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Factor analyses provide evidence of construct validity for NSSE's ten [Engagement Indicators](#) (EI). By examining EI factor structures through exploratory and confirmatory factor analysis (EFA/CFA), quantitative evidence can support claims that the EIs actually measure what they intend to measure. This NSSE Psychometric Portfolio¹ piece documents the results of NSSE's CFA & EFA analyses and concludes that EIs have sufficiently strong construct validity evidence to support their use for college and university assessment efforts.

Data

Prior to conducting the EFA and CFA, we randomly divided all NSSE 2013 respondents into two groups. One group provided data for EFA while the other group provided data for CFA. EFAs were run separately for first-year ($n=32,374$) and senior ($n=46,259$) students as well as for students taking all their coursework online. Due to the small number of first-year students taking all their coursework online, we examined only senior online students ($n=3,464$) in the EFAs. For the CFAs, we developed separate models for all first-year students, seniors, online first-year students, and online seniors². Item frequency distributions for all respondents by Basic 2010 Carnegie classification, public-private status, enrollment size, region, locale, and other demographic characteristics can be found at: http://nsse.indiana.edu/2013_institutional_report/pdf/NSSE_2013_Overview.pdf

Exploratory Factor Analysis

Methods. Given the ordinal nature of the data, the EFAs used polychoric correlations instead of Pearson's correlations (Drasgow, 2006). The EFA included all engagement items on the survey, excluding the high-impact practice items, perceived gains, and two of the "time spent" items. We included time spent preparing for class and reading due to their relationship to academic work, but excluded the remainder of the "time spent" items because they relate to personal demographics (e.g., working for pay, commuting, caring for dependents). In addition, we included a composite score for amount of writing in lieu of individual writing items. EFA models used principal component analysis with direct oblimin rotation (oblique) in order to allow factors to correlate. We identified all valid components with eigenvalues of 1.0 or greater and reported all factor loadings and cross-loadings of 0.4 or greater.

Results. The EFA for first-year students, seniors, and online seniors suggested twelve, thirteen, and eleven distinct components explaining 65%, 69%, and 71% of the variance, respectively. The Kaiser-Meyer-Olkin statistic was .94 in all three analyses indicating "meritorious" factorability of the item set (Kaiser, 1974). In addition, the Bartlett's test of sphericity was significant ($p < .001$) for all three analyses. For each subpopulation, the first ten components aligned with items in the ten EIs and explained over 60% of the variance. For factor loadings for each of the three models, see Appendices A, B, and C. These results informed the CFAs through examination of factor loadings for conceptually similar items, providing evidence that items were grouping in ways that made sense and were statistically appropriate.

Confirmatory Factor Analysis

Methods. Using the second group of randomly selected respondents, we conducted CFAs using the ten EIs organized by four primary content area themes: Academic Challenge, Learning with Peers, Experiences with

¹This report is part of NSSE's Psychometric Portfolio, a framework for presenting our studies of the validity, reliability, and other indicators of quality of NSSE data, available online at nsse.iub.edu/links/psychometric_portfolio

²Ns varied for each CFA model, since due to AMOS specifications, students were excluded from analyses if they had any missing data for survey items used with any particular model. First-year CFA n 's ranged from 43,000 to 59,000; senior n 's ranged from 61,000 to 89,000; online first-year n 's ranged from 1,200 to 2,400; online senior n 's ranged from 4,900 to 10,200.

Faculty, and Campus Environment. We developed separate models for all first-year students, all seniors, online first-year students, and online seniors, including conceptually related EIs together in the same model and allowing them to correlate.

Given its larger size, we used the senior sample to develop an initial set of four models with the EIs grouped into the conceptually related areas. After building these models, we used modification indices to determine whether model fit could be improved by correlating the error terms of factor indicators (or individual survey items). Once the final models with the greatest number of paths for each content area had been created using the senior population, we then proceeded by estimating model fit indices, standardized regression weights, and factor correlation estimates for first-year student, online first-year student, and online senior populations. See model paths for each content area in Appendices D, E, F, and G.

