

Running Head: Canonical Correlation Analysis

Using Canonical Correlation Analysis to Examine Student Engagement and Learning

John Zilvinskis
Center for Postsecondary Research
Indiana University School of Education
1900 E. Tenth Street
Eigenmann Hall, Suite 419
Bloomington, IN 47406-7512

Anthony Masseria
Robert H McKinney School of Law
Indiana University-Purdue University-Indianapolis
530 W. New York Street
Indianapolis, IN 46202

Gary R. Pike
Higher Education and Student Affairs
Indiana University School of Education-Indianapolis
902 W. New York Street, ES3116
Indianapolis, IN 46202

Paper presented at the Annual Forum of the Association for Institutional Research, Denver, CO,
May 2015.

Using canonical correlation analysis this study examined the relationships between student engagement, represented by two versions of the National Survey of Student Engagement (NSSE), and self-reported gains in learning. The study drew on institutional-level data from NSSE participants in 2011 and 2013. The goal of the analyses was to compare evidence of convergence and discrimination for the two versions of NSSE. Results indicated that both versions of NSSE provided clear evidence of convergence in that student engagement measures were significantly and positively related to perceived gains in learning. However, only the most recent version of NSSE provided strong evidence of discrimination (i.e., differential relationships between engagement measures and self-reported learning outcomes).

Using Canonical Correlation Analysis to Examine Student Engagement and Learning

Student engagement occupies a prominent place in the higher education lexicon, representing both an accountability measure that provides an index of institutional quality and effectiveness and a variable in educational research that can be used to explain student learning and development (Axelson & Flick, 2011). A survey of chief academic officers by the National Institute for Learning Outcomes Assessment (NILOA) revealed that 76% of the responding institutions used student engagement and satisfaction surveys to assess student learning outcomes (Kuh & Ikenberry, 2009). The National Survey of Student Engagement's (NSSE) questionnaire, *The College Student Report*, is among the most popular surveys of student engagement, having been used by more than 1,500 four-year colleges and universities since 2000 (National Survey of Student Engagement, 2014a).

Several studies have documented the reliability and validity of using NSSE scores for institution- and group-level assessment and research (Kuh, 2001; Kuh et al., 2001; Kuh, Kinzie, Cruce, Shoup, & Gonyea, 2007; Ouimet, Bunage, Carini, Kuh, & Kennedy, 2004; Pascarella, Seifert, & Blaich, 2009; Pike, 2006a, 2006b, 2013b). In addition, a variety of institutions have reported using NSSE data to make substantial improvements in student engagement and learning outcomes (Banta, Pike, & Hansen, 2009; Kuh, 2005; National Survey of Student Engagement, 2009).

Given the popularity and success of the original NSSE instrument, it was somewhat surprising that the survey's developers would introduce a new version of NSSE in 2013. The new NSSE was intended to be an improved version of the original instrument, with new and refined content, new engagement indicators, and optional modules on focused topics

(McCormick, 2013; McCormick, Gonyea, & Kinzie, 2013). Paul Lingenfelter (2013), former president of the State Higher Education Executive Officers Association, also noted that the new NSSE survey has the potential to be an essential tool for identifying cost-effective methods of improving student learning and degree attainment. To realize that potential, the new NSSE must demonstrate strong, positive relationships with student learning outcomes and be capable of identifying how different types of engagement are associated with different learning outcomes (Banta & Pike, 1989). The present research examined the relationships between self-reports of learning and student engagement measures from both the old and new NSSE surveys. More specifically, this study focuses on the relationships between student engagement and learning (i.e., convergence) and the ability of the engagement measures to differentiate among learning outcomes (i.e., discrimination).

Background

The NSSE Surveys

The origins of student engagement can be found in the work of Ralph Tyler (1932), C. Robert Pace (1980, 1984), Alexander Astin (1984), Chickering and Gamson (1987), and Kuh, Schuh, Whitt, and Associates (1991). The warrant for examining student engagement is based on two premises: (1) student learning and success are related to the amount of time and energy students devote to educational activities, and (2) institutions can influence the extent to which students engage in educationally purposeful activities (Kuh, 2003, 2006). NSSE was developed to collect data from first-year and senior students about their levels of engagement and perceptions of institutional policies in order to document effective education practices and identify opportunities to improve undergraduate education (Kuh, 2001, 2009; Kuh et al., 2001).

In 2000, NSSE pilot tested the survey and made it publicly available the following year. The original survey featured five benchmarks of effective educational practice—level of academic challenge, active and collaborative learning, student-faculty interaction, enriching educational experiences, and supportive campus environment (National Survey of Student Engagement, 2001). The benchmarks were intended for use at the institution level to identify effective educational practices and encourage conversations about improving undergraduate education (Kuh, 2001; Kuh et al., 2001; National Survey of Student Engagement, 2001).

Pike (2006a, 2006b) proposed refining the original NSSE benchmarks by using scalelets to measure student engagement. Drawing on the work of Wainer and Kiley (1987), Pike identified 12 clusters of survey items that could be used to assess levels of engagement for groups of students. Pike (2006a, 2006b) found that the NSSE scalelets produced very dependable measures of engagement and were differentially related to self-reports of student learning outcomes; most important, the results were consistent with student development theory.

The new version of the NSSE survey grew out of feedback from participating institutions, research on the survey, and recognition that the terminology of the original questionnaire needed to be updated (Pike, 2013a). In the revised questionnaire, approximately one-quarter of the items remained unchanged, one-quarter of the items were rewritten with minor changes in wording, one quarter of the items were rewritten with major changes in wording, and one-quarter of the items were new (Pike, 2013a). The new NSSE reports scores for 4 engagement themes—academic challenge, learning with peers, experiences with faculty, and the campus environment—and 10 engagement indicators—higher-order thinking, reflective and integrative learning, learning strategies, quantitative reasoning, collaborative learning, discussions with diverse peers, student-faculty interaction, effective teaching practices, quality of interactions, and

supportive environment (National Survey of Student Engagement, 2014a). Because the engagement themes and indicators are new, relatively few published studies on the reliability and validity of the measures are available.

Evaluating Survey Instruments

The framework used to evaluate the two versions of the NSSE survey is based on the work of Messick (1989), Kane (2006), and the *Standards of Educational and Psychological Testing* (American Educational Research Association, American Psychological Association, & National Council for Measurement in Education, 2014). According to these authors, judgements about surveys and other assessment instruments should focus on how data are to be interpreted and used. If, as previously noted, the NSSE surveys are intended to identify effective educational practices and enhance undergraduate education, it is reasonable to expect that the engagement measures will be related to student learning and academic success.

