FSSE 2017 grouped 50 survey items into several scales: Higher-Order Learning, Reflective and Integrative Learning, Learning Strategies, Quantitative Reasoning, Collaborative Learning, Discussions with Diverse Others, Student-Faculty Interaction, Effective Teaching Practices, Quality of Interactions, and Supportive Environment. The purpose of this study was to evaluate the quality of these scales, with particular focus on their internal structure.

Data

Results for this study were drawn from the 2017 administration of the FSSE survey, with 24,418 faculty from 154 bachelor's-granting colleges and universities. Response rates at individual institutions ranged from 13% to 80%, with an average of 43%.

Methods

In preparation for the exploratory and confirmatory factor analyses, the FSSE 2017 dataset was randomly divided in half. Half of the sample was used in the exploratory factor analysis (EFA) and the other half was used in the confirmatory factor analysis (CFA). We further divide the CFA sample into two, one to identify possible correlational structures and the second to test the identified structure.

First, a principle components exploratory factor analysis was used, in order to explore the factor structure that would emerge from the data. In order to allow for correlations between factors, a principal components analysis with an oblique, direct oblimin rotation was used. Factors with eigenvalues of 1 or greater were kept as potential components. All factor loadings of 0.4 or higher are reported.

In the second stage, a confirmatory factor analysis was done using the AMOS 22.0 statistical software program based on the results from the exploratory factor analysis. We conducted multiple iterations of CFA to identify correlations among items using randomly divided subsets of the data. We considered possible modifications on one subset of the data by first considering common meanings in survey items, magnitude of modification indices, standardized residuals, and improvements in model fit indices CFI, GFI, and RMSEA. Based on the final model identified through this process, separate confirmatory factor analyses on a different subsets of data were estimated for all faculty members who teach lower-division courses and those who teach upper-division courses.

Results: Exploratory Factor Analysis

Given the ordinal nature of the FSSE scale items, we employ exploratory factor analysis based on polychoric correlations. The polychoric correlations better account for this kind of variable than traditional Pearson correlations (Drasgow, 2006). We included all 50 items from the 10 scales listed above in the EFA (see Table 1 for description of each item). We estimated the model separately for faculty who mostly taught freshman and those who mostly taught seniors. We used a principal factor method with direct oblimin rotation 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.

Both populations suggest a 9 factor solution with the factors described above excepting that Collaborative Learning and Learning Strategies load onto a single factor (as opposed to separate factors). Although this is unexpected, it's reasonable that these might load together as both sets of items deal with student learning

activities outside of class. Additionally, these two scales share the same question stem on the survey instrument unlike the other scales in this study. It is possible that faculty view these activities more similarly because they are asked about together. The EFAs for these groups are both powerful explanatory models as they explain 95% and 96% of the variance in the variables for lower and upper division faculty respectively. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy was .87 and 0.89 for lower and upper division respectively indicating "meritorious" factorability of the items (Kaiser, 1974).

