



# Student Engagement And Affordances For Interaction With Diverse Peers: A Network Analysis

By: Kimberly Glass, Chris R. Glass, and **R. Jason Lynch**

## Abstract

This study utilized a network model in order to explore the relationship between patterns of student engagement and affordances for interaction with diverse peers for 12,852 students at 7 universities. The institutions are similar in type and size, with relatively moderate levels of structural racial diversity, and a range of overall cross-cultural peer engagement. The findings indicate that students in the "core" (many connections) share 1 dominant perception of affordances for interaction with many other students that also have a high number of connections. Similarly, students in the "fringe" (few connections) may not share their perception of the affordances for interaction with many other students, but when they do, it is most likely with other students that have only have a few connections in our network. Moreover, our network exhibited a high-degree of assortativity, meaning that there is little mixing between the "core" and "fringe" groups. Importantly, the institutional network structure varied by an institution's overall level of cross-cultural peer engagement. White students reported more co-curricular engagement but less openness to cross-cultural interaction than their peers from all other racial groups; White students reported significantly greater campus support for diversity and less openness to cross-cultural interaction than their peers from all other racial groups. Implications for intergroup dialogue, collaborative programming, and the use of assortativity for institutional assessment are discussed.

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# Student Engagement and Affordances for Interaction With Diverse Peers: A Network Analysis

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This study utilized a network model in order to explore the relationship between patterns of student engagement and affordances for interaction with diverse peers for 12,852 students at 7 universities. The institutions are similar in type and size, with relatively moderate levels of structural racial diversity, and a range of overall cross-cultural peer engagement. The findings indicate that students in the “core” (many connections) share 1 dominant perception of affordances for interaction with many other students that also have a high number of connections. Similarly, students in the “fringe” (few connections) may not share their perception of the affordances for interaction with many other students, but when they do, it is most likely with other students that have only have a few connections in our network. Moreover, our network exhibited a high-degree of assortativity, meaning that there is little mixing between the “core” and “fringe” groups. Importantly, the institutional network structure varied by an institution’s overall level of cross-cultural peer engagement. White students reported more cocurricular engagement but less openness to cross-cultural interaction than their peers from all other racial groups; White students reported significantly greater campus support for diversity and less openness to cross-cultural interaction than their peers from all other racial groups. Implications for intergroup dialogue, collaborative programming, and the use of assortativity for institutional assessment are discussed.

*Keywords:* networks, student engagement, cross-racial interaction, campus diversity

Network analysis has been increasingly used with large datasets to reexamine many well-understood relationships (e.g., Reshef et al., 2011). Included among these are complex network approaches that have been applied to investigate a diversity of systems including, but not limited to, biological, social, and technological systems (Barabási, Gulbahce, & Loscalzo, 2011; Boccaletti, Latora, Moreno, Chavez, &

Hwang, 2006; Barabási & Oltvai, 2004; Newman, 2003a; Palla, Barabási, & Vicsek, 2007; Watts, 2007). Research universities exist in a global context where cross-cultural interaction (i.e., interaction with people from other ethnic and cultural backgrounds) has become commonplace (Jayakumar, 2008). Clarke and Antonio (2012) have called for the application of network analysis to shed fresh perspective on perennial issues in higher education diversity research. One strength of a network approach lies in its ability to simultaneously utilize information about the connections between all members in a system, and there are many measures that harness this information to succinctly summarize large-scale patterns (Chi & Suthers, 2015; Newman, 2003a; Watts, 2007).

Network analysis has been recognized as a particularly promising approach in identifying heterogeneous and homogenous student networks, as well as examining the characteristics of the campuses in which these networks exist

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(Clarke and Antonio, 2012). On the one hand, structural racial diversity counteracts the human tendency to form social ties with persons from similar backgrounds (Chang, Astin, & Kim, 2004; Park, Denson, & Bowman, 2012), especially similar racial backgrounds (McPherson, Smith-Lovin, & Cook, 2001). On the other hand, a larger pool of friendship options at large, structurally diverse research universities also affords more opportunities for students to exhibit less diversity in interpersonal relationships (Bahns, Pickett, & Crandall, 2012). We believe that the complex nature of student engagement and affordances for interaction with diverse peers makes potentially subtle associations among these factors difficult to ascertain using standard multivariate linear models (Newman, 2003b). Network analysis can differentiate ways in which student engagement and affordances for interaction interrelate to detect complex relationships among multiple factors (Newman, 2003b).

The main purpose of this study was to utilize a network model in order to explore the relationship between patterns of student engagement and perceptions of the affordances for interaction with diverse peers. We examine seven universities that are similar in type and size, with relatively moderate levels of structural racial diversity, and a range of overall cross-cultural peer engagement. We hope this study offers a unique and significant contribution to the higher education diversity literature and is useful to theorists and practitioners alike. This study examines the quality and nature of student interactions and its relationship to the composition of student social structures—a pressing issue of interest for diversity researchers (Worthington, 2012). Whereas multivariate analysis would allow diversity researchers to understand the cognitive effects of heterogeneous peer interaction on individual students (Chang, Denson, Sáenz, & Misa, 2006; Gurin, Dey, Hurtado, & Gurin, 2002), network analysis allows researchers to examine how the sharing of information and perspectives may facilitate attitude change on the network structure as a whole (Chi & Suthers, 2015; Clarke and Antonio, 2012; Guimerà, Uzzi, Spiro, & Amaral, 2005). Moreover, the results of this study offer important insights for practitioners who wish to understand the conditions that facilitate the sharing of information and perspectives among students with diverse backgrounds.

## Conceptual Framework

In recent years, the construction of the individual person is increasingly conceptualized in terms of its relationship to a collective, rather than as an autonomous agent (Lazer et al., 2009). Networks connect members of a system, or “nodes,” through connections; the “degree” of a node is the number of connections made to that node. Most social networks mix assortatively by degree (Newman, 2002, 2003b). In assortative networks, members have a propensity to connect to other members based on similar characteristics such as gender, race, and class (McPherson et al., 2001; Park & Denson, 2013). The opposite is true of disassortative networks, where members have many connections with others who do not share similar characteristics and perspectives. These two concepts are not mutually exclusive within the context of a single network. For example, a social network of an international business student organization could be both assortative to the extent that members tend to associate with others that share some characteristics (e.g., major), as well as disassortative to the extent that social ties are also more likely to exist between members who do not share other characteristics (e.g., ethnicity).

