



## **Multicultural dynamics in First-Year Engineering teams in the U.S.**

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## INTRODUCTION

In the last decade, U.S. universities have experienced a significant increase in the number of international students. As reported by the Institute of International Education, the number of international students studying in the U.S. has grown by 40% from 2002/03 academic year to 2012/13 academic year <sup>1</sup>. Business/Management and Engineering are the most popular fields of study among international students, with an average population of 22% and 19% respectively <sup>1</sup>. In some institutions, such as Purdue University, the population of international students in the First-Year Engineering program can be as high as 25% <sup>2,3</sup>.

The increase in the number of international students in the last years is due to multiple factors, as follows: 1) the desire of international students, in particular from India and China, to get top quality education from the best universities in the world <sup>4</sup>, 2) U.S. universities seeking the best students around the world, 3) U.S. universities wanting to provide a more “global” experience for domestic students <sup>5</sup> and 4) U.S. universities looking for other sources of income <sup>5</sup>. Regardless of the reasons behind the migration of undergraduate students to America, U.S. institutions are now faced with the challenge of developing appropriate educational practices for the success of both domestic and international students in their academic programs.

International students experience a variety of adjustment issues that affect the teaching and learning processes that take place in the classrooms. The primary issues are associated with cultural differences, communication, psychological states of mind and academic challenges <sup>6-8</sup>. For example, students from Asia who come from very structured and hierarchical societies are used to a passive-learning, instructor-led approach to education. Those students must adapt to the more active, student-driven education style, found in U.S. institutions <sup>9</sup>.

Developing teamwork skills is essential for any engineering professional since engineering is by nature a collaborative discipline <sup>10</sup>. The importance of this skill is widely recognized and it is demanded by education accreditation agencies <sup>11,12</sup> and employers all over the world <sup>13</sup>.

The development of teamwork skills is an educational process that vividly feels the impact of having a culturally diverse population. In programs with a significant number of international students, students will have the opportunity to develop the skills to work in teams with people from different cultural and communication backgrounds. Although learning to work efficiently in multicultural teams is beneficial for both domestic and international engineering students, it is not an easy task <sup>14,15</sup>. The inherent diversity of multicultural teams has a great impact in team dynamics. It might inhibit team cohesion and led to misunderstandings in communication, factionalism, and disagreements between teammates <sup>15-17</sup>. On the other hand, the great advantage of working in multicultural teams is that people from different backgrounds bring a broader range of perspectives, points of view and ideas to the team discussion that ultimate lead to more robust, flexible and innovative solutions <sup>15,18,19</sup>.

Culture’s structural organization and practices are often reflected on team-member’s perspectives and expectations of team dynamics. In hierarchical, context-orientated cultures such as China and Mexico, levels of authority are well defined and interdependence from others in the society is essential<sup>9</sup>. When working in teams, people from these cultures value team harmony

and preserve it at all times, even if it means avoiding confrontation.<sup>9,20</sup> For them, relationships prevail over tasks. Usually, decisions are made by the team or by a team leader. On the other hand, in flat, independently-oriented cultures, such as U.S. and U.K., teams acquire a flatter organization<sup>9</sup>. Conflict is discussed openly, communication is direct and team-members make decisions independently as needed, without consulting with the team<sup>9</sup>. These differences can play to the advantage or detriment of the team, depending on the situation and the context.<sup>21,22</sup> For instance, team interdependence and cohesiveness can be favored by having team-members from context-oriented societies who will create rapport and consensus among team-members. However, at the same time, team conflict can be increased if disagreements and differences are not dealt with in a healthy and timely manner.

To help international and domestic students to develop the appropriate skills to work in multicultural teams and to better serve the needs of all students, this study explored how the presence of international students affects team dynamics in first-year engineering. Data on student's perceptions on team interdependence, cohesion, conflict and satisfaction were collected in a first-year engineering class. The findings were correlated with students' nationality and the language of their previous instruction before enrolling in the engineering program. Results showed team dynamics to be significantly different when non-U.S. students account for half or more of the team. In these cases, teams exhibit low levels of cohesiveness, high levels of conflict, and low levels of team satisfaction. When investigated further, it was found that in heterogeneous teams, domestic students show the lowest satisfaction levels. Results also showed a strong influence of culture and a moderated effect of language of previous instruction on students' perceptions of team dynamics.

