

Project Report

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Introduction

Client is investigating how foreign language teachers feel about and utilize methods from the Teacher Effectiveness for Language Learning (TELL), and seeking advice about how to improve the survey.

Our purpose for our client in this project: 1. A lot of people don't answer the survey because it's long. Can we reduce the number of questions? 2. Is the survey currently answering the research questions?

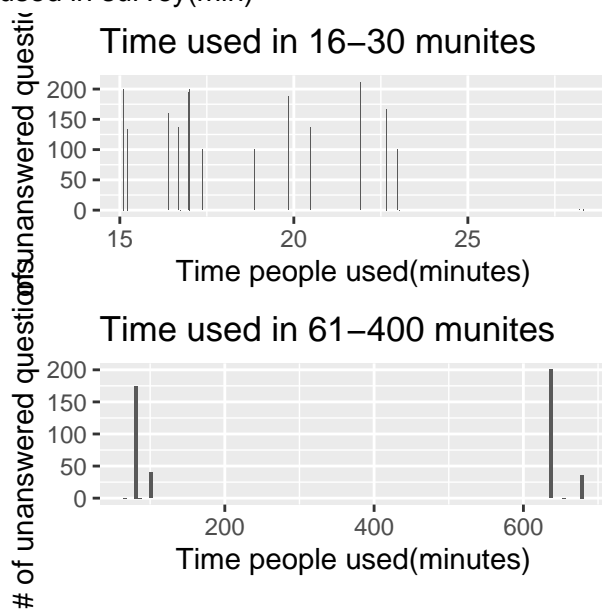
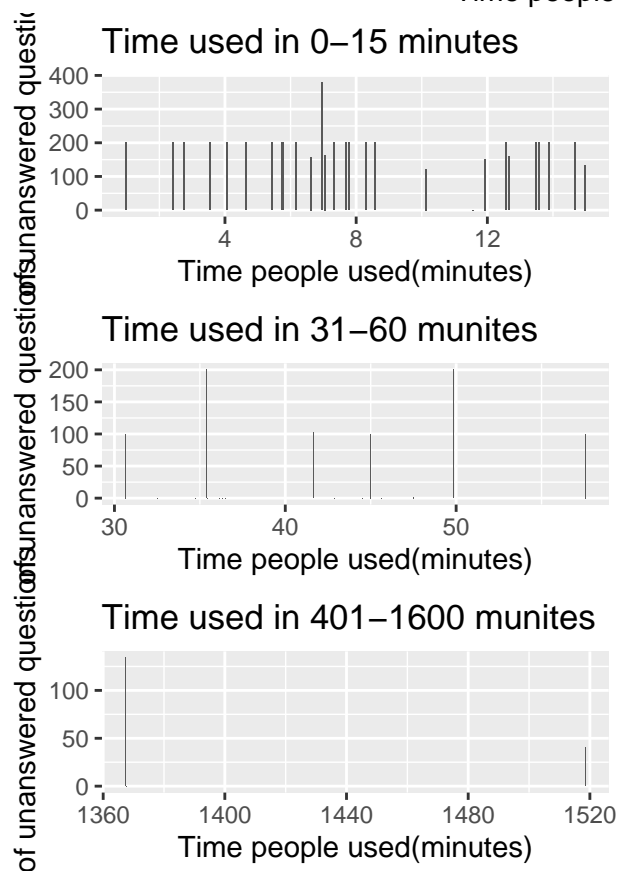
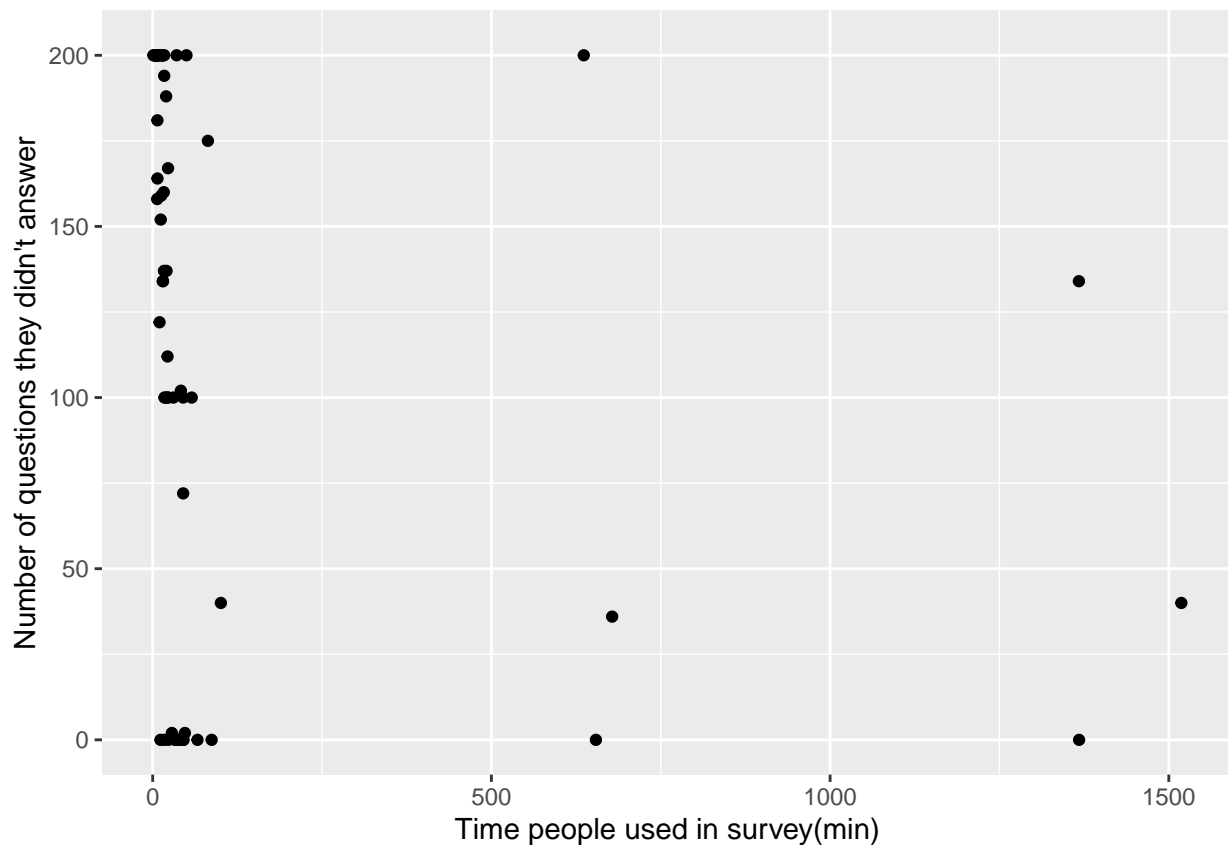
EDA & Concerns

Data Structure

We are provided the data in an excel file with 6 spreadsheets including one sheet of notes, one sheet of personal information and 4 sheets of Teacher Effectiveness for Language Learning (TELL) framework survey questions. The dataset of personal information contains questions regarding respondents' teaching language and education background. The dataset of Teacher Effectiveness for Language Learning (TELL) framework survey contains around 200 questions asking about respondents' attitudes of contribution and confidence towards each practice in the framework. There are 4 domains of Teacher Effectiveness for Language Learning (TELL) survey questions: planning, learning experience, learning tools, and performance & feedback. Each domain contains several subdomains and each subdomain contains a different number of questions. For this project, we focus on reducing the number of questions in the dataset of Teacher Effectiveness for Language Learning (TELL) framework survey.

