Intercultural Readiness: Mapping Effective Teamwork Strategies in Engineering Teams to the Intercultural Development Continuum

Alankrita Chhikara
Center for Intercultural Learning, Mentorship, Assessment, and Research (CILMAR)
Purdue University
West Lafayette, IN, USA
achhikar@purdue.edu

Samantha Lapka
Department of Psychology
The Ohio State University
Columbus, OH, USA
lapka.3@buckeyemail.osu.edu

Brent K. Jesiek
School of Engineering Education
Purdue Univeristy
West Lafayette, IN, USA
bjesiek@purdue.edu

Franki Y. H. Kung
Department of Psychological Sciences
Purdue Univeristy
West Lafayette, IN, USA
frankikung@purdue.edu

2024 IEEE Frontiers in Education Conference (FIE) | 979-8-3503-5150-7/24/$31.00 ©2024 IEEE | DOI: 10.1109/FIE61694.2024.10892844

***Abstract*—This research paper explores the experiences of engineering students and professionals in multicultural teams, aiming to understand successful strategies for working in such environments. With the engineering field diversifying rapidly due to globalization, there is a growing need for engineers to possess cross-cultural communication and collaboration skills alongside technical knowledge. This study aims to improve the effectiveness of engineering education and addresses the evolving needs for engineering education and the role of educators in preparing future engineers for multicultural teamwork. The following research questions guided our study: (i). What strategies do engineering students and professionals hold and employ in navigating multicultural teamwork?, and (ii) How do these specific strategies mentioned by engineering students and professionals align with the developmental orientations on the Intercultural Developmental Continuum (IDC)? The study employed a qualitative approach, with interviews and focus groups conducted with 41 engineering students and 17 professionals who reported prior experience working on multicultural teams. Participants discussed their experiences and strategies, which were categorized into social behavioral, cognitive, and affective attitudinal themes. A total of 17 strategy types were identified in the student data and 16 types in the professional data. Strategies were in turn mapped to different developmental orientations on the IDC, showing a relationship between strategies described by participants and associated stages of intercultural development. Our findings reveal likely gaps in multicultural teamwork abilities among both students and professionals. More specifically, engineering students and professionals may benefit from expanded intercultural development training to foster more ethnorelative approaches to teamwork. Future research could involve participants completing the IDI survey before interviews to better understand their individual levels of intercultural development, followed by efforts to design and pilot training and educational materials aligned with particular intercultural development levels. This research contributes to understanding successful strategies for working in multicultural teams, benefiting educators, practitioners, and engineering students alike.**

Keywords—engineering teamwork, qualitative research, intercultural competence

I. Introduction

This research paper explores the experiences of engineering students and professionals in multicultural teams, aiming to understand successful strategies for working in such environments. Our efforts to explore and cultivate intercultural competence in the context of engineering teamwork is aligned with current ABET accreditation standards, including Outcome 3.5 which stipulates that engineering graduates should have the "ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives" [1]. Moreover, ABET defines a team as "more than one person working toward a common goal and should include individuals of diverse backgrounds, skills, or perspectives" [1]. With the engineering field diversifying rapidly due to globalization, there is a growing need for engineers to possess associated cross-cultural communication and collaboration skills alongside technical knowledge [2] [3]. Indeed, a 2006 report by the multinational firm Continental AG declared that engineers need international mobility and the capacity to function in diverse teams [4]. Accordingly, cross-cultural attitudes and collaborative interpersonal and teamwork skills are touted as among the most desirable competencies and skills for global engineers [5] [6].