In most social and biological networks, a small number of members have a large number of connections, while the majority of members have only a few connections, exhibiting a heavy-tailed, right-tailed degree distribution indicative of a scale-free network topology (Barabási & Albert, 1999; Barabási & Bonabeau, 2003; Strogatz, 2001). This phenomenon has been observed in a large number of real world situations, including the number of citations of academic journal articles and collaborations between actors (Guimerà et al., 2005). In these networks, members with a high degree may tend to either connect to other members with a high degree (“assortative” network) or to members with a very low degree (“disassortative” network). The lack of mixing in assortative networks limits exposure to new information and perspectives; mixing in disassortative networks facilitates such exposure (Chi & Suthers, 2015; Newman, 2002). Consequently, cross-cultural peer interaction—or the lack of it—may not only affect an individual student’s attitude toward difference (e.g., Denson &

Chang, 2015); it may also affect the collective perceptions of the campus context due to the sharing—or lack of sharing—of information and perspectives across subnetworks of students (Chang et al., 2006).

We use a socioecological approach that analyzes how the dynamic interrelations between people are affected by the nature of their social environment (Oishi & Graham, 2010). From this perspective, students' engagement with diverse peers depends on their perceptions of the affordances for interaction with diverse peers within their university context (Oishi, 2010). These perceptions are shaped, in part, by students' direct experiences and observations of their peers' behavior. In universities with high relational mobility, students, when they find it desirable, have more opportunities to venture outside existing relationships and form new relationships (Yuki & Schug, 2012). In contrast, for universities with low relational mobility, environmental affordances constrain relationship formation, and students' social networks are relatively stable and unchanging (Yuki & Schug, 2012). The next section reviews student engagement factors and affordances for interaction with diverse peers.

### Student Engagement

Multicultural coursework that addresses issues of race, ethnicity, gender, class, religion, or sexual orientation is significantly associated with college students' openness to diverse perspectives, even when taking into account students' relative exposure to racial, ethnic, and religious diversity prior to college (Harper & Yeung, 2013; Milem & Umbach, 2003). Recent research has shown students indirectly benefit when they attend institutions where more students are engaged in diversity-related coursework and cocurricular activities (Denson & Chang, 2009). Thus, there appears to be not only individual-level effects on openness to diverse views, cross-racial interaction, and reduced prejudice for students who engage in multicultural coursework; there are indirect effects attributable to the social connections other students have with peers who engage in multicultural coursework (Denson & Chang, 2009).

Moreover, a student's openness to diverse views is not easily attributable to a single course or single demographic factor; more often, it

results from multiple experiences and a learning environment which allows students to directly encounter their peers' experiences, feel safe in doing so, and engage in a variety of forms of diversity (Bryant Rockenbach et al., 2014; King, Perez, & Shim, 2013). Courses that involve dialogue allow students to consider similarities and differences in each other's experiences (Glass, 2013; Gurin & Nagda, 2006; Milem, Chang, & Antonio, 2005). Such experiences have the potential to alter existing ideas, views, and sense of self and encourage new forms of interaction with others who are different from oneself (Merrill, Braskamp, & Braskamp, 2012). At the same time, greater engagement in multicultural coursework is associated with greater sensitivity to—and a more critical assessment of—the campus racial climate (Locks, Hurtado, Bowman, & Oseguera, 2008).

The presence of viewpoints not commonly held among classmates within groups, as well as prolonged contact with racially diverse peers, predicts greater capacity to integrate multiple perspectives, even more so than engagement in formal coursework (Antonio et al., 2004). Recreation, community service, leadership programs, and campus organizations are a rich source of “weak ties” among diverse students (Granovetter, 1973; Pachucki & Breiger, 2010). A tie refers to a social connection, and the strength of the tie describes the closeness of the relationship. Such activities allow students to form weak ties by interacting with peers on the peripheries of their social networks; those peers allow the sharing of new information and perspectives, as well as provide access to social groups students may not usually affiliate with (Chi & Suthers, 2015; Rienties, Johan, & Jindal-Snape, 2015). A small, but growing, body of diversity research has applied insights from network analysis to examine the cognitive effects of weak ties on diversity outcomes (cf., Clarke and Antonio, 2012; Rienties et al., 2015). For example, Bowman and Park (2015) found that cross-racial interactions (i.e., “weak ties”) were significantly related to emotional well-being, self-reported growth, and ease of getting along with peers from other races, whereas cross-racial friendships (i.e., “strong ties”) were not associated with any of these outcomes. Socioecological psychologists have found that people with numerous weak ties ex-

perience higher relational mobility than those with fewer stronger ties (Oishi & Graham, 2010).

Students not only benefit from their own cross-racial interactions, they indirectly benefit from being at a university where their peers actively engage in cross-racial interactions (Chang et al., 2006), as well as from the perception that their campus supports those interactions (Denson & Chang, 2015). Sustained cross-racial interaction exerts positive effects on an individual student's openness to diverse views, intellectual development, and civic commitment (Chang et al., 2006), especially for White students (Chang et al., 2004). Rare or infrequent cross-racial interactions have little or no association with such growth, whereas sustained cross-racial interactions are associated with greater self-reported engagement, well-being, and leadership regardless of a student's race (Bowman, 2013). Numerous studies document the relationship between interaction with diverse peers and diversity related outcomes for individual students (Chang et al., 2006; Locks et al., 2008); less research has been conducted on heterogeneous and homogeneous networks on campus. Researchers have called for network analyses that examine the characteristics of the networks on the campuses in which these networks exist (Clarke and Antonio, 2012).

### **Affordances for Interaction With Diverse Peers**

College students develop expectations for engagement with diverse peers long before they arrive on campus (Hall, Cabrera, & Milem, 2011; Harper & Yeung, 2013); those expectations are further developed in college by observing how their peers actually behave toward diverse others (Oishi & Graham, 2010). For example, students may be open to and desire such cross-cultural interaction, but other students must also be open to such interaction for this desire to be fulfilled. Affordances that create the conditions for cross-cultural interaction include, but are not limited to, a sense of belonging, campus support for diversity, and students' openness to cross-cultural interaction. The presence of these conditions does not guarantee cross-cultural interaction will occur; however, these conditions are necessary for the sharing of information and perspectives among

students with diverse backgrounds (Merrill et al., 2012).

Institutions may be characterized by their structural racial diversity, or the relative representation of various racial groups (Hurtado, Clayton-Pedersen, Milem, & Allen, 1998). While increased structural diversity provides more opportunities for racially heterogeneous networks (Fischer, 2008), it by itself does not guarantee more frequent or high quality interactions (Sáenz, Ngai, & Hurtado, 2006)—or necessarily positive interactions (Engberg, 2007)—associated with the benefits of diverse student populations. Research indicates that, ironically, a larger, more culturally diverse pool of available relationship choices can result in less diversity in interpersonal relationships (Bahns et al., 2012; Putnam, 2007). For example, Pike and Kuh (2006) found that, although student body diversity was associated with an increase in the frequency of cross-racial interaction, it had no significant association with perceptions of campus support for diversity.