Table 1. FSSE scales and component items

Theme	Scale	Variable	Item
Academic Challenge	Higher-Order Learning	fHOapply	Applying facts, theories, or methods to practical problems or new situations
		fHOanalyze	Analyzing an idea, experience, or line of reasoning in depth by examining its parts
		fHOevaluate	Evaluating a point of view, decision, or information source
		fHOform	Forming a new idea or understanding from various pieces of information
	Reflective & Integrative Learning	fRIintegrate	Combine ideas from different courses when completing assignments
		fRIsocietal	Connect their learning to societal problems or issues
		fRIdiverse	Include diverse perspectives (political, religious, racial/ethnic, gender, etc.) in course discussions or assignments
		fRIownview	Examine the strengths and weaknesses of their own views on a topic or issue
		fRIperspect	Try to better understand someone else's views by imagining how an issue looks from their perspective
		fRInewview	Learn something that changes the way they understand an issue or concept
		fRIconnect	Connect ideas from your course to their prior experiences and knowledge
	Learning Strategies	fLSreading	Identify key information from reading assignments
		fLSnotes	Review notes after class
		fLSsummary	Summarize what has been learned from class or from course materials
	Quantitative Reasoning	fQRconclude	Reach conclusions based on their own analysis of numerical information (numbers, graphs, statistics, etc.)
		fQRproblem	Use numerical information to examine a real-world problem or issue (unemployment, climate change, public health, etc.)
		fQRevaluate	Evaluate what others have concluded from numerical information
Learning with Peers	Collaborative Learning	fCLaskhelp	Ask other students for help understanding course material
		fCLexplain	Explain course material to other students
		fCLstudy	Prepare for exams by discussing or working through course material with other students
		fCLproject	Work with other students on course projects or assignments
	Discussions with Diverse Others	fDDrace	People of a race or ethnicity other than their own
		fDDeconomic	People from an economic background other than their own
		fDDreligion	People with religious beliefs other than their own
		fDDpolitical	People with political views other than their own
Experiences with Faculty	Student-Faculty Interaction	fSFcareer	Talked about their career plans
		fSFotherwork	Worked on activities other than coursework (committees, student groups, etc.)
		fSFdiscuss	Discussed course topics, ideas, or concepts outside of class
		fSFperform	Discussed their academic performance
	Effective Teaching Practices	fETgoals	Clearly explain course goals and requirements
		fETorganize	Teach course sessions in an organized way
		fETexample	Use examples or illustrations to explain difficult points
		fETvariety	Use a variety of teaching techniques to accommodate diversity in student learning styles
		fETreview	Review and summarize material for students
		fETstandards	Provide standards for satisfactory completion of assignments (rubrics, detailed outlines, etc.)
		fETdraftfb	Provide feedback to students on drafts or works in progress
		fETfeedback	Provide prompt and detailed feedback on tests or completed assignments
Campus Environment	Quality of Interactions	fQIstudent	Other students
		fQIadvisor	Academic advisors
		fQIfaculty	Faculty
		fQIstaff	Student services staff (career services, student activities, housing, etc.)
		fQIadmin	Other administrative staff and offices (registrar, financial aid, etc.)
	Supportive Environment	fSEacademic	Providing support to help students succeed academically
		fSElearnsup	Students using learning support services (tutoring services, writing center, etc.)
		fSEdiverse	Encouraging contact among students from different backgrounds (social, racial/ethnic, religious, etc.)
		fSEsocial	Providing opportunities for students to be involved socially
		fSEwellness	Providing support for students' overall well-being (recreation, health care, counseling, etc.)
		fSEnonacad	Helping students manage their non-academic responsibilities (work, family, etc.)
		fSEactivities	Students attending campus activities and events (performing arts, athletic events, etc.)
		fSEevents	Students attending events that address important social, economic, or political issues

Table 2. Exploratory Factor Analysis Structure Matrix (Lower Division)

	Component								
	1	2	3	4	5	6	7	8	9
fRIintegrate	0.543								
fRIsocietal	0.821								
fRIdiverse	0.874								
fRIownview	0.862								
fRIperspect	0.903								
fRInewview	0.764								
fRIconnect	0.690								
fSEacademic		0.690							
fSElearnsup		0.632							
fSEdiverse		0.646							
fSEsocial		0.716							
fSEwellness		0.761							
fSEnonacad		0.661							
fSEactivit~s		0.678							
fSEevents		0.641							
fDDrace			0.883						
fDDeconomic			0.906						
fDDreligion			0.912						
fDDpolitical			0.887						
fCLaskhelp				0.923					
fCLexplain				0.939					
fCLstudy				0.752					
fCLproject				0.582					
fLSreading									
fLSnotes				0.425					
fLSsummary									
fETgoals					0.643				
fETorganize					0.731				
fETexample					0.628				
fETvariety					0.504				
fETreview					0.605				
fETstandards					0.561				
fETdraftfb					0.411				
fETfeedback					0.604				
fQIstudent						0.560			
fQIadvisor						0.784			
fQIfaculty						0.758			
fQIstaff						0.812			
fQIadmin						0.791			
fQRconclude							0.808		
fQRproblem							0.910		
fQRevaluate							0.840		
fSFcareer								0.742	
fSFotherwork								0.667	
fSFdiscuss								0.722	
fSFperform								0.543	
fHOapply							0.429		
fHOanalyze	0.407								0.621
fHOevaluate	0.664								0.479
fHOform	0.565								0.472

Extraction Method: Principal Factor Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Table 3. Exploratory Factor Analysis Pattern Matrix (Lower Division)