EDA

We conduct a basic Exploratory Data Analysis (EDA) for this project. Firstly, We focus on the time for respondents to complete this survey.



Data Cleaning

Concerns

We come up with several concerns after the initial EDA. Firstly, the observations we can use in the analysis are very limited since there are many N/A in the dataset. Secondly, some respondents seem like choosing the same answer through the whole survey and if we identify these answers as non-valid, then our sample size would become even smaller. With this limited sample size, the accuracy and reference of results from our subsequent analysis could be affected.

Method we used

We will use Confirmatory Factor Analysis (CFA) to reduce the survey questions number. CFA is a special form of factor analysis and mostly used in social science research. It is used to check whether measures of a construct are consistent with a researcher's understanding of the nature of that construct.

Here we will use CFA to see if there are survey questions equivalent to each other so we can reduce those repeated questions. We will analysis each subdomain separately and will only consider the problems regarding confidence or not. Within each subdomain, there will be several questions and our null hypothesis is that all survey questions are identical to each other. Then our alternative hypothesis is that the questions are not all equal.

We will focus on the p value result we have from CFA and we will take a p value larger than 0.05 to reject our null hypothesis. When we are not able to reject our null hypothesis, we will look at our factor loading to check the correlations between questions. Then we will fit new model by dropping question with lowest factor loading and see if we will reject our null hypothesis now. We will keep doing this until we have a subdomain with an acceptable p value, which gives us a set of survey questions are not identical to each other.

Analysis

Learning Tool Domain Analysis

For Learning Tools table in TELL Statements, we numeric character answers of LT 1a~5c Confidence, and NA values stay as same as NA that will not count in. First, I made CFA models for each subdomain (ex: LT1 has 3 variables: LT1a_Confidence, LT1b_Confidence, LT1c_Confidence). Then we have an available P-value for each subdomain and we find factor loadings of each variables in each subdomain. Third, we compare P-value of each subdomain to 0.05, if P-value > 0.05, our null hypothesis retained, and we do not need to make any further change on that subdomain; if P-value < 0.05, it means our null hypothesis is rejected, and we need to remodel by dropping the variable with lowest factor loadings in that subdomain and check its P-value again. Following are detailed results: # First subdomain:

```
## lavaan 0.6-5 ended normally after 12 iterations
##
##      Estimator                ML
##      Optimization method      NLMINB
##      Number of free parameters      6
##      Number of equality constraints    1
##      Row rank of the constraints matrix 1
##
##                               Used      Total
##      Number of observations      27      84
##
## Model Test User Model:
##
##      Test statistic      0.109
##      Degrees of freedom      1
```

```

##      P-value (Chi-square)                                0.741
##
## Parameter Estimates:
##
##      Information                                Expected
##      Information saturated (h1) model            Structured
##      Standard errors                            Standard
##
## Latent Variables:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      lt1 =~
##      LT1a_Cnfdn (aa)    0.384    0.165    2.331    0.020    0.384    0.488
##      LT1b_Cnfd (aa)    0.384    0.165    2.331    0.020    0.384    0.472
##      LT1c_Cnfd         0.612    0.282    2.167    0.030    0.612    0.722
##
## Variances:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      .LT1a_Confidence  0.472    0.168    2.816    0.005    0.472    0.762
##      .LT1b_Confidence  0.515    0.177    2.914    0.004    0.515    0.777
##      .LT1c_Confidence  0.344    0.314    1.095    0.273    0.344    0.479
##      lt1                1.000
##
##      npar      fmin      chisq
##      5.000      0.002      0.109
##      df      pvalue      baseline.chisq
##      1.000      0.741      7.404
##      baseline.df      baseline.pvalue      cfi
##      3.000      0.060      1.000
##      tli      nnfi      rfi
##      1.607      1.607      0.956
##      nfi      pnfi      ifi
##      0.985      0.328      1.139
##      rni      logl      unrestricted.logl
##      1.202      -94.804      -94.750
##      aic      bic      ntotal
##      199.609      206.088      27.000
##      bic2      rmsea      rmsea.ci.lower
##      190.555      0.000      0.000
##      rmsea.ci.upper      rmsea.pvalue      rmr
##      0.355      0.749      0.018
##      rmr_nomean      srmr      srmr_bentler
##      0.018      0.028      0.028
##      srmr_bentler_nomean      crmr      crmr_nomean
##      0.028      0.028      0.028
##      srmr_mplus      srmr_mplus_nomean      cn_05
##      0.026      0.026      951.942
##      cn_01      gfi      agfi
##      1643.449      0.997      0.984
##      pgfi      mfi      ecvi
##      0.166      1.017      0.374
##
##      lhs op      rhs      mi      epc sepc.lv sepc.all
## 10 LT1a_Confidence ~~ LT1c_Confidence 0.109 0.053 0.053 0.133
## 11 LT1b_Confidence ~~ LT1c_Confidence 0.109 -0.053 -0.053 -0.127
##      sepc.nox

```

```
## 10    0.133
## 11   -0.127
```

Table 1: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
lt1	LT1a_Confidence	0.384	0.165	2.331	0.02	0.488
lt1	LT1b_Confidence	0.384	0.165	2.331	0.02	0.472
lt1	LT1c_Confidence	0.612	0.282	2.167	0.03	0.722

Since p-value of the first subdomain is $0.741 > 0.05$, there is no need to make any change in the first subdomain and we can save all questions.

Second subdomain

```
## lavaan 0.6-5 ended normally after 12 iterations
##
## Estimator ML
## Optimization method NLMINB
## Number of free parameters 6
## Number of equality constraints 1
## Row rank of the constraints matrix 1
##
## Used Total
## Number of observations 28 84
##
## Model Test User Model:
##
## Test statistic 0.003
## Degrees of freedom 1
## P-value (Chi-square) 0.953
##
## Parameter Estimates:
##
## Information Expected
## Information saturated (h1) model Structured
## Standard errors Standard
##
## Latent Variables:
## Estimate Std.Err z-value P(>|z|) Std.lv Std.all
## lt2 =~
## LT2_Cnfdn (aa) 0.443 0.126 3.531 0.000 0.443 0.587
## LT2b_Cnfd (aa) 0.443 0.126 3.531 0.000 0.443 0.603
## LT2c_Cnfd 0.776 0.222 3.499 0.000 0.776 0.817
##
## Variances:
## Estimate Std.Err z-value P(>|z|) Std.lv Std.all
## .LT2a_Confidenc 0.373 0.127 2.930 0.003 0.373 0.655
## .LT2b_Confidenc 0.345 0.122 2.838 0.005 0.345 0.637
## .LT2c_Confidenc 0.300 0.270 1.110 0.267 0.300 0.333
## lt2 1.000 1.000 1.000
##
## npar fmin chisq
```

```

##          5.000          0.000          0.003
##          df          pvalue      baseline.chisq
##          1.000          0.953          15.764
##      baseline.df      baseline.pvalue          cfi
##          3.000          0.001          1.000
##          tli          nnfi          rfi
##          1.234          1.234          0.999
##          nfi          pnfi          ifi
##          1.000          0.333          1.067
##          rni          logl      unrestricted.logl
##          1.078          -93.396          -93.394
##          aic          bic          ntotal
##          196.792          203.453          28.000
##          bic2          rmsea      rmsea.ci.lower
##          187.908          0.000          0.000
##      rmsea.ci.upper      rmsea.pvalue          rmr
##          0.000          0.955          0.003
##          rmr_nomean          srmr      srmr_bentler
##          0.003          0.005          0.005
##      srmr_bentler_nomean          crmr      crmr_nomean
##          0.005          0.004          0.004
##          srmr_mplus      srmr_mplus_nomean          cn_05
##          0.005          0.005          31204.347
##          cn_01          gfi          agfi
##          53894.843          1.000          1.000
##          pgfi          mfi          ecvi
##          0.167          1.018          0.357

##          lhs op          rhs      mi      epc sepc.lv sepc.all
## 10 LT2a_Confidence ~~ LT2c_Confidence 0.003 -0.009 -0.009 -0.027
## 11 LT2b_Confidence ~~ LT2c_Confidence 0.003 0.009 0.009 0.028
##      sepc.nox
## 10      -0.027
## 11      0.028