## **METHODS**

### **1. Participants**

Participants in this study were 1524 students enrolled in 15 sections of a first-year engineering course in a large Midwestern research university in Fall 2013. The participants were selected because of the high number of non-U.S. students enrolled in the course (22%) and because most of the course learning spaces are designed around teams - students develop projects and in-class activities in teams during the semester.

Non-U.S. students came from 29 countries, predominantly from China (45%), India (36%), and South Korea (5%). Gender distribution of U.S. and non-U.S. students was quite similar, with 22% of U.S. students being females versus 17% in the non-U.S. student's population. U.S. student's population was predominantly white (72%), with most representative minorities being American-Asians (12%) and American-Hispanic/Latinos (10%).

### **2. Data collection before teaming**

Student information was collected from university records and using a Team-Maker survey<sup>23</sup> administered at the beginning of the semester. The Team-Maker survey provided information about student's gender, race/ethnicity, previous language of instruction, times unavailable for meeting outside of class, and class level (the class enrolls some non-first-year students). In this

study information about immigration status (U.S. or non-U.S. citizen or permanent resident) and nationality of students was taken from University records and students' previous language of instruction was taken from self-reports. The self-reported language of previous instruction was used as an indication of a student's proficiency in English. It was assumed that students whose previous language of instruction was English had a higher proficiency level in English.

### **3. Team formation procedure**

Team-Maker assigned students to teams of 3 or 4 people using the data collected in the survey and pre-defined criteria by the instructors. The Team-Maker algorithm is described elsewhere<sup>23</sup>. For this course, the criteria used to form teams were: 1) availability for meeting outside class, 2) team size (maximum 4), 3) language of previous instruction (dissimilar), 4) Gender (don't outnumber), 5) Race/ethnicity (don't outnumber) and 6) Class level (dissimilar). The team-formation criteria were the same for all 15 sections.

A total of 386 teams were formed, of which 226 (59 %) were multicultural teams. Of these multicultural teams, 129 (57%) had a majority of U.S. students, 79 (5%) had equal number of U.S. and non-U.S students and only 18 (14%) had a majority of non-U.S students.

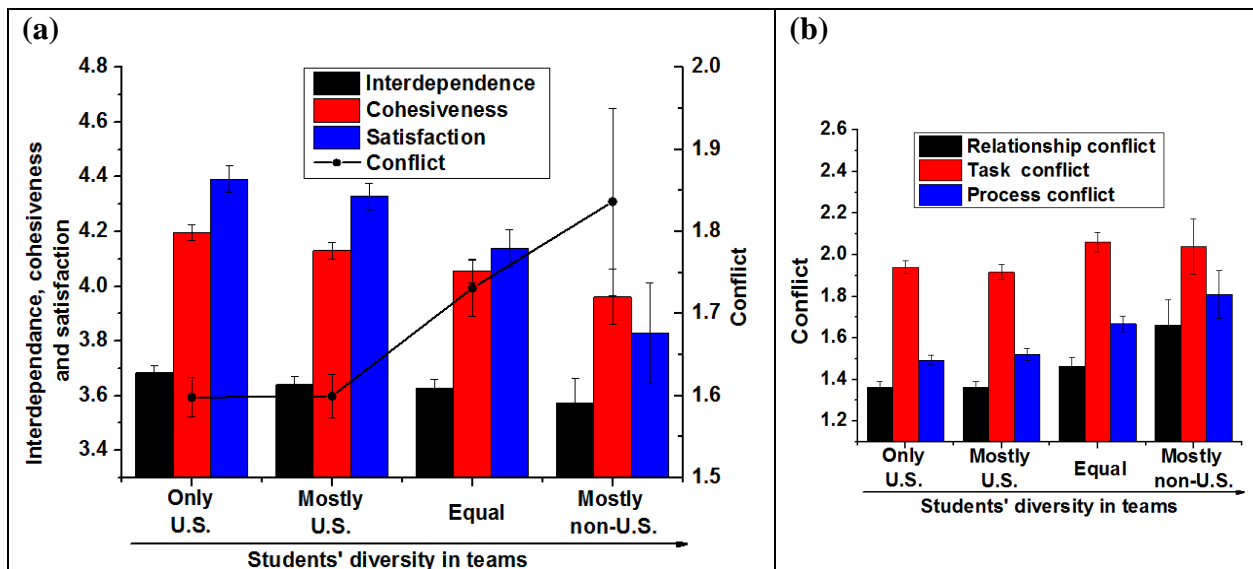
### **4. Data collection for team dynamics characterization**