Banta and Pike (1989) argued that evaluating assessment instruments should focus on the convergence and discrimination of the measures. The concepts of converge and discrimination have their origins in the work of Campbell and Fiske (Campbell, 1960; Campbell & Fiske, 1959; Fiske, 1982) and have been used to evaluate standardized tests of college student learning (Banta & Pike, 1989; Pike, 1989, 1992), as well as a variety of self-report measures (Brackett & Mayer, 2003; Pike, 2006a; Ward, Fisher, Lam, & Hall, 2008). In the context of the current study, engagement measures should be positively related to (i.e., converge with) measures of student learning. In addition, the engagement measures should discriminate among learning outcomes. That is, scores for some engagement measures should be associated with a set of learning outcomes, whereas scores for other engagement measures should be associated with different sets of learning outcomes.

Previous research has provided consistent evidence of convergence and discrimination for measures of student engagement. Studies have reported that engagement measures were positively related to both standardized test scores and students' self-reports of their learning (Gellin, 2003; Kuh, Hu, & Vesper, 2000; Pascarella, Seifert, & Blaich, 2009; Pascarella et al., 1996; Pike, 1995, 2006a; Pike, Kuh, & Gonyea, 2003). In addition, different types of engagement have been found to be differentially related to measures of student learning (Pascarella, Seifert, & Blaich, 2009; Pike, 1995, 2006a; Pike, Smart, & Ethington, 2012).

Pike's (2006a) study of the convergent and discriminant validity of NSSE scalelets demonstrates how convergence and discrimination can be used to compare two assessment measures. Using data from the 2004 administration of NSSE, Pike compared the relationships between two learning outcome scales and both the NSSE benchmarks and the 12 NSSE scalelets. He found that both the benchmarks and the scalelets were significantly related to both outcome measures, although the relationships between the scalelets and learning outcomes were somewhat stronger. These significant positive relationships provided evidence of convergence. Providing evidence of discrimination, the relationships between learning outcomes and the two sets of engagement measures were more nuanced for scalelet scores. For example, results indicated that the NSSE academic challenge benchmark was not related to gains in practical skills. However, the three scalelets derived from the academic challenge benchmark were differentially related to gains in practical skills. Course challenge was not related to gains in practical skills, but higher order thinking was positively and significantly related to gains in practical skills. In contrast, writing experiences was negatively related to gains in practical skills. The more nuanced relationships found for the scalelet scores led Pike (2006a) to conclude that the NSSE scalelets evidenced greater discrimination than the NSSE benchmarks.

Using Pike's (2006a) research as a model, two questions guided the current study:

- (1) To what extent do the engagement measures from the original and new NSSE surveys converge with self-reports of student learning?
- (2) To what extent are the engagement measures from the original and new NSSE surveys differentially related to self-reports of student learning?

Research Methods

Data Source

The data for this study were based on first-year students' responses to the 2011 (original) and 2013 (new) administrations of NSSE. In 2011, slightly more than 185,000 first-year students participated in the survey, and in 2013 more than 135,000 first-year students participated in the survey. Because institutions were the units of analysis in the study, first-year students' scores were aggregated at the institution level. For both administrations, institutions with fewer than 50 first-year students were dropped from the analyses. In addition, preliminary screening identified two institutions in 2011 and three institutions in 2013 that had extreme values for one or more engagement measures. These institutions were dropped from the study.

The final sample for 2011 consisted of 573 institutions. Of this total, 253 (44%) were public colleges and universities and 320 (56%) were private institutions. Approximately 21% of the institutions were research universities, 44% were Master's colleges and universities, and 35% were baccalaureate colleges. The final sample of institutions for 2013 consisted of 456 institutions. Of the total, 195 (43%) were public colleges and universities and 261 (57%) were private institutions. Slightly more than 23% of the participating institutions were research universities, 46% were Master's colleges and universities, and 31% were baccalaureate colleges.

Measures

For the analysis of data from the 2011 NSSE administration, the student engagement measures consisted of 9 of the 12 scalelets developed by Pike (2006a, 2006b). The three scalelets largely based on the enriching educational experiences benchmark were not included because the new version of NSSE does not include an engagement theme that parallels the enriching educational experience benchmark. The nine scalelets and items comprising the scalelets are listed in the appendix. Pike (2006b) reported that all of the scalelets produced acceptable (0.70 or greater) levels of reliability when institutional means are based on 50 or more students. The 10 engagement indicators from the new NSSE survey were used as the engagement measures for analyzing the 2013 data. The engagement indicators and associated survey items are also presented in the appendix. NSSE staff report that the alpha reliability coefficients for 9 of the 10 engagement indicators exceed 0.80 for first-year students. Alpha reliability for the remaining engagement indicator exceeded 0.75 (National Survey of Student Engagement, 2014b).

The outcome measures for the study were derived from 10 learning gains questions common to both versions of the NSSE survey. Preliminary factor analysis identified two, correlated outcome dimensions. The first factor consisted of six items and represents academic and interpersonal gains. The second factor consists of four items and represents gains in application skills. The questions comprising the two outcome scales are presented in the appendix. Alpha reliability coefficients for the 2011 NSSE administration were 0.86 for academic and interpersonal gains and 0.86 for application gains. For the 2013 NSSE administration, alpha reliability coefficients for academic and interpersonal gains and for application gains were 0.88 and 0.79, respectively.

Data Analysis

The relationships between engagement and outcome measures for both the 2011 and 2013 NSSE administrations were analyzed using canonical correlation analysis. Originally developed by Hotelling (1936), canonical correlation analysis is appropriate when examining the relationships between two sets of measures, and the measures within sets are themselves correlated (Sherry & Henson, 2005). An important advantage of canonical correlation analysis over multiple regression is that canonical correlation analysis reduces the likelihood of Type I errors (Thompson, 1991).

Because it is a multivariate procedure, canonical correlation analysis forms functions consisting of weighted linear combinations (i.e., variates) of the independent and dependent variables. A typical canonical function is represented by the equation:

$$a_1Y_{1i} + a_2Y_{2i} + \cdots + a_pY_{pi} = b_1X_{1i} + b_2X_{2i} + \cdots + b_mX_{mi} \quad [1]$$

Where Y_{pi} represents an unspecified dependent variable in the Y-variate, and a_p represents the weight for that variable. X_{mi} represents an unspecified independent variable in the X-variate, and b_m represents the weight for that variable. The correlation between the Y and X variates is referred to as the canonical correlation.

Weights are selected so as to maximize the canonical correlation between the variate representing the dependent variables and the variate representing the independent variables. The number of possible canonical functions is always equal to the number of dependent or independent variables, whichever is less (Sherry & Henson, 2005). It is important to understand that these canonical functions are statistically independent (i.e., uncorrelated) with one another (Thompson, 1984). Multivariate tests (e.g., Wilks lambda) can be used to assess the significance of the relationships between canonical variates (i.e., the canonical correlations), and the squared canonical correlation is analogous to the R^2 coefficient in multiple regression (Sherry & Henson,

2005). Raw and standardized (regression) coefficients, as well as structure coefficients (i.e., correlations between the variables and their variates), can be calculated and used to interpret the variates (Thompson, 1991).