To assess model fit, we considered five different indices: CMIN/DF (chi-square divided by degrees of freedom), GFI (goodness of fit index), CFI (comparative fit index), RMSEA (root mean square error of approximation), and PCLOSE (p-value for test of close fit). Traditional good model fit criteria for CMIN/DF is a value of 5 or less; however, this statistic is very sensitive to sample size and likely to be inflated with large samples. For the other fit indices, good model fit criteria (as recommended by Hu & Bentler, 1999) are as follows:

GFI: .85 or higher

CFI: .90 or higher

RMSEA: .06 or lower

PCLOSE: .05 or higher

Standardized regression weights determined the strength of factor loadings. These values could range between 0 and 1, with higher values being more desirable. We considered values under .40 unacceptably low (Kline, 2002). Correlations between content area factors of .80 or greater indicate multicollinearity and the potential for factor indicators to load on more than one factor.

CFA Results

Academic Challenge. CFA results for the Academic Challenge theme, including Reflective & Integrative Learning (RI), Higher-Order Learning (HO), Quantitative Reasoning (QR), and Learning Strategies (LS) EIs, demonstrated very good model fit overall, with all model fit indices meeting the cutoff criteria (see Table 1a). All four factors correlated between .37 and .63 for first-year students, .33 and .65 for seniors, .29 and .67 for online first-year students, and .36 and .67 for online seniors, suggesting that the factors are related, but do not pose overwhelming multicollinearity concerns. The standardized regression weights for all factors across all four groups were strong, ranging from approximately .6 to .9 (see Table 1b). Overall, fit indices, factor correlations, and regression weights provided sufficient construct validity evidence for RI, HO, QR, and LS.

Table 1a. Academic Challenge: CFA Model Fit Indices

	All Seniors	All First-Year Students	Online Seniors	Online First-Year Students
N	80,144	52,744	9,588	2,278
CMIN/DF	187.862	92.424	18.496	5.248
GFI	.971	.979	.976	.972
CFI	.972	.976	.981	.980
RMSEA	.048	.042	.043	.043
PCLOSE	1.00	1.00	1.00	.999

Table 1b. Academic Challenge: Standardized Regression Weights

	All Seniors	All First-Year Students	Online Seniors	Online First-Year Students
Reflective & Integrative Learning				
RIintegrate	.587	.608	.585	.592
RIsocietal	.716	.691	.711	.668
RIdiverse	.691	.659	.697	.644
RIownview	.749	.711	.782	.775
RIperspect	.734	.696	.775	.751
RInewview	.717	.686	.725	.697
RIconnect	.711	.696	.734	.731
Higher-Order Learning				
HOapply	.645	.648	.787	.791
HOanalyze	.770	.768	.849	.862
HOevaluate	.844	.827	.897	.889
HOform	.805	.780	.832	.825
Quantitative Reasoning				
QRconclude	.773	.735	.803	.791
QRproblem	.884	.862	.928	.915
QRevaluate	.844	.843	.835	.865
Learning Strategies				
LSreading	.609	.596	.675	.702
LSnotes	.754	.738	.765	.820
LSsummary	.865	.846	.856	.881

Learning with Peers. CFA results for the Learning with Peers theme, including Collaborative Learning (CL) and Discussions with Diverse Others (DD) EIs, showed very good model fit overall, with all model fit indices meeting the cutoff criteria (see Table 2a). The factors were correlated at .29 for first-year students, .28 for seniors, .29 for online first-year students, and .30 for online seniors, suggesting that the factors are related to some extent but not to the point where multicollinearity would be a concern. The standardized regression weights for both factors were strong, ranging from approximately .6 to .9 (see Table 2b). Overall, fit indices, factor correlations, and regression weights provided sufficient construct validity evidence for CL and DD.