In the existing literature, a variety of approaches have been proposed to enhance the intercultural skills of engineering students, including study abroad, service-learning, and work-based learning. Sánchez-Parkinson et al. [7], for instance, have discussed the use of immersive design, including service-learning components, to develop cross-cultural humility based on the Development Model of Intercultural Maturity (DMIM). The Cross-Cultural Leadership Program (CCLP) is another innovative approach that facilitated intercultural development among engineering students through ten modules on intercultural attitudes, skills, and knowledge [8]. The CCLP program incorporated the Intercultural Development Continuum (IDC) [9] as a framework to design the program as well as assess the impact of the intervention. These interventions are likely beneficial toward meeting intercultural competence goals but tend to have limited access to small numbers of students . On the other hand, the students in engineering programs are often diverse [10], and intercultural development goals can potentially be realized by tapping into the inter-group diversity of students through structured intercultural teamwork activities and experiences.

Developing and fostering intercultural competence by cultivating the knowledge, skills, and attitudes to work within and across cultures represents an important step toward creating the aforementioned "collaborative and inclusive environment." In general, intercultural competence has been shown to improve the overall effectiveness of international business adaptation, job performance, international student adjustment, and international study abroad [11]. Further, multicultural team effectiveness can be strengthened by adopting various strategies while engaging in teamwork, such as self-awareness and awareness of others, empathy, verbal and non-verbal communication, curiosity, and openness of attitudes [12].

II. Literature Review

A growing body of literature has explored the phenomenon of multicultural teamwork, including barriers and enablers to the performance of such teams [13]. Research by Brett et al. [14], for example, discussed how multicultural teams often face special challenges due to more pronounced variations in communication styles, cultural orientations, and how people relate to one another. Drawing on a wealth of empirical evidence from their own and other studies, Distefano and Maznevski in turn argue that multicultural teams can under- or outperform homogeneous teams depending on the extent to which team members effectively "understood, incorporated, and leveraged their differences" [15, p. 48]. Further, Brett et al. identify four key strategies for managing multicultural teams: "adaptation (acknowledging cultural gaps openly and working around them), structural intervention (changing the shape of the team), managerial intervention (setting norms early or bringing in a higher-level manager), and exit (removing a team member when other options have failed)" [14].

Turning to engineering education and practice more specifically, Ochieng and Price identified eight key dimensions of multicultural teamwork based on interviews with 20 industry leaders overseeing heavy construction engineering projects [16]. Through follow-on focus group interactions, they also identified five practices for enhancing team performance: "1. adherence of defined procedures; 2. clear communication procedures; 3. development of effective people selection; 4. ability to deal with cross‐cultural integration; and 5. collective work plan." Even more germane to the present work, Jiang et al. reported results from a systematic review of 77 journal articles on intercultural teamwork in engineering education [17]. They identified three categories of individual level challenges (related to linguistic, psychological, and prior background/experience dimensions) and three categories of "relational" challenges (time management and planning, interactional, and technological). They also identified a large number of specific "coping strategies" associated with some of the categories, but found none related to psychological or background/experience challenges.

Complementary to the literature cited above, in our own research we sought to explore what specific cross-cultural teamwork strategies were described by both engineering students and professionals, including to see whether and how these resonated with prior research. Yet we also started to sense that some of the identified strategies might actually undermine or limit multicultural team performance, leading us to see a potential connection with other theoretical frameworks like the IDC. Indeed, previous research by Hammer suggested that teams operating at a higher level of intercultural development, as measured by the IDI instrument, were more effective in achieving diversity-related team goals [18]. However, we are not aware of any prior qualitative research where the developmental stages proposed by the IDC were used to classify multicultural teamwork strategies described by study participants. Below is a brief introduction of our theoretical framework.

