Here I am using the WIRS dataset in the ltm package and I am calculating the 1PL model. There are many methods of assessing unidimensionality. In rasch , we use a very specific procedure. There are two methods of assessing unidimensionality.
This procedure reveals the proportion of variance in item responses that can be explained by the Rasch model . Many researchers use a critical value of about 20% of variance explained by Rasch measures as evidence of “close-enough”unidimensionality to support the interpretation of Rasch model results for many practical purposes.

```
>
> ## Raw variance explained by Rasch measures: (VO - VR)/VO
> (VO - VR)/VO
[1] 0.2712589
>
```

It is also somewhat common in Rasch analysis to examine correlations among standardized residuals for evidence of potentially meaningful additional dimensions.PCA of residuals is essentially evaluating the degree to which additional dimensions may have contributed to item responses. If the contrasts come out to be less than 2 then we can say that our model is unidimensional.

```
>
> contrasts
[1] 1.5645327 1.2208999 1.1343585 1.0583101 0.9968146
>
```

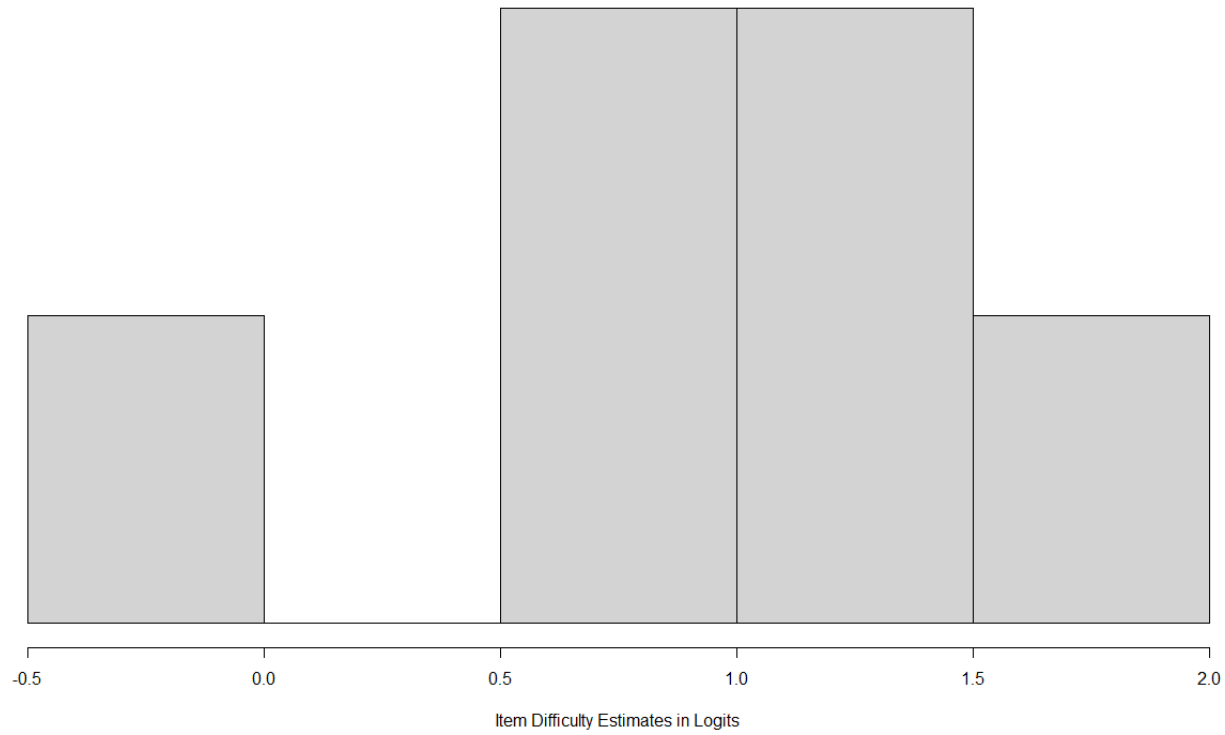
The following are some descriptive statistics

```
> summary(df)
     Item 1           Item 2           Item 3           Item 4           Item 5
 Min.   :0.0000   Min.   :0.0000   Min.   :0.0000   Min.   :0.0000   Min.   :0.0000
 1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.0000
 Median :0.0000   Median :1.0000   Median :0.0000   Median :0.0000   Median :0.0000
 Mean   :0.3731   Mean   :0.5831   Mean   :0.2826   Mean   :0.2398   Mean   :0.3572
 3rd Qu.:1.0000   3rd Qu.:1.0000   3rd Qu.:1.0000   3rd Qu.:0.0000   3rd Qu.:1.0000
 Max.   :1.0000   Max.   :1.0000   Max.   :1.0000   Max.   :1.0000   Max.   :1.0000
     Item 6
 Min.   :0.0000
 1st Qu.:0.0000
 Median :0.0000
 Mean   :0.1473
 3rd Qu.:0.0000
 Max.   :1.0000
> View(df)
```