	Component									Uniqueness
	1	2	3	4	5	6	7	8	9	
fRIintegrate	0.543									0.566
fRIsocietal	0.821									0.249
fRIdiverse	0.874									0.166
fRIownview	0.862									0.228
fRIperspect	0.903									0.136
fRInewview	0.764									0.384
fRIconnect	0.690									0.449
fSEacademic		0.690								0.440
fSElearnsup		0.632								0.488
fSEdiverse		0.646								0.421
fSEsocial		0.716								0.404
fSEwellness		0.761								0.361
fSEnonacad		0.661								0.494
fSEactivit~s		0.678								0.447
fSEevents		0.641								0.406
fDDrace			0.883							0.171
fDDeconomic			0.906							0.117
fDDreligion			0.912							0.125
fDDpolitical			0.887							0.147
fCLaskhelp				0.923						0.112
fCLexplain				0.939						0.087
fCLstudy				0.752						0.351
fCLproject				0.582						0.549
fLSreading										0.524
fLSnotes				0.425						0.587
fLSsummary				0.413						0.528
fETgoals					0.643					0.522
fETorganize					0.731					0.437
fETexample					0.628					0.543
fETvariety					0.504					0.555
fETreview					0.605					0.557
fETstandards					0.561					0.564
fETdraftfb					0.411					0.626
fETfeedback					0.604					0.594
fQIstudent						0.560				0.677
fQIadvisor						0.784				0.378
fQIfaculty						0.758				0.406
fQIstaff						0.812				0.332
fQIadmin						0.791				0.357
fQRconclude							0.808			0.301
fQRproblem							0.910			0.135
fQRevaluate							0.840			0.212
fSFcareer								0.742		0.390
fSFotherwork								0.667		0.521
fSFdiscuss								0.722		0.405
fSFperform								0.543		0.535
fHOapply						0.429				0.637
fHOanalyze	0.407								0.621	0.366
fHOevaluate	0.664								0.479	0.263
fHOform	0.565								0.472	0.411

Extraction Method: Principal Factor Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Table 4. Exploratory Factor Analysis Structure Matrix (Upper Division)

	Component								
	1	2	3	4	5	6	7	8	9
fRIintegrate	0.483								
fRIsocietal	0.780								
fRIdiverse	0.856								
fRIownview	0.842								
fRIperspect	0.881								
fRInewview	0.747								
fRIconnect	0.660								
fSEacademic		0.656							
fSElearnsup		0.624							
fSEdiverse		0.654							
fSEsocial		0.737							
fSEwellness		0.780							
fSEnonacad		0.665							
fSEactivit~s		0.667							
fSEevents		0.644							
fDDrace			0.889						
fDDeconomic			0.915						
fDDreligion			0.910						
fDDpolitical			0.868						
fCLaskhelp				0.825					
fCLexplain				0.843					
fCLstudy				0.760					
fCLproject				0.577					
fLSreading				0.410					
fLSnotes				0.474					
fLSsummary				0.498					
fETgoals					0.655				
fETorganize					0.741				
fETexample					0.608				
fETvariety					0.479				
fETreview					0.563				
fETstandards					0.578				
fETdraftfb					0.421				
fETfeedback					0.586				
fQIstudent						0.604			
fQIadvisor						0.790			
fQIfaculty						0.763			
fQIstaff						0.828			
fQIadmin						0.794			
fQRconclude							0.781		
fQRproblem							0.900		
fQRevaluate							0.826		
fSFcareer								0.696	
fSFotherwork								0.641	
fSFdiscuss								0.735	
fSFperform								0.556	
fHOapply									
fHOanalyze									0.601
fHOevaluate	0.572								0.535
fHOform	0.504								0.473

Extraction Method: Principal Factor Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Table 5. Exploratory Factor Analysis Pattern Matrix (Upper Division)