Three additional measures—adequacy, communality, and redundancy—are useful in assessing whether all of the variables in the analysis contribute to their variates (Thompson, 1991). The adequacy coefficient is the average of the squared structure coefficients for a given variate and provides an indication of the extent to which variables contribute to their respective variates (Thompson, 1984). Communality coefficients, like communality coefficients in principal components analysis, are the sum of a variable's squared structure coefficients over all variates and represent the proportions of the variance in the variables that are “explained” by the variates (Thompson, 1991). Redundancy coefficients provide an indication of whether significant canonical correlations are the product of an extremely large correlation between one or two dependent and independent variables, or whether the canonical correlation represent the relationship between all of the dependent and independent variables (Wollenberg, 1977). Because redundancy coefficients are not symmetrical, Thompson (1984) recommends they be limited to the explanation of the dependent variables by the independent variates.

In the present research, engagement measures were considered to be independent variables and learning outcome measures were considered to be dependent variables. Separate analyses were conducted using the NSSE 2011 and 2013 data. Because each dataset included two learning outcome measures, two canonical functions were analyzed for each dataset. Initially, Wilks lambda was used to determine whether the canonical correlations were statistically significant. Next, standardized canonical coefficients and structure coefficients were used to describe the variates that produced statistically significant canonical correlations. Finally, adequacy

coefficients, communalities, and redundancy coefficients were examined to determine whether the canonical variates adequately represented all of the engagement and learning outcome variables. A comparison of results across the two datasets provided an indication of whether the new version of NSSE represents an improvement over the original survey.

Results

NSSE 2011

The canonical correlation analysis indicated that the canonical correlations for both canonical functions were statistically significant. The first function produce a canonical correlation of 0.79 (Wilks lambda = 0.23; $F = 67.97$; $df = 18,1124$; $p < 0.001$), and the second function produced a canonical correlation of 0.32 (Wilks lambda = 0.70; $F = 30.65$; $df = 8,563$; $p < 0.01$). Table 1 presents the standardized canonical coefficients and structure coefficients for the dependent and independent variables. Also included in the table are the communality coefficients for the variables and the adequacy and redundancy coefficients for the variates. In keeping with Thompson's recommendation, only redundancy coefficients representing the extent to which the independent variables explain the dependent (learning outcome) variables are reported.

Insert Table 1 about here

An examination of the standardized canonical coefficients and the structure coefficients for the first variate representing the learning outcome measures revealed that both academic and interpersonal gains and gains in application were positively related to the variate. The structure coefficients for the first student engagement variate indicated that all of the NSSE scalelets were

positively correlated with the variate. The standardized canonical coefficients, representing the unique relationships between the NSSE scalelets and the variate, indicated that support for student success and to a lesser extent course challenge contributed most to the first student engagement variate. Given the strong positive correlation between student engagement and learning gains, the first canonical function appeared to indicate that learning gains in general were positively related to general student engagement.

An examination of the standardized and structure coefficients for the second learning outcomes variate revealed a bipolar dimension in which gains in application was positive and distant from academic and interpersonal gains. Standardized and structure coefficients for the second engagement variate also revealed what appeared to be a bipolar dimensions in which collaborative learning was positive and distant from writing experiences and in-class interaction with faculty members. The standardized canonical coefficients also seemed to indicate that course challenge was positive and distant from support for student success. However, this last finding appeared to be an artifact of linear dependencies among the engagement measures, given that course challenge and support for student success were only weakly correlated with the engagement variate. Given the significant positive correlation between the two variates, it appeared that, above and beyond the general positive relationship between student engagement and learning gains, collaborative learning was positively related to gains in application, but negatively related to academic and interpersonal gains. Conversely, writing experiences and interacting with faculty in class were negatively related to gains in application, but positively related to academic and interpersonal gains.

An examination of the communalities for the learning outcome measures revealed that the two variates were able to account for all of the variance in the dependent variables. This is

always the case when the number of dependent variables is equal to the number of statistically significant canonical functions. Communality coefficients for the student engagement measures were generally between 0.35 and 0.65, with the communalities for in-class interactions with faculty members and support for student success being substantially higher. Adequacy coefficients for the learning gains variates were 0.79 and 0.21, respectively, whereas the corresponding adequacy coefficients for the student engagement variates were 0.46 and 0.02, respectively. The low adequacy coefficient for the second student engagement variate indicated that relatively few student engagement measures contributed to the variate. The redundancy coefficient representing the strength of the relationships between the first engagement variate and the learning outcomes measures was substantial (0.49). However, the redundancy coefficient for the second student engagement variate and the learning outcomes measures was only 0.02. This low redundancy coefficient indicated that the second engagement variate provided a relatively poor explanation of the learning outcome measures.

NSSE 2013

Canonical correlation analysis of the 2013 NSSE data also produced two statistically significant canonical correlations. The canonical correlation for the first function was 0.83 (Wilks lambda = 0.14; $F = 72.22$; $df = 20.888$; $p < 0.001$), and the canonical correlation for the second function was 0.74 (Wilks lambda = 0.46; $F = 58.03$; $df = 9,445$; $p = 0.001$). Table 2 displays the standardized canonical coefficients and the structure coefficients for the learning outcome measures and the student engagement indicators for both functions. Also included in Table 2 are the adequacy coefficients, communalities, and redundancy coefficients for the variables and variates.

Insert Table 2 about here

The standardized and structure coefficients for the learning outcomes measures revealed that for the first variate academic and interpersonal gains was positive and distant from gains in application. However, this was not a bipolar dimension because gains in application had a modest positive correlation with the first variate. An examination of the structure coefficients for the first engagement indicator variate revealed that 7 of the 10 engagement indicators had substantial positive correlations with the variate. Quantitative reasoning and collaborative learning were not correlated with the variate, and discussions with diverse others was only moderately correlated with the variate. Reflective and integrative learning had the largest correlation with the first engagement variate and also made the largest unique contribution to the variate as shown by its large positive standardized canonical coefficient. Taken together these results suggested that the first canonical function represented the positive relationship between academic and interpersonal gains and academic engagement (higher-order learning, reflective and integrative learning, and learning strategies), experiences with faculty (student-faculty interaction and effective teaching practices), and the campus environment (quality of interaction and supportive environment).