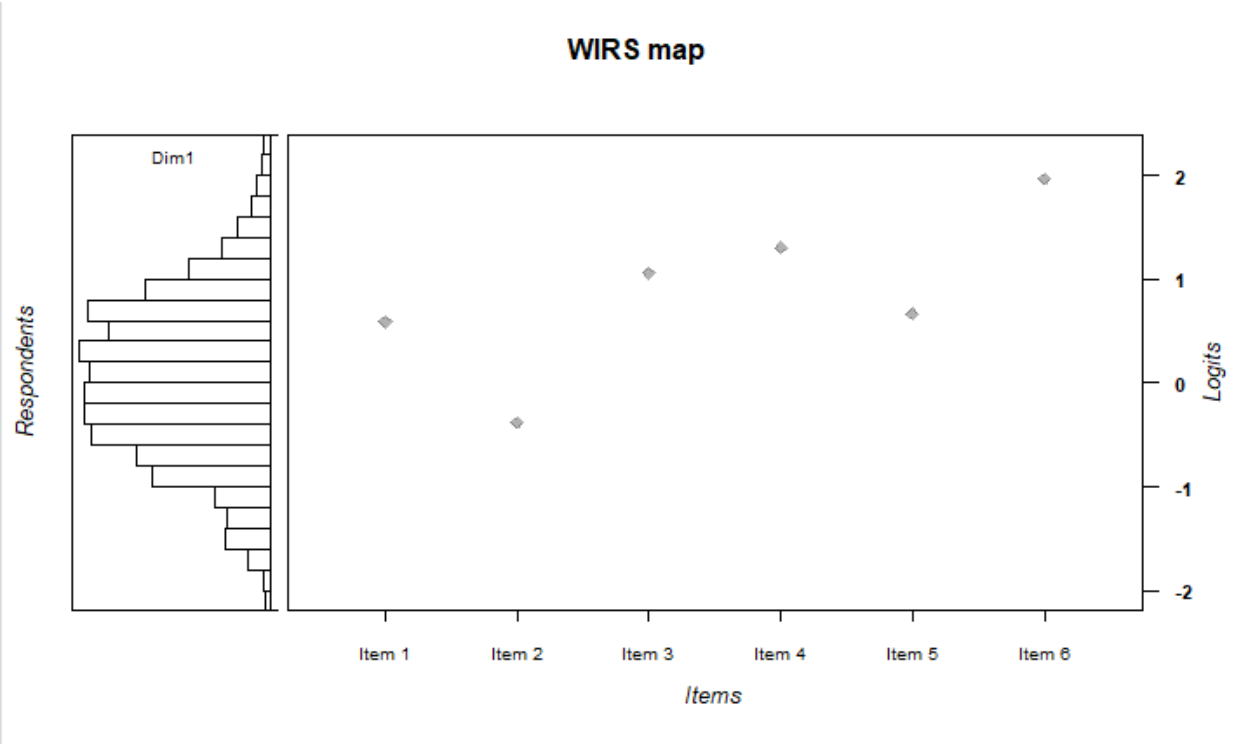
Because this is a rasch model,Slope has been constrained to 1 and beta are item locations(difficulty). Item 6 is the most difficult. I have also summarized the difficulty.

```
Item Parameters in IRT parameterization
    item alpha   beta
1 Item 1     1  0.590
2 Item 2     1 -0.382
3 Item 3     1  1.055
4 Item 4     1  1.303
5 Item 5     1  0.668
6 Item 6     1  1.963
>
```

```
Item 6  1.9634182 0.09260779
> summary(difficulty)
      xsi               se.xsi
 Min.   :-0.3822   Min.   :0.06821
 1st Qu.: 0.6093   1st Qu.:0.06958
 Median : 0.8614   Median :0.07208
 Mean   : 0.8661   Mean   :0.07538
 3rd Qu.: 1.2409   3rd Qu.:0.07692
 Max.   : 1.9634   Max.   :0.09261
> .
```



The following is a wright map. We might need some items for people with low abilities.Although we should confirm the fit of the model before interpreting this.