Data on different team-level outcomes were collected using supplementary questions included at the end of peer-evaluations administered four (4) times during the semester (in weeks 6, 9, 12 and 16). Interdependence was measured in the first administration to verify if students had started to share information, materials, knowledge, etc. and remediate if necessary. Cohesiveness was measured in the second administration to identify if students were being attracted to the team and remediate if necessary. Conflict was measured in the third administration to identify and help teams with high levels of conflict. Finally, satisfaction was measured last to assess the overall team experience. Interdependence, cohesiveness, conflict and satisfaction are some of the most relevant issues to characterize team's dynamics. The questions associated with each outcome were taken from the literature<sup>24-27</sup>, and were rated on a Likert-type-scale (from 1 to 5, where 5 = Strongly Agree). These outcomes can be used individually to represent the experience of individual team members, reported as the average for a subpopulation (e.g., non-U.S. students), or they may be reported as team averages. The effect of team diversity—with respect to immigration status—on each of these outcomes was also studied. For the purpose of this study, students were grouped in teams with only U.S. students, teams with mostly U.S. students (teams of 3 or 4 people with only one non-U.S. student), teams with equal number of U.S. and non-U.S. students and teams with mostly non-U.S. students (teams of 3 or 4 people with only one U.S. student).

## RESULTS

### 1. Team dynamics and team diversity

This study used the four characteristics of team dynamics— interdependence, cohesiveness, conflict and satisfaction – as an initial approximation for understanding the effect of multiculturalism on team dynamics. Figure 1(a) shows the effect of team diversity on each of the team dynamic characteristics studied here. Team dynamics characteristics of team of U.S. students and mostly U.S. students are very similar. As team composition changes to include more non-U.S. students, teams exhibit lower levels of cohesiveness, higher levels of conflict, and lower levels of team satisfaction ( $p$ -value < 0.05 for teams with equal or mostly non-U.S. students compared to teams with only U.S. students). Interdependence is the only team dynamics characteristic that seems to be unaffected by diversity of students in teams.



**Figure 1.** Team dynamics characteristics by team diversity. (a) Team level-outcomes. (b) Types of conflict. Data: Mean  $\pm$  standard error

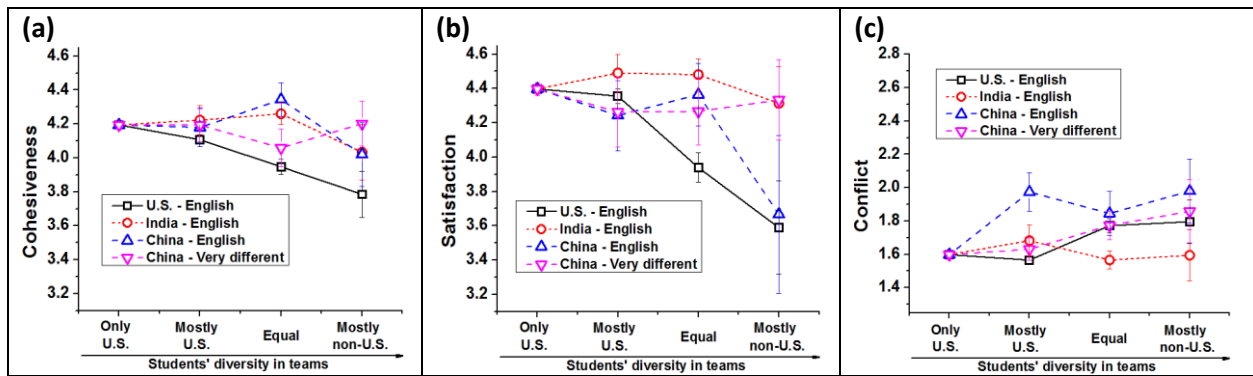
To better understand the effects of multiculturalism in conflict, this study measured levels of relationship conflict, task conflict and process conflict in teams. As shown in Figure 1(b) all types of conflict show an upward trend as the proportion of non-U.S. students increases in teams. Task conflict is rated the highest, followed by process conflict and relationship conflict. Similar to the other team dynamics characteristics, all types of conflict are rated very similar in teams with only U.S. students and mostly U.S. students. When teams have equal number of U.S. and non-U.S. students, a significant increase in all types of conflict is observed. Task and relationship conflict continue to increase as the proportion of non-U.S. students increases but task conflict remains the same, suggesting that relationship conflict and process conflict have the greatest response to team composition.

