mplus_translation

```
library(dplyr)
```

```
Attaching package: 'dplyr'

The following objects are masked from 'package:stats':

    filter, lag

The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

```
library(lavaan)
```

```
Warning: package 'lavaan' was built under R version 4.3.3

This is lavaan 0.6-18
lavaan is FREE software! Please report any bugs.
```

You can add options to executable code like this

```
d_orig <- read.fwf("C:/Users/alex/Downloads/emaildrafttohelenplusfilesfromchapter6/n7171a_
    20)), header = FALSE)
```

```
names(d_orig) <-
  c("childID", "parentid", "s6ID", "x6read", "x6math", "x6sci",
```

```
    "x7read", "x7math", "x7sci", "x8read", "x8math", "x8sci",
    "t6vic", "t6bull", "t7vic", "t7bull", "g8vic", "g8bull", "c8anx",
    "c8lone", "c8peersu", "c8eng", "t6dist", "t7dist", "g8dist",
    "public", "m8bully", "m8acad", "gm8bully", "gm8acad",
    "sd8bully" , "sd8acad"
  )
d <- d_orig %>% dplyr::select(s6ID, x6sci, x7sci, x8sci, t6bull)
summary(d)
```

```
     s6ID          x6sci           x7sci           x8sci           t6bull
 Min.   :1002   Min.   :16.55   Min.   :22.59   Min.   :19.15   Min.   :1.000
 1st Qu.:1343   1st Qu.:45.08   1st Qu.:53.37   1st Qu.:59.05   1st Qu.:1.000
 Median :1706   Median :53.21   Median :61.65   Median :67.31   Median :1.250
 Mean   :1805   Mean   :52.39   Mean   :60.29   Mean   :66.17   Mean   :1.486
 3rd Qu.:2102   3rd Qu.:60.22   3rd Qu.:67.99   3rd Qu.:74.31   3rd Qu.:1.750
 Max.   :4186   Max.   :90.71   Max.   :85.98   Max.   :91.32   Max.   :5.000
                NA's   :5       NA's   :8
```

Table 6.1 Models

```
# This output is exactly the same as the Mplus version
model_6_1_design_based_panel <- '
# Regressions
  x8sci ~ x7sci + x6sci
  x7sci ~ x6sci

  '

fit_model_6_1_design_based_panel <-
  lavaan::sem(
    model = model_6_1_design_based_panel, data = d,
    estimator = "MLR",
    #optim.method = "em")
    cluster = "s6ID",
    missing = "ml")
```

```
Warning: lavaan->lav_data_full():
   5 cases were deleted due to missing values in exogenous variable(s), while
   fixed.x = TRUE.
```

```r
summary(fit_model_6_1_design_based_panel,
        fit.measures = TRUE,
        standardized = TRUE)
```

```
lavaan 0.6-18 ended normally after 19 iterations

  Estimator                                         ML
  Optimization method                           NLMINB
  Number of model parameters                         7

                                                  Used       Total
  Number of observations                          7166        7171
  Number of clusters [s6ID]                       1245
  Number of missing patterns                         2

Model Test User Model:
                                              Standard      Scaled
  Test Statistic                                 0.000       0.000
  Degrees of freedom                                 0           0

Model Test Baseline Model:

  Test statistic                             18505.438   67412.463
  Degrees of freedom                                 3           3
  P-value                                        0.000       0.000
  Scaling correction factor                                  0.275

User Model versus Baseline Model:

  Comparative Fit Index (CFI)                    1.000       1.000
  Tucker-Lewis Index (TLI)                       1.000       1.000

  Robust Comparative Fit Index (CFI)                         1.000
  Robust Tucker-Lewis Index (TLI)                            1.000

Loglikelihood and Information Criteria:

  Loglikelihood user model (H0)              -45456.752  -45456.752
  Loglikelihood unrestricted model (H1)      -45456.752  -45456.752

  Akaike (AIC)                                90927.503   90927.503
  Bayesian (BIC)                              90975.643   90975.643
```