The following are the fit statistics. In general, the MSE versions of Outfit and Infit are expected to be close to 1.00 and the standardized versions of Outfit and Infit are expected to be around 0.00 when data fit the Rasch model expectations..

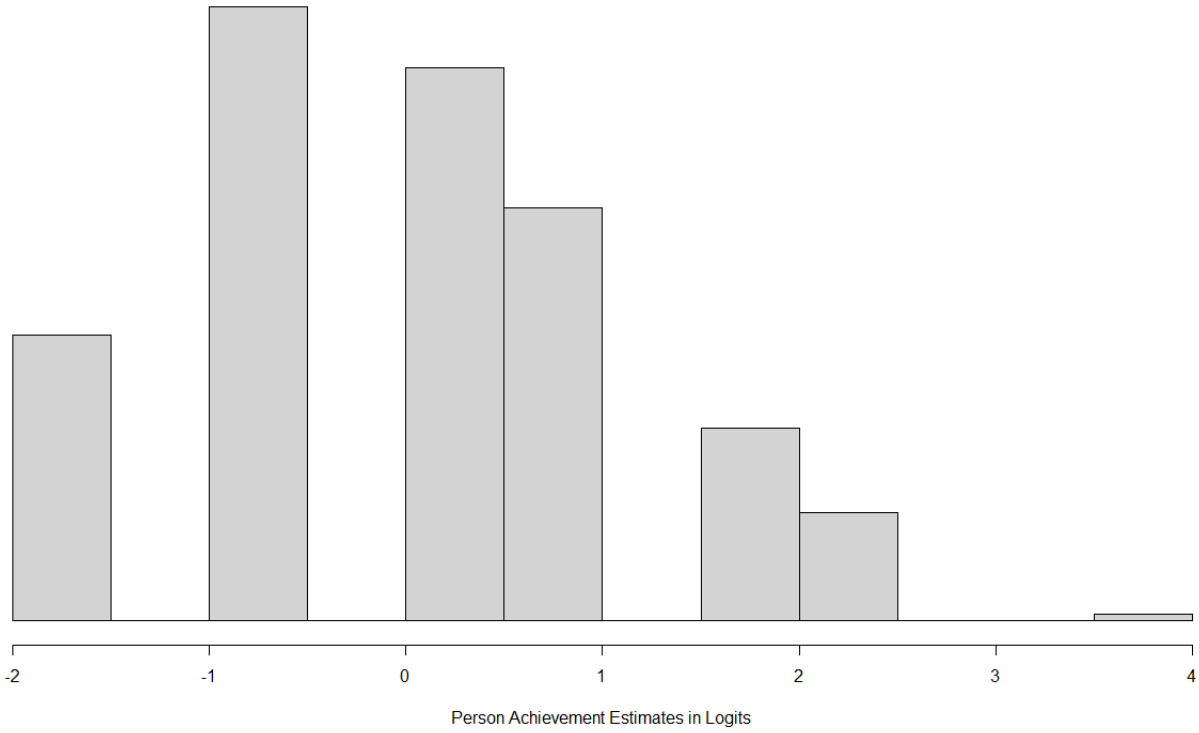
```
> summary(item.fit)
  parameter            Outfit          Outfit_t          Outfit_p          Outfit_pholm
 Length:6           Min.   :0.8777   Min.   :-3.917834   Min.   :1.000e-08   Min.   :4.000e-08
 Class :character   1st Qu.:0.8955   1st Qu.:-2.954540   1st Qu.:2.580e-05   1st Qu.:1.067e-04
 Mode  :character   Median :0.9279   Median :-1.601140   Median :6.496e-04   Median :1.994e-03
                    Mean   :0.9823   Mean   : 0.004964   Mean   :5.173e-02   Mean   :5.801e-02
                    3rd Qu.:1.0713   3rd Qu.: 3.162747   3rd Qu.:2.654e-02   3rd Qu.:5.338e-02
                    Max.   :1.1563   Max.   : 5.804860   Max.   :2.741e-01   Max.   :2.741e-01
     Infit           Infit_t           Infit_p           Infit_pholm
 Min.   :0.9238   Min.   :-2.9177   Min.   :0.0000013   Min.   :0.000008
 1st Qu.:0.9394   1st Qu.:-1.6657   1st Qu.:0.0015140   1st Qu.:0.006688
 Median :0.9634   Median :-0.7185   Median :0.0264168   Median :0.081014
 Mean   :0.9989   Mean   : 0.3086   Mean   :0.1665874   Mean   :0.323814
 3rd Qu.:1.0525   3rd Qu.: 2.3357   3rd Qu.:0.3454452   3rd Qu.:0.703217
 Max.   :1.1290   Max.   : 4.8340   Max.   :0.5016885   Max.   :0.888316
>
```