## 2. Individual perspectives of students on team dynamics characteristics

To further investigate if cultural and language differences could explain the observed team dynamics, the individual perspectives of students on team dynamics were disaggregated depending on the students' country of origin and their self-reported language of previous instruction. In general, U.S. students experience lower levels of cohesiveness and satisfaction than non-U.S. students when they are in teams in which U.S. students are not the dominant group ( $p$ -value < 0.10). On the other hand, levels of cohesiveness, satisfaction and conflict of non-U.S. students show small variations associated with team diversity, except for students from China with an English background. These students exhibit low satisfaction levels when they are part of teams with mostly non-U.S. students.

Students from different countries (U.S., China and India) with same previous language of instruction (English) perceived team dynamics differently (Figure 2). For example, in teams with equal number of U.S. and non-U.S. students, students from India-English (who reported English as previous language of instruction) seemed to be more satisfied than students from China-English and U.S. ( $p$ -value < 0.05). Also, India-English students reported lower levels of conflict compared to students from other countries ( $p$ -value < 0.05). This result indicates that there are two effects at work on team dynamics—cultural differences and language differences.

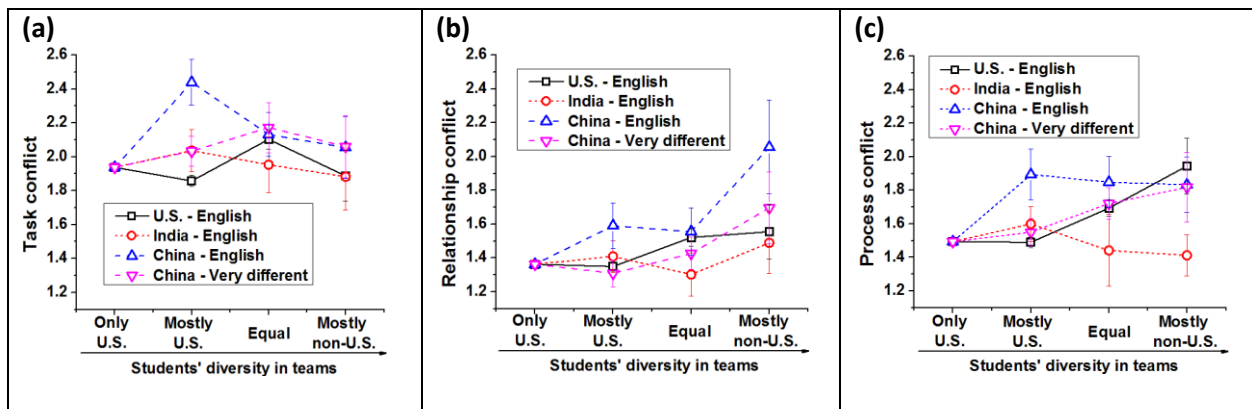
There were commonalities and differences in the perception of team dynamics characteristics by Chinese students depending on their language background. For example, in teams with mostly U.S. students, Chinese students reported similar levels of cohesiveness and satisfaction regardless of language background but there was a big difference in the perception of conflict between Chinese students whose previous language of instruction was English or very different from English ( $p$ -value < 0.05). This result suggest that language proficiency might have some effect on the perception of team dynamics but it is not the main factor driving it.



**Figure 2.** Individual perspectives on team dynamics characteristics depending on team composition, student's country of origin and language of previous instruction. Data: Mean  $\pm$  standard error.