The standardized canonical coefficients and structure coefficients for the second learning outcomes variate revealed an outcomes dimension in which gains in application were positive and distant from academic and interpersonal gains. Once again, this was not a bipolar dimension because academic and personal gains had a modest positive correlation with the second learning outcomes variate. The standardized and structure coefficients for the second engagement indicator variate was strongly aligned with quantitative reasoning and collaborative learning.

Other engagement indicators, including learning strategies, student-faculty interaction, effective teaching, quality of interactions, and supportive environment had modest positive correlations with the variate. Taken together, these results suggested that gains in application were positively and strongly correlated with engagement related to quantitative reasoning and collaborative learning. In addition experiences with faculty and the campus environment were positively related to application gains.

Because the number of learning outcome scales was equal to the number of statistically significant canonical functions, the communalities for the gains in learning scales were 1.00. Communalities for the engagement indicators were comparable to the communalities for the scalelets from NSSE 2011. The exception was the discussion with diverse others indicator, which was weakly associated with the two engagement variables. Adequacy coefficients for both learning outcome variates were substantial, and the adequacy coefficients for the student engagement indicators were also quite respectable. Although the redundancy coefficient for the first learning outcomes variate was lower than its counterpart from NSSE 2011, the redundancy coefficient for the second learning outcomes variate was substantially higher than its counterpart for the 2013 administration of NSSE.

Limitations

Care should be taken not to over-generalize these results. Perhaps the most serious limitation of this study is that different sets of institutions participated in the 2011 and 2013 administrations of NSSE. Although the characteristics of the two sets of institutions were similar, it is possible that institutional differences may have contributed to some of the differences observed in this study. Had the same set of institutions participated in NSSE 2011 and NSSE 2013, results may have differed in unknown ways. In both 2011 and 2013, approximately 40% of the students who

were invited to participate in the surveys actually did so. It is possible, but beyond the scope of this research to ascertain whether nonresponse bias may have influenced the results of the study.

Items included in the NSSE surveys represent a sample from the universe of all possible questions about student engagement that could be asked. Had different sets of questions been included in the 2011 and 2013 questionnaires, results for each year may have differed in unknown ways. This is particularly true with respect to the questions about student learning outcomes. The academic/interpersonal outcomes and application outcomes scales represent a very limited sample of possible learning outcomes that could be related to student engagement. Clearly, more research is needed before making definite conclusions about the superiority of the new NSSE survey. Some authors have questioned the validity of self-report measures of student learning (Bowman, 2011; Bowman & Hill, 2011; Herzog, 2011; Porter, 2011), while others (Gonyea & Miller, 2011; Pike, 2011; Pike, Smart, & Ethington, 2012) have argued that self-report measures can provide adequate and appropriate data on student learning. At a minimum, comparing self-reports of learning to self-reports of engagement represents a less rigorous test of convergence and discrimination than if self-reports of student engagement were compared to objective measures, such as scores on standardized achievement tests (Messick, 1989).

Discussion

Despite these limitations, the findings of the present research have important implications for educational assessment and research. First and foremost, the results of this study provide clear evidence of strong positive relationships between NSSE student engagement measures and self-reports of learning gains. For the 2011 administration of NSSE, the first canonical function indicated that there was a strong positive correlation between all of the NSSE scalelets and the two measures of student learning outcomes. This finding is consistent with previous research

examining the relationships between learning gains and the NSSE benchmarks and scalelet scores (Pike, 2006a), and it provides evidence of the convergent validity of the NSSE scalelet scores. The second canonical function derived from the NSSE 2011 data provides evidence of discriminant validity. Above and beyond the strong positive general relationship between engagement and learning, collaborative learning was positively related to application skills and negatively related to academic and interpersonal gains. Conversely, writing experiences and interaction with faculty in class were negatively related to application skills, but positively related to academic and interpersonal gains. An important caveat regarding evidence of discrimination in the NSSE 2011 data is the fact that the explanatory power of the second canonical function was extremely weak. The adequacy coefficient for the second student engagement coefficients was only 0.02, and the redundancy coefficient representing the average proportion of variance in the outcome measures explained by the second engagement variate was also only 0.02. Stated differently, above and beyond the strong evidence of convergence, the ability of the NSSE scalelets to discriminate among learning outcomes accounted for only 2% of the average variance in learning outcomes.

The analysis of the NSSE 2013 data also provided evidence of convergence and discrimination, although the findings differed in important ways from the results for NSSE 2011. Specifically, the first canonical function did not represent a strong positive relationship between general engagement and learning. Instead, the first canonical function represented a strong positive relationship between 7 of the 10 engagement indicators and academic and interpersonal gains, whereas the second canonical function represented a strong positive relationships between gains in application and three engagement indicators (quantitative reasoning, collaborative learning, and student-faculty interaction). Gains in application skills were positively and

moderately related to five additional engagement indicators. The fact that the first canonical function was focused on academic and interpersonal gains, whereas the second canonical function was focused on gains in application provided evidence of the discriminant validity of the NSSE engagement indicators. Equally important, the redundancy coefficients revealed that the first and second engagement variates were each able to explain a substantial proportion of the average variance in the outcome measures.

From a practical standpoint, the engagement indicators provided in the new NSSE survey appear to be more useful than previous engagement measures in identifying institutional actions that can be used to enhance certain types of learning outcomes. Institutions interested in improving students' academic and interpersonal learning outcomes would be well advised to engage in reflective and integrative learning, higher-order thinking, and effective learning strategies. Institutions interested in promoting academic and interpersonal gains would also be well advised to emphasize effective teaching and a supportive campus environment. Conversely, institutions interested in emphasizing the development of skills related to application would be wise to encourage students to focus on activities related to quantitative reasoning, collaborative learning, and to a lesser extent higher-order thinking. Institutions should also encourage student-faculty interaction, effective teaching, and a supportive campus environment.

A second important finding to emerge from the present research concerns the utility of canonical correlation analysis. Most studies of the relationships between student engagement and student outcomes have relied on multiple regression analysis, even when there were multiple outcomes of interest. The present research demonstrates that canonical correlation analysis provides a useful method for examining relationships between student engagement and learning outcomes when the learning outcomes are interrelated (i.e., correlated). When multiple

regression is used to examine the relationships between student engagement and learning outcomes, the learning outcomes must be treated as statistically independent entities, even though evidence suggests that they are positively correlated. As a result, multiple regression runs the risk of increasing Type I errors by performing multiple statistical analyses when a single analysis may be sufficient to uncover the relationships between engagement and learning. In addition, it may be difficult, if not impossible, to ascertain exactly how engagement measures are related to intercorrelated sets of learning outcomes when multiple regression is utilized. Both of these advantages of canonical correlation analysis are apparent in the analysis of the NSSE 2011 data. Results clearly indicated a single function dominated the relationship between engagement and learning outcomes. Thus, only one test of the engagement-learning relationship was needed. Although the increases in Type I error are likely to be small when two learning outcomes are the focus of study, Type I errors can be much more serious when multiple regression is used to evaluate the relationships between engagement and learning when four, five, or six outcomes are the focus of the inquiry. For example, four separate multiple regression analyses, each at the 0.05 level, would produce an overall error rate of 0.19. Conducting six multiple regression analyses at the 0.05 level would produce an overall error rate of 0.26.