The following are the ability estimates along with reliability estimates.
WLE reliability is the person separation statistic. This value is interpreted similarly to Cronbach's alpha when there is good fit between the data and the Rasch model .

Person separation is similar to reliability in that it represents the extent to which a measure can reproduce and consistently rank scores. It is a signal-to-noise ratio computed by dividing the true person variance on the latent trait by the root mean square measurement error. Separation values larger than 2 are desirable. Person separation indicates the standard deviation of latent trait values in standard error units (Wright & Masters, 1982). Typically, person separation and reliability are used in conjunction to evaluate the quality of a measure. Item reliability and separation are computed similarly, but the interpretation is different. Item reliability refers to how well item difficulties can be rank ordered. It is affected by the spread of item difficulty values and the sample size. Linacre (2012) notes that low item reliability can occur when the sample size is too small to obtain stable item difficulty estimates. Item separation provides similar information about the quality of locating the items on the latent trait. Ideally, item separation values should be larger than 2.

	pid	N.items	PersonScores	PersonMax	theta	error	WLE.rel
1	1	6	0	6	-1.991469	1.662788	0.1142828
2	2	6	0	6	-1.991469	1.662788	0.1142828
3	3	6	0	6	-1.991469	1.662788	0.1142828
4	4	6	0	6	-1.991469	1.662788	0.1142828
5	5	6	0	6	-1.991469	1.662788	0.1142828
6	6	6	0	6	-1.991469	1.662788	0.1142828
7	7	6	0	6	-1.991469	1.662788	0.1142828

```
> View(achievement)
>
> summary(achievement)
      pid          N.items   PersonScores     PersonMax     theta              error
 Min.   :   1   Min.   :6   Min.   :0.000   Min.   :6   Min.   :-1.9915   Min.   :0.8638
 1st Qu.: 252   1st Qu.:6   1st Qu.:1.000   1st Qu.:6   1st Qu.:-0.6127   1st Qu.:0.8981
 Median : 503   Median :6   Median :2.000   Median :6   Median : 0.1990   Median :0.9022
 Mean   : 503   Mean   :6   Mean   :1.983   Mean   :6   Mean   : 0.0469   Mean   :1.0456
 3rd Qu.: 754   3rd Qu.:6   3rd Qu.:3.000   3rd Qu.:6   3rd Qu.: 0.8757   3rd Qu.:1.0508
 Max.   :1005   Max.   :6   Max.   :6.000   Max.   :6   Max.   : 3.6917   Max.   :1.6628
    WLE.rel
 Min.   :0.1143
 1st Qu.:0.1143
 Median :0.1143
 Mean   :0.1143
 3rd Qu.:0.1143
 Max.   :0.1143
>
```



The following are person fit statistics. In general, the MSE versions of Outfit and Infit are expected to be close to 1.00 and the standardized versions of Outfit and Infit are expected to be around 0.00 when data fit the Rasch model expectations.

```
>
> summary(person.fit)
  outfitPerson      outfitPerson_t      infitPerson      infitPerson_t
 Min.   :0.07492   Min.   :-1.3593   Min.   :0.1044   Min.   :-1.5063
 1st Qu.:0.37492   1st Qu.:-0.7745   1st Qu.:0.5057   1st Qu.:-0.8458
 Median :0.78642   Median :-0.3345   Median :0.8765   Median :-0.4125
 Mean   :0.76034   Mean   :-0.1463   Mean   :0.7890   Mean   :-0.2200
 3rd Qu.:1.09484   3rd Qu.: 0.3543   3rd Qu.:1.0739   3rd Qu.: 0.3232
 Max.   :2.22870   Max.   : 2.2141   Max.   :1.6625   Max.   : 2.2285
>
>
```

```
>
> person.fit <- personfit(student.locations)
> summary(person.fit$p.infitMSQ)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.6312  0.6772  0.9272  0.9538  1.1228  1.6619
>
```

```
> summary(person.fit$p.outfitMSQ)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.4066  0.6098  0.8964  0.9304  1.1441  3.6013
```