```

Table 2: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
lt2	LT2a_Confidence	0.443	0.126	3.531	0	0.587
lt2	LT2b_Confidence	0.443	0.126	3.531	0	0.603
lt2	LT2c_Confidence	0.776	0.222	3.499	0	0.817

Since p-value of the second subdomain is $0.953 > 0.05$, there is no need to make any change in the second subdomain and we can save all questions.

Third subdomain

```

## lavaan 0.6-5 ended normally after 15 iterations
##
##      Estimator          ML
##      Optimization method      NLMINB
##      Number of free parameters          8
##

```

```

##                                     Used      Total
##   Number of observations              27        84
##
## Model Test User Model:
##
##   Test statistic              9.736
##   Degrees of freedom              2
##   P-value (Chi-square)          0.008
##
## Parameter Estimates:
##
##   Information              Expected
##   Information saturated (h1) model      Structured
##   Standard errors              Standard
##
## Latent Variables:
##           Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##   lt3 =~
##     LT3a_Confidenc    0.858    0.158    5.419    0.000    0.858    0.885
##     LT3b_Confidenc    0.724    0.147    4.933    0.000    0.724    0.827
##     LT3c_Confidenc    0.528    0.161    3.273    0.001    0.528    0.604
##     LT3d_Confidenc    0.804    0.200    4.020    0.000    0.804    0.709
##
## Variances:
##           Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##   .LT3a_Confidenc    0.204    0.120    1.697    0.090    0.204    0.217
##   .LT3b_Confidenc    0.242    0.102    2.375    0.018    0.242    0.316
##   .LT3c_Confidenc    0.486    0.144    3.376    0.001    0.486    0.635
##   .LT3d_Confidenc    0.638    0.204    3.131    0.002    0.638    0.497
##   lt3                1.000
##
##           npar           fmin           chisq
##           8.000           0.180           9.736
##           df           pvalue      baseline.chisq
##           2.000           0.008           55.912
##           baseline.df      baseline.pvalue           cfi
##           6.000           0.000           0.845
##           tli           nnfi           rfi
##           0.535           0.535           0.478
##           nfi           pnfi           ifi
##           0.826           0.275           0.857
##           rni           logl      unrestricted.logl
##           0.845          -125.493          -120.625
##           aic           bic           ntotal
##           266.987          277.354           27.000
##           bic2           rmsea      rmsea.ci.lower
##           252.501           0.378           0.166
##           rmsea.ci.upper      rmsea.pvalue           rmr
##           0.630           0.010           0.091
##           rmr_nomean           srmr           srmr_bentler
##           0.091           0.093           0.093
##           srmr_bentler_nomean           crmr           crmr_nomean
##           0.093           0.120           0.120
##           srmr_mplus      srmr_mplus_nomean           cn_05

```

```

##          0.093          0.093          17.616
##          cn_01          gfi          agfi
##          26.542          0.859          0.293
##          pgfi          mfi          ecvi
##          0.172          0.867          0.953

##          lhs op          rhs      mi      epc sepc.lv sepc.all
## 10 LT3a_Confidence ~~ LT3b_Confidence 8.454 0.533 0.533 2.396
## 11 LT3a_Confidence ~~ LT3c_Confidence 3.565 -0.210 -0.210 -0.665
## 12 LT3a_Confidence ~~ LT3d_Confidence 0.290 -0.093 -0.093 -0.258
## 13 LT3b_Confidence ~~ LT3c_Confidence 0.290 -0.052 -0.052 -0.151
## 14 LT3b_Confidence ~~ LT3d_Confidence 3.565 -0.269 -0.269 -0.685
## 15 LT3c_Confidence ~~ LT3d_Confidence 8.454 0.364 0.364 0.654
##      sepc.nox
## 10      2.396
## 11     -0.665
## 12     -0.258
## 13     -0.151
## 14     -0.685
## 15      0.654

```

Table 3: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
lt3	LT3a_Confidence	0.858	0.158	5.419	0.000	0.885
lt3	LT3b_Confidence	0.724	0.147	4.933	0.000	0.827
lt3	LT3c_Confidence	0.528	0.161	3.273	0.001	0.604
lt3	LT3d_Confidence	0.804	0.200	4.020	0.000	0.709

Since p-value of the third subdomain is $0.008 < 0.05$, and question LT3c_Confidence has the lowest factor loading 0.604, we drop LT3_c_Confidence and then remodel the third subdomain.

```

## lavaan 0.6-5 ended normally after 14 iterations
##
##      Estimator          ML
##      Optimization method      NLMINB
##      Number of free parameters          6
##      Number of equality constraints      1
##      Row rank of the constraints matrix 1
##
##                               Used      Total
##      Number of observations          27          84
##
## Model Test User Model:
##
##      Test statistic          0.017
##      Degrees of freedom          1
##      P-value (Chi-square)      0.897
##
## Parameter Estimates:
##
##      Information          Expected
##      Information saturated (h1) model      Structured
##      Standard errors          Standard

```



```

##
## Latent Variables:
##           Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##   lt3 =~
##     LT3_Cnfdn      0.931   0.164   5.660   0.000   0.931   0.959
##     LT3b_Cnfd (aa)  0.706   0.144   4.892   0.000   0.706   0.802
##     LT3d_Cnfd (aa)  0.706   0.144   4.892   0.000   0.706   0.629
##
## Variances:
##           Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##   .LT3a_Confidenc  0.075   0.170   0.442   0.659   0.075   0.080
##   .LT3b_Confidenc  0.276   0.122   2.259   0.024   0.276   0.357
##   .LT3d_Confidenc  0.761   0.228   3.330   0.001   0.761   0.604
##   lt3              1.000
##
##           npar      fmin      chisq
##           5.000      0.000      0.017
##           df      pvalue baseline.chisq
##           1.000      0.897      36.819
##           baseline.df baseline.pvalue cfi
##           3.000      0.000      1.000
##           tli      nnfi      rfi
##           1.087      1.087      0.999
##           nfi      pnfi      ifi
##           1.000      0.333      1.027
##           rni      logl unrestricted.logl
##           1.029      -95.478      -95.469
##           aic      bic      ntotal
##           200.955      207.434      27.000
##           bic2      rmsea      rmsea.ci.lower
##           191.902      0.000      0.000
##           rmsea.ci.upper rmsea.pvalue rmr
##           0.233      0.900      0.014
##           rmr_nomean      srmr      srmr_bentler
##           0.014      0.012      0.012
##           srmr_bentler_nomean      crmr      crmr_nomean
##           0.012      0.007      0.007
##           srmr_mplus      srmr_mplus_nomean      cn_05
##           0.011      0.011      6147.974
##           cn_01      gfi      agfi
##           10617.940      1.000      0.998
##           pgfi      mfi      ecvi
##           0.167      1.018      0.371
##
##           lhs op      rhs      mi      epc sepc.lv sepc.all
## 9 LT3a_Confidence ~~ LT3b_Confidence 0.017 -0.025 -0.025 -0.171
## 10 LT3a_Confidence ~~ LT3d_Confidence 0.017 0.025 0.025 0.103
## sepc.nox
## 9 -0.171
## 10 0.103