III. Theoretical Framework

The IDC [9] is a framework that describes how people experience and navigate cultural differences and similarities, with implications for developing and assessing intercultural team effectiveness. The IDC proposes a progression from ethnocentrism to ethnorelativism, or from a monocultural to multicultural mindset. People can operate from denial, polarization, minimization, acceptance, or adaptation orientations when interacting with cultural differences and similarities. Each orientation has inherent strengths and weaknesses. Operating from the *denial* orientation suggests that people are likely to miss deep cultural differences and tend to be comfortable in and loyal to their primary culture. Their strong monocultural lens reflects a lack of awareness for other cultural beliefs and values. By contrast, individuals in the *polarization* (or *defense*) orientation tend to judge differences, either of other cultures or their own. In *minimization*, individuals focus on similarities between cultures and tend to minimize differences. Being in minimization helps to maintain peace and harmony on the surface and may involve behaviors aligned with "The Golden Rule" or similar principles. The last two stages reflect an intercultural and ethnorelative mindset. In the *acceptance* orientation, people understand and can appreciate cultural differences. Finally, in the *adaptation* orientation people use their understanding and agency to adjust cultural perspective and change their behavior in culturally appropriate ways. We propose that more effective kinds of multicultural teamwork should reflect ethnorelative worldviews and approaches. We now turn to our methods, which offer a more detailed discussion of how we collected and analyzed our data.

IV. Methods

The goal of the study was to uncover and interpret the reasons and context for successful and unsuccessful teamwork in multicultural groups, thus a qualitative approach is informative and appropriate. The following research questions guided our investigation:

1. What strategies do engineering students and professionals hold and employ in navigating multicultural teamwork?
2. How do these specific strategies mentioned by engineering students and professionals align with the

developmental orientations on the Intercultural Developmental Continuum (IDC)?

To understand the positive and negative experiences as well as successful strategies for working in multicultural teams, the research team conducted interviews and focus groups with engineering students and professionals who reported prior experience working on multicultural teams. A total of 41 students were interviewed in ten focus groups, and 30 interviews were conducted with professionals. However, during some of the interviews it was apparent that participants (13 of 30) likely misrepresented themselves to secure study compensation. These participants were thus excluded, leaving 17 valid professional interviews for further analysis. We conducted two additional focus group sessions, each involving three engineering professionals from the same company. However, data from the professional focus groups were purposefully excluded from the analysis reported here because all of the participants were from the same organization and was thus more suitable for other analytic approaches (e.g., case study methods). Parallel analysis of the combined professional interview and focus group data did result in another manuscript focused on participants' varied orientations toward intercultural adaptation [19].

A. Recruitment

Engineering students were recruited from a Midwestern university via class and e-mail announcements, as well as flyers posted on campus. Professional engineers were recruited via social media through public recruitment posts and ads (i.e., on Facebook and LinkedIn). Recruitment materials led to a screening survey with questions about demographics (e.g., race, gender, age) and prior experiences with multicultural teams. For the 41 students who participated in focus groups, 35 provided demographic information. In terms of race/ethnicity, 9 of these students identified as White, 15 as Asian, 2 as Black/African American, 2 as Hispanic/Latino, and 7 of Mixed race. In terms of gender, 19 students identified as men, 15 as women, and 1 as non-binary. The most common majors for students were aeronautical/astronautical (7 students) and mechanical (8 students) engineering. For the professionals, 9 identified as White, 7 as Asian, 12 as Black/African American, 1 as Hispanic, and 1 as Native Hawaiian/Pacific Islander. Additionally, 7 of the professionals indicated that their country of origin was the U.S., and the remainder from a wide variety of other countries. Regarding gender, 11 professionals identified as men, 5 as women, and 1 as non-binary. The professionals reported affiliation from a variety of industry sectors, with the most prevalent being Automotive (2), Information Technology (2), Military/Defense (2), Oil and Gas (2), Transportation (2), and Utilities (2). On average, the professionals reported having 8.5 years of work experience. All of the participants reported having at least some experience working in multicultural teams, with the majority of students reporting quite a bit (43%) and very experienced (34%) and most professionals indicating quite a bit (41%) or very experienced (41%).

