TELL Framework Survey Analysis Report

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1. Introduction

Our client, Catherine Ritz, a professor at Boston University's Department of Education, administered a survey pilot, completed by 86 individuals. Her goal was to investigate how foreign language teachers felt about the TELL Framework, a set of suggested characteristics a model foreign language teachers should have. In particular, she was interested in seeing if they would differ by the teacher's demographic or the language of teaching. Her survey included 18 questions regarding the teacher's backgrounds, and 200 questions regarding the TELL Framework. In particular, she took the listed characteristics from four of the major domains, and asked two questions about each one: if the teacher thought it was important for model teaching, and if the teacher was confident in applying it.

At our intake meeting, our client discussed improving the survey design for her final study. In particular, she was looking for a way to reduce the number of survey questions. In this report, we will propose a method and structure to summarize and remove questions.

This report will first start with a description of the Data Structure, as well as our Data Analysis. We will then describe the methods we will use to analyze the data, followed by our analysis.

2. Data Structure and Expolatory Data Analysis

TELL Framework Structure

The Teacher Effectiveness for Language Learning (TELL) framework is categorized into multiple domains. Each domain has its own set of individual characteristics, put into smaller groups. For the purpose of this report, we will call each of the large sets "domains", and each smaller group a "subdomain".

Data Structure

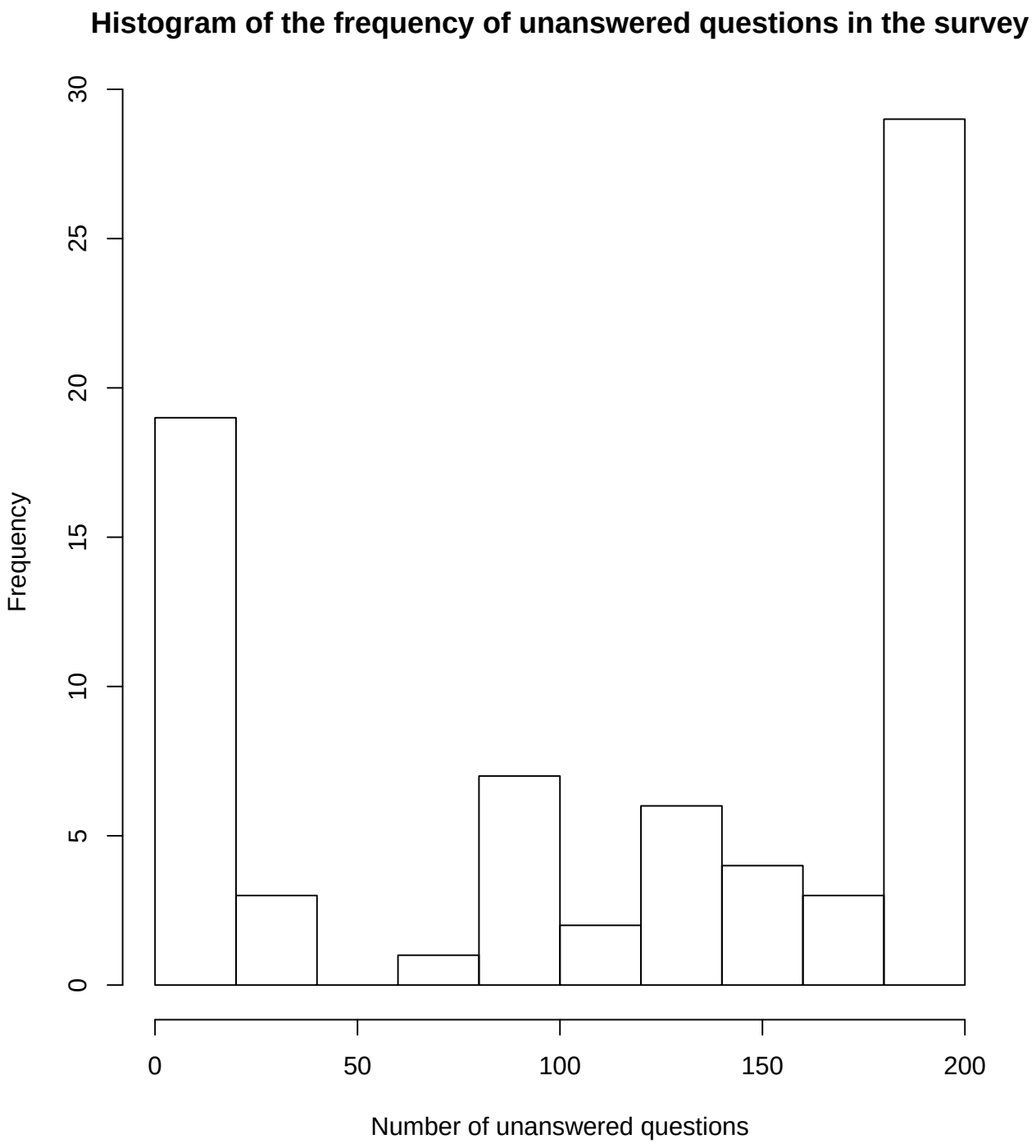
We were provided the data in an excel file with 6 spreadsheets including one sheet of notes, one sheet of personal information, and four sheets of questions on the Teacher Effectiveness for Language Learning (TELL) framework. The dataset of personal information contains questions regarding respondents' teaching language and education background.