The fact that the functions produced by canonical correlation analysis are statistically independent from (i.e., uncorrelated with) one another represents another important advantage of the statistical method. In the analysis of the NSSE 2011 data, the relationships between engagement and learning gains was dominated by a strong general relationship. Without first identifying and setting aside that general relationship, it would not have been possible to identify the relationship between collaborative learning and gains in application skills. In the case of the NSSE 2011 analyses, the relationship between collaborative learning and application skills was

relatively weak. That was not the case in the analysis of the NSSE 2013 data. Gains in application skills were strongly related to collaborative learning and quantitative reasoning, net the relationships between engagement and academic/interpersonal outcomes. In the case of the 2013 data, the strong positive relationship between the two learning outcomes domains likely would obscure some of the important relationships between student engagement and gains in application skills.

Conclusion

The new NSSE survey has been welcomed by a variety of higher education leaders and policy makers (National Survey of Student Engagement, 2014a). However, these positive reviews have largely been based on judgements about content and face validity. The results of the present research indicate that the new engagement indicators that are part of the NSSE survey introduced in 2013 provided clear evidence of convergence and discrimination. Specifically, the results of this research showed that student engagement, as represented by the engagement indicators, was positively related to students' self-reported learning outcomes. At the same time, differences in how students were engaged in learning appeared to be related to differences in what they learned—a tenant that is central to the theory of student engagement.

References

- American Educational Research Association, American Psychological Association, & National Council on Measurement in Education. (2014). *Standard for educational and psychological testing*. Washington, D.C.: American Educational Research Association.
- Astin, A. W. (1984). Student involvement: A developmental theory for higher education. *Journal of College Student Personnel*, 25, 297-307.
- Axelson, R. D., & Flick, A. (2011). Defining student engagement. *Change*, 31(1), 38-43.
- Banta, T. W., & Pike, G. R. (1989). Methods for evaluating assessment instruments. *Research in Higher Education*, 30, 455-470.
- Banta, T. W., Pike, G. R., & Hansen, M. J. (2009). The use of engagement data in accreditation, planning and assessment. In R. M. Gonyea & G. D. Kuh (Eds.), *Using NSSE in institutional research* (New Directions for Institutional Research series, no 141, pp. 21-34). San Francisco: Jossey-Bass.
- Bowman, N. A. (2011). Examining systematic errors in predictors of college student self-reported gains. In S. Herzog & N. A. Bowman (Eds.), *Validity and limitations of college student self-report data* (New Directions for Institutional Research series, no. 150, pp. 7-20). San Francisco: Jossey-Bass.
- Bowman, N. A., & Hill, P. L. (2011). Measuring how college affects students: Social desirability and other potential biases in college student self-reported gains. In S. Herzog & N. A. Bowman (Eds.), *Validity and limitations of college student self-report data* (New Directions for Institutional Research series, no. 150, pp. 73-86). San Francisco: Jossey-Bass.

- Brackett, M. A., & Mayer, J. D. (2003). Convergent, discriminant, and incremental validity of competing measures of emotional intelligence. *Personality and Social Psychology Bulletin*, 29, 1147-1158.
- Campbell, D. T. (1960). Recommendations for APA test standards regarding construct, trait, and discriminant validity. *American Psychologist*, 15, 546-553.
- Campbell, D. T., & Fiske, D. W. (1959). Convergent and discriminant validity by the multitrait-multimethod matrix. *Psychological Bulletin*, 56, 81-105.
- Chickering, A. W., & Gamson, Z. (1987). Seven principles for good practice in undergraduate education. *AAHE Bulletin*, 39(7), 3-7.
- Fiske, D. W. (1982). Convergent-discriminant validation measurements in research strategies. In L. H. Kidder (Ed.), *Forms of validity research* (New Directions for the Methodology of Social and Behavioral Science series, no. 12, pp. 79-92). San Francisco: Jossey-Bass.
- Gellin, A. (2003). The effect of undergraduate student involvement on critical thinking: A meta-analysis of the literature, 1991-2000. *Journal of College Student Development*, 44, 746-762.
- Gonyea, R. M., & Miller, A. (2011). Clearing the air about the use of self-reported gains in institutional research. In S. Herzog & N. A. Bowman (Eds.), *Validity and limitations of college student self-report data* (New Directions for Institutional Research series, no. 150, pp. 99-111). San Francisco: Jossey-Bass.
- Herzog, S. (2011). Gauging academic growth of bachelor degree recipients: Longitudinal vs. self-reported gains in general education. In S. Herzog & N. A. Bowman (Eds.), *Validity and limitations of college student self-report data* (New Directions for Institutional Research series, no. 150, pp. 21-40). San Francisco: Jossey-Bass.
- Hotelling, H. (1936). Relations between two sets of measures. *Biometrika*, 28, 321-377.

- Kane, M. T. (2006). Validation. In R. L. Brennan (Ed.), *Educational measurement* (4th ed., pp. 17-64). Westport, CT: American Council on Education and Praeger.
- Kuh, G. D. (2001). *The National Survey of Student Engagement: Conceptual framework and overview of psychometric properties*. Bloomington, IN: Indiana University Center for Postsecondary Research.
- Kuh, G. D. (2003). What we are learning about student engagement from NSSE. *Change*, 35(2), 24-32.
- Kuh, G. D. (2005). Putting student engagement results to use: Lessons from the field. *Assessment Update: Progress, Trends, and Practices in Higher Education*, 17(1), 12-13.
- Kuh, G. D. (2006). Making students matter. In J. C. Burke (Ed.), *Fixing the fragmented university: Decentralization with discretion* (pp. 235-264). Boston: Jossey-Bass.
- Kuh, G. D. (2009). The National Survey of Student Engagement: Conceptual and empirical foundations. In R. M. Gonyea & G. D. Kuh (Eds.), *Using NSSE in institutional research* (New Directions for Institutional Research series, no. 141, pp. 5-20). San Francisco: Jossey-Bass.
- Kuh, G. D., Hayek, J. C., Carini, R. M., Ouimet, J. A., Gonyea, R. M., & Kennedy, J. (2001). *NSSE technical and norms report*. Bloomington, IN: Indiana University Center for Postsecondary Research.
- Kuh, G. D., Hu, S., & Vesper, N. (2000). "They shall be known by what they do:" An activities-based typology of college students. *Journal of College Student Development*, 41, 228-244.
- Kuh, G. D., & Ikenberry, S. (2009). *More than you think, less than you need: Learning outcomes assessment in American higher education*. Champaign, IL: National Institute for Learning Outcomes Assessment.