Members of the research team contacted eligible participants to schedule participation in an interview or focus group to learn more about their experiences and strategies in multicultural team environments. A semi-structured interview and focus group protocol was created to elicit participants' responses to a series of questions about: (1) their personal experiences in multicultural teams, (2) the mindsets and strategies they used while working in those teams, and (3) their ideas and suggestions for improving multicultural engineering team collaboration. As noted, individual interviews (n=17 deemed valid) and focus groups (n=6) were conducted with the professionals, while focus groups were conducted with the students (n=41). We used a critical incident approach [20] throughout the interview and focus group sessions, encouraging participants to detail both their positive and negative past involvement with multicultural teams, including at crucial moments where the action of the person was definitive in causing the team's success or failure. The goal behind this method is to identify the key specific individual and group factors determining multicultural teamwork effectiveness.

B. Data Collection

All data were collected following appropriate human subjects research procedures approved by Purdue University's institutional review board (IRB). The interviews and focus groups were conducted virtually using the Zoom platform and in all cases were facilitated by two members of the research team. The professional interviews ranged in length from 18 to 36 minutes, with an average duration of 26 minutes. The 10 student focus groups were longer to accommodate discussions with multiple participants (ranging from 3 to 5 students) in each session. They ranged in length from one hour and four minutes to one hour and 22 minutes, with an average duration of one hour and 16 minutes. The interviews and focus groups were audio recorded and machine-transcribed, then deidentified by a member of the research team. Each deidentified transcript was then cleaned to ensure accuracy and ease of comprehension.

Subsequently, a larger team of research assistants reviewed the transcripts and identified quotes where participants discussed the use of strategies. A preliminary total of relevant 174 quotes were identified across the student focus groups, and 217 quotes were identified across the professional engineer interviews. Members of the research team then reviewed the quotes and developed strategy groupings based on common themes that emerged from the collections of quotes (e.g., increasing communication, respect for differences). As reported below, 8 strategy types were generated for the students and 11 strategy types were generated for the professionals of which 6 were common between the two. The co-authors then reviewed the list of strategy-related quotes and mapped each quote to a developmental orientation on the IDC. As introduced above, this continuum includes the following five stages: denial (i.e., misses differences), polarization (i.e., judges differences), minimization (i.e., deemphasizes differences), acceptance (i.e., deeply comprehends differences), and adaption (i.e., bridges across differences). This multi-step coding process served to highlight the relationship between strategies the participants described and the associated intercultural development stages. We next reviewed the results of the coding and reconciled any quotes that the research assistants did not agree on. Second, we organized the quotes by the IDC stages. During this process, the researchers identified some quotes that were either unrelated to strategies for multicultural teams specifically or were too vague to interpret. These quotes were removed from the IDC stage coding data.

C. Positionality

As researchers we acknowledge that various factors shape our perspectives and are susceptible to biases as instruments of analysis for a qualitative study [21]. The research team represented disciplinary diversity (including Psychology, Engineering Education, and Intercultural Learning and Education), as well as differing career stages (graduate student, post-doctoral scholar, and faculty). There was also diversity among the co-authors in terms of gender, nationality, and racial/ethnic backgrounds. Additionally, two team members were Qualified Administrators (QAs) of the Intercultural Development Inventory (IDI), providing further grounding and perspective relevant to our second research question.

V. FINDINGS

Findings from our data analysis are presented here, organized by research question.

A. What strategies do engineering students and professionals hold and employ in navigating multicultural teamwork?

We coded the strategies for engineering students and professionals separately. While many of the strategies identified could be applied to regular teamwork, the themes we focus on here correspond to intercultural dimensions more specifically. For the student focus groups, there was a mix of negative and positive perceptions regarding cultural differences in multicultural teams, but overall, these perceptions skewed more positively. For instance, while some students had more negative expectations regarding multicultural teamwork (e.g., "You're going to work with the people who are coming from a completely different culture and you might feel that you have some challenges upfront") several had more positive expectations (e.g., "For me, going into multicultural teams, I'd like to think that it's going to be this beautiful mix and everyone bringing their tools they come with from their different cultural backgrounds and contributing really positively").

