

```
1236 0 OUTPUT ACTIVATE FornellLarckerCriterionOutput.  
1236 0 M> OUTPUT ACTIVATE FornellLarckerCriterionOutput.  
1237 0 TITLE 'Fornell-Larcker Criterion'.  
1237 0 M> TITLE 'Fornell-Larcker Criterion'.
```

Fornell-Larcker Criterion

```

1238 0
1238 0 M>
1239 0 GET DATA
1239 0 M> GET DATA
1240 0 /TYPE=TXT /FILE='D:\DATA ANALYSIS\L Validity Factor Analysis and Scale Testing\Fornell Larcker Criterion\dataset.csv' /ENC
      ODING='UTF8' /DELCASE=LINE /DELIMITERS=', ' /QUALIFIER='"'
1240 0 M> /TYPE=TXT /FILE='D:\DATA ANALYSIS\L Validity Factor Analysis and Scale Testing\Fornell Larcker Criterion\dataset.csv' /
      ENCODING='UTF8' /DELCASE=LINE /DELIMITERS=', ' /QUALIFIER='"'
1241 0 /ARRANGEMENT=DELIMITED /FIRSTCASE=2
1241 0 M> /ARRANGEMENT=DELIMITED /FIRSTCASE=2
1242 0 /VARIABLES=
1242 0 M> /VARIABLES=
1243 0 school A8 sex A8 age F8.0 address A8 famsize A8 Pstatus A8 Medu F8.0
      Fedu F8.0
1243 0 M> school A8 sex A8 age F8.0 address A8 famsize A8 Pstatus A8 Medu F
      8.0 Fedu F8.0
1244 0 Mjob A16 Fjob A16 reason A16 guardian A16 traveltime F8.0 studytime
      F8.0 failures F8.0
1244 0 M> Mjob A16 Fjob A16 reason A16 guardian A16 traveltime F8.0 studyti
      me F8.0 failures F8.0
1245 0 schoolsup A8 famsup A8 paid A8 activities A8 nursery A8 higher A8 in
      ternet A8 romantic A8
1245 0 M> schoolsup A8 famsup A8 paid A8 activities A8 nursery A8 higher A8
      internet A8 romantic A8
1246 0 famrel F8.0 freetime F8.0 goout F8.0 Dalc F8.0 Walc F8.0 health F8.0
      absences F8.0 G1 F8.0 G2 F8.0 G3 F8.0.
1246 0 M> famrel F8.0 freetime F8.0 goout F8.0 Dalc F8.0 Walc F8.0 health F
      8.0 absences F8.0 G1 F8.0 G2 F8.0 G3 F8.0.
1247 0 DATASET NAME FornellLarckerCriterionData.
1247 0 M> DATASET NAME FornellLarckerCriterionData.
1248 0 COMPUTE subject_id=$CASENUM.
1248 0 M> COMPUTE subject_id=$CASENUM.
1249 0 COMPUTE Dalc_R=6-Dalc.
1249 0 M> COMPUTE Dalc_R=6-Dalc.
1250 0 COMPUTE Walc_R=6-Walc.
1250 0 M> COMPUTE Walc_R=6-Walc.

```

Fornell-Larcker Criterion

```
1251 0 RECODE schoolsup famsup paid activities higher internet ('no'=0) ('yes'=1)
1251 0 M> RECODE schoolsup famsup paid activities higher internet ('no'=0) ('yes'=1)
1252 0 INTO schoolsup_b famsup_b paid_b activities_b higher_b internet_b.
1252 0 M> INTO schoolsup_b famsup_b paid_b activities_b higher_b internet_b
.
1253 0 EXECUTE.
1253 0 M> EXECUTE.
1254 0
1254 0 M>
1255 0 * BEGIN METHOD-SPECIFIC SPSS WORKFLOW.
1255 0 M> * BEGIN METHOD-SPECIFIC SPSS WORKFLOW.
1256 0 TITLE 'Fornell Larcker Criterion'.
1256 0 M> TITLE 'Fornell Larcker Criterion'.
```

Fornell Larcker Criterion

1257 0 SUBTITLE 'Square-root AVE versus interconstruct association'.

1257 0 M> SUBTITLE 'Square-root AVE versus interconstruct association'.