```
  Sample-size adjusted Bayesian (SABIC)      90953.399   90953.399

Root Mean Square Error of Approximation:

  RMSEA                                          0.000          NA
  90 Percent confidence interval - lower         0.000          NA
  90 Percent confidence interval - upper         0.000          NA
  P-value H_0: RMSEA <= 0.050                      NA          NA
  P-value H_0: RMSEA >= 0.080                      NA          NA

  Robust RMSEA                                                0.000
  90 Percent confidence interval - lower                      0.000
  90 Percent confidence interval - upper                      0.000
  P-value H_0: Robust RMSEA <= 0.050                             NA
  P-value H_0: Robust RMSEA >= 0.080                             NA

Standardized Root Mean Square Residual:

  SRMR                                           0.000       0.000

Parameter Estimates:

  Standard errors                          Robust.cluster
  Information                                    Observed
  Observed information based on                   Hessian

Regressions:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  x8sci ~
    x7sci             0.598    0.013   46.871    0.000    0.598    0.562
    x6sci             0.342    0.013   26.540    0.000    0.342    0.332
  x7sci ~
    x6sci             0.816    0.007  120.875    0.000    0.816    0.843

Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .x8sci            12.207    0.477   25.610    0.000   12.207    1.073
   .x7sci            17.531    0.387   45.257    0.000   17.531    1.640

Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .x8sci            33.707    0.689   48.957    0.000   33.707    0.260
   .x7sci            33.117    0.604   54.847    0.000   33.117    0.290
```

```r
# Output slightly different, model does NOT converge when using missing = "ml"
# or "fiml"

model_6_2_model_based_panel <- '
# within group
level: 1
# Regressions
  x8sci ~ x7sci + x6sci
  x7sci ~ x6sci


# between group
level: 2
# Regressions
  x8sci ~ x7sci + x6sci
  x7sci ~ x6sci
'
fit_model_6_2_model_based_panel <-
  lavaan::sem(
    model = model_6_2_model_based_panel, data = d,
    estimator = "MLR",
    optim.method = "em",
    cluster = "s6ID")

summary(fit_model_6_2_model_based_panel,
        fit.measures = TRUE,
        standardized = TRUE)
```

```
lavaan 0.6-18 ended normally after 79 iterations

  Estimator                                         ML
  Optimization method                               EM
  Number of model parameters                        12

                                                  Used       Total
  Number of observations                          7158        7171
  Number of clusters [s6ID]                       1243

Model Test User Model:
                                              Standard      Scaled
  Test Statistic                                 0.079       0.079
  Degrees of freedom                                 0           0
```

Model Test Baseline Model:

Test statistic	17273.484	13953.767
Degrees of freedom	6	6
P-value	0.000	0.000
Scaling correction factor		1.238

User Model versus Baseline Model:

Comparative Fit Index (CFI)	1.000	1.000
Tucker-Lewis Index (TLI)	1.000	1.000
Robust Comparative Fit Index (CFI)		NA
Robust Tucker-Lewis Index (TLI)		NA

Loglikelihood and Information Criteria:

Loglikelihood user model (H0)	-72278.264	-72278.264
Loglikelihood unrestricted model (H1)	-72278.225	-72278.225
Akaike (AIC)	144580.529	144580.529
Bayesian (BIC)	144663.041	144663.041
Sample-size adjusted Bayesian (SABIC)	144624.907	144624.907

Root Mean Square Error of Approximation:

RMSEA	0.000	NA
90 Percent confidence interval - lower	0.000	NA
90 Percent confidence interval - upper	0.000	NA
P-value H_0: RMSEA <= 0.050	NA	NA
P-value H_0: RMSEA >= 0.080	NA	NA
Robust RMSEA		0.000
90 Percent confidence interval - lower		0.000
90 Percent confidence interval - upper		0.000
P-value H_0: Robust RMSEA <= 0.050		NA
P-value H_0: Robust RMSEA >= 0.080		NA

Standardized Root Mean Square Residual (corr metric):

SRMR (within covariance matrix)	0.000	0.000
SRMR (between covariance matrix)	0.000	0.000

Parameter Estimates:

Standard errors	Sandwich
Information bread	Observed
Observed information based on	Hessian

Level 1 [within]:

Regressions:

	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
x8sci ~						
x7sci	0.571	0.013	42.570	0.000	0.571	0.538
x6sci	0.342	0.013	26.744	0.000	0.342	0.332
x7sci ~						
x6sci	0.780	0.008	99.437	0.000	0.780	0.805

Variances:

	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
.x8sci	31.298	0.620	50.468	0.000	31.298	0.314
.x7sci	31.181	0.616	50.654	0.000	31.181	0.352

Level 2 [s6ID]:

Regressions:

	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
x8sci ~						
x7sci	0.962	0.170	5.654	0.000	0.962	0.900
x6sci	0.072	0.168	0.428	0.668	0.072	0.069
x7sci ~						
x6sci	0.943	0.021	44.201	0.000	0.943	0.974

Intercepts:

	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
.x8sci	4.380	1.951	2.245	0.025	4.380	0.775
.x7sci	10.855	1.137	9.551	0.000	10.855	2.054

Variances:

	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
.x8sci	1.999	0.390	5.131	0.000	1.999	0.063
.x7sci	1.433	0.301	4.753	0.000	1.433	0.051

