Measures Technical Brief

Fascination in Science    version 3.2    Mar 2016

Overview

Description of the Construct
Fascination involves interest and positive affect towards science, curiosity about the natural world, and goals of acquiring and mastering scientific skills and ideas. A learner can have emotional and cognitive attachment/obsession with science topics and tasks that serve as a driver for various forms of participation. This dimension includes aspects of what many researchers have referred to as curiosity (Gardner, 1987; Loewenstein, 1994; Litman & Spielberger, 2003), interest in science both in and out of school (Hidi & Renninger, 2006; Kind, Jones, & Barmby, 2007; Reid, 2006; Baram-Tsabari & Yarden, 2005; Girod, 2001; Hulleman, & Harackiewicz, 2009), and mastery goals for science content (Ames, 1992). It also includes affective elements such as emotions related to science, scientific inquiry, and knowledge. Cited research to date in each of these areas suggests that each of these constructs may be compelling motivators to choice towards, engagement during, and attainment in science learning. Therefore, Fascination should be an important driver towards these aspects of success.

Intended Uses of the Instrument
The Measuring Activation (MA) instrument was written for use with 10-14 year-old respondents. The Fascination dimension scale of the MA instrument is used to measure an individual's fascination with natural and physical phenomena at the time of the survey response. The construct is conceived as semi-malleable and therefore is amenable to intervention. However, we expect that changes in scale scores to only be present for interventions that are at least several days or months in duration, not single hour-long experiences. The survey can be used in longitudinal contexts, such as simple pre-post and repeated measures over longer periods of time. We suggest a minimum of week between pre- and post-administrations due to the length of the overall survey and the time required for changes to be observed. The survey is not intended for high-stakes decisions about students (e.g., pass/fail determination, selection of program participants) or programs.

Evidence of Reliability and Internal Structure
Analyses were based on a total sample of 2903 6th and 8th grade students. Both the raw (Cronbach’s) and polychoric alpha coefficients were found to be good (.86 and .90, respectively). Further description of analytical procedures and results are available in the psychometric properties section of this report.

How to Score
As the Fascination scale is designed to be scored using the Rasch model, we encourage the use of programs such as ConQuest (ACER, 2007), Winsteps (Linacre, 2008), IRTpro (Cai, Thissen, & du Toit, 2011), and the R packages eRm (Mair & Hatzinger, 2007) and TAM (Kiefer, Robitzsch, & Wu, 2014). A simple alternative is to produce an overall score comprised of the simple average of all eight items (all of which are based on a 4-point Likert scale). The use of an average score has two notable pitfalls: 1) the contribution of each item to the factor is assumed to be equal which is unlikely to be true and 2) the number of possible variations of average values is more limited. The former varies based on the characteristics of the scale, while the latter is an inherent limitation that should be taken into account during secondary analyses. While occasions of missing data are not problematic to both of these scoring methods, a prevalence of missing data should be resolved prior to analyses (e.g., in the current set of analyses, cases with more than 50% of the items missing were eliminated from analyses).

Analytical Options
Once scores are generated for the scale, researchers and evaluators may be interested in using these scores in various analyses. Both the Rasch ability estimates and the average scores can be treated as continuous dependent variables for t-tests, ANOVA, and regression-type analyses.
**The Instrument**  
Fascination in Science

<table>
<thead>
<tr>
<th>Item ID Number</th>
<th>Prompt</th>
<th>Response Options and Coding</th>
</tr>
</thead>
</table>
| F01            | I wonder about how nature works: | 4=every day  
                             3=once a week  
                             2= once a month  
                             1=never |
| F02            | In general, when I work on science I: | 4=love it  
                             3=like it  
                             2=don't like it  
                             1=hate it |
| F03            | In general, I find science: | 4=very interesting  
                             3=interesting  
                             2=boring  
                             1=very boring |
| F04            | After a really interesting science activity is over, I look for more information about it. | 4=YES!  
                             3=yes  
                             2=no  
                             1=NO! |
| F05            | I need to know how objects work. | 4=YES!  
                             3=yes  
                             2=no  
                             1=NO! |
| F06            | I want to read everything I can find about science. | 4=YES!  
                             3=yes  
                             2=no  
                             1=NO! |
| F07            | I want to know everything about science. | 4=YES!  
                             3=yes  
                             2=no  
                             1=NO! |
| F08            | I want to know how to do everything that scientists do. | 4=YES!  
                             3=yes  
                             2=no  
                             1=NO! |
Psychometric Properties

The Fascination scale was designed to be analyzed using item response theory (specifically, the Rasch model). Classical test theory statistics (reliability and exploratory factor analysis) were utilized to determine the Fascination scale’s unidimensionality prior to Rasch modelling. Analyses were based on a total sample of 2911 youth from 6th and 8th grade science classrooms. The sample was reduced to 2903 after excluding cases where more than 50% of the items (5) were invalid (i.e., omissions or inappropriate multiple selection).

Reliability. Cronbach’s alpha and the polychoric alpha are measures of internal consistency within a particular scale. The polychoric alpha accounts for the ordinal nature (e.g., Likert-scale) of the variables (Gadermann & Zumbo, 2012). A satisfactorily large alpha (i.e., >.80) implies that individuals responded similarly across the items. Both the raw (Cronbach’s) and polychoric alpha coefficients using all eight of the Fascination items were found to be good (.86 and .90, respectively). All items contribute positively to the reliability of the scale, implying that all items contribute to the cohesiveness of the scale.