```

Table 4: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
lt3	LT3a_Confidence	0.931	0.164	5.660	0	0.959

Latent Factor	Indicator	B	SE	Z	p-value	loading
lt3	LT3b_Confidence	0.706	0.144	4.892	0	0.802
lt3	LT3d_Confidence	0.706	0.144	4.892	0	0.629

After we remodel the third subdomain, the p-value of third domain is $0.897 > 0.05$. Then we can save all the remaining questions in the third subdomain (LT3a_Confidence, LT3b_Confidence, LT3d_Confidence).

Fourth subdomain

```
## lavaan 0.6-5 ended normally after 19 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of free parameters      6
##      Number of equality constraints   1
##      Row rank of the constraints matrix 1
##
##                               Used      Total
##      Number of observations          28        84
##
## Model Test User Model:
##
##      Test statistic                  0.016
##      Degrees of freedom              1
##      P-value (Chi-square)            0.899
##
## Parameter Estimates:
##
##      Information                    Expected
##      Information saturated (h1) model Structured
##      Standard errors                 Standard
##
## Latent Variables:
##              Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      lt4 =~
##      LT4_Cnfdn      0.370   0.140   2.640   0.008   0.370   0.469
##      LT4b_Cnfd (aa)  1.077   0.150   7.191   0.000   1.077   1.012
##      LT4c_Cnfd (aa)  1.077   0.150   7.191   0.000   1.077   0.886
##
## Variances:
##              Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      .LT4a_Confidenc 0.485   0.129   3.749   0.000   0.485   0.780
##      .LT4b_Confidenc -0.027   0.095  -0.282   0.778  -0.027  -0.024
##      .LT4c_Confidenc 0.316   0.127   2.486   0.013   0.316   0.214
##      lt4             1.000
##
##              npar      fmin      chisq
##      5.000      0.000      0.016
##              df      pvalue baseline.chisq
##      1.000      0.899      52.579
##      baseline.df baseline.pvalue      cfi
##      3.000      0.000      1.000
```

```

##          tli          nnfi          rfi
##          1.060          1.060          0.999
##          nfi          pnfi          ifi
##          1.000          0.333          1.019
##          rni          logl  unrestricted.logl
##          1.020         -93.343         -93.335
##          aic          bic          ntotal
##          196.686         203.347          28.000
##          bic2          rmsea    rmsea.ci.lower
##          187.802          0.000          0.000
##    rmsea.ci.upper    rmsea.pvalue          rmr
##          0.225          0.902          0.008
##    rmr_nomean          srmr    srmr_bentler
##          0.008          0.007          0.007
## srmr_bentler_nomean          crmr    crmr_nomean
##          0.007          0.006          0.006
##    srmr_mplus    srmr_mplus_nomean          cn_05
##          0.006          0.006          6648.164
##          cn_01          gfi          agfi
##          11481.859          1.000          0.998
##          pgfi          mfi          ecvi
##          0.167          1.018          0.358

##          lhs op          rhs    mi    epc sepc.lv sepc.all
## 9  LT4a_Confidence ~~ LT4b_Confidence 0.016 0.01    0.01    0.089
## 10 LT4a_Confidence ~~ LT4c_Confidence 0.016 -0.01   -0.01   -0.026
##    sepc.nox
## 9      0.089
## 10    -0.026

```

Table 5: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
lt4	LT4a_Confidence	0.370	0.14	2.640	0.008	0.469
lt4	LT4b_Confidence	1.077	0.15	7.191	0.000	1.012
lt4	LT4c_Confidence	1.077	0.15	7.191	0.000	0.886

Since p-value of the fourth subdomain is $0.899 > 0.05$, there is no need to make any change in the fourth subdomain and we can save all questions.

Fifth subdomain

```

## lavaan 0.6-5 ended normally after 13 iterations
##
## Estimator          ML
## Optimization method NLMINB
## Number of free parameters      6
## Number of equality constraints    1
## Row rank of the constraints matrix 1
##
##          Used      Total
## Number of observations      26      84
##

```

```

## Model Test User Model:
##
##   Test statistic                0.774
##   Degrees of freedom            1
##   P-value (Chi-square)          0.379
##
## Parameter Estimates:
##
##   Information                    Expected
##   Information saturated (h1) model Structured
##   Standard errors                Standard
##
## Latent Variables:
##
##           Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##   lt5 =~
##     LT5a_Cnfdn (aa)    0.398   0.124   3.205   0.001   0.398   0.618
##     LT5b_Cnfd         0.620   0.186   3.331   0.001   0.620   0.844
##     LT5c_Cnfd (aa)    0.398   0.124   3.205   0.001   0.398   0.532
##
## Variances:
##
##           Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##   .LT5a_Confidenc    0.257   0.101   2.544   0.011   0.257   0.618
##   .LT5b_Confidenc    0.155   0.186   0.832   0.405   0.155   0.287
##   .LT5c_Confidenc    0.402   0.132   3.034   0.002   0.402   0.717
##   lt5                1.000                1.000   1.000
##
##           npar           fmin           chisq
##           5.000           0.015           0.774
##           df           pvalue baseline.chisq
##           1.000           0.379          15.415
##           baseline.df baseline.pvalue       cfi
##           3.000           0.001          1.000
##           tli           nnfi           rfi
##           1.055           1.055          0.849
##           nfi           pnfi           ifi
##           0.950           0.317          1.016
##           rni           logl unrestricted.logl
##           1.018          -76.441          -76.054
##           aic           bic           ntotal
##           162.882          169.172          26.000
##           bic2           rmsea rmsea.ci.lower
##           153.653           0.000           0.000
##           rmsea.ci.upper rmsea.pvalue       rmr
##           0.494           0.394           0.041
##           rmr_nomean      srmr srmr_bentler
##           0.041           0.079           0.079
##           srmr_bentler_nomean crmr crmr_nomean
##           0.079           0.063           0.063
##           srmr_mplus      srmr_mplus_nomean cn_05
##           0.070           0.070          130.124
##           cn_01           gfi           agfi
##           224.020          0.981           0.885
##           pgfi           mfi           ecvi
##           0.163           1.004           0.414

```

```

##          lhs op          rhs    mi    epc sepc.lv sepc.all
## 9  LT5a_Confidence ~~ LT5b_Confidence 0.762 -0.102 -0.102 -0.512
## 11 LT5b_Confidence ~~ LT5c_Confidence 0.762  0.102  0.102  0.409
##      sepc.nox
## 9      -0.512
## 11      0.409

```

Table 6: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
lt5	LT5a_Confidence	0.398	0.124	3.205	0.001	0.618
lt5	LT5b_Confidence	0.620	0.186	3.331	0.001	0.844
lt5	LT5c_Confidence	0.398	0.124	3.205	0.001	0.532

Since p-value of the fifth subdomain is $0.379 > 0.05$, there is no need to make any change in the fifth subdomain and we can save all questions.