Fornell Larcker Criterion
Square-root AVE versus interconstruct association

```

1258  0  FACTOR /VARIABLES=G1 G2 G3 famrel freetime goout /MISSING=LISTWISE /A
NALYSIS=G1 G2 G3 famrel freetime goout
1258  0 M>  FACTOR /VARIABLES=G1 G2 G3 famrel freetime goout /MISSING=LISTWISE
 /ANALYSIS=G1 G2 G3 famrel freetime goout
1259  0  /PRINT=INITIAL EXTRACTION KMO CORRELATION /PLOT=EIGEN
1259  0 M>  /PRINT=INITIAL EXTRACTION KMO CORRELATION /PLOT=EIGEN
1260  0  /CRITERIA=FACTORS(2) ITERATE(500) /EXTRACTION=PAF /ROTATION=NOROTATE
 /METHOD=CORRELATION.
1260  0 M>  /CRITERIA=FACTORS(2) ITERATE(500) /EXTRACTION=PAF /ROTATION=NOROT
ATE /METHOD=CORRELATION.

```

Factor Analysis

Notes

Output Created		18-JUL-2026 10:56:08
Comments		
Input	Data	D:\DATA ANALYSIS\L Validity Factor Analysis and Scale Testing\Fornell Larcker Criterion\dataset. csv
	Active Dataset	FornellLarckerCriterionDat a
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	649
Missing Value Handling	Definition of Missing	MISSING=EXCLUDE: User-defined missing values are treated as missing.
	Cases Used	LISTWISE: Statistics are based on cases with no missing values for any variable used.

Fornell Larcker Criterion
Square-root AVE versus interconstruct association

Notes

Syntax		FACTOR /VARIABLES=G1 G2 G3 famrel freetime goout /MISSING=LISTWISE /ANALYSIS=G1 G2 G3 famrel freetime goout /PRINT=INITIAL EXTRACTION KMO CORRELATION /PLOT=EIGEN /CRITERIA=FACTORS(2) ITERATE(500) /EXTRACTION=PAF /ROTATION=NOROTATE /METHOD=CORRELATIO N.
Resources	Processor Time	00:00:00.22
	Elapsed Time	00:00:00.32
	Maximum Memory Required	5704 (5.570K) bytes

[FornellLarckerCriterionData]

Correlation Matrix

		G1	G2	G3	famrel	freetime	goout
Correlation	G1	1.000	.865	.826	.049	-.094	-.074
	G2	.865	1.000	.919	.090	-.107	-.079
	G3	.826	.919	1.000	.063	-.123	-.088
	famrel	.049	.090	.063	1.000	.129	.090
	freetime	-.094	-.107	-.123	.129	1.000	.346
	goout	-.074	-.079	-.088	.090	.346	1.000

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.732
Bartlett's Test of Sphericity	Approx. Chi-Square	2220.632
	df	15
	Sig.	.000

Fornell Larcker Criterion
Square-root AVE versus interconstruct association

Communalities

	Initial	Extraction
G1	.755	.775
G2	.880	.966
G3	.849	.878
famrel	.034	.045
freetime	.140	.474
goout	.125	.252