	Component									Uniqueness
	1	2	3	4	5	6	7	8	9	
fRIintegrate	0.483									0.593
fRIsocietal	0.780									0.312
fRIdiverse	0.856									0.191
fRIownview	0.842									0.241
fRIperspect	0.881									0.174
fRInewview	0.747									0.400
fRIconnect	0.660									0.490
fSEacademic		0.656								0.500
fSElearnsup		0.624								0.518
fSEdiverse		0.654								0.442
fSEsocial		0.737								0.389
fSEwellness		0.780								0.329
fSEnonacad		0.665								0.505
fSEactivit~s		0.667								0.493
fSEevents		0.644								0.429
fDDrace			0.889							0.171
fDDeconomic			0.915							0.121
fDDreligion			0.910							0.142
fDDpolitical			0.868							0.204
fCLaskhelp				0.825						0.282
fCLexplain				0.843						0.254
fCLstudy				0.760						0.343
fCLproject				0.577						0.573
fLSreading				0.410						0.554
fLSnotes				0.474						0.508
fLSsummary				0.498						0.443
fETgoals					0.655					0.504
fETorganize					0.741					0.442
fETexample					0.608					0.529
fETvariety					0.479					0.569
fETreview					0.563					0.579
fETstandards					0.578					0.539
fETdraftfb					0.421					0.679
fETfeedback					0.586					0.612
fQIstudent						0.604				0.619
fQIadvisor						0.790				0.367
fQIfaculty						0.763				0.391
fQIstaff						0.828				0.307
fQIadmin						0.794				0.354
fQRconclude							0.781			0.346
fQRproblem							0.900			0.154
fQRevaluate							0.826			0.245
fSFcareer								0.696		0.414
fSFotherwork								0.641		0.536
fSFdiscuss								0.735		0.382
fSFperform								0.556		0.524
fHOapply										0.687
fHOanalyze									0.601	0.416
fHOevaluate	0.572								0.535	0.319
fHOform	0.504								0.473	0.459

Extraction Method: Principal F Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Results: Confirmatory Factor Analysis

We ran CFA models for each of the four themes organizing the 10 scales: Academic Challenge, Learning with Peers, Experiences with Faculty, and Campus Environment. Although the EFA above found that the Collaborative Learning and Learning Strategies loaded on the same factor, we maintained separate factors for the purposes of maintaining comparability with NSSE results. As noted above, we used an iterative process in identifying the final CFA model (see the appendix for details on the models). This involved running the models without any correlations among the error terms. We then added correlations on items that we believed were correlated and showed possible improvements of fit. Thereafter, we estimated the model with a separate sample to ensure the model was not sample driven. Given that FSSE was developed as a companion to NSSE and thus uses its structure, it should be expected that a more complex structure is necessary to achieve good fit.

We assessed fit with criteria commonly used across CFA studies: 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). The typical cutoff criteria suggesting the model fits the observed data well are GFI > .95, CFI>.95, RMSEA < .06 and PCLOSE >.05; alternatively, poor fit would be GFI < .85, CFI < .85, and RMSEA > .08 (Hu & Bentler, 1999). The CMIN/df ratio should be between 2 and 5 (Marsh & Hocevar, 1985); however, this measure is strongly influenced by the sample size and thus may not be a meaningful measure of fit in our study. Similarly, the pclose is simply a hypothesis test of whether RMSEA falls below 0.05, and thus we do not pay too close attention to that measure (Kenny, 2014).

Based on these criteria, Table 6 suggests moderate to good fit across the divisions and the different scales. We highlight in maroon those criteria that fall outside of the range of the cutoff values. As might be expected from the strong EFA loadings for the associated subscales, Learning with Peers and Campus Environment have strong fit between model and data. The only scale that has a number of questionable indices is Academic Challenge for the lower division.

Table 6. Summary of Fit Indices for Confirmatory Factor Analysis

	Upper Division					Lower Division				
	CMIN/ df	GFI	CFI	RMSEA	PCLOS E	CMIN/ df	GFI	CFI	RMSEA	PCLOS E
Academic Challenge	9.75	.95	.95	.06	.00	9.79	.92	.94	.07	.00
Learning With Peers	3.51	.995	.997	.03	.999	1.79	.996	.999	.02	1.00
Experiences with Faculty	9.80	.97	.94	.06	.004	6.25	.97	.95	.05	.09
Campus Environment	4.62	.98	.98	.04	1.00	3.72	.98	.98	.04	.998

Finally, Table 7 presents the standardized regression weights from the confirmatory factor analysis. Standardized regression weights indicate the strength of the factor loadings. The standardized regression weights showed good strength of factor loadings (i.e. > 0.40, see Kline, 2002) for all scales for both lower-division faculty and upper-division faculty except for the item (fHOapply) "*Applying facts, theories, or methods to practical problems or new situations*" in the High-order Learning scale. Overall,

the fit indices, factor correlations, and regression weights suggest good subscales in the FSSE survey. For researchers interested in using strong measures for advanced statistical methods, special attention should be given to the Higher-Order Learning scale, particularly the item fHOapply, and the relationship between Collaborative Learning and Learning Strategies in the particular researcher's data set to see if adjustments to the scales need to be made. The current measures, however, are well suited for more conceptually based studies or examinations of FSSE, or NSSE and FSSE, results for assessment and improvement purposes. See figures of the path models in the Appendix.