```
model_6_3_design_based_latent_growth_model <- '

  # Latent intercept and slope factors
  i_sci =~ 1*x6sci + 1*x7sci + 1*x8sci
  s_sci =~ 0*x6sci + 1*x7sci + 2*x8sci

  # Covariance between intercept and slope, set to 0
  i_sci ~~ 0*s_sci

  # Set the intercepts of the observed variables to 0
  x6sci ~ 0*1
  x7sci ~ 0*1
  x8sci ~ 0*1

  # Free the means of the latent factors
  i_sci ~ 1
  s_sci ~ 1

'




fit_model_6_3_design_based_latent_growth_model <-
  lavaan::sem(
    model = model_6_3_design_based_latent_growth_model, data = d,
    estimator = "MLR",
    #optim.method = "em",
    cluster = "s6ID")

summary(fit_model_6_3_design_based_latent_growth_model,
        fit.measures = TRUE,
        standardized = TRUE)
```

```
lavaan 0.6-18 ended normally after 92 iterations

  Estimator                                         ML
  Optimization method                           NLMINB
  Number of model parameters                         7

                                                  Used       Total
  Number of observations                          7158        7171
```

```
  Number of clusters [s6ID]                       1243

Model Test User Model:
                                              Standard      Scaled
  Test Statistic                               278.580     214.779
  Degrees of freedom                                 2           2
  P-value (Chi-square)                           0.000       0.000
  Scaling correction factor                                  1.297
    Yuan-Bentler correction (Mplus variant)

Model Test Baseline Model:

  Test statistic                             18491.215   67506.066
  Degrees of freedom                                 3           3
  P-value                                        0.000       0.000
  Scaling correction factor                                  0.274

User Model versus Baseline Model:

  Comparative Fit Index (CFI)                    0.985       0.997
  Tucker-Lewis Index (TLI)                       0.978       0.995

  Robust Comparative Fit Index (CFI)                         0.985
  Robust Tucker-Lewis Index (TLI)                            0.978

Loglikelihood and Information Criteria:

  Loglikelihood user model (H0)              -72912.041  -72912.041
  Scaling correction factor                                  1.601
      for the MLR correction
  Loglikelihood unrestricted model (H1)      -72772.751  -72772.751
  Scaling correction factor                                  1.533
      for the MLR correction

  Akaike (AIC)                               145838.081  145838.081
  Bayesian (BIC)                             145886.213  145886.213
  Sample-size adjusted Bayesian (SABIC)      145863.969  145863.969

Root Mean Square Error of Approximation:

  RMSEA                                          0.139       0.122
  90 Percent confidence interval - lower         0.125       0.110
  90 Percent confidence interval - upper         0.153       0.134
```

```
  P-value H_0: RMSEA <= 0.050                    0.000       0.000
  P-value H_0: RMSEA >= 0.080                    1.000       1.000