PER & FEEDBACK Domain Analysis

For PER&FEEDBACK table in TELL Statements, I numeric character answers of PF 1a~5c Confidence, and NA values stay as same as NA that will not count in. First, I made CFA models for each subdomain whose variables should greater than 2 (ex: PF1 has 5 variables: PF1a_Confidence, PF1b_Confidence, PF1c_Confidence, PF1d_Confidence and PF1e_Confidence), or the P-value of that model will become NA. And we get an exception in PF table: PF4 only has 2 variables, so I combine PF4 with PF5 to one CFA model so that we have an available P-value. Second, we find factor loadings of each variables in each subdomain and record them. Third, we compare P-value of each subdomain to 0.05, if P-value > 0.05 , our null hypothesis retained, and we do not need to make any further change on that subdomain; if P-value < 0.05 , it means our null hypothesis is rejected, and we need to remodel by dropping the variable with lowest factor loadings in that subdomain and check its P-value again. Following are detailed results

First subdomain:

```

## lavaan 0.6-5 ended normally after 21 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of free parameters      10
##
##                                     Used      Total
##      Number of observations          27         84
##
## Model Test User Model:
##
##      Test statistic                  15.646
##      Degrees of freedom              5
##      P-value (Chi-square)            0.008
##
## Parameter Estimates:
##
##      Information                    Expected
##      Information saturated (h1) model Structured
##      Standard errors                 Standard
##
## Latent Variables:

```

```

##           Estimate Std.Err z-value P(>|z|) Std.lv Std.all
## PF1 =~
##   PF1a_Confidenc  0.690  0.202  3.421  0.001  0.690  0.609
##   PF1b_Confidenc  0.879  0.168  5.229  0.000  0.879  0.830
##   PF1c_Confidenc  0.828  0.128  6.471  0.000  0.828  0.946
##   PF1d_Confidenc  0.823  0.135  6.110  0.000  0.823  0.915
##   PF1e_Confidenc  0.584  0.178  3.275  0.001  0.584  0.587
##
## Variances:
##           Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##   .PF1a_Confidenc  0.808  0.228  3.545  0.000  0.808  0.630
##   .PF1b_Confidenc  0.349  0.110  3.160  0.002  0.349  0.311
##   .PF1c_Confidenc  0.080  0.049  1.628  0.104  0.080  0.105
##   .PF1d_Confidenc  0.132  0.057  2.306  0.021  0.132  0.163
##   .PF1e_Confidenc  0.647  0.182  3.559  0.000  0.647  0.655
##   PF1              1.000
##

```

Table 7: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
PF1	PF1a_Confidence	0.690	0.202	3.421	0.001	0.609
PF1	PF1b_Confidence	0.879	0.168	5.229	0.000	0.830
PF1	PF1c_Confidence	0.828	0.128	6.471	0.000	0.946
PF1	PF1d_Confidence	0.823	0.135	6.110	0.000	0.915
PF1	PF1e_Confidence	0.584	0.178	3.275	0.001	0.587

Since p-value of first subdomain is $0.008 < 0.05$, and the factor loadings of “PF1e_Confidence” is lowest, thus, we try to drop it from the first subdomain:

```

## lavaan 0.6-5 ended normally after 31 iterations
##
## Estimator ML
## Optimization method NLMINB
## Number of free parameters 8
##
## Used Total
## Number of observations 28 84
##
## Model Test User Model:
##
## Test statistic 0.068
## Degrees of freedom 2
## P-value (Chi-square) 0.967
##
## Parameter Estimates:
##
## Information Expected
## Information saturated (h1) model Structured
## Standard errors Standard
##
## Latent Variables:
##           Estimate Std.Err z-value P(>|z|) Std.lv Std.all
## PF1 =~

```

```

##      PF1a_Confidenc    0.660    0.196    3.360    0.001    0.660    0.593
##      PF1b_Confidenc    0.835    0.173    4.830    0.000    0.835    0.780
##      PF1c_Confidenc    0.796    0.130    6.135    0.000    0.796    0.914
##      PF1d_Confidenc    0.831    0.129    6.432    0.000    0.831    0.940
##
## Variances:
##              Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##      .PF1a_Confidenc    0.804    0.223    3.601    0.000    0.804    0.649
##      .PF1b_Confidenc    0.449    0.135    3.321    0.001    0.449    0.392
##      .PF1c_Confidenc    0.125    0.061    2.048    0.041    0.125    0.165
##      .PF1d_Confidenc    0.091    0.061    1.498    0.134    0.091    0.116
##      PF1                1.000
##                        1.000

```

P-value = 0.967 > 0.05, thus we do not need to change any more on the first subdomain.

Second subdomain:

```

## lavaan 0.6-5 ended normally after 18 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of free parameters    10
##
##                        Used      Total
##      Number of observations      27      84
##
## Model Test User Model:
##
##      Test statistic          14.489
##      Degrees of freedom        5
##      P-value (Chi-square)      0.013
##
## Parameter Estimates:
##
##      Information              Expected
##      Information saturated (h1) model  Structured
##      Standard errors          Standard
##
## Latent Variables:
##              Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##      PF2 =~
##      PF2a_Confidenc    0.561    0.172    3.255    0.001    0.561    0.587
##      PF2b_Confidenc    0.948    0.159    5.981    0.000    0.948    0.905
##      PF2c_Confidenc    0.575    0.188    3.060    0.002    0.575    0.558
##      PF2d_Confidenc    0.896    0.151    5.941    0.000    0.896    0.901
##      PF2e_Confidenc    1.016    0.173    5.880    0.000    1.016    0.896
##
## Variances:
##              Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##      .PF2a_Confidenc    0.599    0.169    3.534    0.000    0.599    0.655
##      .PF2b_Confidenc    0.199    0.083    2.384    0.017    0.199    0.181
##      .PF2c_Confidenc    0.731    0.206    3.554    0.000    0.731    0.689
##      .PF2d_Confidenc    0.185    0.076    2.439    0.015    0.185    0.188
##      .PF2e_Confidenc    0.255    0.101    2.520    0.012    0.255    0.198

```

```
##      PF2                1.000                1.000      1.000
```

Table 8: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
PF2	PF2a_Confidence	0.561	0.172	3.255	0.001	0.587
PF2	PF2b_Confidence	0.948	0.159	5.981	0.000	0.905
PF2	PF2c_Confidence	0.575	0.188	3.060	0.002	0.558
PF2	PF2d_Confidence	0.896	0.151	5.941	0.000	0.901
PF2	PF2e_Confidence	1.016	0.173	5.880	0.000	0.896