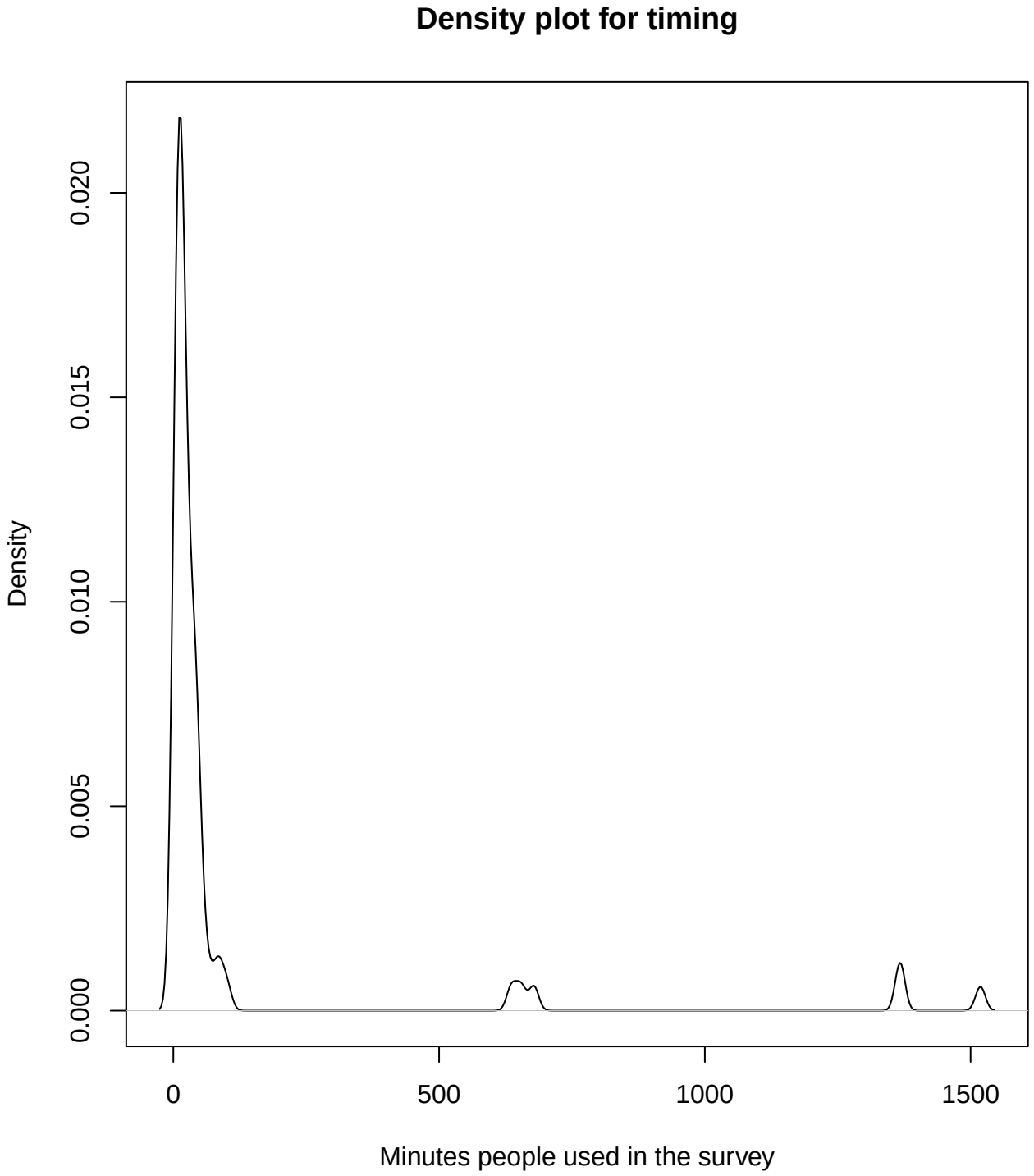
Each sheet in the TELL Framework of the survey includes answers for part of one of four domains from the TELL Framework: planning, learning experience, learning tools, and performance & feedback. There are two questions asked for each characteristic, regarding the respondents' attitudes of contribution and Contributes towards the characteristic, with 200 questions in total.

In this report, we will primarily focus on the questions regarding "Contributes". Additionally, we will refer to each question with its letter code, such as "PL1a". Each subdomain will be referred to by its shorter letter code, "PL1".

Exploratory Data Analysis

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


Histogram of the frequency of unanswered questions in the survey
Frequency
0
5
10
15
20
25
30
0
50
100
150
200
Number of unanswered questions



From the histogram graph, it shows that most people (about 29 people) did not answer any questions in the survey, and the second high frequency (about 19 people) in the survey answered all questions, rest of people answered questions between 0 to 200.

From the density plot, it shows most people spend no longer than about 100 minutes for this survey, and only few of people used about 600 minutes or ever longer than 1300 minutes.

Data Cleaning

Data Cleaning was conducted using R, primarily using the tidyverse package. The sheets were read in and bound together by row, allowing each row to contain the background data and all of the answers of an individual. Extra answers attached to no questions were removed. Names were also changed to fit a consistent structure among questions, allowing them to be effectively analyzed.

Concerns

Based on exploring the data, we found a few areas that may cause limitations. Firstly, many people did not answer most of the questions, meaning that the number of overall observations is limited. This may limit our analysis and our results.

3. Methods

We used a confirmatory factor analysis to assess how well questions can be grouped into their subdomains. A confirmatory factor analysis allows us to assess how well parts of a survey can fall within a proposed structure. Using this, we can try to group each survey questions into parts. If the questions all can be effectively grouped under a subdomain using a CFA, we can propose that each of those individual questions can be removed, and replaced with one question that addresses the listed subdomain. To do this, we used the lavaan package in R. A model was created for each subdomain, composed of all of its questions. We looked only at individuals who answered questions for each model, and excluded blank answers. For this report, we chose to focus on questions regarding Contributes. The questions regarding contribution fall outside of our scope, so we would recommend consulting a survey expert if you want to find a way to address those.

To construct a model, we followed the structure of the TELL Framework, as described in the "Data Strcture" part of this report. We then used a protocol to assess the model and reduce questions. First, we looked at the standard errors for each of the questions and the loading. If the values of each were too low (in each case, lower than ~0.55), the question was considered not a good fit in the subdomain, and removed from the model. The process then continued, and the p-value was collected afterwards. Then, we checked the p-value of the model. A p-value higher than 0.05 indicates that the questions are all similar under the model, and the grouping is good. If the p-value was lower, it means there was strong evidence that questions were not equal, and one of the questions could be removed. We continued this process until achieving a sufficient model, and then collected summary statistics.

There were a few additional cases we had to consider as well. For subdomains with three questions, rather than removing questions, a transformation was done in order to assess the subdomain. Additionally, subdomains with two questions cannot be analyzed using this method. Rather than treating them by themselves, they were grouped with another subdomain, effectively grouping them together.

4. Analysis

Planning Domain

Table 1: 'Planning' Subdomain Summary

Section	Questions	P-Value	CFI	TLI
PL1	PL1a,PL1b,PL1c,PL1d,PL1f	0.887	0.95	0.876
PL2	PL2a,PL2b,PL2c	0.292	1	1.108
PL3	PL3a,PL3d,PL3e	0.902	1	1.097
PL4	PL4a,PL4b,PL4c	0.051	0.993	0.978
PL5	PL5a,PL5b,PL5c,PL5d	0.261	0.954	0.862
PL6	PL6a,PL6b,PL6c	0.283	1	1.028
PL7	PL7a,PL7b,PL7c	0.903	1	1.037
PL8	PL8a,PL8b,PL8c	0.301	1	1.148

Summary statistics for the subdomains of PL1 are shown in Table 1. Questions were removed based on our protocol, and the remaining questions are shown in the "Questions" table. Questions PL1e, PL1g, PL3b,PL3c, PL6d, and PL8d were removed. All additional questions were found to not fit well within the model, and may need to be treated separately. The models meet the gold standard of a Comparative Fit Index (CFI) of 0.90, indicating that there is not a major discrepancy between the hypothetical models and the data. The Tucker-Lewis Index (TLI) for each model are also close or lower to 1, supporting that the data and models seem to be close. The P-values for each of the model all are relatively high, indicating that they most likely follow the null hypothesis. Effectively, this means that the questions within the model can be grouped into their subdomain. PL4 may be the only exception, since it has a P-value close to 0.051. However, the CFI and TLI of the model remain high, so it may be correct to use it as one model.