  Robust RMSEA                                               0.139
  90 Percent confidence interval - lower                     0.123
  90 Percent confidence interval - upper                     0.155
  P-value H_0: Robust RMSEA <= 0.050                         0.000
  P-value H_0: Robust RMSEA >= 0.080                         1.000

Standardized Root Mean Square Residual:

  SRMR                                           0.027       0.027

Parameter Estimates:

  Standard errors                         Robust.cluster
  Information                                   Observed
  Observed information based on                  Hessian

Latent Variables:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  i_sci =~
    x6sci             1.000                               9.995    0.905
    x7sci             1.000                               9.995    0.929
    x8sci             1.000                               9.995    0.886
  s_sci =~
    x6sci             0.000                               0.000    0.000
    x7sci             1.000                               0.882    0.082
    x8sci             2.000                               1.764    0.156

Covariances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  i_sci ~~
    s_sci             0.000                               0.000    0.000

Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .x6sci             0.000                               0.000    0.000
   .x7sci             0.000                               0.000    0.000
   .x8sci             0.000                               0.000    0.000
    i_sci            52.809    0.215  245.419    0.000    5.283    5.283
    s_sci             6.913    0.052  133.803    0.000    7.838    7.838
```

```
Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .x6sci             22.137    0.912   24.264    0.000   22.137    0.181
   .x7sci             15.030    0.545   27.585    0.000   15.030    0.130
   .x8sci             24.298    1.138   21.352    0.000   24.298    0.191
    i_sci             99.909    2.282   43.785    0.000    1.000    1.000
    s_sci              0.778    0.413    1.886    0.059    1.000    1.000
```

```r
model_6_4_design_based_latent_growth_model_with_an_estimated_loading <- '

  # Latent intercept and slope factors
  i_sci =~ 1*x6sci + 1*x7sci + 1*x8sci

  # free x7sci, let it be what it wants
  s_sci =~ 0*x6sci + est_2 * x7sci + 2*x8sci

  # Covariance between intercept and slope, set to 0
  i_sci ~~ 0*s_sci

  # Set the intercepts of the observed variables to 0
  x6sci ~ 0*1
  x7sci ~ 0*1
  x8sci ~ 0*1

  # Free the means of the latent factors
  i_sci ~ 1
  s_sci ~ 1

'

fit_model_6_4_design_based_latent_growth_model_with_an_estimated_loading <-
  lavaan::sem(
    model = model_6_4_design_based_latent_growth_model_with_an_estimated_loading,
    data = d,
    estimator = "MLR",
    #optim.method = "em",
    cluster = "s6ID")


summary(fit_model_6_4_design_based_latent_growth_model_with_an_estimated_loading,
        fit.measures = TRUE,
        standardized = TRUE)
```

```
lavaan 0.6-18 ended normally after 134 iterations

  Estimator                                         ML
  Optimization method                           NLMINB
  Number of model parameters                         8

                                                  Used       Total
  Number of observations                          7158        7171
  Number of clusters [s6ID]                       1243

Model Test User Model:
                                              Standard      Scaled
  Test Statistic                                 4.026       3.029
  Degrees of freedom                                 1           1
  P-value (Chi-square)                           0.045       0.082
  Scaling correction factor                                  1.329
    Yuan-Bentler correction (Mplus variant)

Model Test Baseline Model:

  Test statistic                             18491.215   67506.066
  Degrees of freedom                                 3           3
  P-value                                        0.000       0.000
  Scaling correction factor                                  0.274

User Model versus Baseline Model:

  Comparative Fit Index (CFI)                    1.000       1.000
  Tucker-Lewis Index (TLI)                       1.000       1.000

  Robust Comparative Fit Index (CFI)                         1.000
  Robust Tucker-Lewis Index (TLI)                            1.000

Loglikelihood and Information Criteria:

  Loglikelihood user model (H0)              -72774.764  -72774.764
  Scaling correction factor                                  1.559
      for the MLR correction
  Loglikelihood unrestricted model (H1)      -72772.751  -72772.751
  Scaling correction factor                                  1.533
      for the MLR correction