Data collected from the professionals likewise revealed both positive and negative perceptions of cultural differences in multicultural teams. Interestingly, communication challenges were mentioned often by this group, with one participant noting that the presence of different native languages "slowed down work" while another observed that you had to "make certain allowances for people" who were not native speakers. Other participants offered additional nuances, with one explaining that challenges can stem from "the way people talk" and another describing how "dealing with people from cultures where showing emotions or showing the true self is not customary, at times [it's] a little dodgy." Yet some other participants directly commented on the benefits of diverse teams, including in terms of leveraging a wider variety of perspectives: "And it is, it's more of an experience which I remember the fact that we were able to talk it out, and you know, having the experience to get different views and people come from different backgrounds, there was a key thing." Or, as another professional participant summarized, "When the teams have been more homogeneous, the project has not been so smooth actually. So, it actually helps I think that you have these different backgrounds in a project."

Based on the keywords and themes discussed by the students and professionals, strategy types to navigate multicultural teamwork became evident. We grouped related strategy types into the categories listed and defined in Table 1. The table also indicates if the categories were noted by professionals and/or students, and includes example quotes from participants for each strategy category. 6 strategy constructs overlapped across the groups and there were some differences between the types of strategy constructs for professionals and students. One that stands out is students calling for *building rapport/establishing trust* which is a softer approach to what we refer to as *respecting cultural diversity* for the professionals. The divergence in their strategies likely stems from their differing levels of experience with multicultural teamwork. Another construct that warrants a comparative analysis is students focus on *social bonding and building interpersonal relationships* and professionals' emphasis on *improving interpersonal team dynamics.* A possible reason for this difference can be explained through the social needs for students navigating a difficult college experience while professionals want to ensure conflict-free and productive work environments. We additionally observe that *leveraging communication* to improve intercultural communication was noted by both groups.

TABLE I. STRATEGY CATEGORIES, DEFINITIONS, and EXAMPLES

Strategy categories	Stu	Pro	Definitions	Examples
leveraging communication	✓	✓	Engaging in multi-modal communication methods to promote mutual understanding; Encourage proactive and fluid interactions that bridge gaps and acknowledge diverse communication styles, including non-verbal and written forms.	"You know you don't know anything, or you don't know everything nobody does so just try and communicate, you know your perspective on things and listen to what other people know too." (FG5); "Emphasizing a more direct communication path to myself or the PI or the other support staff so that we're not waiting until a meeting to bring up concerns." (Interview 16)
respecting cultural diversity		✓	Creating an inclusive and supportive environment through open discussion, accommodating cultural preferences (e.g., dietary), and demonstrating curiosity and respect for different cultures through listening, learning, and fostering cultural sensitivity.	"When I'm engaging in a conversation with any person I try to make them comfortable. Show you know I'm interested in learning about your culture I'm interested in learning and listening the way you talk." (Interview 3); "There's a lot of just generally being respectful and understanding of other people's (religious) beliefs." (Interview 11)
improve interpersonal team dynamics		✓	Fostering an approachable atmosphere where everyone feels a sense of belonging and engagement, including by enhancing	"You can actually talk outside of a working environment and in a more relaxed way and that actually helps then in the day to day, so you felt ease that connections between people." (Interview 18);