- Kuh, G. D., Kinzie, J., Cruce, T., Shoup, R., & Gonyea, R. M. (2009). *Connecting the dots: Multifaceted analyses of the relationships between student engagement results from the NSSE and the institutional practices and conditions that foster student success*. Bloomington, IN: Indiana University Center for Postsecondary Research.
- Kuh, G. D., Schuh, J. H., Whitt, E. J., & Associates. (1991). *Involving colleges: Encouraging student learning and personal development through out-of-class experiences*. San Francisco: Jossey-Bass.
- Lingenfelter, P. E. (2013). Forward: Why a fresh look at student engagement? In *A fresh look at student engagement: Annual results 2013* (pp. 2-3). Bloomington, IN: Indiana University Center for Postsecondary Research.
- McCormick, A. C. (2013). Director's Message: If it's not broken ... make it better. In *A fresh look at student engagement: Annual results 2013* (pp. 4-5). Bloomington, IN: Indiana University Center for Postsecondary Research.
- McCormick, A. C., Gonyea, R. M., & Kinzie, J. (2013). Refreshing engagement: NSSE at 13. *Change*, 45(3), 6-15.
- Messick, S. (1989). Validity. In R. L. Linn (Ed.), *Educational measurement* (3rd ed., pp. 13-103). New York: American Council on Education and Macmillan.
- National Survey of Student Engagement (2001). *Improving the college experience: National benchmarks of effective educational practice*. Bloomington, IN: Indiana University Center for Postsecondary Research.
- National Survey of Student Engagement (2009). *Using NSSE to assess and improve undergraduate education: Lessons from the field, 2009*. Bloomington, IN: Indiana University Center for Postsecondary Research.

- National Survey of Student Engagement. (2014a). *About NSSE*. Bloomington, IN: Indiana University Center for Postsecondary Research. Retrieved from <http://nsse.iub.edu/html/about.cfm>.
- National Survey of Student Engagement. (2014b). *NSSE 2014 engagement indicators: Internal consistency statistics by class level*. Bloomington, IN: Indiana University Center for Postsecondary Research. Retrieved from http://nsse.iub.edu/2014_institutional_report/pdf/EI%20Intercorrelations%202014.pdf.
- Ouimet, J. A., Bunnage, J. B., Carini, R. M., Kuh, G. D., & Kennedy, J. (2004). Using focus groups to establish the validity and reliability of a college student survey. *Research in Higher Education*, 45, 223-250.
- Pace, C. R. (1980). Measuring the quality of student effort. *Current Issues in Higher Education*, 2, 10-16.
- Pace, C. R. (1984). *Measuring the quality of college student experiences*. Los Angeles, CA: Center for the Study of Evaluation, University of California Los Angeles.
- Pascarella, E. T., Seifert, T. A., & Blaich, C. (2009). How effective are the NSSE benchmarks in predicting important educational outcomes? *Change*, 42(1), 16-22.
- Pascarella, E. T., Whitt, E. J., Nora, A., Edison, M., Hagedorn, L. S., & Terenzini, P. T. (1996). What have we learned from the first year of the national study of student learning? *Journal of College Student Development*, 37, 182-192.
- Pike, G. R. (1989). Background, college experiences, and the ACT-COMP exam: Using construct validity to evaluate assessment instruments. *Review of Higher Education*, 13, 91-118.

- Pike, G. R. (1992). Components of construct validity: A comparison of two measures of general education outcomes. *Journal of General Education, 41*, 130-150.
- Pike, G. R. (1995). The relationship between self-reports of college experiences and achievement test scores. *Research in Higher Education, 36*, 1-21.
- Pike, G. R. (2006a). The convergent and discriminant validity of NSSE scalelet scores. *Journal of College Student Development, 47*, 550-563.
- Pike, G. R. (2006b). The dependability of NSSE scalelets for college and department-level assessment. *Research in Higher Education, 47*, 177-195.
- Pike, G. R. (2011). Using college students' self-reported learning outcomes in scholarly research. In S. Herzog & N. A. Bowman (Eds.), *Validity and limitations of college student self-report data* (New Directions for Institutional Research series, no. 150, pp. 41-58). San Francisco: Jossey-Bass.
- Pike, G. R. (2013a). Assessment measures: The updated National Survey of Student Engagement (NSSE). *Assessment Update: Progress, Trends, and Practices in Higher Education, 25*(4), 10-11.
- Pike, G. R. (2013b). NSSE benchmarks and institutional outcomes: A note on the importance of considering the intended uses of a measure in validity studies. *Research in Higher Education, 54*, 149-170.
- Pike, G. R., Kuh, G. D., & Gonyea, R. M. (2003). The relationship between institutional mission and students' involvement and educational outcomes. *Research in Higher Education, 44*, 243-263.

- Pike, G. R., Smart, J. C., & Ethington, C. A. (2012). The mediating effects of student engagement on the relationships between academic disciplines and learning outcomes: An extension of Holland's theory. *Research in Higher Education, 53*, 550-575.
- Porter, S. R. (2011). Do college student surveys have any validity? *Review of Higher Education, 35*, 45-76.
- Sherry, A., & Henson, R. K. (2005). Conducting and interpreting canonical correlation analysis in personality research: A user-friendly primer. *Journal of Personality Assessment, 84*, 37-48.
- Thompson, B. (1984) *Canonical correlation analysis: Uses and interpretation* (Sage Quantitative Applications in the Social Sciences series, no. 47). Beverly Hills, CA: Sage.
- Thompson, B. (1991). A primer on the logic and use of canonical correlation analysis. *Measurement and Evaluation in Counseling and Development, 24*, 80-95.
- Wainer, H., & Kiely, G. L. (1987). Item clusters and computer adaptive testing: A case for testlets. *Journal of Educational Measurement, 24*, 185-201.
- Ward, C., Fisher, R., Lam, F. S. Z., & Hall, L. (2009). The convergent, discriminant, and incremental validity of scores on a self-report measure of cultural intelligence. *Educational and Psychological Measurement, 69*, 85-105.
- Wollenberg, A. L. Van Den (1977). Redundancy analysis: An alternative for canonical correlation analysis. *Psychometrika, 42*, 207-219.