  Akaike (AIC)                               145565.527  145565.527
```

```
  Bayesian (BIC)                             145620.535  145620.535
  Sample-size adjusted Bayesian (SABIC)      145595.113  145595.113

Root Mean Square Error of Approximation:

  RMSEA                                          0.021       0.017
  90 Percent confidence interval - lower         0.003       0.000
  90 Percent confidence interval - upper         0.043       0.037
  P-value H_0: RMSEA <= 0.050                    0.987       0.998
  P-value H_0: RMSEA >= 0.080                    0.000       0.000

  Robust RMSEA                                                0.019
  90 Percent confidence interval - lower                      0.000
  90 Percent confidence interval - upper                      0.046
  P-value H_0: Robust RMSEA <= 0.050                          0.973
  P-value H_0: Robust RMSEA >= 0.080                          0.000

Standardized Root Mean Square Residual:

  SRMR                                           0.006       0.006

Parameter Estimates:

  Standard errors                          Robust.cluster
  Information                                    Observed
  Observed information based on                   Hessian

Latent Variables:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  i_sci =~
    x6sci             1.000                               9.998    0.906
    x7sci             1.000                               9.998    0.932
    x8sci             1.000                               9.998    0.885
  s_sci =~
    x6sci             0.000                               0.000    0.000
    x7sci    (es_2)   1.145    0.010  113.551    0.000    1.020    0.095
    x8sci             2.000                               1.780    0.158

Covariances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  i_sci ~~
    s_sci             0.000                               0.000    0.000
```

```
Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .x6sci             0.000                              0.000    0.000
   .x7sci             0.000                              0.000    0.000
   .x8sci             0.000                              0.000    0.000
    i_sci            52.392    0.217  241.808    0.000    5.240    5.240
    s_sci             6.893    0.052  132.291    0.000    7.743    7.743

Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .x6sci            21.903    0.896   24.451    0.000   21.903    0.180
   .x7sci            14.104    0.506   27.895    0.000   14.104    0.123
   .x8sci            24.378    0.954   25.551    0.000   24.378    0.191
    i_sci            99.969    2.280   43.851    0.000    1.000    1.000
    s_sci             0.792    0.355    2.230    0.026    1.000    1.000
```

```
# two level model, between and within
model_6_5_model_based_latent_growth_model_with_an_estimated_loading <- '

# within group
level: 1
# factor loadings
Iw_sci =~ 1 * x6sci + 1 * x7sci + 1 * x8sci
Sw_sci =~ 0 * x6sci + est_2 * x7sci + 2 * x8sci

# measured variable intercepts
x6sci ~ 0
x7sci ~ 0
x8sci ~ 0

# slope intercept covariance fixed to 0
Iw_sci ~~ 0 * Sw_sci


level: 2

# between group
# factor loadings
Ib_sci =~ 1 * x6sci + 1 * x7sci + 1 * x8sci
Sb_sci =~ 0 * x6sci + est_2 * x7sci + 2 * x8sci
```

```
  # measured variable intercepts
  x6sci ~ 0
  x7sci ~ 0
  x8sci ~ 0
  Ib_sci ~ 1
  Sb_sci ~ 1

  # slope intercept covariance fixed to 0
  Ib_sci ~~ 0 * Sb_sci
  '

  fit_model_6_5_model_based_latent_growth_model_with_an_estimated_loading <-
    lavaan::sem(
      model = model_6_5_model_based_latent_growth_model_with_an_estimated_loading,
      data = d,
      estimator = "MLR",
      optim.method = "em",
      cluster = "s6ID")

  summary(fit_model_6_5_model_based_latent_growth_model_with_an_estimated_loading,
          fit.measures = TRUE,
          standardized = TRUE,
          )
```

```
lavaan 0.6-18 ended normally after 103 iterations

  Estimator                                         ML
  Optimization method                               EM
  Number of model parameters                        14
  Number of equality constraints                     1