Structural diversity is a necessary condition for racially heterogeneous social ties (cf., Harper & Yeung, 2013; Park & Denson, 2013), although it may have little bearing on racially heterogeneous friendships (Bowman & Park, 2014). An institution's structural diversity is among the strongest predictors of heterogeneous interactions and friendships for White students (Bowman, 2012; Bowman & Park, 2014). Students of color tend to have more heterogeneous interactions and friendships regardless of the structural diversity of their institutions (Bowman & Park, 2014), even when taking into account the demographics, attitudes, and experiences of students. Weak ties generated through cocurricular involvement have been shown to create a sense of belonging that indirectly exerts a significant positive effect on racially heterogeneous social ties (Glass & Westmont, 2013). Positive cross-racial interactions not only foster a sense of belonging; a sense of belonging also creates a secure base from which students can safely interact with diverse peers (Wang & Mallinckrodt, 2006).

### **Hypotheses**

The main purpose of this study was to utilize a network model in order to explore the relationship between patterns of student engage-

ment and affordances for interaction with diverse peers at seven universities which are similar in type and size, with relatively moderate levels of structural racial diversity, and a range of overall cross-cultural peer engagement. Accordingly, the researchers examined two questions, posing five hypotheses:

Research Question 1: How do the views of the campus context vary by college students' race/ethnicity?

*Hypothesis 1:* White students will exhibit less multicultural curricular engagement, more cocurricular engagement, and less cross-cultural peer engagement when compared with students of color.

*Hypothesis 2:* White students will exhibit more of a sense of belonging, greater perceptions of campus support for diversity, and less openness to cross-cultural interaction when compared with students of color.

Research Question 2: What are the characteristics of the overall network structure for college students' perceptions of the affordances for interaction with diverse peers at their universities?

*Hypothesis 3:* The overall network degree distribution will be scale-free, that is, a highly right-tailed distribution where a large majority of participants have only a few connections, but a few participants have many connections.

*Hypothesis 4:* The overall network will exhibit a high level of assortativity, that is, the extent to which students with either few, or many, connections tend to preferentially be connected to other students with either few, or many, connections, respectively.

*Hypothesis 5:* The network degree distribution will differ by institution.

## Method

In this study, we utilized a network model in order to explore the relationship between patterns of student engagement (multicultural curricular engagement, cocurricular engagement, and cross-cultural peer engagement) and affordances for interaction with diverse peers (sense

of belonging, campus support for diversity, openness to cross-cultural interaction). We adopted techniques from network analysis to construct a network by connecting students that share similar perceptions of affordances for interaction with diverse peers in order to examine relationships among students who, although they may not directly know one another, share similar views of their campus context. We were motivated by the fundamentally different, but somewhat analogous, application of network tools to studying shared opinions in social networks (Holme & Newman, 2006; Lazer, Rubineau, Chetkovich, Katz, & Neblo, 2010). In these social models shared opinions are often found between two people who also share a social connection, for example, through friendship; however, shared opinions can also be found between individuals with no direct social connections. In contrast to these models, the data we use to construct our network model does not include any information that directly measures the social connections between students (Pujol, Sangüesa, & Delgado, 2002); thus, shared perceptions in our network may be acquired either due to, or independent of, social connections. This approach has been applied in other network-based research, for example, to identify relationships based on similarity of shared perceptions within large online communities (Pujol et al., 2002).

## Data Source and Participants

Data from the Global Perspective Inventory (GPI) were used. The GPI has been administered to over 150,000 undergraduates at more than 100 colleges and universities. Since interaction with different-race peers is a function of a university's type and size, structural racial diversity, and students' own race, we purposefully selected seven universities for further examination. These universities are similar in type and size, with relatively moderate levels of structural racial diversity, and a range of cross-cultural peer engagement.

To collect data, each university provided invitations to complete an online questionnaire to a subsample of undergraduates; the invitation provided a short description of the purpose of the study and promised anonymity. Institutions used unique numeric identifiers to avoid receiving duplicate responses; students did not receive

incentives for participation. To protect participants' privacy, all individual identifiers were encrypted. A total of 16,684 undergraduates responded to the online questionnaire at the seven universities. We then took a stratified random sample of respondents by institution based on the race/ethnicity and gender variables from the Integrated Postsecondary Education Data System (U.S. Department of Education, 2013).

We used Chang's (1999) diversity index as a measure of structural racial diversity. This index measures the variance in student population across four racial/ethnic groups: African/African American/Black (Black), Asian/Pacific Islander (Asian), European/White (White), and Hispanic/Latino (Latino). More heterogeneous student populations (e.g., 20% Black, 30% Asian, 35% White, and 15% Latino) have higher structural diversity index scores than institutions with more homogenous student populations (e.g., 10% Black, 15% Asian, 25% White, and 50% Latino). The final sample consisted of 12,852 undergraduates from the selected institutions (see Table 1 for campus demographic information).

## Measures

All scales use empirically validated construct measures from the GPI (Merrill et al., 2012). Researchers developed an initial item pool of several hundred items; experts in student development reviewed the items for clarity and credibility. Sixty-nine items were selected for a pilot

test; the final set of items was determined by the factor structure to ensure items measure the constructs under consideration. All scale reliabilities met the minimum required alpha of .70 (DeVellis, 2003).

We collected a cross-sectional data set by merging three distinct, but related, data structures collected by the GPI. The first section requests information specifying personal attributes: institution, gender, race/ethnicity, and age.

The second section obtains information on student engagement factors: The multicultural curricular engagement subscale (1 = *one term*; 2 = *two terms*; etc.) measures engagement in multicultural curricular experiences, such as courses that include opportunities for intensive dialogue among students with different backgrounds and beliefs; service-learning courses; world history courses; global/international issues courses; and courses that address multicultural issues such as race, ethnicity, gender, class, religion, or sexual orientation (five items:  $\alpha = .79$ ). The cocurricular engagement subscale (0 = *never* to 4 = *very often*) measures cocurricular involvement such as participation in community service activities, leadership programs, religious or spiritual activities, and extra-curricular activities sponsored by groups reflecting the student's own cultural heritage (four items;  $\alpha = .76$ ). The cross-cultural peer engagement subscale (0 = *never* to 4 = *very often*) measures the frequency of actual interactions with "students from a country different from your own" and with

Table 1  
*Institutional Characteristics*

Institution no.	Carnegie classification <sup>a</sup>	U.S. region	Total undergrad. enrollment	<i>n</i>	AA	API	W	LAT	NA	ME	NR	SRD
				12,852	849	673	8,236	2,005	28	573	488	.75
1	RU/H	South Atlantic	35,000–40,000	2,596	334	84	348	1,586	2	163	79	.75
2	RU/VH	East South Central	20,000–25,000	4,213	285	123	3,411	52	14	120	208	.63
3	RU/VH	South Atlantic	15,000–20,000	1,111	96	104	752	39	3	66	51	.71
4	RU/VH	West South Central	40,000–45,000	1,986	48	111	1,454	202	5	102	64	.68
5	DRU	East North Central	5,000–10,000	1,491	27	67	1,229	67	3	59	39	.63
6	RU/VH	South Atlantic	15,000–20,000	1,025	53	93	754	45	0	46	34	.68
7	RU/VH	East North Central	25,000–30,000	430	6	91	288	14	1	17	13	.72

*Note.* W = European/White; AA = African/African American/Black; APA = Asian/Pacific Islander; LAT = Hispanic/Latino; NA = Native American; ME = Multiple Ethnicities; NR = I prefer not to respond; SRD = structural racial diversity.