Since p-value of first subdomain is $0.013 < 0.05$, and the factor loadings of “PF2c_Confidence” is lowest, thus, we try to drop it from the second subdomain:

```
## lavaan 0.6-5 ended normally after 18 iterations
##
##      Estimator                ML
##      Optimization method      NLMINB
##      Number of free parameters      8
##
##                                Used      Total
##      Number of observations        28        84
##
## Model Test User Model:
##
##      Test statistic                1.559
##      Degrees of freedom              2
##      P-value (Chi-square)           0.459
##
## Parameter Estimates:
##
##      Information                Expected
##      Information saturated (h1) model      Structured
##      Standard errors              Standard
##
## Latent Variables:
##                                Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##      PF2 =~
##      PF2a_Confidenc      0.553      0.169      3.275      0.001      0.553      0.583
##      PF2b_Confidenc      0.910      0.158      5.765      0.000      0.910      0.877
##      PF2d_Confidenc      0.884      0.147      6.012      0.000      0.884      0.901
##      PF2e_Confidenc      1.011      0.167      6.057      0.000      1.011      0.905
##
## Variances:
##                                Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##      .PF2a_Confidenc      0.596      0.166      3.588      0.000      0.596      0.660
##      .PF2b_Confidenc      0.248      0.093      2.675      0.007      0.248      0.231
##      .PF2d_Confidenc      0.182      0.077      2.349      0.019      0.182      0.189
##      .PF2e_Confidenc      0.227      0.099      2.280      0.023      0.227      0.181
##      PF2                  1.000                1.000      1.000
```

P-value = $0.459 > 0.05$, thus we can stay here for the second subdomain.

Third subdomain:

```
## lavaan 0.6-5 ended normally after 15 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of free parameters      10
##
##                               Used      Total
##      Number of observations          28        84
##
## Model Test User Model:
##
##      Test statistic                  2.920
##      Degrees of freedom              5
##      P-value (Chi-square)            0.712
##
## Parameter Estimates:
##
##      Information                    Expected
##      Information saturated (h1) model Structured
##      Standard errors                Standard
##
## Latent Variables:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      PF3 =~
##      PF3a_Confidence 0.466 0.184 2.533 0.011 0.466 0.485
##      PF3b_Confidence 0.869 0.173 5.032 0.000 0.869 0.838
##      PF3c_Confidence 0.628 0.146 4.300 0.000 0.628 0.746
##      PF3d_Confidence 0.753 0.169 4.468 0.000 0.753 0.767
##      PF3e_Confidence 0.543 0.171 3.179 0.001 0.543 0.588
##
## Variances:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      .PF3a_Confidence 0.706 0.199 3.543 0.000 0.706 0.765
##      .PF3b_Confidence 0.320 0.149 2.153 0.031 0.320 0.298
##      .PF3c_Confidence 0.315 0.109 2.893 0.004 0.315 0.444
##      .PF3d_Confidence 0.396 0.143 2.759 0.006 0.396 0.411
##      .PF3e_Confidence 0.557 0.164 3.396 0.001 0.557 0.654
##      PF3              1.000                1.000 1.000
```

Table 9: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
PF3	PF3a_Confidence	0.466	0.184	2.533	0.011	0.485
PF3	PF3b_Confidence	0.869	0.173	5.032	0.000	0.838
PF3	PF3c_Confidence	0.628	0.146	4.300	0.000	0.746
PF3	PF3d_Confidence	0.753	0.169	4.468	0.000	0.767
PF3	PF3e_Confidence	0.543	0.171	3.179	0.001	0.588
Since p-value > 0.05, the third subdomain is ok, no longer to remove it.						

Fourth subdomain:

PF4 only has 2 variables, so I combine PF4 with PF5 to one CFA model so that we can get an available P-value.

```
## lavaan 0.6-5 ended normally after 22 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of free parameters      11
##
##                               Used      Total
##      Number of observations         24        84
##
## Model Test User Model:
##
##      Test statistic                12.824
##      Degrees of freedom              4
##      P-value (Chi-square)           0.012
##
## Parameter Estimates:
##
##      Information                      Expected
##      Information saturated (h1) model Structured
##      Standard errors                  Standard
##
## Latent Variables:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      PF4 =~
##      PF4a_Confidenc 0.754 0.148 5.099 0.000 0.754 0.888
##      PF4b_Confidenc 0.681 0.145 4.699 0.000 0.681 0.835
##      PF5 =~
##      PF5a_Confidenc 0.690 0.173 3.988 0.000 0.690 0.757
##      PF5b_Confidenc 0.632 0.158 4.003 0.000 0.632 0.759
##      PF5c_Confidenc 0.535 0.192 2.782 0.005 0.535 0.567
##
## Covariances:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      PF4 ~~
##      PF5          0.877 0.113 7.732 0.000 0.877 0.877
##
## Variances:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      .PF4a_Confidenc 0.153 0.101 1.511 0.131 0.153 0.212
##      .PF4b_Confidenc 0.201 0.094 2.131 0.033 0.201 0.302
##      .PF5a_Confidenc 0.355 0.143 2.484 0.013 0.355 0.427
##      .PF5b_Confidenc 0.294 0.119 2.470 0.014 0.294 0.424
##      .PF5c_Confidenc 0.603 0.192 3.135 0.002 0.603 0.678
##      PF4          1.000
##      PF5          1.000
```

Table 10: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
PF4	PF4a_Confidence	0.754	0.148	5.099	0.000	0.888

Latent Factor	Indicator	B	SE	Z	p-value	loading
PF4	PF4b_Confidence	0.681	0.145	4.699	0.000	0.835
PF5	PF5a_Confidence	0.690	0.173	3.988	0.000	0.757
PF5	PF5b_Confidence	0.632	0.158	4.003	0.000	0.759
PF5	PF5c_Confidence	0.535	0.192	2.782	0.005	0.567

Since P-value is $0.012 < 0.05$, and the lowest factor loading is “PF5c_Confidence”, thus we try to drop it from the subdomain:

```
## lavaan 0.6-5 ended normally after 21 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of free parameters      9
##
##                               Used      Total
##      Number of observations         24        84
##
## Model Test User Model:
##
##      Test statistic                  0.832
##      Degrees of freedom              1
##      P-value (Chi-square)            0.362
##
## Parameter Estimates:
##
##      Information                    Expected
##      Information saturated (h1) model Structured
##      Standard errors                Standard
##
## Latent Variables:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      PF4 =~
##      PF4a_Confidenc 0.724 0.155 4.671 0.000 0.724 0.851
##      PF4b_Confidenc 0.710 0.148 4.808 0.000 0.710 0.871
##      PF5 =~
##      PF5a_Confidenc 0.812 0.171 4.742 0.000 0.812 0.890
##      PF5b_Confidenc 0.635 0.160 3.970 0.000 0.635 0.763
##
## Covariances:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      PF4 ~~
##      PF5      0.755 0.137 5.507 0.000 0.755 0.755
##
## Variances:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      .PF4a_Confidenc 0.199 0.116 1.720 0.085 0.199 0.275
##      .PF4b_Confidenc 0.160 0.107 1.497 0.134 0.160 0.241
##      .PF5a_Confidenc 0.173 0.157 1.100 0.271 0.173 0.207
##      .PF5b_Confidenc 0.289 0.124 2.342 0.019 0.289 0.418
##      PF4            1.000      1.000 1.000
##      PF5            1.000      1.000 1.000
```

P-value is $0.362 > 0.05$, thus no longer remodel this subdomain.