Table 2a. Learning with Peers: CFA Model Fit Indices

	All Seniors	All First-Year Students	Online Seniors	Online First-Year Students
N	85,106	56,325	10,229	2,451
CMIN/DF	106.731	58.536	13.064	2.545
GFI	.995	.996	.995	.996
CFI	.995	.996	.997	.998
RMSEA	.035	.032	.034	.025
PCLOSE	1.00	1.00	1.00	1.00

Table 2b. Learning with Peers: Standardized Regression Weights

	All Seniors	All First-Year Students	Online Seniors	Online First-Year Students
Collaborative Learning				
CLaskhelp	.642	.633	.587	.598
CLexplain	.676	.640	.750	.721
CLstudy	.803	.819	.678	.724
CLproject	.684	.713	.636	.632
Discussions with Diverse Others				
DDrace	.839	.816	.927	.930
DDeconomic	.897	.879	.960	.968
DDreligion	.749	.716	.804	.793
DDpolitical	.742	.723	.844	.832

Experiences with Faculty. CFA results for the Experiences with Faculty theme, including Student-Faculty Interaction (SF) and Effective Teaching Practices (ET) EIs, showed very good model fit overall, with all model fit indices meeting the cutoff criteria (see Table 3a). The factors were correlated at .21 for first-year students, .25 for seniors, .19 for online first-year students, and .20 for online seniors, suggesting that the factors are related to some extent but not to the point where multicollinearity would be a concern. The standardized regression weights for both factors were strong, ranging from approximately .6 to .9 (see Table 3b). Overall, fit indices, factor correlations, and regression weights provided sufficient construct validity evidence for SF and ET.

Table 3a. Experiences with Faculty: CFA Model Fit Indices

	All Seniors	All First-Year Students	Online Seniors	Online First-Year Students
N	89,391	59,976	10,296	2,449
CMIN/DF	183.533	98.421	30.266	8.357
GFI	.993	.995	.990	.988
CFI	.993	.993	.989	.989
RMSEA	.045	.040	.053	.055
PCLOSE	1.00	1.00	.094	.174

Table 3b. Experiences with Faculty: Standardized Regression Weights

	All Seniors	All First-Year Students	Online Seniors	Online First-Year Students
Student-Faculty Interaction				
SFcareer	.758	.691	.670	.683
SFotherwork	.765	.720	.746	.731
SFdiscuss	.814	.764	.739	.730
SFperform	.783	.788	.780	.784
Effective Teaching Practices				
ETgoals	.804	.763	.855	.846
ETorganize	.812	.772	.843	.863
ETexample	.798	.794	.780	.770
ETdraftfb	.577	.561	.557	.646
ETfeedback	.672	.626	.701	.734

Campus Environment. CFA results for the Campus Environment theme, including Quality of Interactions (QI) and Supportive Environment (SE) factors, showed adequate model fit overall (see Table 4a). The only model fit indices that did not meet the criteria were RMSEA and PCLOSE for online seniors (RMSEA and PCLOSE are more conservative indices of model fit). The factors were correlated at .42 for first-year students, .49 for seniors, .44 for online first-year students, and .52 for online seniors, suggesting that the factors are related to some extent but not to the point where multicollinearity would be a concern. The standardized regression weights for both factors were strong, ranging from approximately .5 to .9 (see Table 4b). Overall, fit indices, factor correlations, and regression weights provided sufficient construct validity evidence for QI and SE (but slightly less adequate for online seniors).

Table 4a. Campus Environment: CFA Model Fit Indices

	All Seniors	All First-Year Students	Online Seniors	Online First-Year Students
N	61,495	43,221	4,910	1,277
CMIN/DF	144.994	88.825	21.493	4.724
GFI	.980	.983	.962	.968
CFI	.977	.981	.972	.981
RMSEA	.048	.045	.065	.054
PCLOSE	.999	1.00	.000	.149

Table 4b. Campus Environment: Standardized Regression Weights

	All Seniors	All First-Year Students	Online Seniors	Online First-Year Students
Quality of Interactions				
QIstudent	.451	.464	.557	.620
QIadvisor	.561	.650	.763	.813
QIfaculty	.622	.742	.760	.848
QIstaff	.829	.845	.862	.861
QIadmin	.794	.832	.849	.868
Supportive Environment				
SEacademic	.632	.629	.648	.648
SElearnsup	.597	.579	.623	.609
SEdiverse	.712	.722	.758	.799
SEsocial	.799	.804	.841	.854
SEwellness	.808	.803	.873	.859
SEnonacad	.669	.666	.740	.744
SEactivities	.684	.709	.681	.675
SEevents	.674	.682	.695	.717

