Measuring Maker Mindset: Establishing Content Validity With Card Sorting

Jonathan D. Cohen, Georgia State University, jcohen@gsu.edu
Lauren Margulieux, Georgia State University, lmargulieux@gsu.edu
Maggie Renken, Georgia State University, mrenken@gsu.edu
W. Monty Jones, Virginia Commonwealth University, joneswm2@vcu.edu
Shaunna Smith, Texas State University, Shaunna_smith@txstate.edu

Abstract: This poster describes the development of an instrument to measure maker mindset and establishes its content validity. We identified five component constructs of maker mindsets and developed an instrument that asks participants to respond to vignettes related to each construct. To establish content validity, a group of maker professionals (n=17) completed a card sorting task in which they grouped the 25 vignette-based items based on the maker mindset attribute that they thought each item was intended to measure. Analysis of the results revealed 16 items that were grouped in one of three clusters that largely aligned with the five original constructs after collapsing some constructs. We conclude that the 16 remaining items have content validity.

Introduction

Recently, researchers have identified and defined the problems, constructs, challenges, and opportunities associated with the infusion of maker principles and technologies into education. Much of that body of research has identified constructs—often aggregated into the concept of a *maker mindset* (further defined below)—that represent the cognitive characteristics important to making. We believe that maker research has advanced to the point at which it is now time to apply the lessons learned through this type of exploratory research to the development of a methodologically rigorous psychometric scale that measures maker mindset. We therefore describe the first stage of development of the Maker Mindset Instrument (MMI), a scale designed to measure component factors of a maker mindset. To develop a scale for maker mindset, we identified a set of constructs to serve as sub-scales because although we expect an individual's maker mindset to holistically represent his or her approach to making environments and activities, we also expect certain features of the mindset may be more or less relevant to certain students, in certain environments, and when attempting certain activities.

Maker mindset constructs

Via a thorough literature search, we identified a set of five constructs to include in the MMI through a review of the literature on making, which is the upper limit of the number of constructs that should be measured with one scale. For our first construct, we grouped together resilience, grit, and "can-do" attitude into a general **resilience** construct. The next construct is **growth mindset**. This construct likely contributes to resilience but is a distinct set of beliefs about aptitude and intelligence (Dweck, 2006). Our third construct is **creativity**. Makerspaces remove many barriers between ideas and implementation. Therefore, creativity is central to a maker mindset. Our fourth construct combines several related constructs: curiosity about how things work, playfulness in trying new things, iterative practices, and a do-it-yourself attitude. All of these aspects are subsumed into the **willingness to tinker** construct. Researchers have characterized tinkering as including some of the problem-solving and iterative design-focused behaviors as engineering, but with a more playful, experimental orientation (Martinez & Stager, 2013; Resnick & Rosenbaum, 2013; Vossoughi, Escudé, Kong, & Hooper, 2013). The fifth construct is a **collaboration orientation**, which combines disposition to share and collaborate with an interdisciplinary approach to challenges.

Scale development

We wrote five situational vignettes per construct, for a total of 25 vignettes. Vignettes allow respondents to reveal their own mindset by answering a question about a fictitious character without requiring potentially biased self-reporting (Wallander, 2009). Following each vignette, respondents are tasked with answering how much they agree with a statement about the vignette character's mindset. For each vignette, i.e., item, the scale of agreement was the same—a 7-point Likert scale, anchored between strongly disagree and strongly agree. An example of a vignette follows:

> Sadik built a fort out of sticks. He built it to play in with his friends. It took him a while to build it. It's not very stable, but it hasn't fallen down. Sadik wants the fort to stay standing for a long time. He thinks he knows a way to make it more stable. He decides to tear it down and rebuild it with a new design. How much do you agree with the following statement: *It's worth Sadik's time to rebuild the fort, even though it hasn't fallen down yet.*

Participants

Twenty-one individuals responded to our recruitment. We excluded 4 of the 21 total responses for being incomplete or completed incorrectly. Nine of the 17 respondents (53%) identified as male, and the remaining 8 (47%) identified as female. One of the respondents (6%) identified as Hispanic or Latino. Fourteen of the respondents (82%) identified as white, 2 (12%) identified as Black or African American, and 1 (6%) identified as Asian. Fourteen of the respondents (82%) reported speaking English at home, and 3 (18%) reported speaking English and/or another language at home.

Procedure

The card sorting task was conducted online. In an open card sorting task, participants are presented with a number of stimuli (in this case, the 25 vignettes) and are asked to sort them into piles based on some criteria established by the researchers. Participants started by watching a brief, one-minute instructional video that introduced the task. Participants were instructed to read through the vignettes, then sort them into 3-7 groups based on what construct/attitude the participant felt the vignettes were attempting to measure. Once participants completed sorting all of the cards, they named each group and submitted their answers.

Validation results and discussion

To quantitatively analyze the groups that participants had created, we used multidimensional scaling (MDS). To compare participants' categories to the constructs, we made agreement matrices for each participant. In the agreement matrix, the matrix was organized by construct, and we indicated which cards were grouped together.

These matrices were then analyzed using ALSCAL to determine the number of dimensions present in the data and the coordinates of each card in p dimensional space (i.e., to determine which cards clustered together). Based on the analysis, we determined that three unique dimensions were represented. Young's S-stress was .299 with a single dimension. With two dimensions, S-stress (.166) improved by .132. With three dimensions, S-stress (.143) improved by .023, which is a small improvement, but, based on inspection of the coordinates for each item, was meaningful. With four dimensions, S-stress improvement was only .006 and, therefore, not meaningful enough to justify the inclusion of a fourth dimension.

Based on the first dimension, cards 3-8 were separate from the others. These cards are supposed to represent resilience and growth mindset, which are related theoretically, so we called this dimension **Resilience/Growth Mindset**. Based on the second dimension, cards 21-25 clustered closely and are supposed to represent collaboration orientation, so these items represent the dimension **Collaboration Orientation**. The last dimension is harder to parse, which makes sense based on the .023 S-stress improvement that it contributes. It roughly accounts for the creativity and willingness to tinker constructs, though, which are fundamental to maker mindset, so it makes sense that expert makers would group them with other constructs frequently. We called this dimension **Tinkering** and retained cards 11-12, 14-16, and 18 because they clustered closely.

References

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