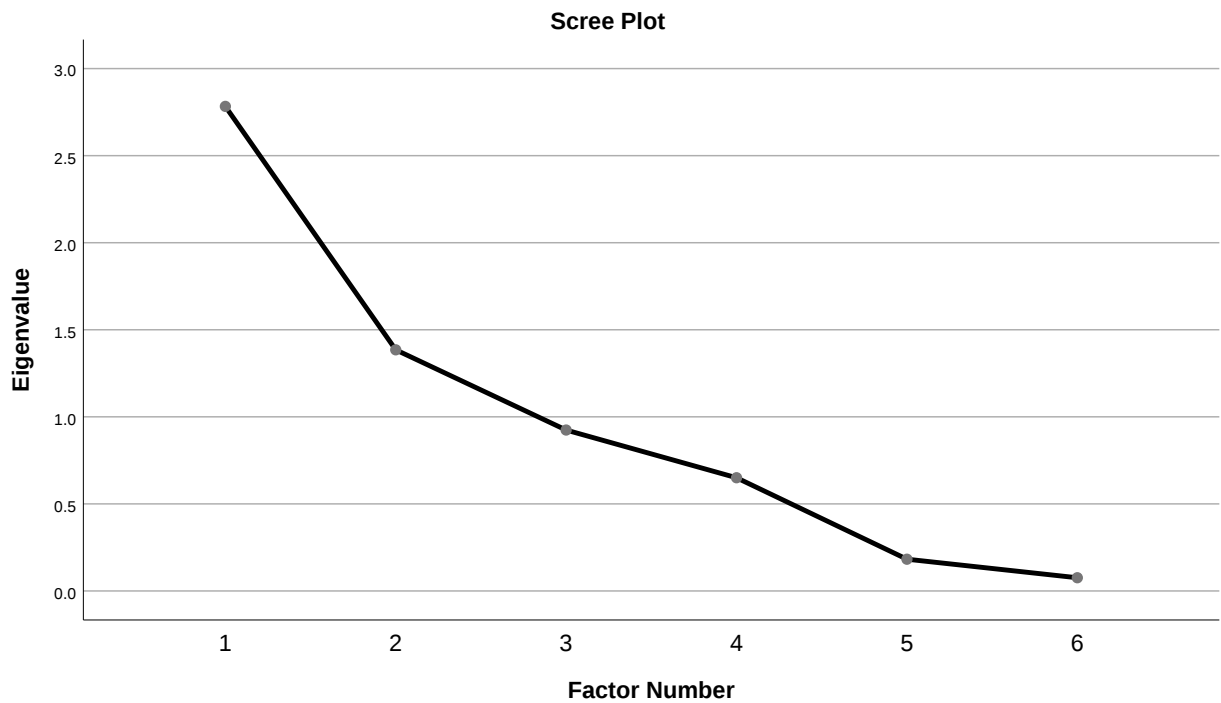
Extraction Method: Principal Axis Factoring.

Total Variance Explained

Factor	Total	Initial Eigenvalues		Extraction Sums of Squared Loadings		
		% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.783	46.381	46.381	2.650	44.166	44.166
2	1.385	23.080	69.461	.740	12.337	56.503
3	.924	15.402	84.863			
4	.650	10.835	95.698			
5	.182	3.038	98.736			
6	.076	1.264	100.000			

Extraction Method: Principal Axis Factoring.

Fornell Larcker Criterion
Square-root AVE versus interconstruct association



Factor Matrix^a

	Factor	
	1	2
G1	.879	.053
G2	.980	.070
G3	.936	.033
famrel	.061	.204
freetime	-.153	.671
goout	-.114	.489

Extraction Method: Principal Axis Factoring.

a. 2 factors extracted. 41 iterations required.

```
1261 0 RELIABILITY /VARIABLES=G1 G2 G3 /SCALE('Academic measurement block')
ALL /MODEL=ALPHA /STATISTICS=DESCRIPTIVE SCALE CORR.
1261 0 M> RELIABILITY /VARIABLES=G1 G2 G3 /SCALE('Academic measurement block
') ALL /MODEL=ALPHA /STATISTICS=DESCRIPTIVE SCALE CORR
```

Fornell Larcker Criterion
Square-root AVE versus interconstruct association

Reliability

Notes

Output Created		18-JUL-2026 10:56:08
Comments		
Input	Data	D:\DATA ANALYSIS\L Validity Factor Analysis and Scale Testing\Fornell Larcker Criterion\dataset. csv
	Active Dataset	FornellLarckerCriterionDat a
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	649
	Matrix Input	D:\DATA ANALYSIS\L Validity Factor Analysis and Scale Testing\Fornell Larcker Criterion\fornell_larcker_cr iterion_spss_syntax.sps
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on all cases with valid data for all variables in the procedure.
Syntax		RELIABILITY /VARIABLES=G1 G2 G3 /SCALE('Academic measurement block') ALL /MODEL=ALPHA /STATISTICS=DESCRIPT IVE SCALE CORR.
Resources	Processor Time	00:00:00.05
	Elapsed Time	00:00:00.03

Fornell Larcker Criterion
Square-root AVE versus interconstruct association

Scale: Academic measurement block

Case Processing Summary

		N	%
Cases	Valid	649	100.0
	Excluded ^a	0	.0
	Total	649	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.951	.953	3