References

- Dragow, F. (2006). Polychoric and polyserial correlations. Encyclopedia of statistical sciences. Retrieved from <http://onlinelibrary.wiley.com/book/10.1002/0471667196>
- Hu, L.T., & Bentler, P.M. (1999). Cutoff criteria for fit indices in covariance structure analysis: Conventional versus new alternatives. *Structural Equation Modeling, 6*, 1-55.
- Kaiser, H.F. (1974). An index of factorial simplicity. *Psychometrika, 39*, 31-36.
- Kline, P. (2002). *An easy guide to factor analysis*. New York, NY: Routledge.

Appendix A. Exploratory Factor Analysis Loadings: First-year Students

Component	1	2	3	4	5	6	7	8	9	10	11	12
RSocietal	0.816											
RLowview	0.812											
RConnect	0.812									-0.448		
RPerspect	0.795											
RIDiverse	0.794											
RNewview	0.771									-0.442		
RIntegrate	0.726											
askquest	0.454								0.413			
SEsocial		-0.849										
SEwellness		-0.836										
SEevents		-0.817										
SEactivities		-0.809										
SEdiverse		-0.773										
SEacademic		-0.756					-0.456					
SEnonacad		-0.741										
SElearnsup		-0.725										
empstudy		-0.538										-0.44
CLstudy			0.841									
CLaskhelp			0.816									
CLproject			0.781									
CLexplain			0.769									
DEeconomic				-0.909								
DDreligion				-0.881								
DDpolitical				-0.874								
DDrace				-0.871								
Qladmin					0.868							
Qlstaff					0.867							
Qlfaculty					0.836		-0.442					
Qladvisor					0.788							
Qlstudent					0.582							
LSnotes						0.829						
LSsummary						0.799						
LSreading	0.478					0.603	-0.401			-0.441		
drafts						0.496						
unpreparedr						-0.485						
challenge						0.403						
ETorganize							-0.852					
ETexample							-0.845					
ETgoals							-0.823					
ETfeedback							-0.807					
ETdraftfb							-0.783					
QRproblem								-0.909				
QRevaluate								-0.898				
QRconclude								-0.868				
SFdiscuss									0.851			
SFperform									0.837			
SFcareer									0.82			
SFOtherwork									0.802			
attendart												
HOanalyze	0.44									-0.894		
HOevaluate	0.465									-0.869		
HOform	0.451									-0.854		
HOapply										-0.817		
memorize												
tmreadhrs											0.76	
tmprephrs											0.723	
wrpages											0.602	
present			0.407									0.48

Extraction Method: Principal Component Analysis; Rotation Method: Oblimin with Kaiser Normalization

Note: For details about item wording and Engagement Indicators, please see the [NSSE 2013 codebook](#)