                                                  Used       Total
  Number of observations                          7158        7171
  Number of clusters [s6ID]                       1243

Model Test User Model:
                                              Standard      Scaled
  Test Statistic                                 4.724       3.908
  Degrees of freedom                                 2           2
  P-value (Chi-square)                           0.094       0.142
  Scaling correction factor                                  1.209
    Yuan-Bentler correction (Mplus variant)
```

```
Model Test Baseline Model:

  Test statistic                                17273.435   13988.563
  Degrees of freedom                                    6           6
  P-value                                           0.000       0.000
  Scaling correction factor                                     1.235

User Model versus Baseline Model:

  Comparative Fit Index (CFI)                       1.000       1.000
  Tucker-Lewis Index (TLI)                          1.000       1.000

  Robust Comparative Fit Index (CFI)                            1.000
  Robust Tucker-Lewis Index (TLI)                               1.000

Loglikelihood and Information Criteria:

  Loglikelihood user model (H0)                -72280.587  -72280.587
  Scaling correction factor                                     1.089
      for the MLR correction
  Loglikelihood unrestricted model (H1)        -72278.225  -72278.225
  Scaling correction factor                                     1.177
      for the MLR correction

  Akaike (AIC)                                 144587.174  144587.174
  Bayesian (BIC)                               144676.561  144676.561
  Sample-size adjusted Bayesian (SABIC)        144635.250  144635.250

Root Mean Square Error of Approximation:

  RMSEA                                             0.014       0.012
  90 Percent confidence interval - lower            0.000       0.000
  90 Percent confidence interval - upper            0.030       0.027
  P-value H_0: RMSEA <= 0.050                       1.000       1.000
  P-value H_0: RMSEA >= 0.080                       0.000       0.000

  Robust RMSEA                                                  0.013
  90 Percent confidence interval - lower                        0.000
  90 Percent confidence interval - upper                        0.031
  P-value H_0: Robust RMSEA <= 0.050                            1.000
  P-value H_0: Robust RMSEA >= 0.080                            0.000
```

```
Standardized Root Mean Square Residual (corr metric):

  SRMR (within covariance matrix)                0.001       0.001
  SRMR (between covariance matrix)               0.002       0.002

Parameter Estimates:

  Standard errors                             Sandwich
  Information bread                           Observed
  Observed information based on                Hessian


Level 1 [within]:

Latent Variables:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  Iw_sci =~
    x6sci             1.000                               8.587    0.884
    x7sci             1.000                               8.587    0.911
    x8sci             1.000                               8.587    0.862
  Sw_sci =~
    x6sci             0.000                               0.000    0.000
    x7sci    (es_2)   1.148    0.010  113.059    0.000    1.004    0.107
    x8sci             2.000                               1.749    0.176

Covariances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  Iw_sci ~~
    Sw_sci            0.000                               0.000    0.000

Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .x6sci             0.000                               0.000    0.000
   .x7sci             0.000                               0.000    0.000
   .x8sci             0.000                               0.000    0.000

Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .x6sci            20.527    0.827   24.827    0.000   20.527    0.218
   .x7sci            14.127    0.517   27.309    0.000   14.127    0.159
   .x8sci            22.372    0.874   25.600    0.000   22.372    0.226
    Iw_sci           73.731    1.763   41.816    0.000    1.000    1.000
    Sw_sci            0.765    0.326    2.348    0.019    1.000    1.000
```

```
Level 2 [s6ID]:

Latent Variables:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  Ib_sci =~
    x6sci             1.000                               5.325    0.976
    x7sci             1.000                               5.325    0.999
    x8sci             1.000                               5.325    0.966
  Sb_sci =~
    x6sci             0.000                               0.000    0.000
    x7sci    (es_2)   1.148    0.010  113.059    0.000     0.126    0.024
    x8sci             2.000                               0.219    0.040

Covariances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  Ib_sci ~~
    Sb_sci            0.000                               0.000    0.000

Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .x6sci             0.000                               0.000    0.000
   .x7sci             0.000                               0.000    0.000
   .x8sci             0.000                               0.000    0.000
    Ib_sci           51.696    0.218  236.741    0.000     9.708    9.708
    Sb_sci            6.893    0.052  132.010    0.000    62.976   62.976

Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .x6sci             1.422    0.644    2.210    0.027     1.422    0.048
   .x7sci             0.024    0.327    0.072    0.943     0.024    0.001
   .x8sci             1.982    0.622    3.186    0.001     1.982    0.065
    Ib_sci           28.359    2.060   13.770    0.000     1.000    1.000
    Sb_sci            0.012    0.266    0.045    0.964     1.000    1.000
```

```
model_6_6_model_based_latent_growth_model_estimated_loading_and_time_invariant_covariate <
# within group
level: 1
# factor loadings
Iw_sci =~ 1 * x6sci + 1 * x7sci + 1 * x8sci
Sw_sci =~ 0 * x6sci + est_2 * x7sci + 2 * x8sci
```

```
  # measured variable intercepts
  x6sci ~ 0
  x7sci ~ 0
  x8sci ~ 0

  # slope intercept covariance fixed to 0
  Iw_sci ~~ 0 * Sw_sci

  # Regress iw_sci on t6bull
  Iw_sci ~ t6bull

  level: 2

  # between group
  # factor loadings
  Ib_sci =~ 1 * x6sci + 1 * x7sci + 1 * x8sci
  Sb_sci =~ 0 * x6sci + est_2 * x7sci + 2 * x8sci

  # measured variable intercepts
  x6sci ~ 0
  x7sci ~ 0
  x8sci ~ 0
  Ib_sci ~ 1
  Sb_sci ~ 1

  # slope intercept covariance fixed to 0
  Ib_sci ~~ 0 * Sb_sci

  # Regress iw_sci on t6bull
  Ib_sci ~ t6bull
  '

  fit_model_6_6_model_based_latent_growth_model_estimated_loading_and_time_invariant_covaria
    lavaan::sem(
      model = model_6_6_model_based_latent_growth_model_estimated_loading_and_time_invariant
      data = d,
      estimator = "MLR",
      optim.method = "em",
      cluster = "s6ID")
```

```
Warning: lavaan->lav_data_full():
```

```
   Level-1 variable "t6bull" has no variance within some clusters . The
   cluster ids with zero within variance are: 1158, 1165, 1208, 1214, 1256,
   1265, 1418, 1460, 1500, 1559, 1630, 1806, 1869, 1875, 1944, 1996, 2112,
   2228, 2310, 2506, 2544, 2563, 2617, 2633, 2733, 2768, 2784, 2874, 2877,
   2957, 3088, 3135, 3161, 3224, 3243, 3290, 3376, 3865, 3949, 4003, 4105,
   4176.

Warning: lavaan->lav_object_post_check():
   some estimated ov variances are negative

Warning: lavaan->lav_object_post_check():
   some estimated lv variances are negative
```

```r
summary(fit_model_6_6_model_based_latent_growth_model_estimated_loading_and_time_invariant
        fit.measures = TRUE,
        standardized = TRUE,
        )
```

```
lavaan 0.6-18 ended normally after 105 iterations

  Estimator                                         ML
  Optimization method                               EM
  Number of model parameters                        16
  Number of equality constraints                     1

                                                  Used       Total
  Number of observations                          7158        7171
  Number of clusters [s6ID]                       1243

Model Test User Model:
                                              Standard      Scaled
  Test Statistic                                20.195      17.999
  Degrees of freedom                                 6           6
  P-value (Chi-square)                           0.003       0.006
  Scaling correction factor                                  1.122
    Yuan-Bentler correction (Mplus variant)

Model Test Baseline Model:

  Test statistic                             17492.527   15143.731
  Degrees of freedom                                12          12
```

```
  P-value                                       0.000       0.000
  Scaling correction factor                                 1.155

User Model versus Baseline Model:

  Comparative Fit Index (CFI)                   0.999       0.999
  Tucker-Lewis Index (TLI)                      0.998       0.998

  Robust Comparative Fit Index (CFI)                        0.999
  Robust Tucker-Lewis Index (TLI)                           0.998