Learning Tool Domain

Table 2: 'Learning Tools' Subdomain Summary

Section	Questions	P-Value	CFI	TLI
LT1&LT2	LT1a,LT1b,LT1c,LT2a	0.659	1	1.038
LT3&LT4	LT3a,LT3b,LT3c,LT3d,LT4b	0.149	0.977	0.955
LT5	LT5a,LT5b,LT5c	0.141	0.946	0.837

The summary statistics for the Learning Tools subdomains are shown in Table 2. As before, questions included in each subdomain are listed in the "Questions" column. The questions removed due to the protocal were LT2b, LT2c, LT4a, and LT4c, which may need to be treated separately. The CFI and TLI both seem high and close to 1 respectively, showing that the data and proposed models are relatively close. LT1 may need to be considered more closely, since its LT1 is relatively larger than the rest of these values. However, it still seems to show a relatively close comparison between the data and proposed models. Once again, our p-values indicate that the null hypothesis cannot be rejected, and the questions can effectively be grouped into a subdomain.

Per & Feedback Domain

```
## Warning in lav_object_post_check(object): lavaan WARNING: some estimated ov
## variances are negative

## Warning in lav_object_post_check(object): lavaan WARNING: some estimated ov
```

```
## variances are negative
```

Table 3: 'Performance & Feedback' Subdomain Summary

Section	Questions	P-Value	CFI	TLI
PF1	PF1a,PF1b,PF1c,PF1d,PF1e	0.707	1	1.03
PF2	PF2a,PF2b,PF2c,PF2d	0.575	1	1.027
PF3	PF3a,PF3c,PF3e	0	1	1.097
PF4 & PF5	PF4a,PF4b,PF5a,PF5b	0.146	0.987	0.924

The summary statistics for the Performance and Feedback subdomain is shown in Table 3. Excluded questions from our protocol were PF1e, PF2c, and PF5c. Since PF4 only contained two questions, following our protocol, it was treated in combination with PL5 in order to be assessed with our CFA method.

Once again, the calculated CFI and TLI are above 0.9 and close to 1 respectively, indicating that the data and proposed models follow each other well. Additionally, p-values are higher than the 0.05 threshold, indicating that these subdomains can be used to group questions together effectively.

Learning Experience Domain

Table 4: 'Learning Experience' Subdomain Summary

Section	Questions	P-Value	CFI	TLI
LE1	LE1a,LE1b,LE1c,LE1d	0.672	1	1.008
LE2	LE2a,LE2c,LE2d,LE2f	0.412	0.953	0.86
LE3	LE3a,LE3b,LE3d,LE3e,LE3f	0.951	0.832	0.664
LE4	LE4a,LE4b,LE4c,LE4d	0.13	1	1.104
LE5	LE5a,LE5c,LE5d	0.857	0.958	0.873
LE6	LE6b,LE6c,LE6d	0.657	1	1.172

The results for the Learning Experience Domain can be shown in Table 4. The questions removed due to the question removal protocol are LE1a, LE2b, LE2e, LE3c, LE3g, LE4e, LE5b, and LE6a. These questions may need to be treated separately when restructuring the survey.

Our CFI and TLI values are both high and close to 1, indicating that the models fit the data. The TLI for LE3 is relatively higher than the rest, which may mean it needs to be considered separately. However, it is still relatively close to 1, and still indicates a decent fit between data and model. The p-values are above our threshold of 0.05, indicating that each one groups each set of questions well.

5. Conclusion

In this report, we have proposed a structure to group and remove large set of question based on the structure of the TELL Framework. In our analysis, we used a Confirmatory Factor Analysis to show that many of the survey questions can be grouped in a larger structure. This may highlight a method to reduce question number, where, rather than asking each of the questions, one question is asked for each group. However, this will require a change in questioning and possibly a change in structure.

The questions removed from the subdomains must be considered separately. Usually, they were removed because the way they were answered followed a significantly different pattern from other questions. There may be a final structure that does group these with the rest. Our analysis only shows that they don't fit best under the groupings provided by the TELL framework.

Appendix

Learning Tool Domain Analysis

For Learning Tools table in TELL Statements, we numeric character answers of LT 1a~5c Contributes, 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_Contributes, LT1b_Contributes, LT1c_Contributes).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 droping 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 15 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                            36          84
##
## Model Test User Model:
##
##   Test statistic                                 0.021
##   Degrees of freedom                                 1
##   P-value (Chi-square)                           0.885
##
## 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 =~
##     LT1_Cntrb (aa)    0.770    0.106    7.232    0.000    0.770    0.825
##     LT1b_Cntr (aa)    0.770    0.106    7.232    0.000    0.770    0.904
##     LT1c_Cntr         0.638    0.137    4.648    0.000    0.638    0.711
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .LT1a_Contribts    0.277    0.093    2.983    0.003    0.277    0.319
##    .LT1b_Contribts    0.133    0.073    1.817    0.069    0.133    0.183
##    .LT1c_Contribts    0.399    0.111    3.605    0.000    0.399    0.495
##     lt1               1.000                              1.000    1.000
```

Table 5: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
lt1	LT1a_Contributes	0.770	0.106	7.232	0	0.825
lt1	LT1b_Contributes	0.770	0.106	7.232	0	0.904
lt1	LT1c_Contributes	0.638	0.137	4.648	0	0.711

Since p-value of the first subdomain is 0.885> 0.05 and all factor loadings are larger than 0.55, there is no need to make any change in the first subdomain.

Second subdomain

```
## lavaan 0.6-5 ended normally after 15 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                            36          84
##
## Model Test User Model:
##
##   Test statistic                                 3.132
##   Degrees of freedom                                 1
##   P-value (Chi-square)                           0.077
##
## 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_Cntrb         1.039    0.314    3.309    0.001    1.039    1.124
##     LT2b_Cntr (aa)    0.364    0.145    2.510    0.012    0.364    0.477
##     LT2c_Cntr (aa)    0.364    0.145    2.510    0.012    0.364    0.448
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .LT2a_Contribts   -0.226    0.625   -0.361    0.718   -0.226   -0.264
##    .LT2b_Contribts    0.451    0.130    3.464    0.001    0.451    0.773
##    .LT2c_Contribts    0.527    0.145    3.630    0.000    0.527    0.799
##     lt2               1.000                              1.000    1.000
```

Table 6: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
lt2	LT2a_Contributes	1.039	0.314	3.309	0.001	1.124
lt2	LT2b_Contributes	0.364	0.145	2.510	0.012	0.477
lt2	LT2c_Contributes	0.364	0.145	2.510	0.012	0.448

Since p-value of the second subdomain is $0.077 > 0.05$ and question b & c have factor loadings smaller than 0.55, so we suggest that these two questions do not fit in this subdomain.

First subdomain and second subdomain