<sup>a</sup> RU/VH: research universities (very high research activity); RU/H: research universities (high research activity); and DRU: doctoral/research universities.

“students from a race/ethnic group different from your own” (two items;  $\alpha = .83$ ).

The third section obtains information on the affordances for interaction with diverse peers, including sense of belonging, campus support for diversity, and openness to cross-cultural interaction. The belonging subscale (1 = *strongly disagree* to 5 = *strongly agree*) measured students’ sense of belonging based on [Hurtado and Carter’s \(1997\)](#) model. The items included “I have a strong sense of affiliation with my college/university,” “I am both challenged and supported at my college/university,” “I am encouraged to develop my strengths and talents at my college/university,” and “I feel I am a part of a close and supportive community of colleagues and friends” (four items;  $\alpha = .82$ ). The campus support for diversity variable (1 = *strongly disagree* to 5 = *strongly agree*) measured students’ perceptions of the campus support for diversity with the item: “I feel that my college/university community honors diversity and internationalism.” The social interaction subscale (1 = *strongly disagree* to 5 = *strongly agree*) measured students’ openness to cross-cultural interaction. This item measured subjective perceptions of students’ openness to interaction with peers from backgrounds different from their own, for example, “Most of my friends are from my own ethnic background” (reversed), “I am open to people who strive to live lives very different from my own life style,” and “I intentionally involve people from many cultural backgrounds in my life” (six items;  $\alpha = .78$ ). [Tables 2](#) and [3](#) report descriptive statistics and confidence intervals for each variable by institution.

## Data Analysis

$H_1$  and  $H_2$  were tested using a multivariate analysis of variance (MANOVA) with race/ethnicity as the independent variable and student engagement factors and affordances for interaction with diverse peers factors as the dependent variables respectively. Separate univariate analyses of variance (ANOVAs) were conducted on dependent variables for factors that exerted significant effects.

$H_3$  and  $H_4$  were tested by constructing a network. We used information from the student engagement factors (multicultural curricular engagement, cocurricular engagement, and cross-cultural peer engagement) and the affordances for interaction with diverse peers factors (sense of belonging, campus support for diversity, openness to cross-cultural interaction) to construct a network by connecting students that share similar perceptions of affordances for interaction with diverse peers in order to examine relationships among students who share similar perceptions of the opportunities to form new relationships in a given university context. Specifically, between each pair of students, we calculated the Pearson correlation coefficient across six factors. We created a network by linking pairs of students with the highest values, thresholding the correlation ( $r > .9267$ ) so that in the final network we will have linked exactly one quarter of all possible student pairs. In the Results section, we quantitatively assess the properties of this network model. By aggregating information from thousands of college student respondents, our results represent general regularities within the context of research universities.

Table 2  
Descriptive Statistics and Confidence Intervals for Student Engagement Factors by Institution

Institution no.	Multicultural curricular engagement		Cocurricular engagement		Cross-cultural peer engagement	
	<i>M</i> ( <i>SD</i> )	95% CI	<i>M</i> ( <i>SD</i> )	95% CI	<i>M</i> ( <i>SD</i> )	95% CI
1	1.21 (1.25)	[1.16, 1.26]	.87 (1.03)	[.82, .91]	.80 (1.24)	[.75, .85]
2	1.18 (1.10)	[1.14, 1.21]	1.27 (1.20)	[1.23, 1.31]	.91 (1.25)	[.87, .95]
3	1.36 (1.00)	[1.31, 1.42]	1.39 (1.05)	[1.32, 1.45]	1.27 (1.40)	[1.19, 1.36]
4	1.26 (1.06)	[1.21, 1.31]	1.92 (1.21)	[1.87, 1.97]	1.45 (1.34)	[1.39, 1.51]
5	1.41 (.99)	[1.36, 1.46]	1.85 (.97)	[1.80, 1.90]	1.67 (1.19)	[1.61, 1.73]
6	1.95 (.98)	[1.89, 2.01]	2.09 (1.09)	[2.03, 2.16]	1.83 (1.52)	[1.74, 1.93]
7	1.13 (1.03)	[1.09, 1.17]	.83 (1.07)	[.79, .87]	2.22 (1.29)	[2.18, 2.26]



Table 3  
*Descriptive Statistics And Confidence Intervals for Affordances for Interaction With Diverse Peers by Institution*

Institution no.	Sense of belonging		Campus support for diversity		Openness to cross-cultural interaction	
	<i>M</i> ( <i>SD</i> )	95% CI	<i>M</i> ( <i>SD</i> )	95% CI	<i>M</i> ( <i>SD</i> )	95% CI
1	3.84 (.73)	[3.81, 3.87]	4.33 (.80)	[4.30, 4.36]	3.85 (.48)	[3.83, 3.87]
2	3.72 (.71)	[3.70, 3.74]	3.84 (.83)	[3.81, 3.86]	3.52 (.51)	[3.50, 3.53]
3	4.11 (.64)	[4.07, 4.15]	4.04 (.85)	[3.99, 4.09]	3.69 (.49)	[3.66, 3.72]
4	4.21 (.69)	[4.18, 4.24]	3.89 (.98)	[3.84, 3.93]	3.68 (.54)	[3.65, 3.70]
5	4.15 (.62)	[4.12, 4.18]	3.79 (.90)	[3.74, 3.84]	3.77 (.44)	[3.75, 3.79]
6	4.04 (.65)	[4.00, 4.08]	4.10 (.76)	[4.06, 4.15]	3.83 (.45)	[3.80, 3.85]
7	3.95 (.67)	[3.91, 3.99]	3.85 (.85)	[3.81, 3.89]	3.74 (.47)	[3.69, 3.78]

To test  $H_5$ , we partitioned students into five groups (A–E) based on their overall connectivity. We evaluated if partitioning students into five groups (A–E) might be sensitive to the correlation threshold chosen to construct the network. Therefore, we reconstructed multiple alternate versions of the network in the same manner as previously described except using correlation thresholds that correspond to a network density ranging from 5% to 50%. The Spearman correlation of the degrees of students in these alternate networks compared to the one presented here (density = 25%) is never less than 0.985, indicating a strong robustness in the results. From this analysis we conclude that our division of students into five groups will not change based on what correlation threshold we use to build the network. A chi-square was performed to determine whether the degree distribution differed by institution.