Appendix B. Exploratory Factor Analysis Loadings: Seniors

Component	1	2	3	4	5	6	7	8	9	10	11	12	13
Rlownview	0.839									-0.423			
RI societal	0.831									-0.427			
RI diverse	0.816												
RIperspect	0.815												
RIconnect	0.812									-0.487			
RI newview	0.779									-0.467			
RIintegrate	0.71									-0.403			
askquest	0.459							0.404					
SEsocial		-0.839											
SEwellness		-0.838											
SEevents		-0.823											
SEactivities		-0.798											
SEnonacad		-0.752											
SEdiverse		-0.746											
SEacademic		-0.733				-0.496			0.429				
SElearnsup		-0.725											
CLproject			0.823										
CLstudy			0.823										
CLaskhelp			0.786										
CLexplain present			0.742					0.452					
			0.616										
DDeconomic				-0.917									
DDreligion				-0.899									
DDpolitical				-0.886									
DDrace				-0.886									
LSnotes					0.821								
LSsummary					0.794					-0.42			
LSreading drafts	0.477				0.582	-0.402				-0.448	0.406		
unpreparedr					0.581								0.403
					-0.535								
ETorganize						-0.88							
ETexample						-0.859							
ETgoals						-0.85							
ETfeedback						-0.843							
ETdraftfb						-0.792							
QRproblem							-0.918						
QRconclude							-0.907						
QRevaluate							-0.905						
SFdiscuss								0.876					
SFotherwork								0.839					
SFcareer								0.833					
SFperform								0.8					
attendart								0.449					
QIstaff									0.859				
QIadmin									0.852				
QIfaculty						-0.543			0.746				
QIadvisor									0.733				
QIstudent									0.622				
HOanalyze	0.434									-0.902			
HOform	0.481									-0.862			
HOevaluate	0.506									-0.86			
HOapply										-0.807			
wrpages											0.695		
tmreadhrs											0.641	0.423	
tmprephrs												0.772	
empstudy												0.555	
challenge		-0.416										0.46	
memorize					0.442	-0.411				-0.445			0.75

Extraction Method: Principal Component Analysis; Rotation Method: Oblimin with Kaiser Normalization

Note: For details about item wording and Engagement Indicators, please see the [NSSE 2013 codebook](#)

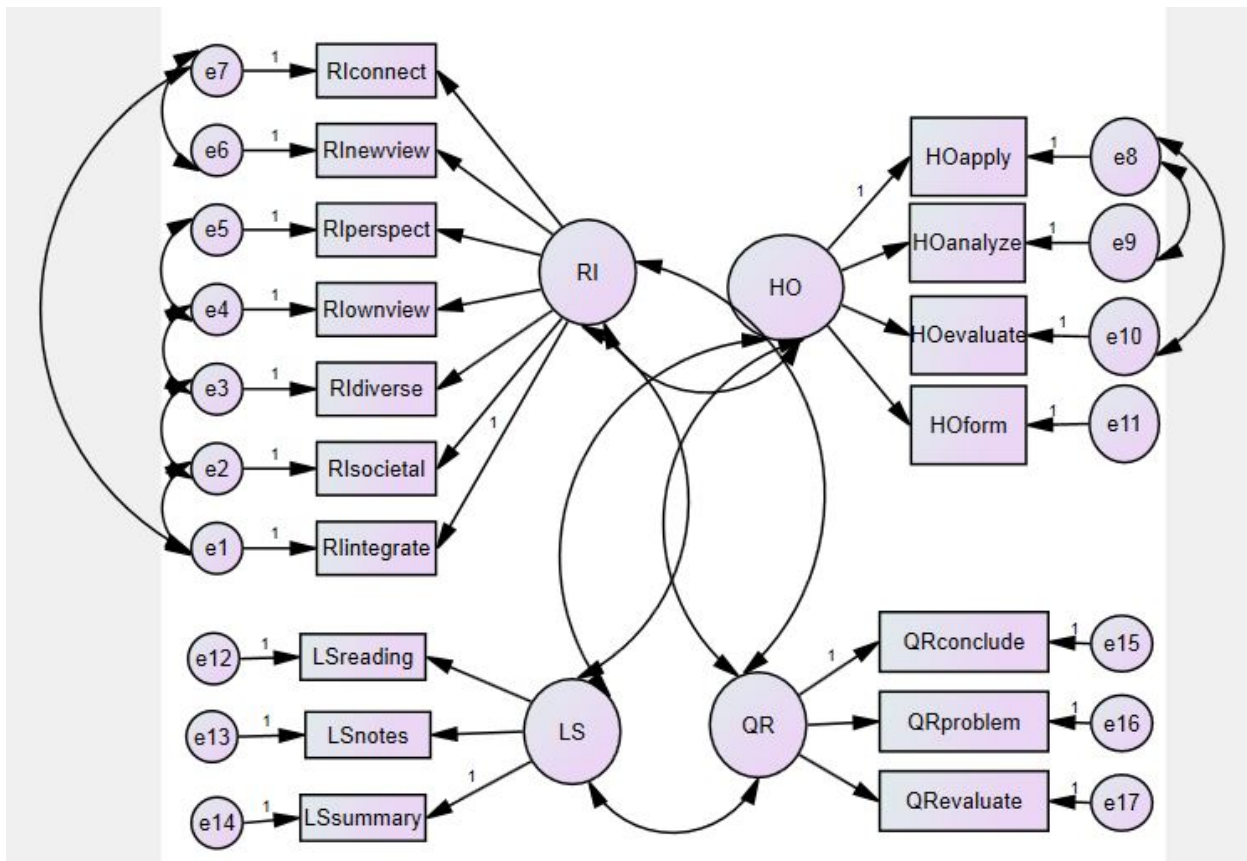
Appendix C. Exploratory Factor Analysis Loadings: Online Seniors