```
## lavaan 0.6-5 ended normally after 20 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                          8
##
##                                                   Used       Total
##   Number of observations                            36          84
##
## Model Test User Model:
##
##   Test statistic                                 0.834
##   Degrees of freedom                                 2
##   P-value (Chi-square)                           0.659
##
## 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
##   lt2new =~
##     LT1a_Contribts    0.740    0.130    5.678    0.000    0.740    0.799
##     LT1b_Contribts    0.807    0.109    7.368    0.000    0.807    0.944
##     LT1c_Contribts    0.607    0.135    4.501    0.000    0.607    0.676
##     LT2a_Contribts    0.837    0.123    6.798    0.000    0.837    0.899
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .LT1a_Contribts    0.310    0.084    3.692    0.000    0.310    0.361
##    .LT1b_Contribts    0.080    0.047    1.687    0.092    0.080    0.109
##    .LT1c_Contribts    0.437    0.109    3.993    0.000    0.437    0.543
##    .LT2a_Contribts    0.166    0.062    2.693    0.007    0.166    0.192
##     lt2new            1.000                              1.000    1.000
```

Table 7: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
lt2new	LT1a_Contributes	0.740	0.130	5.678	0	0.799
lt2new	LT1b_Contributes	0.807	0.109	7.368	0	0.944
lt2new	LT1c_Contributes	0.607	0.135	4.501	0	0.676
lt2new	LT2a_Contributes	0.837	0.123	6.798	0	0.899

After adding the remain question LT2a into LT1 subdomain, the model fits well.

Third subdomain

```
## lavaan 0.6-5 ended normally after 21 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                          8
##
##                                                   Used       Total
##   Number of observations                            37          84
##
## Model Test User Model:
##
##   Test statistic                                 4.989
##   Degrees of freedom                                 2
##   P-value (Chi-square)                           0.083
##
## 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_Contribts    0.786    0.115    6.815    0.000    0.786    0.891
##     LT3b_Contribts    0.804    0.107    7.535    0.000    0.804    0.946
##     LT3c_Contribts    0.721    0.121    5.974    0.000    0.721    0.819
##     LT3d_Contribts    0.552    0.108    5.126    0.000    0.552    0.737
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .LT3a_Contribts    0.161    0.054    2.975    0.003    0.161    0.206
##    .LT3b_Contribts    0.076    0.043    1.754    0.079    0.076    0.105
##    .LT3c_Contribts    0.256    0.070    3.678    0.000    0.256    0.330
##    .LT3d_Contribts    0.257    0.065    3.954    0.000    0.257    0.457
##     lt3               1.000                              1.000    1.000
```

Table 8: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
lt3	LT3a_Contributes	0.786	0.115	6.815	0	0.891
lt3	LT3b_Contributes	0.804	0.107	7.535	0	0.946
lt3	LT3c_Contributes	0.721	0.121	5.974	0	0.819
lt3	LT3d_Contributes	0.552	0.108	5.126	0	0.737

Since p-value of the third subdomain is $0.083 < 0.05$, and all factor loadings are larger than 0.55, all questions fit well in the subdomain.

Fourth subdomain

```
## lavaan 0.6-5 ended normally after 18 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                            37          84
##
## Model Test User Model:
##
##   Test statistic                                 4.319
##   Degrees of freedom                                 1
##   P-value (Chi-square)                           0.038
##
## 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_Cntrb (aa)    0.394    0.154    2.557    0.011    0.394    0.446
##     LT4b_Cntr         1.043    0.285    3.657    0.000    1.043    1.270
##     LT4c_Cntr (aa)    0.394    0.154    2.557    0.011    0.394    0.481
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .LT4a_Contribts    0.627    0.164    3.812    0.000    0.627    0.801
##    .LT4b_Contribts   -0.414    0.590   -0.701    0.483   -0.414   -0.613
##    .LT4c_Contribts    0.516    0.142    3.631    0.000    0.516    0.769
##     lt4               1.000                              1.000    1.000
```

Table 9: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
lt4	LT4a_Contributes	0.394	0.154	2.557	0.011	0.446
lt4	LT4b_Contributes	1.043	0.285	3.657	0.000	1.270
lt4	LT4c_Contributes	0.394	0.154	2.557	0.011	0.481

Since p-value of the fourth subdomain is $0.038 < 0.05$, we need to remove the (a&c) with small factor loadings to fit the model.

Third subdomain and fourth subdomain

```
## lavaan 0.6-5 ended normally after 22 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         10
##
##                                                   Used       Total
##   Number of observations                            37          84
##
## Model Test User Model:
##
##   Test statistic                                 8.140
##   Degrees of freedom                                 5
##   P-value (Chi-square)                           0.149
##
## 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_Contribts    0.790    0.114    6.897    0.000    0.790    0.895
##     LT3b_Contribts    0.790    0.107    7.358    0.000    0.790    0.929
##     LT3c_Contribts    0.734    0.119    6.156    0.000    0.734    0.834
##     LT3d_Contribts    0.559    0.107    5.223    0.000    0.559    0.746
##     LT4b_Contribts    0.652    0.114    5.717    0.000    0.652    0.794
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .LT3a_Contribts    0.155    0.050    3.100    0.002    0.155    0.199
##    .LT3b_Contribts    0.098    0.040    2.455    0.014    0.098    0.136
##    .LT3c_Contribts    0.236    0.065    3.645    0.000    0.236    0.305
##    .LT3d_Contribts    0.249    0.063    3.947    0.000    0.249    0.444
##    .LT4b_Contribts    0.249    0.065    3.815    0.000    0.249    0.369
##     lt3               1.000                              1.000    1.000
```

Table 10: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
lt3	LT3a_Contributes	0.790	0.114	6.897	0	0.895
lt3	LT3b_Contributes	0.790	0.107	7.358	0	0.929
lt3	LT3c_Contributes	0.734	0.119	6.156	0	0.834
lt3	LT3d_Contributes	0.559	0.107	5.223	0	0.746
lt3	LT4b_Contributes	0.652	0.114	5.717	0	0.794

After combining the LT3 subdomain and LT4b, the model fits very well.

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                            34          84
##
## Model Test User Model:
##
##   Test statistic                                 2.163
##   Degrees of freedom                                 1
##   P-value (Chi-square)                           0.141
##
## 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 =~
##     LT5_Cntrb (aa)    0.434    0.134    3.252    0.001    0.434    0.521
##     LT5b_Cntr         0.903    0.221    4.082    0.000    0.903    0.990
##     LT5c_Cntr (aa)    0.434    0.134    3.252    0.001    0.434    0.556
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .LT5a_Contribts    0.506    0.146    3.457    0.001    0.506    0.728
##    .LT5b_Contribts    0.016    0.345    0.046    0.964    0.016    0.019
##    .LT5c_Contribts    0.421    0.130    3.249    0.001    0.421    0.691
##     lt5               1.000                              1.000    1.000
```