### Limitations

Our work is not without limitations. First, it is subject to the effects of positivity bias (Stoutenborough, 2008). Positivity bias suggests that students may evaluate impersonal groups, such as their college or university, less favorably than individuals. Therefore, it is possible that a student may indicate they do not have a sense of belonging or that their campus does not support diversity; yet, they believe that they are personally well connected with a warm, supportive group of friends from diverse cultural and ethnic backgrounds. In order to partially address this issue we evaluated the possibility that the network structure might arise from a response bias, randomizing the data used to construct the

network model 100 times. For all randomizations, the degree distribution of the constructed networks was distinct from the U-shaped bimodal pattern we observed when constructing the network from the original data. So, while there are likely some respondents for whom positivity bias may apply, our use of repeated randomizations demonstrates that the observed U-shaped bimodal distribution is not merely a consequence of a general response bias, thus mitigating this limitation.

Second, although single-item measures are commonly used in network analysis where respondents provide summary assessments (Marsden, 2011), a single-item measure for campus support for diversity variable is not ideal. Nor is it ideal to include perceptions of diversity and internationalism together in a single item, since it is possible that students could perceive these things to be different and differentially valued at their institution. The researchers acknowledge that a multi-item scale, limited to students' perceptions of diversity alone, would have provided a more complete measure of the construct. Finally, it should be noted that our network analysis is correlational in nature and thus does not necessarily prove causation. The results, nonetheless, provide evidence for the temporal and reciprocal relations among the factors.

## Results

### Factorial Analysis

To establish a point of comparison, we first analyzed whether the dataset exhibited well-

Table 4

*Descriptive Statistics and Confidence Intervals for Student Engagement Factors by Students' Race/Ethnicity*

	<i>n</i>	Multicultural curricular engagement		Cocurricular engagement		Cross-cultural peer engagement	
		<i>M</i> ( <i>SD</i> )	95% CI	<i>M</i> ( <i>SD</i> )	95% CI	<i>M</i> ( <i>SD</i> )	95% CI
African/African American/Black	849	1.36 (1.21)	[1.27, 1.44]	1.50 (1.30)	[1.41, 1.58]	1.38 (1.45)	[1.14, 1.35]
Asian/Pacific Islander	673	.98 (1.23)	[.89, 1.07]	1.25 (1.39)	[1.14, 1.35]	1.32 (1.61)	[1.20, 1.44]
European/White	8,236	1.22 (1.21)	[1.18, 1.28]	1.44 (1.24)	[1.41, 1.46]	.84 (1.25)	[.79, .89]
Hispanic/Latino	2,005	1.25 (1.13)	[1.22, 1.27]	.98 (1.08)	[.93, 1.02]	1.10 (1.34)	[1.07, 1.12]
Native American	28	1.30 (1.15)	[.90, 1.71]	1.53 (1.26)	[1.10, 1.97]	1.26 (1.50)	[.74, 1.79]
Multiple Ethnicities	573	1.25 (1.16)	[1.16, 1.34]	1.18 (1.14)	[1.09, 1.27]	1.21 (1.39)	[1.10, 1.32]
I prefer not to respond	488	1.35 (1.28)	[1.24, 1.46]	1.31 (1.27)	[1.20, 1.42]	1.14 (1.44)	[1.01, 1.26]

established patterns in the research literature on campus diversity. Main effects were analyzed using a multivariate analysis of variance (MANOVA) to test the first two hypotheses. Tables 4 and 5 report descriptive statistics and confidence intervals for each variable by students' race/ethnicity.

The first hypothesis predicted White students would exhibit less multicultural curricular engagement, more cocurricular engagement, and less cross-cultural peer engagement when compared with students of color. Using Wilk's statistic, there was a small but significant effect of race on student engagement factors,  $\lambda = 0.96$ ,  $F(6, 12,851) = 33.20$ ,  $p < .0001$ ,  $\eta^2 = 0.02$ . Separate univariate ANOVAs on the dependent variables revealed small but significant effects of race on multicultural curricular engagement,  $F(6, 12,851) = 8.23$ ,  $p < .0001$ ,  $\eta^2 = 0.01$ , cocurricular engagement,  $F(6, 12,851) = 69.45$ ,

$p < .0001$ ,  $\eta^2 = 0.02$ , and to cross-cultural peer engagement,  $F(6, 12,851) = 42.436$ ,  $p < .0001$ ,  $\eta^2 = 0.01$ . Asian/Pacific Islander students reported significantly less multicultural curricular engagement than students in all other racial groups. White students reported significantly more cocurricular engagement than Asian/Pacific Islander, Hispanic/Latino, and Multiple Ethnicity students. White students reported significantly less openness to cross-cultural interaction than all other racial groups (see Table 4).

The second hypothesis predicted White students would exhibit more of a sense of belonging, greater campus support for diversity, and less openness to cross-cultural social interaction than students of color. Using Wilk's statistic, there was a small but significant effect of race on perceptions of affordances for interaction with diverse peers,  $\lambda = 0.92$ ,  $F(6, 12,851) = 61.29$ ,  $p < .0001$ ,  $\eta^2 = 0.03$ . Separate univar-

Table 5

*Descriptive Statistics and Confidence Intervals for Affordances for Interaction With Diverse Peers by Students' Race/Ethnicity*

	<i>n</i>	Sense of belonging		Campus support for diversity		Openness to cross-cultural interaction	
		<i>M</i> ( <i>SD</i> )	95% CI	<i>M</i> ( <i>SD</i> )	95% CI	<i>M</i> ( <i>SD</i> )	95% CI
African/African American/Black	849	3.83 (.77)	[3.77, 3.88]	3.83 (1.04)	[3.79, 3.90]	3.77 (.50)	[3.75, 3.82]
Asian/Pacific Islander	673	3.32 (1.64)	[3.20, 3.44]	3.42 (1.64)	[3.30, 3.54]	3.82 (.45)	[3.79, 3.85]
European/White	8,236	3.89 (.79)	[3.85, 3.92]	4.23 (.88)	[4.20, 4.27]	3.62 (.51)	[3.61, 3.63]
Hispanic/Latino	2,005	3.85 (1.04)	[3.82, 3.86]	3.87 (1.05)	[3.85, 3.90]	3.85 (.48)	[3.82, 3.87]
Native American	28	3.74 (.71)	[3.49, 3.99]	4.03 (.83)	[3.74, 4.32]	3.63 (.47)	[3.47, 3.80]
Multiple Ethnicities	573	3.71 (1.07)	[3.63, 3.79]	3.87 (1.13)	[3.79, 3.96]	3.84 (.50)	[3.80, 3.88]
I prefer not to respond	488	3.52 (1.04)	[3.43, 3.61]	3.64 (1.10)	[3.54, 3.73]	3.64 (.60)	[3.59, 3.69]