Item Statistics

	Mean	Std. Deviation	N
G1	11.40	2.745	649
G2	11.57	2.914	649
G3	11.91	3.231	649

Inter-Item Correlation Matrix

	G1	G2	G3
G1	1.000	.865	.826
G2	.865	1.000	.919
G3	.826	.919	1.000

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
34.88	72.251	8.500	3

Fornell Larcker Criterion
Square-root AVE versus interconstruct association

```
1262  0  RELIABILITY /VARIABLES=famrel freetime goout /SCALE('Social measureme
nt block') ALL /MODEL=ALPHA /STATISTICS=DESCRIPTIVE SC
      ALE CORR.
1262  0 M> RELIABILITY /VARIABLES=famrel freetime goout /SCALE('Social measur
ement block') ALL /MODEL=ALPHA /STATISTICS=DESCRIPTIVE
      SCALE CORR.
```

Reliability

Notes

Output Created		18-JUL-2026 10:56:08
Comments		
Input	Data	D:\DATA ANALYSIS\L Validity Factor Analysis and Scale Testing\Fornell Larcker Criterion\dataset. csv
	Active Dataset	FornellLarckerCriterionDat a
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	649
	Matrix Input	D:\DATA ANALYSIS\L Validity Factor Analysis and Scale Testing\Fornell Larcker Criterion\fornell_larcker_cr iterion_spss_syntax.sps
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on all cases with valid data for all variables in the procedure.

Fornell Larcker Criterion
Square-root AVE versus interconstruct association

Notes

Syntax		RELIABILITY /VARIABLES=famrel freetime goout /SCALE ('Social measurement block') ALL /MODEL=ALPHA /STATISTICS=DESCRIPT IVE SCALE CORR.
Resources	Processor Time	00:00:00.05
	Elapsed Time	00:00:00.04

Scale: Social measurement block

Case Processing Summary

		N	%
Cases	Valid	649	100.0
	Excluded ^a	0	.0
	Total	649	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.419	.411	3

Item Statistics

	Mean	Std. Deviation	N
famrel	3.93	.956	649
freetime	3.18	1.051	649
goout	3.18	1.176	649

Fornell Larcker Criterion
Square-root AVE versus interconstruct association

Inter-Item Correlation Matrix

	famrel	freetime	goout
famrel	1.000	.129	.090
freetime	.129	1.000	.346
goout	.090	.346	1.000

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
10.30	4.718	2.172	3

```

1263  0  COMPUTE academic_score=MEAN(G1,G2,G3).
1263  0 M>  COMPUTE academic_score=MEAN(G1,G2,G3).
1264  0  COMPUTE social_score=MEAN(famrel,freetime,goout).
1264  0 M>  COMPUTE social_score=MEAN(famrel,freetime,goout).
1265  0  CORRELATIONS /VARIABLES=academic_score social_score /PRINT=TWOTAIL NO
SIG.
1265  0 M>  CORRELATIONS /VARIABLES=academic_score social_score /PRINT=TWOTAIL
NOSIG.

```

Correlations

Fornell Larcker Criterion
Square-root AVE versus interconstruct association

Notes

Output Created		18-JUL-2026 10:56:08
Comments		
Input	Data	D:\DATA ANALYSIS\L Validity Factor Analysis and Scale Testing\Fornell Larcker Criterion\dataset. csv
	Active Dataset	FornellLarckerCriterionDat a
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	649
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each pair of variables are based on all the cases with valid data for that pair.
Syntax		CORRELATIONS /VARIABLES=academic_s core social_score /PRINT=TWOTAIL ...
Resources	Processor Time	00:00:00.05
	Elapsed Time	00:00:00.04

Correlations

		academic_scor e	social_score
academic_score	Pearson Correlation	1	-.070
	Sig. (2-tailed)		.076
	N	649	649
social_score	Pearson Correlation	-.070	1
	Sig. (2-tailed)	.076	
	N	649	649