### 3. Individual perspectives of students on different types of conflict

Students from different countries perceive types of conflict differently. In many cases, these perceptions are also dependent on team composition. In general, Chinese students with previous instruction in English experience higher levels of all types of conflict (Figure 3). Task conflict is particularly highly rated by these students when they are working in teams with mostly U.S. students ( $p$ -value < 0.05) (Figure 3(a)). On the other hand, when Chinese students with previous instruction in English are in teams with mostly non-U.S. students, they perceive higher levels of relationship conflict ( $p$ -value < 0.10) (Figure 3(b)). These students also have higher perceptions of process conflict compared with other students, regardless of team composition ( $p$ -value < 0.10) (Figure 3(c)). Surprisingly, U.S. students and Chinese students with a previous instruction in a language very different from English have similar perceptions of all types of conflict. For these students, relationship and process conflict seem to positively correlate with diversity in team composition (Figure 3(b-c)). On the other hand, the perception of task conflict for U.S. students and Chinese students with a previous instruction in a language very different from English seem to peak when these students work in teams with equal number of U.S. and non-U.S. students (Figure 3(a)). Finally, Indian students show the lowest levels of conflict, for all three types of conflict, independent of team composition except when they work in teams with mostly U.S. students (Figure 3). In this case, Indian students show similar levels of relationship and process conflict to U.S. students (Figure 3(b-c)), and higher levels of task conflict compared to U.S. students (Figure 3(a)).



**Figure 3.** Individual perceptions of different type of conflict depending on team composition, student's country of origin and previous language of instruction. (a) Task conflict, (b) Relationship conflict and (c) Process conflict. Data: Mean  $\pm$  standard error.

## DISCUSSION

Identifying and understanding the factors that influence multicultural team dynamics at the level of first-year engineering classes is the first step towards designing good practices to improve the development of team skills of domestic and international students, in particular in engineering programs with high enrollment of international students. This study characterized team dynamics of multicultural teams in a First-Year Engineering course by measuring four

characteristics of team dynamics—interdependence, cohesiveness, conflict and satisfaction. The influence of culture, language background and team diversity on these characteristics was investigated. The results showed that team diversity, understood as the proportion of U.S. and non-U.S. students, had a dramatic effect on team dynamics characteristics, particularly on team conflict and satisfaction. Country of origin and language of previous instruction influenced the perception of students about multicultural teams' dynamics, suggesting an influence of culture and communication on team's function.

### **1. Individuals in multicultural teams have heterogeneous perceptions of team dynamics characteristics**

Team composition affect team dynamics in different ways depending on the proportion of non-U.S. students in the team. It was found that the individual perceptions of team dynamics of members of these multicultural teams are not homogeneous. U.S. students perceive lower levels of conflict than non-U.S. students in multicultural teams with mostly U.S. students. This asymmetry could be the result of exclusionary practices by U.S. students (the dominant group) and/or settling behaviors from non-U.S. student (the minority group)<sup>28,29</sup>. Both of these behaviors, 1) exclusion of others based on their outgroup status, for example gender, age, novelty, and in this case immigration status, and 2) pressure to give into the desires of the majority are not uncommon when group exclusion takes place and are typical of students in the common age range of first-year students<sup>29</sup>. Proper coaching and advising of these teams, oriented to minimize exclusionary practices by U.S. students and maximize participation of non-U.S. students, should be beneficial to improve team performance and satisfaction with the team experience in these cases.

As diversity increases, cohesiveness and satisfaction of multicultural teams dramatically drop, mainly due to the negative perceptions of U.S. students. This asymmetry suggest that U.S. students working in multicultural teams in which they are not the majority do not feel attracted to their team and do not feel comfortable working with their teammates. Some of these dissatisfaction and conflict might come from the formation of cliques within highly diverse multicultural teams.<sup>30</sup> Cliques might arise due to commonalities in culture, language and communication styles and they might be a strategy for students to deal with the fact that they are working in a multicultural team. In the case of U.S. students, the clique might offer the possibility to stay in a comfort zone and not having to accommodate to the different communication and work style that non-U.S. students might bring. On the other hand, the clique might help non-U.S. students to deal with adjustment issues such as loneliness and low feelings of belonging. Other research has shown that the segregation caused by cliques compromises communication among team-members and is detrimental for team work<sup>30,31</sup>—the results of this study align with these findings. Coaching and advising focused on opening communication channels among team members and discouraging clique-oriented behaviors might help these teams to function better.