Loglikelihood and Information Criteria:

  Loglikelihood user model (H0)            -79727.312  -79727.312
  Scaling correction factor                                 1.086
      for the MLR correction
  Loglikelihood unrestricted model (H1)    -79717.215  -79717.215
  Scaling correction factor                                 1.148
      for the MLR correction

  Akaike (AIC)                             159484.624  159484.624
  Bayesian (BIC)                           159587.764  159587.764
  Sample-size adjusted Bayesian (SABIC)    159540.097  159540.097

Root Mean Square Error of Approximation:

  RMSEA                                         0.018       0.017
  90 Percent confidence interval - lower        0.010       0.009
  90 Percent confidence interval - upper        0.027       0.025
  P-value H_0: RMSEA <= 0.050                   1.000       1.000
  P-value H_0: RMSEA >= 0.080                   0.000       0.000

  Robust RMSEA                                              0.018
  90 Percent confidence interval - lower                    0.009
  90 Percent confidence interval - upper                    0.027
  P-value H_0: Robust RMSEA <= 0.050                        1.000
  P-value H_0: Robust RMSEA >= 0.080                        0.000

Standardized Root Mean Square Residual (corr metric):

  SRMR (within covariance matrix)               0.004       0.004
  SRMR (between covariance matrix)              0.016       0.016
```

```
Parameter Estimates:

  Standard errors                             Sandwich
  Information bread                           Observed
  Observed information based on                Hessian


Level 1 [within]:

Latent Variables:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  Iw_sci =~
    x6sci             1.000                               8.589    0.884
    x7sci             1.000                               8.589    0.912
    x8sci             1.000                               8.589    0.863
  Sw_sci =~
    x6sci             0.000                               0.000    0.000
    x7sci    (es_2)   1.148    0.010  113.387    0.000    0.963    0.102
    x8sci             2.000                               1.676    0.168

Regressions:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  Iw_sci ~
    t6bull           -1.546    0.172   -8.989    0.000   -0.180   -0.120

Covariances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
 .Iw_sci ~~
    Sw_sci            0.000                               0.000    0.000

Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .x6sci             0.000                               0.000    0.000
   .x7sci             0.000                               0.000    0.000
   .x8sci             0.000                               0.000    0.000

Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .x6sci            20.670    0.825   25.068    0.000   20.670    0.219
   .x7sci            14.076    0.513   27.456    0.000   14.076    0.159
   .x8sci            22.470    0.871   25.784    0.000   22.470    0.227
   .Iw_sci           72.721    1.754   41.468    0.000    0.986    0.986
    Sw_sci            0.703    0.323    2.173    0.030    1.000    1.000
```

Level 2 [s6ID]:

Latent Variables:

		Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
Ib_sci =~							
x6sci		1.000				5.354	0.969
x7sci		1.000				5.354	1.007
x8sci		1.000				5.354	0.974
Sb_sci =~							
x6sci		0.000				NA	NA
x7sci	(es_2)	1.148	0.010	113.387	0.000	NA	NA
x8sci		2.000				NA	NA

Regressions:

	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
Ib_sci ~						
t6bull	-10.094	1.437	-7.025	0.000	-1.885	-0.435

Covariances:

	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
.Ib_sci ~~						
Sb_sci	0.000				0.000	0.000

Intercepts:

	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
.x6sci	0.000				0.000	0.000
.x7sci	0.000				0.000	0.000
.x8sci	0.000				0.000	0.000
.Ib_sci	66.838	2.156	30.997	0.000	12.483	12.483
Sb_sci	6.897	0.052	132.901	0.000	NA	NA

Variances:

	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
.x6sci	1.847	0.627	2.947	0.003	1.847	0.061
.x7sci	-0.146	0.307	-0.475	0.635	-0.146	-0.005
.x8sci	2.288	0.603	3.794	0.000	2.288	0.076
.Ib_sci	23.247	2.151	10.806	0.000	0.811	0.811
Sb_sci	-0.178	0.253	-0.706	0.480	NA	NA