- Expected value is about 1.00 when data fit the model
- Less than 1.00: Responses are too predictable; they resemble a Guttman-like (deterministic) pattern (“muted”)
- Greater than 1.00: Responses are too haphazard (“noisy”); there is too much variation to suggest that the estimate is a good representation of the response pattern
- Some variation is expected, but noisy responses are usually considered more cause for concern than muted responses

There are different rules of thumb for deciding whether an item or person fits well. They are synthesized here to provide you with guidance. A narrow range of infit and outfit mean square values such as 0.8 to 1.2 is recommended for high stakes tests (Bond & Fox, 2007), but values between 0.5 and 1.5 are still productive for measurement (Linacre, 2012). Of most concern are infit and outfit mean square values larger than 2.0 because they degrade the measure. Less concerning are small infit and outfit values, but the quality of the measure will be artificially inflated with values smaller than 0.5 (Linacre, 2012). Keep in mind that these are rules of thumb and should not be used reflexively. They should serve as flags for items or persons that need extra attention.

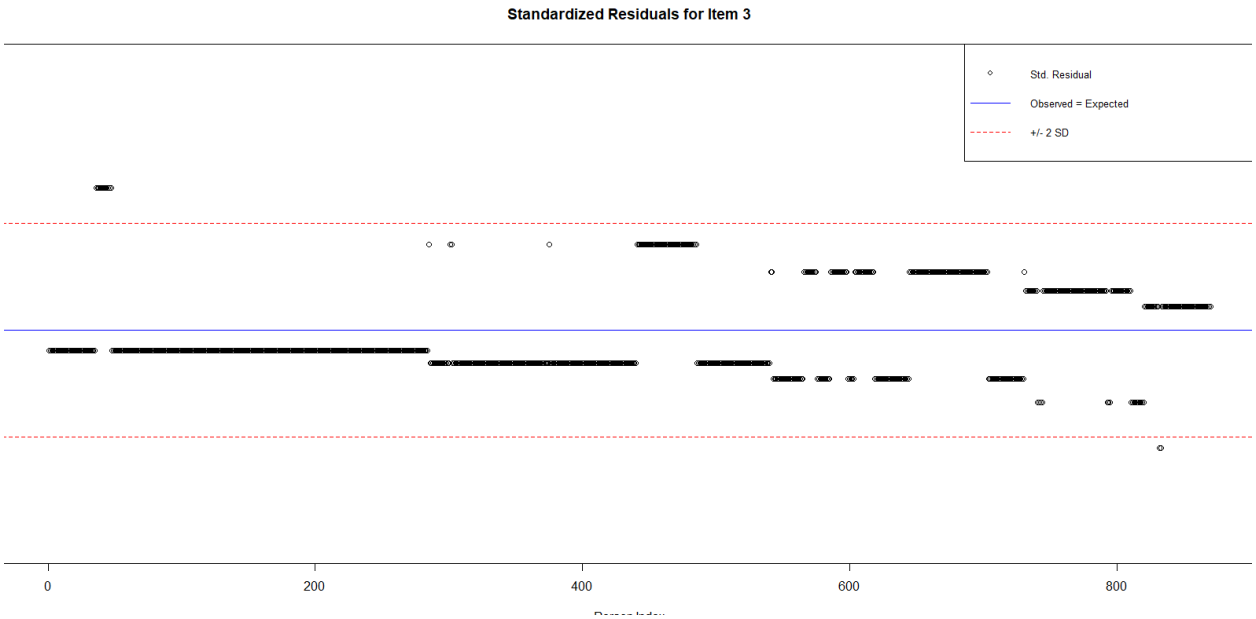
Items or persons with standardized infit and outfit values greater than 3 in absolute value indicate a problem with fit and warrant additional scrutiny. Note that standardized