Table 11: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
lt5	LT5a_Contributes	0.434	0.134	3.252	0.001	0.521
lt5	LT5b_Contributes	0.903	0.221	4.082	0.000	0.990
lt5	LT5c_Contributes	0.434	0.134	3.252	0.001	0.556

Since p-value of the fifth subdomain is $0.141 > 0.05$ and all factor loadings are larger than or around 0.55, there is no need to make any change in the fifth subdomain.

PER & FEEDBACK Domain Analysis

For PER&FEEDBACK table in TELL Statements, I numeric character answers of PF 1a~5c Contributes, 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_Contributes, PF1b_Contributes, PF1c_Contributes,PF1d_Contributes and PF1e_Contributes), or the P-value of that model will become NA. And we get an exception in PF table: PF4 only has 2 varaibles, 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 droping 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 24 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         10
##
##                                                   Used       Total
##   Number of observations                            36          84
##
## Model Test User Model:
##
##   Test statistic                                 2.952
##   Degrees of freedom                                 5
##   P-value (Chi-square)                           0.707
##
## 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_Contribts    0.466    0.121    3.840    0.000    0.466    0.591
##     PF1b_Contribts    0.627    0.100    6.293    0.000    0.627    0.849
##     PF1c_Contribts    0.716    0.092    7.752    0.000    0.716    0.960
```

```
##     PF1d_Contribts    0.547    0.109    5.023    0.000    0.547    0.728
##     PF1e_Contribts    0.722    0.097    7.473    0.000    0.722    0.941
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .PF1a_Contribts    0.403    0.097    4.146    0.000    0.403    0.650
##    .PF1b_Contribts    0.153    0.041    3.757    0.000    0.153    0.280
##    .PF1c_Contribts    0.043    0.023    1.861    0.063    0.043    0.078
##    .PF1d_Contribts    0.265    0.066    4.037    0.000    0.265    0.470
##    .PF1e_Contribts    0.068    0.027    2.522    0.012    0.068    0.115
##     PF1               1.000                              1.000    1.000
```

Table 12: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
PF1	PF1a_Contributes	0.466	0.121	3.840	0	0.591
PF1	PF1b_Contributes	0.627	0.100	6.293	0	0.849
PF1	PF1c_Contributes	0.716	0.092	7.752	0	0.960
PF1	PF1d_Contributes	0.547	0.109	5.023	0	0.728
PF1	PF1e_Contributes	0.722	0.097	7.473	0	0.941

Since p-value of first subdomain is $0.707 > 0.05$, thus no futher work to do.

Second subdomain:

```
## lavaan 0.6-5 ended normally after 22 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         10
##
##                                                   Used       Total
##   Number of observations                            36          84
##
## Model Test User Model:
##
##   Test statistic                                23.592
##   Degrees of freedom                                 5
##   P-value (Chi-square)                           0.000
##
## 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_Contribts    0.615    0.086    7.147    0.000    0.615    0.923
##     PF2b_Contribts    0.563    0.093    6.029    0.000    0.563    0.830
##     PF2c_Contribts    0.629    0.088    7.130    0.000    0.629    0.922
```

```
##     PF2d_Contribts    0.507    0.105    4.834    0.000    0.507    0.713
##     PF2e_Contribts    0.436    0.123    3.549    0.000    0.436    0.559
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .PF2a_Contribts    0.066    0.027    2.436    0.015    0.066    0.148
##    .PF2b_Contribts    0.143    0.040    3.589    0.000    0.143    0.310
##    .PF2c_Contribts    0.070    0.028    2.466    0.014    0.070    0.151
##    .PF2d_Contribts    0.249    0.063    3.946    0.000    0.249    0.492
##    .PF2e_Contribts    0.418    0.102    4.114    0.000    0.418    0.688
##     PF2               1.000                              1.000    1.000
```

Table 13: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
PF2	PF2a_Contributes	0.615	0.086	7.147	0	0.923
PF2	PF2b_Contributes	0.563	0.093	6.029	0	0.830
PF2	PF2c_Contributes	0.629	0.088	7.130	0	0.922
PF2	PF2d_Contributes	0.507	0.105	4.834	0	0.713
PF2	PF2e_Contributes	0.436	0.123	3.549	0	0.559

Since p-value of first subdomain is $0.000 < 0.05$, and the factor loadings of "PF2e_Contributes" is lowest, thus, we try to drop it from the second subdomain:

```
## lavaan 0.6-5 ended normally after 23 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                          8
##
##                                                   Used       Total
##   Number of observations                            36          84
##
## Model Test User Model:
##
##   Test statistic                                 1.106
##   Degrees of freedom                                 2
##   P-value (Chi-square)                           0.575
##
## 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_Contribts    0.614    0.086    7.116    0.000    0.614    0.921
##     PF2b_Contribts    0.568    0.093    6.105    0.000    0.568    0.837
##     PF2c_Contribts    0.633    0.088    7.211    0.000    0.633    0.929
##     PF2d_Contribts    0.488    0.106    4.591    0.000    0.488    0.686
##
```

```
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .PF2a_Contribts    0.067    0.028    2.415    0.016    0.067    0.151
##    .PF2b_Contribts    0.138    0.039    3.548    0.000    0.138    0.299
##    .PF2c_Contribts    0.064    0.029    2.245    0.025    0.064    0.138
##    .PF2d_Contribts    0.268    0.067    3.988    0.000    0.268    0.529
##     PF2               1.000                              1.000    1.000
```

P-value = $0.575 > 0.05$, thus we can stay here for the second subdomain.

Third subdomain:

```
## lavaan 0.6-5 ended normally after 20 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         10
##
##                                                   Used       Total
##   Number of observations                            37          84
##
## Model Test User Model:
##
##   Test statistic                                26.024
##   Degrees of freedom                                 5
##   P-value (Chi-square)                           0.000
##
## 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_Contribts    0.604    0.102    5.936    0.000    0.604    0.819
##     PF3b_Contribts    0.459    0.118    3.897    0.000    0.459    0.600
##     PF3c_Contribts    0.661    0.100    6.640    0.000    0.661    0.881
##     PF3d_Contribts    0.452    0.131    3.451    0.001    0.452    0.543
##     PF3e_Contribts    0.629    0.088    7.167    0.000    0.629    0.923
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .PF3a_Contribts    0.179    0.051    3.531    0.000    0.179    0.330
##    .PF3b_Contribts    0.375    0.091    4.100    0.000    0.375    0.640
##    .PF3c_Contribts    0.126    0.044    2.889    0.004    0.126    0.224
##    .PF3d_Contribts    0.490    0.118    4.153    0.000    0.490    0.706
##    .PF3e_Contribts    0.068    0.033    2.095    0.036    0.068    0.147
##     PF3               1.000                              1.000    1.000
```

Table 14: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	
PF3	PF3a_Contributes	0.604	0.102	5.936	0.000	
PF3	PF3b_Contributes	0.459	0.118	3.897	0.000	
PF3	PF3c_Contributes	0.661	0.100	6.640	0.000	
PF3	PF3d_Contributes	0.452	0.131	3.451	0.001	
PF3	PF3e_Contributes	0.629	0.088	7.167	0.000	
Since p-value <	0.05, and the facto	r loadin	gs of "P	F3d_Cont	ributes" i	s lowest, thus, we try to drop it from

```
m3.1 <- 'PF3 =~ PF3a_Contributes + PF3b_Contributes + PF3c_Contributes + PF3e_Contributes'
fit3.1 <- cfa(m3.1,data = PF.number, std.lv=TRUE)
summary(fit3.1,standardized=T)
```

```
## lavaan 0.6-5 ended normally after 19 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                          8
##
##                                                   Used       Total
##   Number of observations                            37          84
##
## Model Test User Model:
##
##   Test statistic                                17.469
##   Degrees of freedom                                 2
##   P-value (Chi-square)                           0.000
##
## 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_Contributs    0.598    0.102    5.863    0.000    0.598    0.811
##     PF3b_Contributs    0.420    0.119    3.517    0.000    0.420    0.548
##     PF3c_Contributs    0.652    0.100    6.495    0.000    0.652    0.869
##     PF3e_Contributs    0.650    0.086    7.534    0.000    0.650    0.953
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .PF3a_Contributs    0.186    0.051    3.613    0.000    0.186    0.342
##    .PF3b_Contributs    0.410    0.098    4.174    0.000    0.410    0.699
##    .PF3c_Contributs    0.138    0.045    3.039    0.002    0.138    0.245
##    .PF3e_Contributs    0.043    0.033    1.303    0.193    0.043    0.092
##     PF3                1.000                              1.000    1.000
```

```
#p value = 0
parameterEstimates(fit3.1, standardized=TRUE) %>%
```

```
  filter(op == "=~") %>%
  select('Latent Factor'=lhs, Indicator=rhs, B=est, SE=se, Z=z, 'p-value'=pvalue, loading=std.all) %>%
  kable(digits = 3, format="pandoc", caption="Factor Loadings")
```

Table 15: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
PF3	PF3a_Contributes	0.598	0.102	5.863	0	0.811
PF3	PF3b_Contributes	0.420	0.119	3.517	0	0.548
PF3	PF3c_Contributes	0.652	0.100	6.495	0	0.869
PF3	PF3e_Contributes	0.650	0.086	7.534	0	0.953

```
m3.2 <- 'PF3 =~ PF3a_Contributes + PF3c_Contributes + PF3e_Contributes'
fit3.2 <- cfa(m3.2,data = PF.number, std.lv=TRUE)
```

```
## Warning in lav_object_post_check(object): lavaan WARNING: some estimated ov
## variances are negative
```

```
# lavaan WARNING: some estimated ov variances are negative ??????????????????
summary(fit3.2,standardized=T)
```

```
## lavaan 0.6-5 ended normally after 19 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                          6
##
##                                                   Used       Total
##   Number of observations                            37          84
##
## Model Test User Model:
##
##   Test statistic                                 0.000
##   Degrees of freedom                                 0
##
## 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_Contribts    0.568    0.105    5.430    0.000    0.568    0.771
##     PF3c_Contribts    0.622    0.104    6.011    0.000    0.622    0.830
##     PF3e_Contribts    0.689    0.084    8.205    0.000    0.689    1.011
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .PF3a_Contribts    0.221    0.059    3.765    0.000    0.221    0.406
##    .PF3c_Contribts    0.175    0.053    3.304    0.001    0.175    0.312
##    .PF3e_Contribts   -0.010    0.042   -0.246    0.806   -0.010   -0.022
```

```
##     PF3               1.000                                1.000    1.000
```

```
#p value = 0
parameterEstimates(fit3.2, standardized=TRUE) %>%
  filter(op == "=~") %>%
  select('Latent Factor'=lhs, Indicator=rhs, B=est, SE=se, Z=z, 'p-value'=pvalue, loading=std.all) %>%
  kable(digits = 3, format="pandoc", caption="Factor Loadings")
```

Table 16: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
PF3	PF3a_Contributes	0.568	0.105	5.430	0	0.771
PF3	PF3c_Contributes	0.622	0.104	6.011	0	0.830
PF3	PF3e_Contributes	0.689	0.084	8.205	0	1.011
??????????						

Fourth subdomain:

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

```
## Warning in lav_object_post_check(object): lavaan WARNING: some estimated ov
## variances are negative
```

```
## lavaan 0.6-5 ended normally after 27 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         11
##
##                                                   Used       Total
##   Number of observations                            34          84
##
## Model Test User Model:
##
##   Test statistic                                26.714
##   Degrees of freedom                                 4
##   P-value (Chi-square)                           0.000
##
## 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_Contribts    0.686    0.119    5.783    0.000    0.686    0.839
##     PF4b_Contribts    0.775    0.105    7.379    0.000    0.775    0.987
##   PF5 =~
##     PF5a_Contribts    0.529    0.114    4.640    0.000    0.529    0.706
##     PF5b_Contribts    0.946    0.121    7.829    0.000    0.946    1.014
##     PF5c_Contribts    0.526    0.121    4.350    0.000    0.526    0.670
```