Exploratory Factor Analysis. Exploratory factor analysis is used to identify an underlying latent factor among the measured items in the scale. Adequate fit to a unidimensional model is determined by a satisfactory visual inspection of the scree plot, sufficiently large factor loadings on each item (> .30), and satisfactory fit statistics (RMSEA<.06, CFI>.90, TLI>.90) (e.g. Costello & Osborne, 2005; Hu & Bentler, 1999; Byrne, 2010).

Figure 1: Fascination Scree Plot

The Fascination scale was subject to exploratory factor analysis using a forced one-factor solution. As shown in Figure 1, the shape of the scree plot (i.e., an “L” shape) suggests a single dominant factor. The factor loadings were sufficiently large (see Table 1). In terms of fit statistics, the CFI and TLI were satisfactory (.966 and .953, respectively), but the RMSEA was found to be larger than the set conventions (.121).

Table 1: Fascination Results

<table>
<thead>
<tr>
<th>Items</th>
<th>Alpha if Deleted</th>
<th>Factor 1 Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>F01</td>
<td>0.86</td>
<td>0.531</td>
</tr>
<tr>
<td>F02</td>
<td>0.84</td>
<td>0.831</td>
</tr>
<tr>
<td>F03</td>
<td>0.83</td>
<td>0.847</td>
</tr>
<tr>
<td>F04</td>
<td>0.83</td>
<td>0.720</td>
</tr>
<tr>
<td>F05</td>
<td>0.85</td>
<td>0.529</td>
</tr>
<tr>
<td>F06</td>
<td>0.83</td>
<td>0.806</td>
</tr>
<tr>
<td>F07</td>
<td>0.83</td>
<td>0.825</td>
</tr>
<tr>
<td>F08</td>
<td>0.83</td>
<td>0.754</td>
</tr>
<tr>
<td>Scale</td>
<td>0.86</td>
<td>0.90</td>
</tr>
</tbody>
</table>

Rasch Model Fit. The Rasch model is used to provide estimates of the “ability” of survey participants, and the “difficulty” of each of the items. In this case, “ability” pertains to the amount of the Fascination factor in each participant, and “difficulty” pertains to the hesitation to agree with or endorse the statements provided in each of the items. Thus, the Rasch model can account for the varying difficulties of the items in generating estimates of participant ability (something notably missing in factor analysis).

The eight Fascination items were fit to the partial credit Rasch model (Masters, 1982) using ConQuest and examined for significant deviations in the unweighted (outfit) and weighted (infit) mean square error statistics (Wu, Adams, Wilson, & Haldane, 2007). Infit and outfit levels between 0.6 and 1.4 are generally considered satisfactorily fitting the Rasch model for rating scales (Wright & Linacre, 1994). Another indicator of scale validity is the person-separation reliability statistic, which is used to determine the inter-item reliability of the construct (Wright & Stone, 1979). As with Cronbach’s alpha, values of .80 and above are considered sufficient (Andrich, 1982).
The model fit statistics of the *Fascination* scale are shown in Table 2. Both infit and outfit statistics were satisfactory with the exception of the first item (F01). The person-separation reliability statistic was satisfactory (EAP/PV=.868).

A Wright map depicting the difficulty levels of thresholds for each of the items is shown on the following page. As depicted in the map, the item with the lowest threshold of moving from the lowest response option to the next lowest response option is "In general, when I work on science, I: (Love it, Like it, Don't Like, hate it)" (F02). The most difficult threshold to endorse is to respond "YES!" to the item "I want to read everything I can find about science" (F07). Of note is that each item has correctly ordered thresholds meaning that moving from non-endorsement to endorsement of the item is indicative of moving higher on along the latent trait.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unweighted</th>
<th></th>
<th>Weighted</th>
</tr>
</thead>
<tbody>
<tr>
<td>F01</td>
<td>1.59</td>
<td>19.1</td>
<td>1.38</td>
</tr>
<tr>
<td>F02</td>
<td>0.86</td>
<td>-5.7</td>
<td>0.88</td>
</tr>
<tr>
<td>F03</td>
<td>0.82</td>
<td>-7.1</td>
<td>0.83</td>
</tr>
<tr>
<td>F04</td>
<td>0.93</td>
<td>-2.6</td>
<td>0.94</td>
</tr>
<tr>
<td>F05</td>
<td>1.24</td>
<td>8.6</td>
<td>1.22</td>
</tr>
<tr>
<td>F06</td>
<td>0.87</td>
<td>-5.1</td>
<td>0.88</td>
</tr>
<tr>
<td>F07</td>
<td>0.87</td>
<td>5.4</td>
<td>0.87</td>
</tr>
<tr>
<td>F08</td>
<td>0.99</td>
<td>-0.5</td>
<td>0.98</td>
</tr>
</tbody>
</table>

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Suggested Citation:
MAP OF LATENT DISTRIBUTIONS AND THRESHOLDS

Generalised-Item Thresholds

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Each 'X' represents 18.3 cases
The labels for thresholds show the levels of item, and step, respectively

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References