iate ANOVAs on the dependent variables revealed small but significant effects of race on sense of belonging,  $F(6, 12,851) = 37.28, p < .0001, \eta^2 = 0.02$ , campus support for diversity,  $F(6, 12,851) = 65.46, p < .0001, \eta^2 = 0.03$ , and openness to cross-cultural social interaction,  $F(6, 12,851) = 87.56, p < .0001, \eta^2 = 0.04$ . Asian/Pacific Islander students reported significantly less sense of belonging than students from all other racial groups. White students reported significantly greater campus support for diversity than students from all other racial groups. White students reported significantly less openness to cross-cultural interaction than students from all other racial groups except Native American students (see Table 5).

### Analysis of Network Structure

The third hypothesis predicted that the overall network degree distribution would be scale-free, that is, a highly right-tailed distribution where a large majority of participants have only a few connections, but a few participants have many connections. To test this hypothesis, we constructed a network model in which a link between two students represented a shared perception of affordances for interaction with diverse peers. The final network contained over 47 million connections between 12,852 students. To quantify patterns among connections in the full network, we investigated the degree of, or number of connections made to, students in our model. The “degree” of a node (student) is the number of connections made to that node; the degree distribution can be displayed with a histogram of the relative frequencies of students for consecutive, nonoverlapping intervals of the number of connections made. The distribution of these degree values is shown in Figure 1, and indicates that the network is not scale-free; it structurally contains two modes. The left-side mode (few network connections) contains a wide variety of many small networks of students, each network with *distinctly similar perceptions* of the affordances for interaction with diverse peers. The right-side mode (many network connections) contains one relatively large network of students who share *one strongly similar dominant perception* of the affordances for interaction with diverse peers.

To test whether the degree distribution might be explained by chance from the underlying

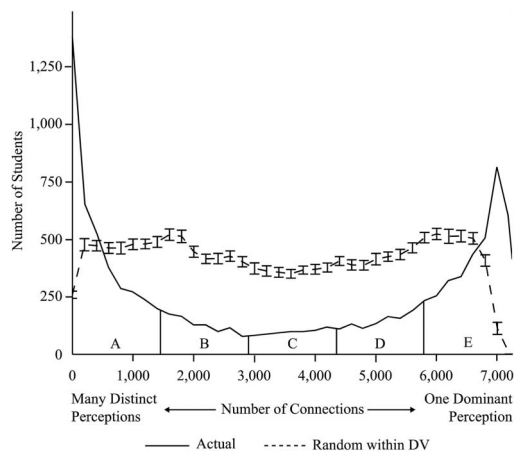


Figure 1. Distribution showing the number of students that have a given number of connections in the network model (solid line) as well as the number of student that have a given number of connections, averaged across 100 randomizations within the measured variables (dashed line, error bars indicate  $\pm 1 SD$ ). The distribution generated from the randomized data is distinct from the bimodal observed in the actual data, indicating that the network model distribution cannot be explained by chance. For the network model produced using the actual data, we divided the students into five groups, labeled A–E, based on their number of connections in the network model.

distribution of the values of each of the six factors, we randomized the data used to construct the network model. For each factor, we randomly reordered the measured values, and then assigned those randomly ordered values to the (not randomly ordered) students. In this permutation the distribution within each factor stayed the same, but the pattern an individual student has across the six factors reflects a random sampling from the data. We repeated this randomization 100 times, constructing a network (described above) and calculating the resulting degree distribution for each randomization. In Figure 1, we plot the average distribution, with error bars representing the standard deviation across the 100 randomizations. The degree distribution of the networks constructed from this randomized data is fairly flat and distinct from the U-shaped bimodal pattern in the original data. Therefore, the degree distribution reflects a fundamental pattern in shared perceptions of the affordances for interaction with diverse peers that is not obtainable by chance.

The fourth hypothesis predicted a high level of assortativity in the network model. To test

this hypothesis, we assessed the assortativity of the network—the extent to which students with either few, or many, connections tend to preferentially be connected to other students with either few, or many, connections, respectively—by calculating the assortativity coefficient,  $r$  (Newman, 2002). We observed a high level of degree assortativity in our network,  $r = .408$  (Newman, 2003b). An illustration of the assortativity of the full network would be too visually complex to convey detailed information; however, to illustrate the network's assortativity, Figure 2 visualizes connections among a subset of 200 randomly selected students. In this visualization, each node (circle) represents one of the randomly selected students; students are connected (black lines) if they share a similar perception of the affordances for interaction with diverse peers, the nodes are colored based on the student's response to the "campus support for diversity" item (light gray = 5, medium gray = 4, dark gray = 3 or less), and the number in the node is the rounded average across the three multicultural engagement factors. The structure of this small subnetwork appears to be one of a tight "core" with very high connectivity between nodes as well as a "fringe" of nodes with only a few or no connections. Although we only show one example here, the subnetworks associated with other random selections of 200 students produce visually similar results.

The fifth hypothesis predicted that network degree distribution would differ by institution. The chi-square obtained demonstrated a significant association between institution and the network degree distribution into the five groups (A–E),  $\chi^2(30) = 774.04, p < .0001$ . Institutions 1–3 exhibited the unexpected U-shaped bimodal distribution; Institutions 4–7 exhibited the expected heavy right-tailed distribution (Table 6).