Table 1
Canonical Correlation Results for the NSSE 2011 Data

	Canonical Function I		Canonical Function II		Communality
	Standardized Coefficients	Structure Coefficients	Standardized Coefficients	Structure Coefficients	
Academic & Interpersonal Gains	0.58	0.90	-1.09	-0.44	1.00
Application Gains	0.55	0.88	1.11	0.47	1.00
Adequacy Coefficients		0.79		0.21	
Redundancy Coefficients		0.49		0.02	
	Canonical Function I		Canonical Function II		
	Standardized Coefficients	Structure Coefficients	Standardized Coefficients	Structure Coefficients	Communality
Course Challenge	0.28	0.70	0.47	0.21	0.53
Writing Experiences	-0.01	0.39	-0.30	-0.49	0.39
Higher-Order Thinking	0.06	0.71	-0.20	-0.18	0.54
Active Learning	0.10	0.57	0.04	-0.17	0.35
Collaborative Learning	0.14	0.67	0.77	0.45	0.65
Faculty-Student Interaction In Class	0.15	0.75	-0.83	-0.40	0.72
Faculty-Student Interaction Out-of-Class	0.13	0.59	0.37	-0.02	0.35
Support for Student Success	0.48	0.89	-0.54	-0.08	0.80
Interpersonal Environment	0.01	0.70	0.38	0.02	0.49
Adequacy Coefficients		0.46		0.02	

Table 2
Canonical Correlation Results for the NSSE 2013 Data

	Canonical Function I		Canonical Function II		Communality
	Standardized Coefficients	Structure Coefficients	Standardized Coefficients	Structure Coefficients	
Academic & Interpersonal Gains	1.11	0.97	-0.31	0.25	1.00
Application Gains	-0.29	0.27	1.12	0.96	1.00
Adequacy Coefficients		0.50		0.50	
Redundancy Coefficients		0.35		0.27	

	Canonical Function I		Canonical Function II		Communality
	Standardized Coefficients	Structure Coefficients	Standardized Coefficients	Structure Coefficients	
Higher-Order Learning	0.26	0.76	0.09	0.31	0.67
Reflective & Integrative learning	0.47	0.81	-0.41	-0.04	0.66
Quantitative Reasoning	-0.16	0.02	0.73	0.90	0.81
Learning Strategies	0.09	0.63	0.12	0.29	0.48
Collaborative Learning	-0.29	-0.07	0.28	0.55	0.31
Discussions with Diverse Others	-0.24	0.24	-0.02	0.17	0.09
Student-Faculty Interaction	0.28	0.42	0.01	0.42	0.35
Effective Teaching Practices	0.22	0.71	0.20	0.31	0.60
Quality of Interactions	-0.07	0.43	0.18	0.30	0.27
Supportive Environment	0.29	0.54	-0.04	0.31	0.39
Adequacy Coefficient		0.29		0.18	

Appendix A
Items Comprising the NSSE Scalets

Course Challenge ($E\rho^2 = 0.73$)

How often have you . . . worked harder than you thought you could to meet an instructor's standards or expectations? [workhard]

How often have you . . . come to class without completing readings or assignments? {Reverse Scored} [clunprep]

To what extent have . . . your examinations during the current school year challenged you to do your best work? [exams]

How many hours a week do you spend . . . preparing for class (studying, reading, writing, rehearsing, and other activities related to you academic program)? [acadpr01]

To what extent does your institution emphasize . . . spending significant amounts of time studying and on academic work? [envschol]

Writing ($E\rho^2 = 0.75$)

How often have you . . . prepared two or more drafts of a paper or assignment before turning it in? [rewropap]

How often have you . . . worked on a paper or project that required integrating ideas or information from various sources? [integrat]

During the current school year . . . number of written papers or reports of 20 pages or more? [writemor]

During the current school year . . . number of written papers or reports between 5 and 19 pages? [writemid]

During the current school year . . . number of written papers or reports of fewer than 5 pages? [writesml]

Higher-Order Thinking Skills ($E\rho^2 = 0.77$)

During the current school year, to what extent has your coursework emphasized . . . memorizing facts, ideas, or methods from your courses and readings so you can repeat them in pretty much the same form? {Reverse Scored} [memorize]

During the current school year, to what extent has your coursework emphasized . . . analyzing the basic elements of an idea, experience, or theory, such as examining a particular case or situation in depth and considering its components? [analyze]

During the current school year, to what extent has your coursework emphasized . . . synthesizing and organizing ideas, information, or experiences into new, more complex interpretations and relationships? [synthesz]

During the current school year, to what extent has your coursework emphasized . . . making judgments about the value of information, arguments, or methods such as examining how others gathered and interpreted data and assessing the soundness of

their conclusions? [evaluate]

During the current school year, to what extent has your coursework emphasized . . .
Applying theories or concepts to practical problems or in new situations? [applying]

Active Learning ($E_p^2 = 0.84$)

How often have you . . . asked questions in class or contributed to class discussions?
[clquest]

How often have you . . . made a class presentation? [clpresen]

How often have you . . . participated in a community-based project as part of a regular
course? [commproj]

Collaborative Learning ($E_p^2 = 0.72$)

How often have you . . . worked with other students on projects during class?
[classgrp]

How often have you . . . worked with classmates outside of class to prepare class
assignments? [occgrp]

How often have you . . . tutored or taught other students (paid or voluntary)? [tutor]

How often have you . . . discussed ideas from your readings or classes with others
outside of class (students, family members, coworkers, etc.)? [oocideas]

Course Interaction ($E_p^2 = 0.80$)

How often have you . . . discussed grades or assignments with an instructor? [facgrade]

How often have you . . . discussed ideas from your readings or classes with faculty
members outside of class? [facideas]

How often have you . . . received prompt feedback from faculty on your academic
performance (written or oral)? [facfeed]

Out-of-Class Interaction ($E_p^2 = 0.84$)

How often have you . . . talked about career plans with a faculty member or advisor?
[facplans]

How often have you . . . worked with faculty members on activities other than
coursework (committees, orientation, student-life activities, etc.)? [facother]

Have you, or do you plan to, . . . work on a research project with a faculty member
outside of course or program requirements? [research]

Varied Experiences ($E_p^2 = 0.94$)

Have you, or do you plan to, . . . participate in a practicum, internship, field
experiences, co-op experience, or clinical assignment? [intern]

Have you, or do you plan to, . . . participate in community service or volunteer work?
[volunteer]

Have you, or do you plan to, . . . participate in a learning community or some other formal program where groups of students take two or more classes together? [learncom]

Have you, or do you plan to, . . . take foreign-language coursework? [forlang]

Have you, or do you plan to, . . . study abroad? [studyabr]

Have you, or do you plan to, . . . participate in an independent study or self-designed major? [indstudy]

Have you, or do you plan to, . . . participate in a culminating senior experiences (comprehensive exam, capstone course, thesis, project, etc.)? [seniorx]

How many hours a week do you spend . . . participating in co-curricular activities (organizations, campus publications, student government, social fraternity or sorority, intercollegiate or intramural sports, etc.)? [cocurr01]