Table 7. Standardized Regression Weights

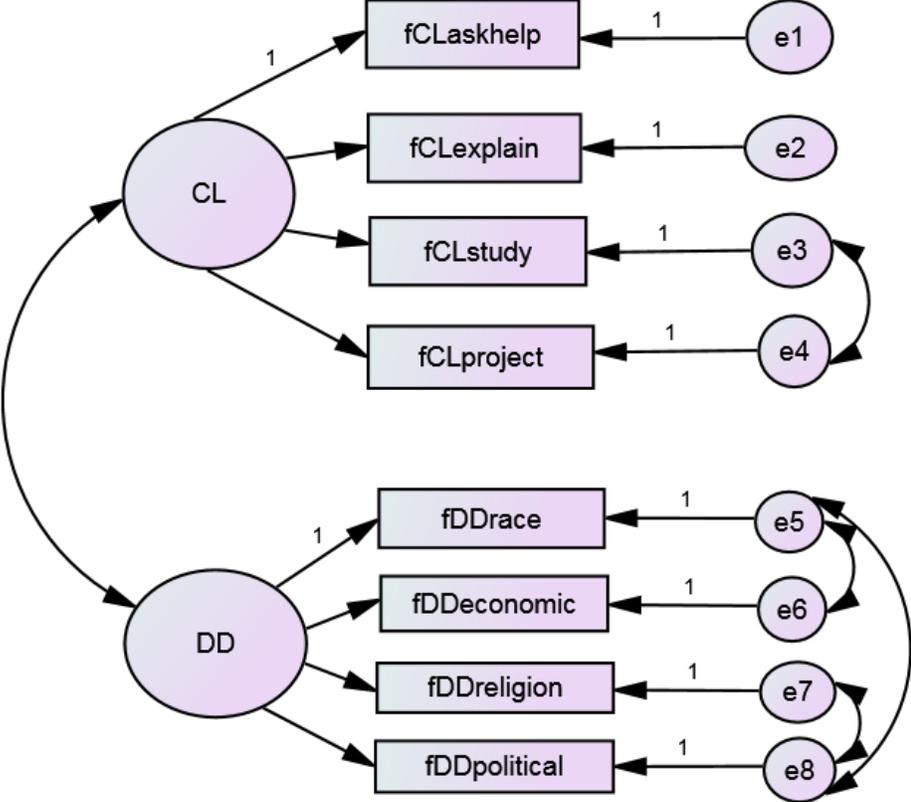|			Upper Division	Lower Division
Academic Challenge	Higher-Order Learning	fHOapply	0.239	0.202
		fHOanalyze	0.598	0.636
		fHOevaluate	0.859	0.889
		fHOform	0.708	0.683
	Reflective & Integrative Learning	fRIintegrate	0.417	0.512
		fRIsocietal	0.719	0.792
		fRIdiverse	0.739	0.788
		fRIownview	0.825	0.872
		fRIperspect	0.820	0.830
		fRInewview	0.662	0.627
		fRIconnect	0.505	0.540
	Quantitative Reasoning	fQRconclude	0.753	0.769
		fQRproblem	0.908	0.916
		fQRevaluate	0.867	0.856
	Learning Strategies	fLSreading	0.796	0.863
		fLSnotes	0.568	0.457
		fLSsummary	0.678	0.568
Learning with Peers	Collaborative Learning	fCLaskhelp	0.847	0.878
		fCLexplain	0.892	0.896
		fCLstudy	0.674	0.693
		fCLproject	0.532	0.585
	Discussions with Diverse Others	fDDrace	0.891	0.982
		fDDeconomic	0.946	1.022
		fDDreligion	0.841	0.772
		fDDpolitical	0.821	0.753
Experiences with Faculty	Student-Faculty Interaction	fSFcareer	0.708	0.763
		fSFotherwork	0.655	0.654
		fSFdiscuss	0.745	0.738
		fSFperform	0.694	0.681
	Effective Teaching Practices	fETreview	0.642	0.650
		fETstandards	0.609	0.601
		fETdraftfb	0.489	0.515
		fETfeedback	0.437	0.483
		fETgoals	0.506	0.551
		fETorganize	0.418	0.444
		fETexample	0.459	0.508
		fETvariety	0.598	0.612
Campus Environment	Quality of Interactions	fQIstudent	0.589	0.572
		fQIadvisor	0.830	0.784
		fQIfaculty	0.770	0.779
		fQIstaff	0.704	0.713
		fQIadmin	0.653	0.658
	Supportive Environment	fSEacademic	0.521	0.518
		fSElearnsup	0.515	0.492
		fSEdiverse	0.658	0.641
		fSEsocial	0.778	0.732
		fSEwellness	0.800	0.785
		fSEnonacad	0.674	0.719
		fSEactivities	0.636	0.610
		fSEevents	0.582	0.622