```
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   PF4 ~~
##     PF5               0.724    0.097    7.503    0.000    0.724    0.724
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .PF4a_Contribts    0.197    0.070    2.838    0.005    0.197    0.295
##    .PF4b_Contribts    0.016    0.064    0.250    0.802    0.016    0.026
##    .PF5a_Contribts    0.281    0.073    3.853    0.000    0.281    0.501
##    .PF5b_Contribts   -0.025    0.088   -0.282    0.778   -0.025   -0.029
##    .PF5c_Contribts    0.339    0.086    3.947    0.000    0.339    0.551
##     PF4               1.000                              1.000    1.000
##     PF5               1.000                              1.000    1.000
```

Table 17: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
PF4	PF4a_Contributes	0.686	0.119	5.783	0	0.839
PF4	PF4b_Contributes	0.775	0.105	7.379	0	0.987
PF5	PF5a_Contributes	0.529	0.114	4.640	0	0.706
PF5	PF5b_Contributes	0.946	0.121	7.829	0	1.014
PF5	PF5c_Contributes	0.526	0.121	4.350	0	0.670

Since P-value is $0.000 < 0.05$, and the factor loadings of "PF5c_Contributes" is lowest, thus, we try to drop it from the fourth subdomain:

```
## lavaan 0.6-5 ended normally after 28 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                          9
##
##                                                   Used       Total
##   Number of observations                            34          84
##
## Model Test User Model:
##
##   Test statistic                                 2.113
##   Degrees of freedom                                 1
##   P-value (Chi-square)                           0.146
##
## 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_Contribts    0.709    0.116    6.115    0.000    0.709    0.867
```

```
##     PF4b_Contribts    0.751    0.106    7.112    0.000    0.751    0.956
##   PF5 =~
##     PF5a_Contribts    0.591    0.113    5.224    0.000    0.591    0.790
##     PF5b_Contribts    0.842    0.135    6.258    0.000    0.842    0.904
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   PF4 ~~
##     PF5               0.838    0.083   10.144    0.000    0.838    0.838
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .PF4a_Contribts    0.166    0.063    2.652    0.008    0.166    0.249
##    .PF4b_Contribts    0.053    0.055    0.960    0.337    0.053    0.086
##    .PF5a_Contribts    0.211    0.068    3.082    0.002    0.211    0.376
##    .PF5b_Contribts    0.160    0.100    1.597    0.110    0.160    0.184
##     PF4               1.000                              1.000    1.000
##     PF5               1.000                              1.000    1.000
```

P-value is $0.146 > 0.05$, 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 Contributes, 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_Contributes, LE1b_Contributes, LE1c_Contributes,LE1d_Contributes and LE1e_Contributes).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 droping 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                            38          84
##
## Model Test User Model:
##
##   Test statistic                                 3.086
##   Degrees of freedom                                 5
##   P-value (Chi-square)                           0.687
##
## Parameter Estimates:
##
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##   Standard errors                             Standard
##
```

```
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   LE1 =~
##     LE1a_Contribts    1.000
##     LE1b_Contribts    0.953    0.307    3.099    0.002
##     LE1c_Contribts    1.148    0.389    2.950    0.003
##     LE1d_Contribts    0.603    0.246    2.451    0.014
##     LE1e_Contribts    0.851    0.290    2.932    0.003
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .LE1a_Contribts    1.767    0.500    3.533    0.000
##    .LE1b_Contribts    0.982    0.327    3.001    0.003
##    .LE1c_Contribts    2.011    0.592    3.399    0.001
##    .LE1d_Contribts    1.196    0.305    3.923    0.000
##    .LE1e_Contribts    1.144    0.333    3.433    0.001
##     LE1               1.117    0.599    1.863    0.062
```

Table 18: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
LE1	LE1a_Contributes	1.000	0.000	NA	NA	0.622
LE1	LE1b_Contributes	0.953	0.307	3.099	0.002	0.713
LE1	LE1c_Contributes	1.148	0.389	2.950	0.003	0.650
LE1	LE1d_Contributes	0.603	0.246	2.451	0.014	0.503
LE1	LE1e_Contributes	0.851	0.290	2.932	0.003	0.643

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

Second Subdomain

```
## lavaan 0.6-5 ended normally after 27 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         12
##
##                                                   Used       Total
##   Number of observations                            38          84
##
## Model Test User Model:
##
##   Test statistic                                11.962
##   Degrees of freedom                                 9
##   P-value (Chi-square)                           0.215
##
## Parameter Estimates:
##
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##   Standard errors                             Standard
##
## Latent Variables:
```

```
##                    Estimate  Std.Err  z-value  P(>|z|)
##   LE2 =~
##     LE2a_Contribts    1.000
##     LE2b_Contribts    0.920    0.371    2.478    0.013
##     LE2c_Contribts    1.016    0.332    3.061    0.002
##     LE2d_Contribts    0.781    0.302    2.586    0.010
##     LE2e_Contribts    1.495    0.468    3.196    0.001
##     LE2f_Contribts    1.331    0.442    3.010    0.003
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .LE2a_Contribts    2.436    0.608    4.009    0.000
##    .LE2b_Contribts    2.333    0.576    4.050    0.000
##    .LE2c_Contribts    0.913    0.271    3.364    0.001
##    .LE2d_Contribts    1.414    0.354    3.991    0.000
##    .LE2e_Contribts    1.194    0.438    2.726    0.006
##    .LE2f_Contribts    1.787    0.512    3.493    0.000
##     LE2               1.024    0.612    1.673    0.094
```

Table 19: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
LE2	LE2a_Contributes	1.000	0.000	NA	NA	0.544
LE2	LE2b_Contributes	0.920	0.371	2.478	0.013	0.520
LE2	LE2c_Contributes	1.016	0.332	3.061	0.002	0.733
LE2	LE2d_Contributes	0.781	0.302	2.586	0.010	0.554
LE2	LE2e_Contributes	1.495	0.468	3.196	0.001	0.811
LE2	LE2f_Contributes	1.331	0.442	3.010	0.003	0.710

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 26 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         10
##
##                                                   Used       Total
##   Number of observations                            38          84
##
## Model Test User Model:
##
##   Test statistic                                 9.547
##   Degrees of freedom                                 5
##   P-value (Chi-square)                           0.089
##
## Parameter Estimates:
##
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##   Standard errors                             Standard
##
```