Component	1	2	3	4	5	6	7	8	9	10	11
Rlownview	0.876									-0.482	
Rlperspect	0.851			0.412						-0.484	
RI societal	0.848									-0.409	
RIdiverse	0.831										
Rlconnect	0.826						-0.414			-0.522	
Rlnewview	0.78									-0.492	
Rl integrate	0.737										
askquest	0.493										
CL explain		0.82									
CL study		0.813									
CL askhelp		0.793							-0.492		
CL project		0.792									
present		0.704									
attendart											
SE wellness			0.884				-0.439				
SE events			0.882								
SE social			0.878				-0.429				
SE activities			0.861								
SE nonacad			0.788				-0.411				
SE diverse			0.781		0.409		-0.474				
SE academic			0.716		0.48		-0.569			-0.44	
SE learnsup			0.715		0.415		-0.49				
empstudy			0.497							-0.488	
DE economic	0.411			0.961							
DD political				0.951							
DD race	0.401			0.95							
DD religion				0.935							
Ql staff					0.892		-0.404				
Ql admin					0.887		-0.43				
Ql advisor					0.858		-0.445				
Ql faculty					0.842		-0.602				
Ql student					0.709		-0.41				
tmprephrs						0.796					
tmreadhrs						0.78					
wrpages						0.583					
ET organize					0.418		-0.91			-0.42	
ET goals					0.421		-0.893			-0.416	
ET feedback					0.455		-0.89				
ET example							-0.877				
ET draftfb							-0.831				
challenge					0.489		-0.503			-0.484	-0.431
QR problem								-0.948			
QR evaluate								-0.92			
QR conclude								-0.915			
SF discuss									-0.867		
SF otherwork		0.458							-0.86		
SF perform									-0.791		
SF career									-0.766		
HO analyze	0.532						-0.456	-0.419		-0.918	
HO evaluate	0.578						-0.454			-0.913	
HO apply	0.539						-0.456	-0.413		-0.882	
HO form	0.564						-0.451			-0.876	
LS notes										-0.414	-0.838
LS summary	0.448			0.401			-0.416			-0.489	-0.749
LS reading	0.501			0.474			-0.487			-0.554	-0.602
memorize											-0.429
drafts											-0.405
unpreparedr											