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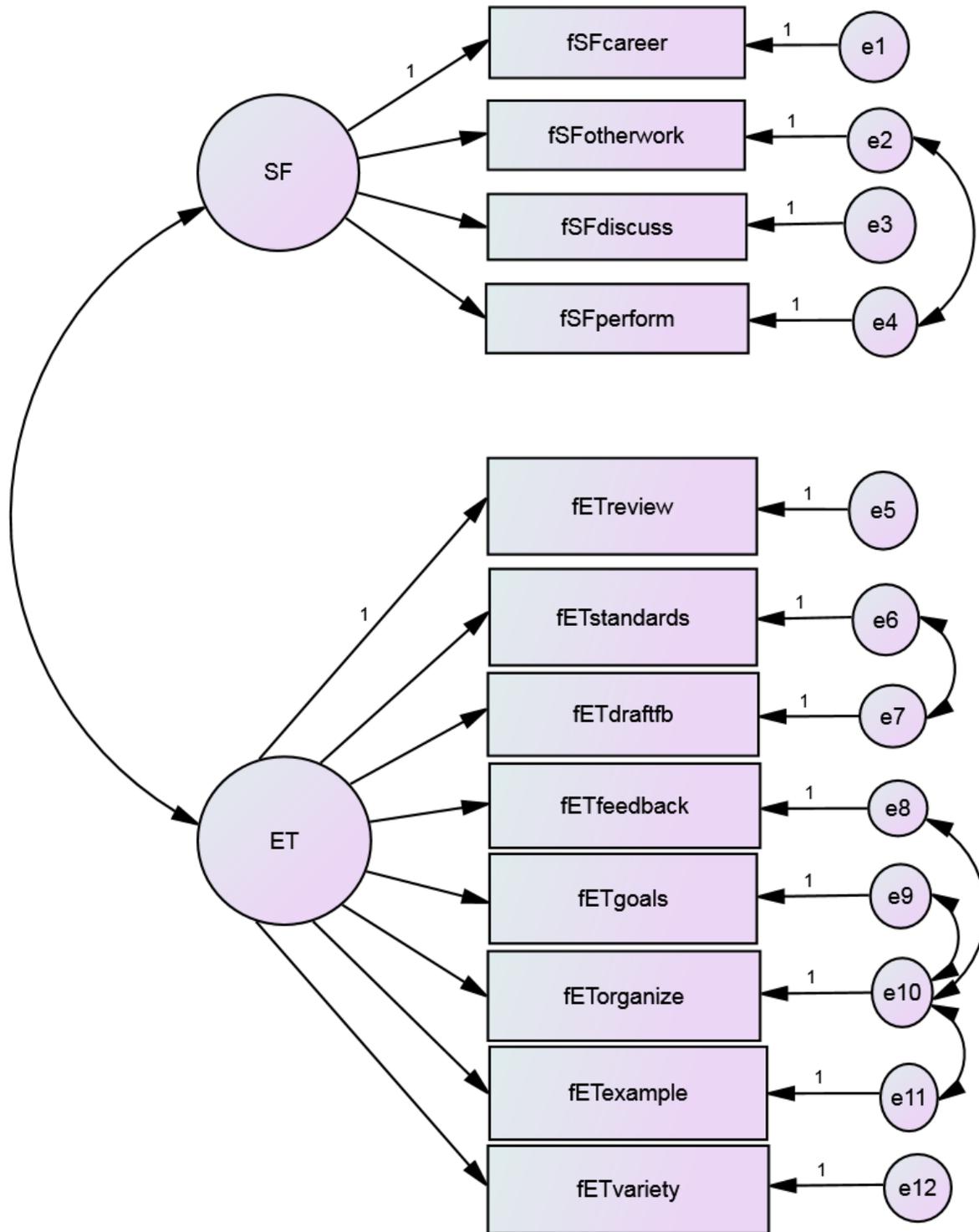
Academic Challenge (Upper and Lower Division)
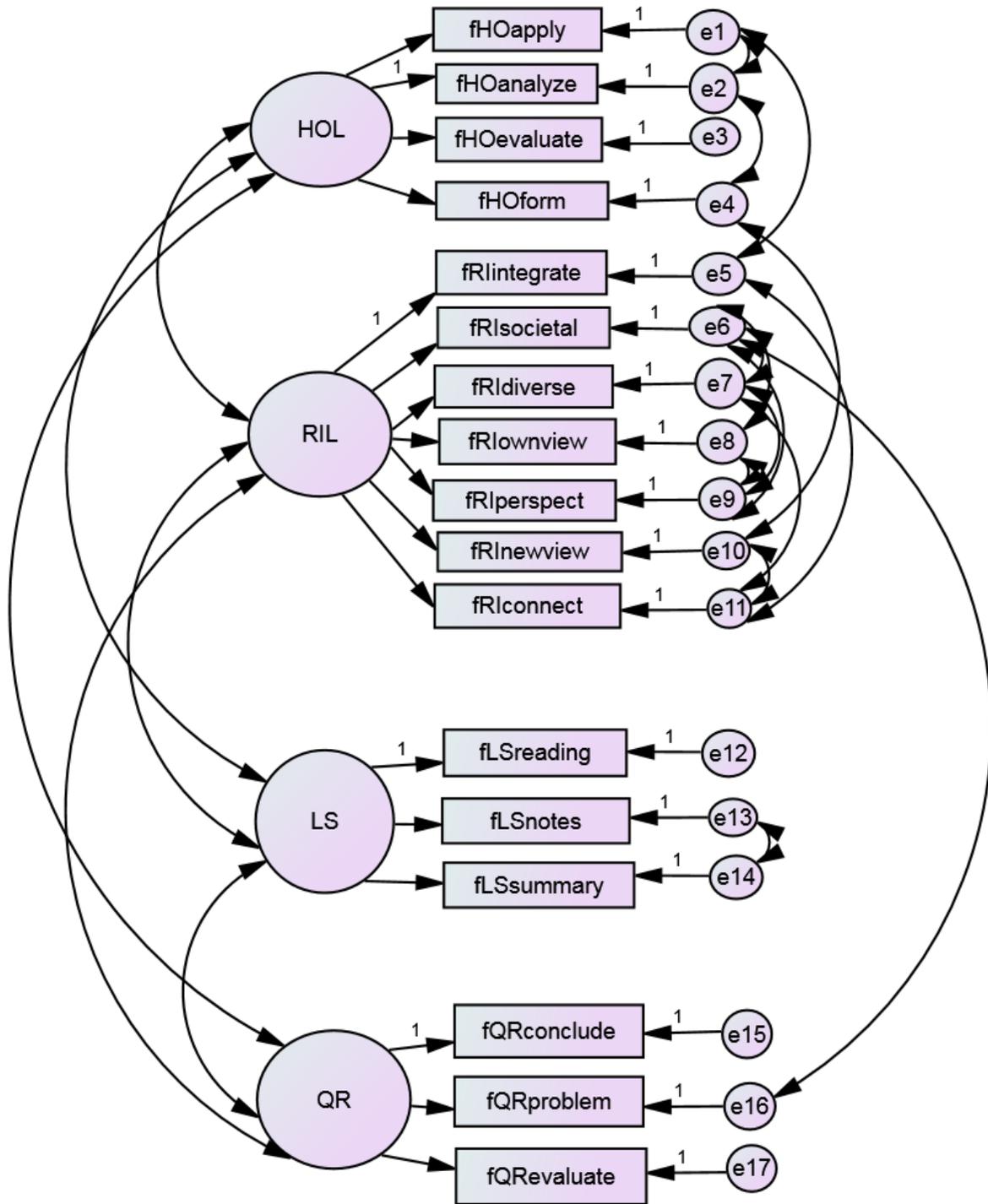
Learning with Peers (Upper and Lower Division)

Experiences with Faculty (Upper and Lower Division)

Campus Environment (Upper and Lower Division)