To what extent does your institution emphasize . . . attending campus events and activities (special speakers, cultural performances, athletic events, etc.)? [envevent]

Information Technology ($E\rho^2 = 0.81$)

How often have you . . . used an electronic medium (list-serv, chat group, Internet, etc.) to discuss or complete an assignment? [itacadem]

How often have you . . . used e-mail to communicate with an instructor? [email]

To what extent does your institution emphasize . . . using computers in academic work? [envcompt]

Diversity ($E\rho^2 = 0.77$)

How often have you . . . had serious conversations with students of a different race or ethnicity than your own? [divrstud]

How often have you . . . had serious conversations with students who differ from you in terms of their religious beliefs, political opinions, or personal values? [diffstu2]

To what extent does your institution emphasize . . . encouraging contact among students from different economic, social, and racial or ethnic backgrounds? [envdivrs]

Support for Student Success ($E\rho^2 = 0.83$)

To what extent does your institution emphasize . . . providing the support you need to help you succeed academically? [envsuprt]

To what extent does your institution emphasize . . . helping you cope with your non-academic responsibilities (work, family, etc.)? [envnacad]

To what extent does your institution emphasize . . . providing the support you need to thrive socially? [envsocial]

Interpersonal Environment ($E\rho^2 = 0.80$)

Quality of your relationships with . . . other students? [envstu]

Quality of your relationships with . . . faculty members? [envfac]

Quality of your relationships with . . . administrative personnel and offices? [envadm]

Appendix B
Items Comprising the NSSE Engagement Indicators

Higher-Order Learning ($E\rho^2 = 0.85$)

During the current school year, how much has your coursework emphasized the following:

Applying facts, theories, or methods to practical problems or new situations [Hoapply]

Analyzing an idea, experience, or line of reasoning in depth by examining its parts [Hoanalyze]

Evaluating a point of view, decision, or information source [Hoevaluate]

Forming a new idea or understanding from various pieces of information [Hiform]

Reflective & Integrative Learning ($E\rho^2 = 0.87$)

During the current school year, how often have you:

Combined ideas from different courses when completing assignments [RIintegrate]

Connected your learning to societal problems or issues [RIsocietal]

Included diverse perspectives (political, religious, racial/ethnic, gender, etc.) in course discussions or assignments [RIdiverse]

Examined the strengths and weaknesses of your own views on a topic or issue [RIownview]

Tried to better understand someone else's views by imagining how an issue looks from his or her perspective [RIperspect]

Learned something that changed the way you understand an issue or concept [RInewview]

Connected ideas from your courses to your prior experiences and knowledge [RIconnect]

Learning Strategies ($E\rho^2 = 0.77$)

During the current school year, how often have you:

Identified key information from reading assignments [LSreading]

Reviewed your notes after class [LSnotes]

Summarized what you learned in class or from course materials [LSsummary]

Quantitative Reasoning ($E\rho^2 = 0.86$)

During the current school year, how often have you:

Reached conclusions based on your own analysis of numerical information (numbers, graphs, statistics, etc.) [QRconclude]

Used numerical information to examine a real-world problem or issue (unemployment, climate change, public health, etc.) [QRproblem]

Evaluated what others have concluded from numerical information [QRevaluate]

Collaborative Learning ($E\rho^2 = 0.81$)

During the current school year, how often have you:

Asked another student to help you understand course material [CLaskhelp]

Explained course material to one or more students [CLexplain]
 Prepared for exams by discussing or working through course material with other students [CLstudy]
 Worked with other students on course projects or assignments [CLproject]

Discussions with Diverse Others ($E\rho^2 = 0.89$)

During the current school year, how often have you had discussions with people from the following groups:

People from a race or ethnicity other than your own [DDrace]
 People from an economic background other than your own [DDeconomic]
 People with religious beliefs other than your own [DDreligion]
 People with political views other than your own [DDpolitical]

Student-Faculty Interaction ($E\rho^2 = 0.83$)

During the current school year, how often have you:

Talked about career plans with a faculty member [SFcareer]
 Worked with a faculty member on activities other than coursework (committees, student groups, etc.) [SFotherwork]
 Discussed course topics, ideas, or concepts with a faculty member outside of class [SFdiscuss]
 Discussed your academic performance with a faculty member [SFperform]

Effective Teaching Practices ($E\rho^2 = 0.85$)

During the current school year, to what extent have your instructors done the following:

Clearly explained course goals and requirements [ETgoals]
 Taught course sessions in an organized way [ETorganize]
 Used examples or illustrations to explain difficult points [ETexample]
 Provided feedback on a draft or work in progress [ETdraftfb]
 Provided prompt and detailed feedback on tests or completed assignments [ETfeedback]

Quality of Interactions ($E\rho^2 = 0.84$)

Indicate the quality of your interactions with the following people at your institution:

Students [QIstudent]
 Academic advisors [QIadvisor]
 Faculty [QIfaculty]
 Student services staff (career services, student activities, housing, etc.) [QIstaff]
 Other administrative staff and offices (registrar, financial aid, etc.) [QIadmin]

Supportive Environment ($E\rho^2 = 0.89$)

How much does your institution emphasize the following:

Providing support to help students succeed academically [SEacademic]

Using learning support services (tutoring services, writing center, etc.) [SElearnsup]

Encouraging contact among students from different backgrounds (social, racial/ethnic, religious, etc.) [SEdiverse]

Providing opportunities to be involved socially [SEsocial]

Providing support for your overall well-being (recreation, health care, counseling, etc.) [SEwellness]

Helping you manage your non-academic responsibilities (work, family, etc.) [SEnonacad]

Attending campus activities and events (performing arts, athletic events, etc.) [SEactivities]

Attending events that address important social, economic, or political issues [SEevents]

Appendix C
Items Comprising the NSSE Learning Gains Factors

Academic and Interpersonal Gains ($E\rho^2 = 0.86$, 2011; $E\rho^2 = 0.88$, 2013)

How much has your experience at this institution contributed to your knowledge, skills, and personal development in the following areas?

Writing clearly and effectively [pgwrite]

Speaking clearly and effectively [pgspeak]

Thinking critically and analytically [pgthink]

Developing or clarifying a personal code of values and ethics [pgvalues]

Understanding people of other backgrounds (economic, racial/ethnic, political, religious, nationality, etc.) [pgdiverse]

Being an informed and active citizen [pgcitizen]

Application Gains ($E\rho^2 = 0.86$ 2011; $E\rho^2 = 0.79$, 2013)

How much has your experience at this institution contributed to your knowledge, skills, and personal development in the following areas?

Analyzing numerical and statistical information [pganalyze]

Acquiring job- or work-related knowledge and skills [pgwork]

Working effectively with others [pgothers]

Solving complex real-world problems [pgprobsolve]