JSO JOURNAL of STEM OUTREACH

Vol. 4, Issue 1, July 2021

Peer Communities and STEM Development - Koo

Supplementary Material 2. Linking Surveys with Different Response Scales across Years.

Traditionally, surveys administered at multiple time-points are equated through common items. However, although item stems for a set of items were identical, response scales across different cohorts were different. This made the use of common item equating impractical. Instead, we adopted the technique described in Schwartz, Ayers, and Wilson (2017) to this context—by initially allowing each survey (i.e., for each cohort) to have its own metric, and then projecting them onto a reference (e.g., first time point) scale. Specifically, we: (1) ran a unidimensional analysis for each of the years separately; (2) computed mean and standard deviation of item location estimates for each year using the estimates obtained from the previous step; (3) selected the reference year (e.g., first year), and transformed the item location estimates from the other years, using the following formula:

$$\delta i(t) = [\delta i(y) - \text{Mean}(y)]^* [\text{SD}(r)/\text{SD}(y)] + \text{Mean}(r), \quad (1)$$

where:

$\delta i(t)$ = transformed location estimate for item i;
$\delta i(y)$ = location estimate for item i from the unidimensional model for year y;
Mean (y) = mean item location estimate from the unidimensional model for year y;
Mean (r) = mean item location estimate from the unidimensional model for the reference year;
SD(r) = standard deviation of item location estimates from the unidimensional model for the reference year;
SD(y)= standard deviation of item location estimates from the unidimensional model for year y.

Through this linear transformation the scale of item parameter estimates for the target year is now transformed to the scale of the reference year. We repeat the process for each of the years (except for the reference year). We transform item step estimates in a similar way as below:

$$\delta ik\ (t) = \delta ik\ (y)\ ^* [\text{SD}(r)/\text{SD}(y)], \quad (2)$$

where:

$\delta ik\ (t)$ = transformed estimate of step k for item i
$\delta ik(y)$ = estimate of step k for item i from the unidimensional model for year y

Once we transform item parameters, we re-calibrate the measure for each year by fixing (anchoring) parameters to the transformed item and step parameters.