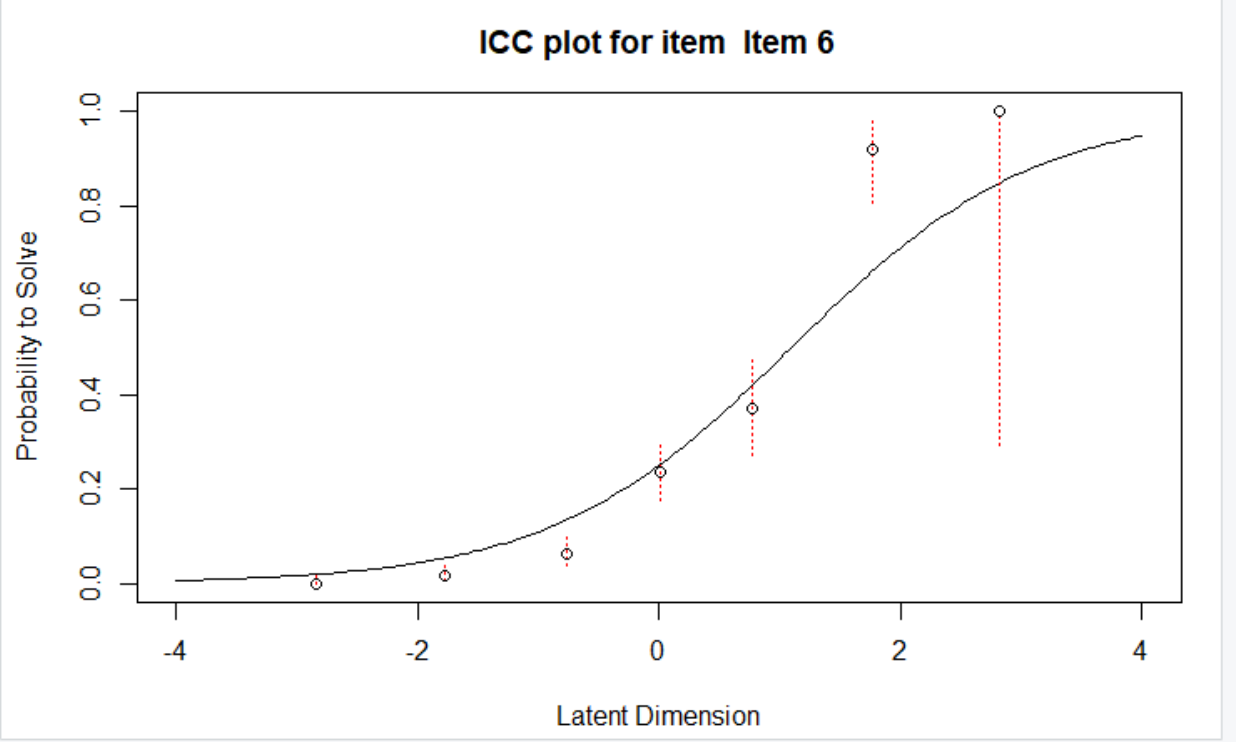
infit and outfit statistics are sensitive to sample size. As such, they are only useful for sample sizes less than 300 examinees

Researchers usually begin individual Rasch fit analyses by examining fit statistics for items, rather than persons.

```
Itemfit Statistics:
          Chisq  df p-value Outfit MSQ Infit MSQ Outfit t Infit t Discrim
Item 1 1243.272 869       0      1.429     1.317    9.360   9.287  -0.284
Item 2 1123.961 869       0      1.292     1.196    5.345   6.311  -0.188
Item 3  616.772 869       1      0.709     0.780   -6.403  -6.512   0.531
Item 4  705.955 869       1      0.811     0.871   -3.405  -3.313   0.330
Item 5  622.054 869       1      0.715     0.766   -7.607  -7.999   0.554
Item 6  544.934 869       1      0.626     0.744   -4.865  -5.147   0.448
```

We can also draw plots for individual items





Following is the reliability:-

```
> summary(sepRel(student.locations))

       Separation Reliability: 0.0637

            Observed Variance: 1.0576 (Squared Standard Deviation)
Mean Square Measurement Error: 0.9902 (Model Error Variance)

> |
```