mean ratings increased about 0.15 points (about 0.4 standard deviations). The lack of control group requires caution in interpreting this result, as other factors may be responsible for the change. However, the change is in the anticipated direction, and it shows promise for the sensitivity of the measure to an intervention. Further analysis of the data will investigate the sensitivity of the measure at the individual item level.

## Discussion and Conclusion

The photo sort task showed several promising properties. It was reasonably consistent from pre- to post-test, while still being responsive to an intervention. Most important, it was sensitive to students' real world experiences with the items depicted in the photographs. The analysis given here should not be taken to suggest that the photo sort task, as presented, should be widely adopted. Instead, the results provide a proof of concept that non-verbal, photograph-based tasks may provide a promising addition to researchers' arsenal of measures of students' beliefs about mathematics.

## References

Hammer, D., & Elby, A. (2002). On the form of a personal epistemology. In B.K. Hofer and P.R. Pintrich, (Eds.) *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 169 - 190). Mahwah, NJ: Erlbaum.

Muis, K. R. (2004). Personal epistemology and mathematics: A critical review and synthesis of research. *Review of Educational Research, 74*(3), 317-377.

Schoenfeld, A. H. (1991). On mathematics as sense-making: An informal attack on the unfortunate divorce of formal and informal mathematics. In J. F. Voss, & D. N. Perkins (Eds.), *Informal reasoning and education*. (pp. 311-343). Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc.

Schwartz, D. L., Chang, J., & Martin, L. (2008). Innovation and instrumentation: Taking the turn to efficiency. In A. E. Kelly, R. A. Lesh, & J. Y. Baek (Eds.), *Handbook of design research methods in education: Innovations in science, technology, engineering, and mathematics learning and teaching* (pp. 47-67). New York: Routledge.