Learning Experience Domain Analysis

For learning experience table in TELL Statements, we numeric character answers of LE 1a~6d Confidence, and NA values stay as same as NA that will not count in. First, I made CFA models for each subdomain (ex: LE1 has 5 variables: LE1a_Confidence, LE1b_Confidence, LE1c_Confidence, LE1d_Confidence and LE1e_Confidence). Then we have an available P-value for each subdomain and we find factor loadings of each variables in each subdomain. Third, we compare P-value of each subdomain to 0.05, if P-value > 0.05, our null hypothesis retained, and we do not need to make any further change on that subdomain; if P-value < 0.05, it means our null hypothesis is rejected, and we need to remodel by dropping the variable with lowest factor loadings in that subdomain and check its P-value again. Following are detailed results

First subdomian

```
## lavaan 0.6-5 ended normally after 28 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of free parameters      10
##
##                                     Used      Total
##      Number of observations          29         84
##
## Model Test User Model:
##
##      Test statistic                  2.594
##      Degrees of freedom              5
##      P-value (Chi-square)            0.762
##
## Parameter Estimates:
##
##      Information                      Expected
##      Information saturated (h1) model  Structured
##      Standard errors                  Standard
##
## Latent Variables:
##
##      Estimate  Std.Err  z-value  P(>|z|)
##      LE1 =~
##      LE1a_Confide 1.000
##      LE1b_Confide 0.601  0.230   2.619   0.009
##      LE1c_Confide 0.837  0.298   2.812   0.005
##      LE1d_Confide 0.589  0.236   2.495   0.013
##      LE1e_Confide 0.351  0.215   1.632   0.103
##
## Variances:
##
##      Estimate  Std.Err  z-value  P(>|z|)
##      .LE1a_Confide 0.690  0.699   0.987   0.324
##      .LE1b_Confide 2.142  0.632   3.391   0.001
##      .LE1c_Confide 3.173  0.985   3.221   0.001
##      .LE1d_Confide 2.411  0.696   3.465   0.001
##      .LE1e_Confide 2.590  0.698   3.711   0.000
##      LE1          2.646  1.091   2.424   0.015
```

Table 11: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
LE1	LE1a_Confidence	1.000	0.000	NA	NA	0.891
LE1	LE1b_Confidence	0.601	0.230	2.619	0.009	0.556
LE1	LE1c_Confidence	0.837	0.298	2.812	0.005	0.607
LE1	LE1d_Confidence	0.589	0.236	2.495	0.013	0.525
LE1	LE1e_Confidence	0.351	0.215	1.632	0.103	0.334

The p-value of this subdomain is 0.762, so we will keep all the questions in this subdomain.

Second Subdomain

```
## lavaan 0.6-5 ended normally after 32 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of free parameters      12
##
##                                Used      Total
##      Number of observations         28         84
##
## Model Test User Model:
##
##      Test statistic                  18.696
##      Degrees of freedom                9
##      P-value (Chi-square)             0.028
##
## Parameter Estimates:
##
##      Information                      Expected
##      Information saturated (h1) model  Structured
##      Standard errors                  Standard
##
## Latent Variables:
##              Estimate  Std.Err  z-value  P(>|z|)
##      LE2 =~
##      LE2a_Confidenc    1.000
##      LE2b_Confidenc    1.036    0.486    2.131    0.033
##      LE2c_Confidenc    1.428    0.539    2.647    0.008
##      LE2d_Confidenc    1.164    0.493    2.360    0.018
##      LE2e_Confidenc    0.855    0.407    2.101    0.036
##      LE2f_Confidenc    1.419    0.597    2.378    0.017
##
## Variances:
##              Estimate  Std.Err  z-value  P(>|z|)
##      .LE2a_Confidenc    1.221    0.403    3.033    0.002
##      .LE2b_Confidenc    2.313    0.691    3.345    0.001
##      .LE2c_Confidenc    1.539    0.593    2.595    0.009
##      .LE2d_Confidenc    1.975    0.627    3.151    0.002
##      .LE2e_Confidenc    1.656    0.492    3.364    0.001
##      .LE2f_Confidenc    2.840    0.907    3.131    0.002
##      LE2                0.769    0.482    1.596    0.110
```

Table 12: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
LE2	LE2a_Confidence	1.000	0.000	NA	NA	0.622
LE2	LE2b_Confidence	1.036	0.486	2.131	0.033	0.513
LE2	LE2c_Confidence	1.428	0.539	2.647	0.008	0.710
LE2	LE2d_Confidence	1.164	0.493	2.360	0.018	0.587
LE2	LE2e_Confidence	0.855	0.407	2.101	0.036	0.503
LE2	LE2f_Confidence	1.419	0.597	2.378	0.017	0.594

In the second subdomain, the p-value is $0.028 < 0.05$, so we will drop the question LE2a to see how the model will be.

```
## lavaan 0.6-5 ended normally after 30 iterations
##
## Estimator ML
## Optimization method NLMINB
## Number of free parameters 10
##
## Used Total
## Number of observations 29 84
##
## Model Test User Model:
##
## Test statistic 1.583
## Degrees of freedom 5
## P-value (Chi-square) 0.903
##
## Parameter Estimates:
##
## Information Expected
## Information saturated (h1) model Structured
## Standard errors Standard
##
## Latent Variables:
## Estimate Std.Err z-value P(>|z|)
## LE2 =~
## LE2b_Confidenc 1.000
## LE2c_Confidenc 1.065 0.423 2.520 0.012
## LE2d_Confidenc 0.791 0.363 2.179 0.029
## LE2e_Confidenc 0.640 0.305 2.098 0.036
## LE2f_Confidenc 0.871 0.424 2.053 0.040
##
## Variances:
## Estimate Std.Err z-value P(>|z|)
## .LE2b_Confidenc 1.704 0.642 2.652 0.008
## .LE2c_Confidenc 1.676 0.675 2.482 0.013
## .LE2d_Confidenc 2.153 0.662 3.250 0.001
## .LE2e_Confidenc 1.610 0.485 3.323 0.001
## .LE2f_Confidenc 3.219 0.959 3.358 0.001
## LE2 1.354 0.811 1.670 0.095
```

Table 13: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
LE2	LE2b_Confidence	1.000	0.000	NA	NA	0.665
LE2	LE2c_Confidence	1.065	0.423	2.520	0.012	0.692
LE2	LE2d_Confidence	0.791	0.363	2.179	0.029	0.532
LE2	LE2e_Confidence	0.640	0.305	2.098	0.036	0.506
LE2	LE2f_Confidence	0.871	0.424	2.053	0.040	0.492

After dropping the LE2a, we have a p value of $0.9 > 0.05$. So we will keep all the other questions.

