Investigating Measurement Invariance and other Psychometric Measures of the Mindset Instrument

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ABSTRACT

Psychometric analysis was conducted on the Dweck Mindset Instrument (DMI) to evaluate model fit and determine if the measure had measurement invariance between Japanese and American students. There was a specific mathematics focus due to an increased demand for STEM related skills and with American students often falling behind other industrialized countries in mathematics achievement measures. Middle and high school students were the sample due to the decrease in math achievement and interest that occurs around middle school. Other scales such as math self-efficacy, self-concept, interest, and math anxiety scales as well as perceived control were measured in order to see how mindset relates to those more traditional concepts. The model fit was analyzed with a bi-factor negative method effects model showing the best fit of the models tested. While both the correlations with the others scales and the measurement invariance analysis showed that the mindset instrument tended to work similarly within each country, the measure did not meet stricter measurement invariance standards meaning that the group means might not be comparable.

Keywords: Dweck Mindset Instrument, Measurement Invariance, Wording Effects

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INTRODUCTION

- Previous research focused on comparing Western and Eastern academic attitudes found Eastern citizens put more emphasis on effort and persistence as factors contributing to academic success than Western citizens. This research was done in a variety or ways with a variety of methods.
- The Dweck Mindset Instruments (DMI) tries to categorize how one views intelligence. If one views intelligence as malleable and something that can grow they have an incremental or growth mindset. If intelligence is viewed as largely unchangeable they have an entity mindset.
- Based on previous cross-cultural research, since Eastern citizens put more focus on effort and studying to improve academic achievement than Western citizens it was hypothesized that Eastern citizens would have more of an incremental mindset.
- Research has shows that an incremental mindset relates to better academic attitudes and academic outcomes so it would be useful to understand more about how to best measure this concept and how this concept may differ across cultures.

Method

- **Participants:**
  - Sample of 407 American students from two junior high and one high school.
  - There was 426 Japanese students from one junior high and one high school.
- **Measurement tools:**
  - A few demographic questions as well as the Dwesk Mindset Instrument (DMI) which includes seven subscales measuring various academic attitudes
  - (fill out more info for scales; purpose of this subscale)
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- **Analysis:**
  - Correlations and reliabilities on the scales was done on the whole sample.
  - For testing the model fit of the DMI, 35% of the sample was used for exploratory purpose to see which model fit best and 65% was used for additional model fit analysis such as CFA and measurement invariance analysis.
  - Mplus, SAS???
- **Limitation:**
  - The American sample needed a parental consent form, unlike with the Japanese sample, the response rate for American students was around 40% while the Japanese students was near 100%.

RESULTS

- American students tended to have more positive academic attitudes than the Japanese students. This fits with previous findings as the PISA showed that math anxiety was higher in Japanese students but math interest and math self-concept was higher in American students.
- However, contrary to the literature review, Japanese students reported having a lower incremental mindset than American students, though as will later be discussed strict measurement invariance for the DMI was not established.

RESULTS

Measure	2	3	4	5	6	7	Alpha	Mean	SD
1. Mindset	.50/.52	.33/.24	-.29/-.25	.22/.23	.33/.29	.64/.60	.85/.83	4.73/4.01	.94/.88
2. Perceived Control	–	.38/.28	-.42/-.20	.26/.28	.42/.29	.49/.54	.73/.74	4.21/3.85	.55/.57
3. Math Self-concept	–	–	-.72/-.61	.62/.65	.85/.83	.33/.35	.85/.90	2.86/2.10	.68/.74
4. Math Anxiety	–	–	–	-.51/-.48	-.78/-.71	-.34/-.33	.85/.87	2.11/2.43	.71/.75
5. Math Interest	–	–	–	–	.63/.60	.21/.40	.90/.88	2.60/2.00	.82/.72
6. Math Self-Efficacy	–	–	–	–	–	.39/.40	.90/.86	3.55/2.80	.80/.74
7. Math Mindset	–	–	–	–	–	–	.70/.77	3.92/3.45	.48/.51

Note. **United States sample is on the left and Japan sample is on the right, all correlations and t-tests were significant at the p < .001 level**

- The above correlations also tended to be as hypothesized. Positive academic attitudes were positively correlated with each other while being negatively correlated with a negative academic attitude.
- While the DMI correlated with many other scales it was not highly correlated enough to show that the concept of mindset is not distinct from other concepts such as self-efficacy and perceived control.
- The correlations and Cronbach's alpha among the scales were very similar across cultures for a majority of the scales.
- An exploratory factor analysis was done with the DMI on 35% of the data comparing a single factor model, a two factor correlated model (with incremental/positively worded questions on one factor and entity/negatively worded questions on the other factor), and two bi-factor models with the secondary factor being either the positively or negatively worded questions. This analysis showed the bi-factor entity negative method effects model fit best.
- This was also replicated when CFA was used on the other 65% of the data.

Model	X^2	SRMR	RMSEA	CFI
United States and Japan				
One factor	113.34/201.04	.07/.11	.14/.19	.86/.79
Two factor correlated	73.00/67.15	.07/.07	.11/.10	.92/.95
Bi-factor positive method effects	65.71/29.06	.06/.04	.12/.06	.92/.98
Bi-factor negative method effects	27.76/59.47	.03/.06	.06/.11	.98/.95
Combined				
One factor	314.37	.093	.167	.821
Two factor correlated	140.16	.067	.105	.933
Bi-factor positive method effects	94.77	.051	.094	.958
Bi-factor negative method effects	87.23	.047	.088	.963

Note. **The United States sample is on the left and Japan is on the right Smaller X^2 values indicate better fit, SRMR <.08, RMSEA <.08, and CFI >.95 is generally considered an adequate fit**

- However, even thought the overall sample showed adequate fit indices for the bi-factor negative method effects model, it just barely met fit indices.
- Additionally, the two bi-factor models had very differing fit between the two countries with the bi-factor negative method effects model being the best fit for the United States sample, but the bi-factor positive method effects model being the best fit for the Japanese sample which is a concern when measurement invariance for this instrument hopes to be established.

- Configural, scalar, and metric invariance models were tested on the bi-factor negative method effect model.

Bi-factor negative method effects	X^2	SRMR	RMSEA	CFI
Configural Invariance	87.582	.042	.086	.963
Scalar Invariance	168.280	.074	.102	.921
Metric Invariance	241.601	.165	.137	.871

Note. **Smaller X^2 values indicate better fit, SRMR <.08, RMSEA <.08, and CFI >.95 is generally considered an adequate fit**

- Configural invariance means that the factor loadings across the groups are similar, that is, the measurement seems to be working similarly within each group. This is also supported by the similar correlations the DMI has with other constructs across the two cultures.
- Configural invariance was the only model that showed adequate fit and other stricter tests of measurement invariance failed. Basically, while the DMI seems to be working similarity within each culture, it may be problematic to compare the DMI scores across those cultures.

CONCLUSIONS

- Differences between the Japanese and American students tended to be consistent with previous findings with Japanese students reported to having more negative mathematics attitudes.
- The DMI did not show a good one-factor fit. Other models were tested and the bi-factor negative method effects model was used for measurement invariance analysis.
- Even though the American sample reported having a more incremental mindset than the Japanese sample, the DMI did not shown to meet strict measurement invariance standards.
- Some limitations are that the response rates were very different between the two populations. The measure also had the wording of the questions and the type of intelligence the question is measuring conflated it is hard to see whether the method effects are from wording of the questions or the concept it is trying to measure.

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