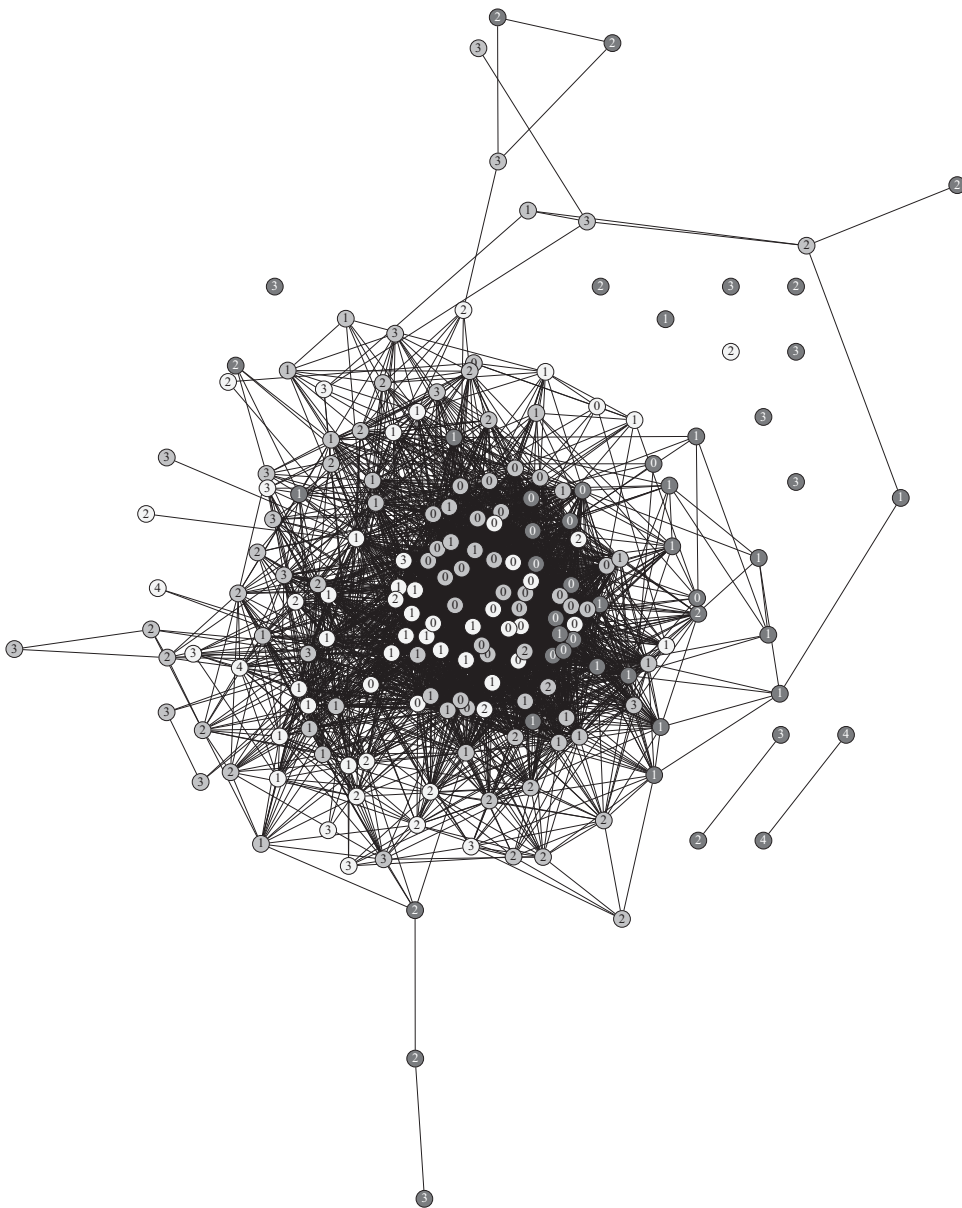
## Discussion

We utilized a network model in order to explore the relationship between patterns of student engagement and affordances for interaction with diverse peers at seven universities which are similar in type and size, with relatively moderate levels of structural racial diversity, and a range of cross-cultural peer engagement. The results supported the first hypothesis: White students reported more cocurricular engagement but less openness to cross-cultural

interaction than their peers from all other racial groups; Asian/Pacific Islander students reported less multicultural curricular engagement than their peers from all other racial groups. The results supported the second hypothesis: White students reported significantly greater campus support for diversity and less openness to cross-cultural interaction than their peers from all other racial groups; Asian/Pacific Islander students reported less sense of belonging than their peers from all other racial groups.

The results for the third hypothesis were contrary to our expectations: the overall network had two modes, which is at odds with the highly right-tailed distributions found in most network models. The results supported the fourth hypothesis: students with a particular network connectivity were most likely to share similar perspectives of the affordances for interaction with diverse peers with other students that have the same or similar network connectivity. The results supported the fifth hypothesis: the institutional network structure varied by overall cross-cultural peer engagement.

To date, much of higher education diversity research has examined the effects of diversity on individual students (Chang et al., 2006; Gurin et al., 2002). Network analysis allows diversity researchers to take a broader perspective of student perceptions by examining the effects of cross-racial interaction on the network structure as a whole (Clarke & Antonio, 2012). Our network approach examined the extent to which various perceptions were *shared* among network members. In most networks, only a few participants have many connections, while most participants have only a few connections, since network members prefer to make connections with similar others (Barabási & Bonabeau, 2003; Strogatz, 2001). This preference generates a highly right-tailed distribution (McPherson et al., 2001). Surprisingly, the overall network in this study exhibited an unusual U-shaped bimodal pattern rather than the typical right-tailed one. The structure of our network, with its U-shaped distribution, exhibits a large tight "core" of students with very high connectivity and an equally large "fringe" of students with few connections. Both "core" and "fringe" perceptions coexist within the same network; however, the number of students in the "core" is much larger than what is typical of most real world networks (Newman, 2003a; Watts, 2007).



*Figure 2.* A randomly selected portion of the network model. Each node (circle) represents one of 200 randomly selected students. In the network model students are connected (black lines) if they share a similar perception of the affordances for interaction with diverse peers, measured by the Pearson correlation ( $>0.9267$ ). The nodes are colored based on the “Campus Support for Diversity” rating (light gray = 5, medium gray = 4, dark gray = 3 or less). The number in the node is the rounded average across the three student engagement variables.

The findings indicate that students in the “core” (many connections) share one dominant perception of the affordances for interaction with diverse peers with many other students that also have a

high number of connections. Similarly, students in the “fringe” (few connections) may not share their perception of the affordances for interaction with diverse peers with many other students, but when

Table 6  
*Degree Distribution Group (A-E) by Institution*

Institution no.	Distribution shape	(A) Degree range 0–1,446	(B) Degree range 1,447–2,892	(C) Degree range 2,893–4,338	(D) Degree range 4,339–5,785	(E) Degree range 5,786–7,231
	<i>n</i>	4,794	1,362	977	1,529	4,190
1	U-shaped bimodal	779	241	195	350	1,031
2	U-shaped bimodal	1,365	347	257	481	1,763
3	U-shaped bimodal	348	109	93	150	411
4	Right-tailed	884	261	167	199	475
5	Right-tailed	675	219	148	194	255
6	Right-tailed	523	145	88	101	168
7	Right-tailed	245	58	39	45	43

they do, it is most likely with other students that have only a few connections in our network. Moreover, our network exhibited a high-degree of assortativity, meaning that there is little mixing between the “core” and “fringe” groups, and students in these two subnetworks had significantly fewer connections with one another than would be expected if mixing occurred at random (Newman, 2002, 2003b).