```
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   LE2 =~
##     LE2b_Contribts    1.000
##     LE2c_Contribts    1.105    0.391    2.827    0.005
##     LE2d_Contribts    0.826    0.347    2.382    0.017
##     LE2e_Contribts    1.720    0.578    2.975    0.003
##     LE2f_Contribts    1.494    0.528    2.827    0.005
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .LE2b_Contribts    2.372    0.584    4.059    0.000
##    .LE2c_Contribts    0.959    0.282    3.397    0.001
##    .LE2d_Contribts    1.474    0.366    4.029    0.000
##    .LE2e_Contribts    1.034    0.456    2.268    0.023
##    .LE2f_Contribts    1.752    0.516    3.397    0.001
##     LE2               0.828    0.537    1.542    0.123
```

Table 20: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
LE2	LE2b_Contributes	1.000	0.000	NA	NA	0.509
LE2	LE2c_Contributes	1.105	0.391	2.827	0.005	0.716
LE2	LE2d_Contributes	0.826	0.347	2.382	0.017	0.526
LE2	LE2e_Contributes	1.720	0.578	2.975	0.003	0.838
LE2	LE2f_Contributes	1.494	0.528	2.827	0.005	0.716

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 32 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         14
##
##                                                   Used       Total
##   Number of observations                            38          84
##
## Model Test User Model:
##
##   Test statistic                                24.187
##   Degrees of freedom                                14
##   P-value (Chi-square)                           0.043
##
## Parameter Estimates:
##
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##   Standard errors                             Standard
##
## Latent Variables:
```

```
##                    Estimate  Std.Err  z-value  P(>|z|)
##   LE3 =~
##     LE3a_Contribts    1.000
##     LE3b_Contribts    1.508    0.564    2.675    0.007
##     LE3c_Contribts    0.829    0.391    2.123    0.034
##     LE3d_Contribts    1.661    0.593    2.799    0.005
##     LE3e_Contribts    1.725    0.687    2.512    0.012
##     LE3f_Contribts    1.321    0.487    2.714    0.007
##     LE3g_Contribts    1.295    0.513    2.526    0.012
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .LE3a_Contribts    1.387    0.340    4.074    0.000
##    .LE3b_Contribts    1.163    0.325    3.576    0.000
##    .LE3c_Contribts    1.161    0.281    4.125    0.000
##    .LE3d_Contribts    0.899    0.288    3.127    0.002
##    .LE3e_Contribts    2.333    0.606    3.852    0.000
##    .LE3f_Contribts    0.790    0.228    3.473    0.001
##    .LE3g_Contribts    1.272    0.332    3.835    0.000
##     LE3               0.447    0.301    1.487    0.137
```

Table 21: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
LE3	LE3a_Contributes	1.000	0.000	NA	NA	0.494
LE3	LE3b_Contributes	1.508	0.564	2.675	0.007	0.683
LE3	LE3c_Contributes	0.829	0.391	2.123	0.034	0.458
LE3	LE3d_Contributes	1.661	0.593	2.799	0.005	0.761
LE3	LE3e_Contributes	1.725	0.687	2.512	0.012	0.603
LE3	LE3f_Contributes	1.321	0.487	2.714	0.007	0.705
LE3	LE3g_Contributes	1.295	0.513	2.526	0.012	0.609

In the third subdomian,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 24 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         10
##
##                                                   Used       Total
##   Number of observations                            38          84
##
## Model Test User Model:
##
##   Test statistic                                 2.798
##   Degrees of freedom                                 5
##   P-value (Chi-square)                           0.731
##
## Parameter Estimates:
##
```

```
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##   Standard errors                             Standard
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   LE4 =~
##     LE4a_Contribts    1.000
##     LE4b_Contribts    0.874    0.257    3.404    0.001
##     LE4c_Contribts    1.337    0.309    4.332    0.000
##     LE4d_Contribts    0.377    0.152    2.484    0.013
##     LE4e_Contribts    1.079    0.336    3.215    0.001
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .LE4a_Contribts    0.952    0.272    3.507    0.000
##    .LE4b_Contribts    1.309    0.331    3.951    0.000
##    .LE4c_Contribts    0.334    0.277    1.204    0.229
##    .LE4d_Contribts    0.588    0.140    4.209    0.000
##    .LE4e_Contribts    2.381    0.591    4.029    0.000
##     LE4               0.951    0.411    2.314    0.021
```

Table 22: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
LE4	LE4a_Contributes	1.000	0.000	NA	NA	0.707
LE4	LE4b_Contributes	0.874	0.257	3.404	0.001	0.598
LE4	LE4c_Contributes	1.337	0.309	4.332	0.000	0.914
LE4	LE4d_Contributes	0.377	0.152	2.484	0.013	0.433
LE4	LE4e_Contributes	1.079	0.336	3.215	0.001	0.563

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 23 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                          8
##
##                                                   Used       Total
##   Number of observations                            38          84
##
## Model Test User Model:
##
##   Test statistic                                 0.535
##   Degrees of freedom                                 2
##   P-value (Chi-square)                           0.765
##
## Parameter Estimates:
##
##   Information                                 Expected
```

```
##   Information saturated (h1) model          Structured
##   Standard errors                             Standard
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   LE5 =~
##     LE5a_Contribts    1.000
##     LE5b_Contribts    0.584    0.118    4.959    0.000
##     LE5c_Contribts    0.705    0.101    7.005    0.000
##     LE5d_Contribts    0.705    0.108    6.555    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .LE5a_Contribts    0.781    0.298    2.619    0.009
##    .LE5b_Contribts    1.048    0.266    3.939    0.000
##    .LE5c_Contribts    0.463    0.160    2.885    0.004
##    .LE5d_Contribts    0.636    0.192    3.313    0.001
##     LE5               2.898    0.859    3.375    0.001
```

Table 23: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
LE5	LE5a_Contributes	1.000	0.000	NA	NA	0.888
LE5	LE5b_Contributes	0.584	0.118	4.959	0	0.697
LE5	LE5c_Contributes	0.705	0.101	7.005	0	0.870
LE5	LE5d_Contributes	0.705	0.108	6.555	0	0.833

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

Sixth subdomain

```
## lavaan 0.6-5 ended normally after 27 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                          8
##
##                                                   Used       Total
##   Number of observations                            38          84
##
## Model Test User Model:
##
##   Test statistic                                 2.158
##   Degrees of freedom                                 2
##   P-value (Chi-square)                           0.340
##
## Parameter Estimates:
##
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##   Standard errors                             Standard
##
## Latent Variables:
```

```
##                    Estimate  Std.Err  z-value  P(>|z|)
##   LE6 =~
##     LE6a_Contribts    1.000
##     LE6b_Contribts    0.904    0.312    2.894    0.004
##     LE6c_Contribts    0.354    0.180    1.973    0.049
##     LE6d_Contribts    0.695    0.236    2.943    0.003
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .LE6a_Contribts    3.562    0.973    3.660    0.000
##    .LE6b_Contribts    0.559    0.422    1.324    0.186
##    .LE6c_Contribts    1.322    0.318    4.158    0.000
##    .LE6d_Contribts    1.185    0.366    3.234    0.001
##     LE6               1.846    1.073    1.721    0.085
```

Table 24: Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	loading
LE6	LE6a_Contributes	1.000	0.000	NA	NA	0.584
LE6	LE6b_Contributes	0.904	0.312	2.894	0.004	0.854
LE6	LE6c_Contributes	0.354	0.180	1.973	0.049	0.386
LE6	LE6d_Contributes	0.695	0.236	2.943	0.003	0.655

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