## **2. Cultural differences and language proficiency as elements in dynamics of multicultural teams**

It is widely accepted that cultural and communication differences are two of the main challenges that face multicultural teams<sup>14,15,20</sup>. In this study the effects of culture and language proficiency on team dynamics characteristics were observed. The results showed that language proficiency, although necessary for communication among team-members, was not as influential as culture on team dynamics. This is not surprising since many aspects of effective communication, beyond language proficiency, are strongly influenced by culture<sup>32-35</sup>. For example, Eastern cultures with high levels of collectivism prefer indirect communication styles while in American culture, due to its high levels of individualism, a direct communication style is preferred<sup>9</sup>. Culture also affects perceptions of interdependence, cohesiveness, satisfaction and conflict. For example, the direct communication style of American culture might seem aggressive to students from Eastern cultures in which team harmony and indirect communication styles are preferred. As a results, these students might have a higher perception of conflict than American students.

Our current approach to improve teamwork experience involves the use of a behavioral anchored tool for team-member effectiveness that describes the behavior of effective team-members (CATME)<sup>36</sup>. These approach has the advantage of clearly state the expectations about team-member behavior for every student, regardless of their cultural background. Students do self- and peer-evaluations of their performance in the team using the CATME tool four times during the semester. This allows students to constantly reflect and receive feedback about their own behaviors as part of the team. Using this approach, U.S. and non-U.S. students in this first-year engineering program have shown improvements in their overall team-member effectiveness throughout the semester (data not shown), but this approach might not be enough.

Overcoming cultural differences might seem the way to improve team experience of first-year students in multicultural teams. However, even the most experienced professionals have difficulties when working in multicultural teams. An additional step to improve the experience of freshman students working in multicultural teams could be helping students to become aware of their own culture and how it is different from others' culture – in other words, help students to develop cultural competence<sup>14,15,20</sup>. Good advising, instruction and even including some culture awareness activities as part of the course program might be the starting steps towards developing cultural competence.

## **CONCLUSIONS AND FUTURE WORK**

The results from this research raise awareness of the consequences of globalizing the campus and shed light on the challenges associated with the development of professional skills in engineering students (domestic and international). Specifically, these findings have implications for the way student teams are formed and how instructors or others coach/advise multicultural teams to maximize team skill development and team member satisfaction. Future research might investigate the development of team skills if some of the strategies associated with developing cultural awareness are implemented in the first-year engineering program. Also, it will be interesting to investigate the influence of cultural background on survey response.

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## REFERENCES

- (1) Open doors Fast Facts 2013 <http://www.iie.org/Research-and-Publications/Open-Doors/Data/Fast-Facts> (accessed Apr 2, 2014).
- (2) Purdue University. Data Digest 2013 - 2014 <http://www.purdue.edu/datadigest/Students/studrilldowns> (accessed May 9, 2014).
- (3) UIUC. IUIC Student Enrollment <http://www.dmi.illinois.edu/stuent/> (accessed Jan 1, 2014).
- (4) Institute of International Education. Open Doors Report 2013 <http://www.iie.org/Who-We-Are/News-and-Events/Press-Center/Press-releases/2013/2013-11-11-Open-Doors-Data>.
- (5) Altbach, P. G.; Knight, J. *J. Stud. Int. Educ.* **2007**, *11*, 290.
- (6) Wang, Y. Young Chinese Students ' Teamwork Experiences In A UK Business School, PhD Thesis. University of Westminster, 2010.
- (7) Nassim, S. Z. The World is Knocking on our Doors : International Students and Support Services Programs, PhD Thesis. University of Delaware, 2011.
- (8) Barnes, W.; Loui, M. C. In *42nd ASEE/IEEE Frontiers in Education Conference*; Seattle, WA, 2012; pp. 658–663.
- (9) Hofstede, G.; Hofstede, G. J.; Minkov, M. *Cultures and Organizations: Software of the Mind: Intercultural cooperation and its importance for survival*; Third Edit.; McGraw Hill: New York, 2010.
- (10) Lingard, R.; Barkataki, S. In *41st ASEE/IEEE Frontiers in Education Conference*; IEEE: Rapid City, SD, 2011; pp. F1C – 1–F1C – 5.
- (11) ABET. Criteria for Accrediting Engineering Programs, 2014 - 2015 <http://www.abet.org/eac-criteria-2014-2015/> (accessed Oct 9, 2014).
- (12) ENAEE. EUR-ACE Framework Standards Engineering Programmes [http://www.enaee.eu/wp-content/uploads/2012/01/EUR-ACE\\_Framework-Standards\\_2008-11-0511.pdf](http://www.enaee.eu/wp-content/uploads/2012/01/EUR-ACE_Framework-Standards_2008-11-0511.pdf).
- (13) Passow, H. *J. Eng. Educ.* **2012**, *101*, 95.
- (14) Brett, J.; Behfar, K.; Kern, M. C. In *The Essential Guide to Leadership*; Harvard Business Review, 2009; pp. 85–97.