The findings highlight the centrality of institutional context in the creation of network structures among students. We purposefully selected seven institutions similar in type and size, with relatively moderate levels of structural racial diversity, and a range of cross-cultural peer engagement. Institutions 1–3, which reported low levels of cross-cultural peer engagement (None to Rarely), exhibited the unexpected U-shaped bimodal distribution. Institutions 4–7, which reported moderate levels of cross-cultural peer engagement (Rarely to Sometimes), exhibited the typical highly right-tailed distribution. Thus, the overall network structure is primarily due to the inclusion of Institutions 1–3 in our sample, where cross-cultural peer engagement is rare. This pattern suggests that rare or no cross-cultural peer engagement results in the development of a dominant view of the affordances for interaction with diverse peers by a large group of students which coexists alongside a typical range of distinct views of many smaller groups of students. Even moderate levels of cross-cultural peer engagement (Rarely to Sometimes) characteristic of more numerous weak ties reflects a typical distribution of a range of distinct views held by a variety of smaller groups of students (Chi & Suthers, 2015; Granovetter, 1973; Pachucki & Breiger, 2010).

As the overall level of cross-cultural peer engagement increases, a greater variety of in-

formation about the affordances for interaction with diverse peers is exchanged (Granovetter, 1973; Oishi & Graham, 2010; Pachucki & Breiger, 2010); consequently, groups develop a greater range of views about the affordances for interaction with diverse peers. This exchange of information may result in some groups developing more negative views of their campus (high openness to cross-cultural interaction thwarted by diminished belonging and negative views of campus support for diversity). At the same time, this exchange of information may result in other groups developing more positive views of their campus (high openness to cross-cultural interaction with enhanced belonging and positive views of campus support for diversity). This exchange of perceptions may also help to illuminate issues of cross-cultural exchange that those holding positive views may not be aware of. For example, if students holding negative views, due to diminished belonging and negative views of campus support for diversity, were not a part of the dominant core network, their interactions with the dominant core could help expose falsely held assumptions about the socioecological context of the university. Such exposure could help campuses more accurately assess their attempts in fostering campus cultures that support inclusion and cross-cultural interactions. Regardless of the view itself, the exchange of a greater variety of information results more differentiated, independently minded views of the campus context within subgroups (Locks et al., 2008).

The results add further support to consistent patterns found by diversity researchers. First, White students reported less openness to cross-cultural interaction and less actual cross-cultural peer engagement than their peers from

all other racial groups (Hall et al., 2011; Sáenz et al., 2006); yet, they reported greater perceptions of campus support for diversity than their peers from all other racial groups. Second, as an aggregate, students in the “core” (many connections) reported participating in few to none multicultural activities but reported generally positive perceptions of the affordances for interaction with diverse peers (high belonging, high campus support for diversity, and high openness to cross-cultural interaction), suggesting that more distinct perceptions are dependent on student engagement (Pike & Kuh, 2006). We believe the consistency of these findings with previous research bolsters the credibility of the new findings we report regarding heterogeneous peer interactions and network structure.

The results of this study illustrate heterogeneous and homogenous student networks at seven institutions, as well the characteristics of the campuses in which these networks exist. The findings illustrate how interactions with diverse peers foster the exchange of a greater variety of information (Chi & Suthers, 2015; Granovetter, 1973), where students develop more differentiated, independently minded views of the campus context (Locks et al., 2008). We explore the reasons for these results and their implications for theory and practice below.

### **Implications for Practice**

The findings suggest several implications for practice. Below we highlight specific proposals by which practitioners might increase the exchange of a greater variety of information and perspectives between students of varying backgrounds.

**Intergroup dialogue.** Given the importance of cultural competence and the ability to work across differences (Jayakumar, 2008), faculty and administrators must analyze how the curriculum allows for student exchange of a greater variety of information and perspectives. Students develop expectations for engagement with diverse peers and perspectives long before their first year of college (Hall et al., 2011; Harper & Yeung, 2013). While general education courses may offer the opportunity for students to take courses that allow them to engage in class discussions and meet peers from

different backgrounds, this is not guaranteed (Milem et al., 2005). We believe specific course offerings should be made available, or required, to help to foster frequent and meaningful discussions on diversity, such as the intergroup dialogue model adopted at many institutions across the nation (Gurin et al., 2002; Gurin & Nagda, 2006). Intergroup dialogue allows students to exchange differing perspectives and engage in sustained discussions of their experiences through the lens of a specific social identity such as race, gender, ability, spirituality, or sexual orientation (King et al., 2013). Likewise, introductory courses in Ethnic Studies, Women’s Studies, Queer Studies, and so forth could also serve as a springboard for first year diversity requirements (Milem et al., 2005). Observing behaviors and techniques of intergroup dialogue in a classroom setting provides students with a framework in which to engage in these discussions outside-of-class.

**Collaborative programming.** Much of a student’s collegiate experience takes place out of the classroom in a cocurricular environment (Hurtado et al., 1998; Pike & Kuh, 2006). Traditional models of cocurricular activities have often been described as silos, with little collaboration, strategic planning, or sequencing in approaching student development (Glass, 2013). This siloed-approach inhibits the exchange of information across student subcultures (Pachucki & Breiger, 2010; Rienties et al., 2015). Campuses should encourage student affairs professionals to work collaboratively on programming that encourages the creation of weak ties among students. We propose three examples: First, Offices of Fraternity and Sorority Life could promote collaboration between organization governing councils. These collaborations typically go beyond team pairings for Greek week, encouraging collaboration over a course of multiple weeks or months. Second, residence life offices can employ the use of an emerging practice known as the Residential Curriculum, which practically supports collaboration with campus partners to focus on student experiences, sequential developmental interventions, and continued assessment of outcomes. Third, Orientation and First Year Experience programs have a large role in setting the tone for subsequent cross-cultural interactions. Holding workshops on dialoguing across differences, creating chances for

students to share lived experiences, and modeling expectations for cross-cultural exchange can play pivotal roles in how incoming students engage with peers as they journey through college (Bryant Rockenbach et al., 2014).

**Assortative mixing in institutional assessment.** Network approaches may supplement traditional measures of campus structural diversity (Chang, 1999; Hurtado et al., 1998). The potential significance of network structure on student learning is suggested by recent research which highlights effects attributable to the social connections of students whose peers engaged in diversity-related coursework and cocurricular activities (Denson & Chang, 2009). Since humans have a propensity to connect (or not connect) to others based on gender, race, and class (McPherson et al., 2001; Park & Denson, 2013), one indicator of the affordances for student interaction with diverse peers is the assortativity of a network. In more disassortative networks, students will still exhibit a propensity to associate with peers based on some characteristics, but they will also exhibit mixing based on others, as in our example of an international business student organization in the introduction of this article. More disassortative networks provide greater affordances for sustained cross-racial interactions which have been linked to greater self-reported engagement, well-being, and leadership regardless of a student's race (Bowman, 2013; King et al., 2013).

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