Third Subdomain

```
## lavaan 0.6-5 ended normally after 33 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of free parameters      14
##
##                                Used      Total
##      Number of observations         29        84
##
## Model Test User Model:
##
##      Test statistic                20.428
##      Degrees of freedom              14
##      P-value (Chi-square)           0.117
##
## Parameter Estimates:
##
##      Information                    Expected
##      Information saturated (h1) model Structured
##      Standard errors                Standard
##
## Latent Variables:
##      Estimate  Std.Err  z-value  P(>|z|)
##      LE3 =~
##      LE3a_Confidenc  1.000
##      LE3b_Confidenc  0.977    0.377    2.593    0.010
##      LE3c_Confidenc  0.273    0.219    1.242    0.214
##      LE3d_Confidenc  0.563    0.326    1.729    0.084
##      LE3e_Confidenc  0.653    0.306    2.132    0.033
##      LE3f_Confidenc  0.679    0.308    2.205    0.027
##      LE3g_Confidenc  0.302    0.246    1.229    0.219
##
## Variances:
##      Estimate  Std.Err  z-value  P(>|z|)
##      .LE3a_Confidenc  2.782    1.002    2.778    0.005
##      .LE3b_Confidenc  1.836    0.785    2.340    0.019
##      .LE3c_Confidenc  1.865    0.504    3.700    0.000
##      .LE3d_Confidenc  3.508    0.985    3.561    0.000
##      .LE3e_Confidenc  2.503    0.751    3.335    0.001
##      .LE3f_Confidenc  2.399    0.733    3.272    0.001
```

```
## .LE3g_Confidenc 2.355 0.636 3.703 0.000
## LE3 2.069 1.248 1.657 0.097
```

Table 14: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
LE3	LE3a_Confidence	1.000	0.000	NA	NA	0.653
LE3	LE3b_Confidence	0.977	0.377	2.593	0.010	0.720
LE3	LE3c_Confidence	0.273	0.219	1.242	0.214	0.276
LE3	LE3d_Confidence	0.563	0.326	1.729	0.084	0.397
LE3	LE3e_Confidence	0.653	0.306	2.132	0.033	0.511
LE3	LE3f_Confidence	0.679	0.308	2.205	0.027	0.534
LE3	LE3g_Confidence	0.302	0.246	1.229	0.219	0.273

In the third subdomain, we have a p value of $0.117 > 0.05$, so we will keep all the questions.

Fourth Subdomain

```
## lavaan 0.6-5 ended normally after 30 iterations
##
## Estimator ML
## Optimization method NLMINB
## Number of free parameters 10
##
## Used Total
## Number of observations 29 84
##
## Model Test User Model:
##
## Test statistic 8.065
## Degrees of freedom 5
## P-value (Chi-square) 0.153
##
## Parameter Estimates:
##
## Information Expected
## Information saturated (h1) model Structured
## Standard errors Standard
##
## Latent Variables:
## Estimate Std.Err z-value P(>|z|)
## LE4 =~
## LE4a_Confidenc 1.000
## LE4b_Confidenc 0.570 0.215 2.654 0.008
## LE4c_Confidenc 0.593 0.171 3.466 0.001
## LE4d_Confidenc 0.869 0.224 3.872 0.000
## LE4e_Confidenc 0.522 0.229 2.285 0.022
##
## Variances:
## Estimate Std.Err z-value P(>|z|)
## .LE4a_Confidenc 1.148 0.708 1.622 0.105
## .LE4b_Confidenc 3.175 0.893 3.555 0.000
## .LE4c_Confidenc 1.603 0.496 3.234 0.001
```



```
##      .LE4d_Confidenc    2.159    0.766    2.820    0.005
##      .LE4e_Confidenc    3.848    1.059    3.635    0.000
##      LE4                3.501    1.345    2.603    0.009
```

Table 15: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
LE4	LE4a_Confidence	1.000	0.000	NA	NA	0.868
LE4	LE4b_Confidence	0.570	0.215	2.654	0.008	0.513
LE4	LE4c_Confidence	0.593	0.171	3.466	0.001	0.659
LE4	LE4d_Confidence	0.869	0.224	3.872	0.000	0.742
LE4	LE4e_Confidence	0.522	0.229	2.285	0.022	0.446

In the fourth subdomain, we have a p value of 0.153. We will keep all the questions in this subdomain.

Fifth subdomain

```
## lavaan 0.6-5 ended normally after 26 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of free parameters      8
##
##                               Used      Total
##      Number of observations         29      84
##
## Model Test User Model:
##
##      Test statistic                4.188
##      Degrees of freedom              2
##      P-value (Chi-square)           0.123
##
## Parameter Estimates:
##
##      Information                    Expected
##      Information saturated (h1) model Structured
##      Standard errors                Standard
##
## Latent Variables:
##      Estimate Std.Err z-value P(>|z|)
##      LE5 =~
##      LE5a_Confidenc    1.000
##      LE5b_Confidenc    0.570    0.243    2.343    0.019
##      LE5c_Confidenc    1.325    0.474    2.794    0.005
##      LE5d_Confidenc    0.629    0.289    2.178    0.029
##
## Variances:
##      Estimate Std.Err z-value P(>|z|)
##      .LE5a_Confidenc    1.564    0.580    2.696    0.007
##      .LE5b_Confidenc    1.328    0.381    3.487    0.000
##      .LE5c_Confidenc    0.689    0.723    0.952    0.341
##      .LE5d_Confidenc    1.985    0.558    3.557    0.000
##      LE5                1.351    0.765    1.766    0.077
```

Table 16: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
LE5	LE5a_Confidence	1.000	0.000	NA	NA	0.681
LE5	LE5b_Confidence	0.570	0.243	2.343	0.019	0.498
LE5	LE5c_Confidence	1.325	0.474	2.794	0.005	0.880
LE5	LE5d_Confidence	0.629	0.289	2.178	0.029	0.460

In the fifth subdomain, we have a p-value of 0.123, so we will keep all the questions in this subdomain.

Sixth subdomain

```
## lavaan 0.6-5 ended normally after 37 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of free parameters      8
##
##                               Used      Total
##      Number of observations         29         84
##
## Model Test User Model:
##
##      Test statistic                0.832
##      Degrees of freedom              2
##      P-value (Chi-square)           0.660
##
## Parameter Estimates:
##
##      Information                    Expected
##      Information saturated (h1) model Structured
##      Standard errors                Standard
##
## Latent Variables:
##      Estimate Std.Err z-value P(>|z|)
##      LE6 =~
##      LE6a_Confidence 1.000
##      LE6b_Confidence 2.725 2.229 1.223 0.222
##      LE6c_Confidence 2.058 1.717 1.198 0.231
##      LE6d_Confidence 3.160 2.585 1.222 0.222
##
## Variances:
##      Estimate Std.Err z-value P(>|z|)
##      .LE6a_Confidence 4.983 1.322 3.770 0.000
##      .LE6b_Confidence 0.807 0.466 1.732 0.083
##      .LE6c_Confidence 1.545 0.473 3.270 0.001
##      .LE6d_Confidence 1.195 0.640 1.867 0.062
##      LE6              0.309 0.503 0.614 0.539
```

Table 17: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
LE6	LE6a_Confidence	1.000	0.000	NA	NA	0.241

Latent Factor	Indicator	B	SE	Z	p-value	loading
LE6	LE6b_Confidence	2.725	2.229	1.223	0.222	0.860
LE6	LE6c_Confidence	2.058	1.717	1.198	0.231	0.677
LE6	LE6d_Confidence	3.160	2.585	1.222	0.222	0.849

In the sixth subdomain, the p-value is $0.66 > 0.05$. We will not drop any question in this subdomain.

Conclusion / Discussion

For PER&FEEDBACK table, I dropped “PF1e_Confidence”, “PF2c_Confidence” and “PF5c_Confidence” so that P-value of all subdomains are greater than 0.05 finally.

For the Learning Experience table, we will only drop “LE2a_Confidence” and keep all the remaining questions in order to let the P-value of all subdomains are greater than 0.05 finally.

For the Learning Experience table, we will only drop “LT3c_Confidence” and keep all the remaining questions in order to let the P-value of all subdomains are greater than 0.05 finally.

Appendix