Fornell Larcker Criterion
Square-root AVE versus interconstruct association

```
1266 0 * END METHOD-SPECIFIC SPSS WORKFLOW.
1266 0 M> * END METHOD-SPECIFIC SPSS WORKFLOW.
1267 0
1267 0 M>
1268 0 SAVE OUTFILE='D:\DATA ANALYSIS\L Validity Factor Analysis and Scale T
esting\Fornell Larcker Criterion\SPSS_Output\sav\forne
ll-larcker-criterion_spss_ready_data.sav' /COMPRESSED.
1268 0 M> SAVE OUTFILE='D:\DATA ANALYSIS\L Validity Factor Analysis and Scal
e Testing\Fornell Larcker Criterion\SPSS_Output\sav\fo
rnell-larcker-criterion_spss_ready_data.sav' /COMPRESSED.
1269 0
1269 0 M>
1270 0 ECHO '=====
====='.
1270 0 M> ECHO '=====
====='.
=====
1271 0 ECHO 'FORNELL-LARCKER CRITERION'.
1271 0 M> ECHO 'FORNELL-LARCKER CRITERION'.
FORNELL-LARCKER CRITERION
1272 0 ECHO 'Design: Square roots of construct AVE compared with the absolut
e latent correlation.'.
1272 0 M> ECHO 'Design: Square roots of construct AVE compared with the abso
lute latent correlation.'.
Design: Square roots of construct AVE compared with the absolute latent correl
ation.
1273 0 ECHO 'Null hypothesis: At least one construct's square-root AVE does
not exceed its interconstruct correlation.'.
1273 0 M> ECHO 'Null hypothesis: At least one construct's square-root AVE d
oes not exceed its interconstruct correlation.'.
Null hypothesis: At least one construct's square-root AVE does not exceed its
interconstruct correlation.
1274 0 ECHO 'Formula: Discriminant validity requires  $\sqrt{\text{AVE}_j} > |\phi_{jk}|$  fo
r every k not equal to j.'.
1274 0 M> ECHO 'Formula: Discriminant validity requires  $\sqrt{\text{AVE}_j} > |\phi_{jk}|$ 
for every k not equal to j.'.
Formula: Discriminant validity requires  $\sqrt{\text{AVE}_j} > |\phi_{jk}|$  for every k not e
qual to j.
1275 0 ECHO 'Variables: G1, G2, G3, famrel, freetime, goout'.
```

Fornell Larcker Criterion
Square-root AVE versus interconstruct association

```
1275  0 M> ECHO 'Variables: G1, G2, G3, famrel, freetime, goout'.
Variables: G1, G2, G3, famrel, freetime, goout
1276  0 ECHO 'Rows analyzed: 649'.
1276  0 M> ECHO 'Rows analyzed: 649'.
Rows analyzed: 649
1277  0 ECHO 'criterion_pass = True'.
1277  0 M> ECHO 'criterion_pass = True'.
criterion_pass = True
1278  0 ECHO 'factor_correlation = -0.14469453186032052'.
1278  0 M> ECHO 'factor_correlation = -0.14469453186032052'.
factor_correlation = -0.14469453186032052
1279  0 ECHO 'minimum_margin = 0.37308689286090924'.
1279  0 M> ECHO 'minimum_margin = 0.37308689286090924'.
minimum_margin = 0.37308689286090924
1280  0 ECHO 'sqrt_ave_academic = 0.934069241707824'.
1280  0 M> ECHO 'sqrt_ave_academic = 0.934069241707824'.
sqrt_ave_academic = 0.934069241707824
1281  0 ECHO 'sqrt_ave_social = 0.5177814247212298'.
1281  0 M> ECHO 'sqrt_ave_social = 0.5177814247212298'.
sqrt_ave_social = 0.5177814247212298
1282  0 ECHO 'Cross-check status: pass'.
1282  0 M> ECHO 'Cross-check status: pass'.
Cross-check status: pass
1283  0 ECHO '=====
====='.
1283  0 M> ECHO '=====
====='.
=====
1284  0
1284  0 M>
1285  0 OUTPUT SAVE OUTFILE='D:\DATA ANALYSIS\L Validity Factor Analysis and
Scale Testing\Fornell Larcker Criterion\SPSS_Output\sp
v\fornell-larcker-criterion_spss_output.spv'.
1285  0 M> OUTPUT SAVE OUTFILE='D:\DATA ANALYSIS\L Validity Factor Analysis a
nd Scale Testing\Fornell Larcker Criterion\SPSS_Output
\spv\fornell-larcker-criterion_spss_output.spv'.
1286  0 OUTPUT EXPORT /CONTENTS EXPORT=ALL LAYERS=PRINTSETTING MODELVIEWS=PRI
NTSETTING
```

Fornell Larcker Criterion
Square-root AVE versus interconstruct association

```
1286  0 M>  OUTPUT EXPORT /CONTENTS EXPORT=ALL LAYERS=PRINTSETTING MODELVIEWS=
PRINTSETTING
```