- (15) Halverson, C. In *Effective Multicultural Teams: Theory and Practice*; Halverson, C. B.; Tirmizi, S. A., Eds.; Springer, 2008; pp. 81–110.
- (16) Pelled, L. H.; Eisenhardt, K. M.; Xin, K. R. *Adm. Sci. Q.* **1999**, *44*, 1.
- (17) Watson, W. E. *Acad. Manag. J.* **1993**, *36*, 590.
- (18) Horwitz, S. K. *Hum. Resour. Dev. Rev.* **2005**, *4*, 219.
- (19) Manning, M. L.; Lucking, R. *Clear. House* **1993**, *67*, 12.
- (20) Matveev, A. V.; Milter, R. G. *Team Perform. Manag.* **2004**, *10*, 104.
- (21) Stahl, G. K.; Maznevski, M. L.; Voigt, A.; Jonsen, K. *J. Int. Bus. Stud.* **2009**, *41*, 690.
- (22) Cheng, C.; Chua, R. O. Y. Y. J.; Morris, M. W.; Lee, L. **2012**, *411*, 389.
- (23) Layton, R. A.; Loughry, M. L.; Ohland, M. W.; Ricco, G. D. *Adv. Eng. Educ.* **2010**, *2*, 1.
- (24) Van der Vegt, G. S.; Emans, B. J. M.; Van de Vliert, E. *Pers. Psychol.* **2001**, *54*, 51.
- (25) Carless, S. A.; De Paola, C. *Small Gr. Res.* **2000**, *31*, 71.
- (26) Loughry, M. L.; Tosi, H. L. *Organ. Sci.* **2008**, *19*, 876.
- (27) Jehn, K. A.; Mannix, E. A. *Acad. Manag. J.* **2001**, *44*, 238.
- (28) Kriesberg, L. *Dyn. Asymmetric Confl.* **2009**, *2*, 4.
- (29) Recchia, H. E.; Brehl, B. a.; Wainryb, C. *Cogn. Dev.* **2012**, *27*, 195.
- (30) Curşeu, P. L.; Janssen, S. E. a.; Raab, J. *High. Educ.* **2011**, *63*, 621.
- (31) Tichy, N. *Adm. Sci. Q.* **1973**, *18*, 194.
- (32) Singelis, T. M.; Brown, W. J. *Hum. Commun. Res.* **1995**, *21*, 354.
- (33) Tsolidis, G. *J. Res. Int. Educ.* **2002**, *1*, 213.
- (34) Wendt, H.; Euwema, M. C.; van Emmerik, I. J. H. *Leadersh. Q.* **2009**, *20*, 358.
- (35) Gudykunst, W. B.; Matsumoto, Y.; Ting-toomey, S.; Nishida, T.; Kim, K.; Heyman, S. *Hum. Commun. Res.* **1996**, *22*, 510.
- (36) Ohland, M. W.; Loughry, M. L.; Woehr, D. J.; Bullard, L. G.; Finelli, C. J.; Layton, R. A.; Pomeranz, H. R.; Schmucker, D. G. *Acad. Manag. Learn. Educ.* **2012**, *11*, 609.