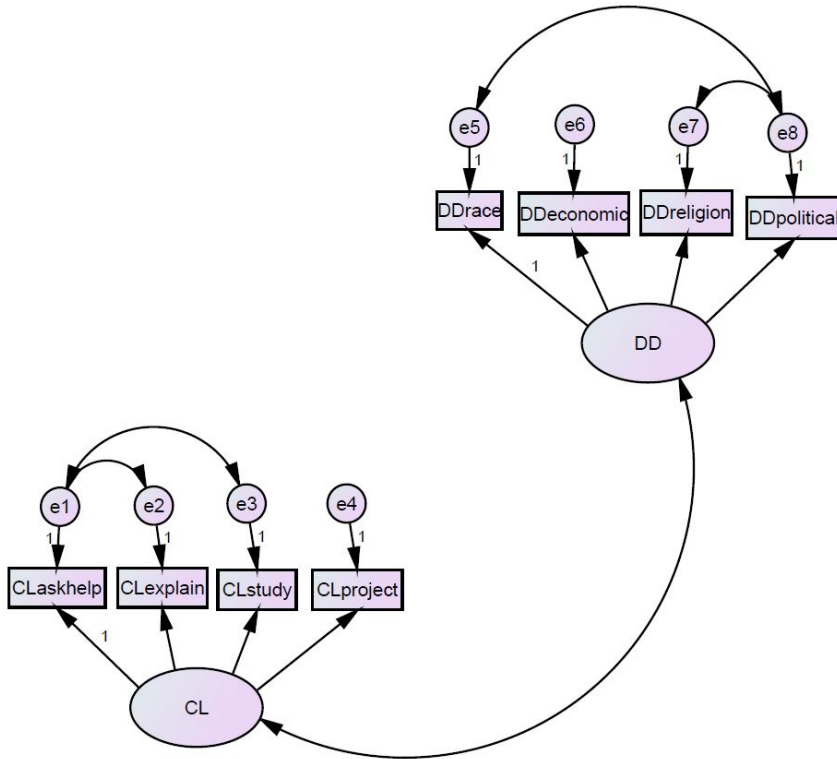
Extraction Method: Principal Component Analysis; Rotation Method: Oblimin with Kaiser Normalization

Note: For details about item wording and Engagement Indicators, please see the [NSSE 2013 codebook](#)

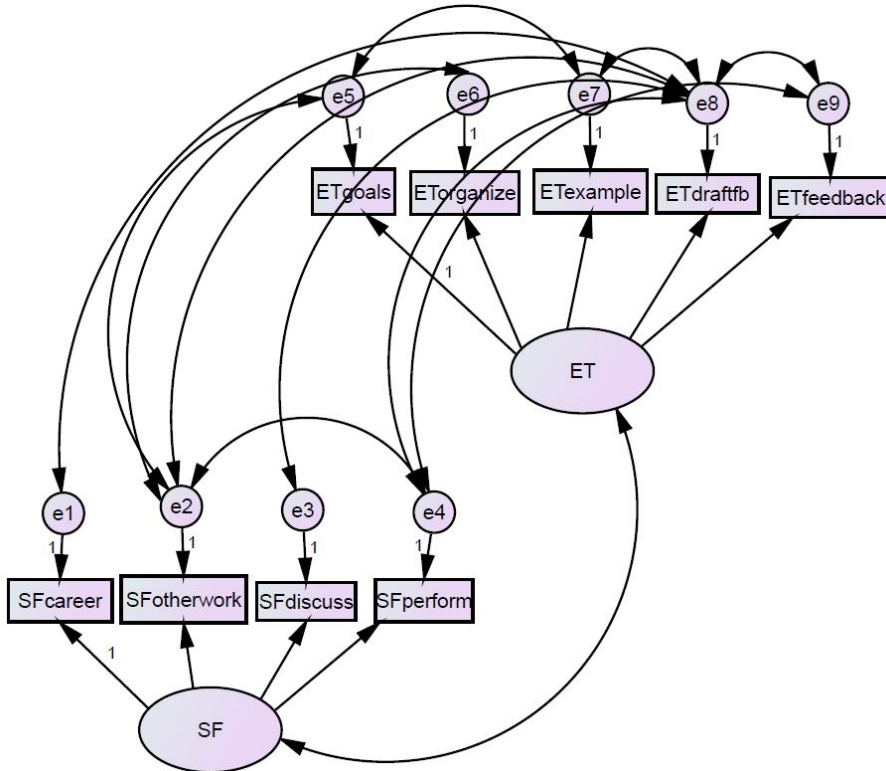
Appendix D. Academic Challenge CFA Model: Reflective & Integrative Learning (RI), Higher-Order Learning (HO), Quantitative Reasoning (QR), and Learning Strategies (LS)



Appendix E. Learning with Peers CFA Model: Collaborative Learning (CL) and Discussions with Diverse Others (DD)



Appendix F. Experiences with Faculty CFA Model: Student-Faculty Interaction (SF) and Effective Teaching Practices (ET)



Appendix G. Campus Environment CFA Model: Quality of Interactions (QI) and Supportive Environment (SE)