			interaction through personal communication, sharing cultural experiences, and other social activities or events.	"Inviting the individuals out for a drink after work or doing something like that, because you really learned about those people outside of know working on technical work like that, so that was definitely one of the things I tried." (Interview 20)
building rapport/ establishing trust	✓	✓	Creating a trusting environment through strategic, open, honest, and transparent communication and interactions.	"I think the first thing and, like the root of it all is really just making sure that people have somewhat of an understanding of how they fit into the overall picture of like I guess just your country and also just the world... I think that really helps to know how you can tailor things and how you can make sure that there is a greater understanding with your team overall." (FG 3)
proactive conflict resolution	✓	✓	Preempting conflicts by setting clear rules and expectations and addressing issues proactively in alignment with everyone's needs and goals.	"We made some rules up front, we tried to make some procedures for resolving disputes on the team" (FG 5); "Figuring out what's, what compromise that I'm willing to take in their culture and then figuring out what compromise they're willing to take relative to my culture and where does the give and take lie." (Interview 15)
appreciation of and adapting to cultural differences	✓	✓	Fostering cultural awareness and respect for cultural diversity, using adaptive strategies to amplify the strengths and opportunities that diversity brings.	"I'm trying to find a gentle way to remind maybe like, you know, an English-first type of speaker that you can think it, just slow down a little bit that that that may help others on the call understand." (Interview 28); "Any activity where people learn to be open minded, I think, because I think like people learning to be more open minded before they go into like being on a multicultural team, make [...] you more of an accepting person, you're more open to the ways other people might think or live their life and I guess it breaks down those walls of judgment." (FG 7)
decrease bias		✓	Breaking down stereotypes, countering prejudices, and fostering a discrimination-free environment.	"Having opportunities to demonstrate your competence or abilities in these situations to others who might doubt that." (Interview 17)
participate in culturally relevant training or other interactions	✓	✓	Engaging in organized training sessions, workshops, and travel opportunities, or informal interactions, that enhance cultural awareness, cognitive flexibility, problem-solving skills, and communication.	"What really helped me is having a little bit of training, about the team members, about the cultural background they come from." (Interview 3); "Maybe like a course on how to be ignorant without being offensive would be good, so like, feel like some people may be so scared to ask questions because they're worried that they'll be offensive, but there's definitely a way to approach asking people questions about their culture, or just asking questions in general, that can that can be in a way that's not offensive and come from a genuine place of wanting to now, and so, for me, that's just like I try to show enthusiasm for learning about people's cultures." (FG 9)
leverage tools and resources	✓	✓	Utilizing various technologies and platforms, persons, training, workshops, etc. to develop skills that enhance team collaboration and multicultural interaction.	"Get engaged in support groups in university for community before you graduate, and it should help you get ready for employment." (Interview 21); "Adjusting to using different technology that works well for everyone in the team. For example, using GroupMe instead of WhatsApp to communicate for teamwork." (FG 7)
seek interpersonal and work-life balance		✓	Setting boundaries to ensure harmonious balance between professional responsibilities and personal well-being.	"I have to set a boundary that I'll be open, I will be warm, but then it has to be certain level. I just cannot be good to everyone, because not everybody will be the same way with me so that's something that I have learned, it is balanced in this process." (Interview 3); "It was an initial adjustment because it's a lot of good work life balance, so they understand very well when you need to like people leave work at three o'clock because they need to pick up the kids." (Interview 18)
encourage diverse representation		✓	Encouraging diverse representation in all levels of organizations.	"You need to start hiring diverse people (professors), you need to start letting students coming to the university, but at the same time, you need to have some people at the upper level that represents the people you want to bring." (Interview 29); "Another thing that we did when we opened higher positions, there was a requirement that we interview at least, a woman, and a person of color as candidates for that position to be proactive to try and get diversity higher up in the management chain." (Interview 21)
social bonding & building interpersonal relationships	✓		Building meaningful friendships and personal connections.	"I found that like talking for five to 10 minutes with your teammates but like at the beginning of each meeting was really helpful and just building that relationship and actually getting to know people so that you feel comfortable working with them." (FG 1); "I would invite people over to my place, and you know feed them Korean food, and you know, like that kind of like acts like a lubricant or icebreaker so, and they, once like I provide them some cultural item they become more acceptable to my cultural difference." (FG 6)
going outside one's comfort zone	✓		Embracing challenge, including encounters with new/unfamiliar experiences, ideas, and beliefs.	"Push yourself out of your comfort zone doing activities, feel free to express your thoughts and also, as long as you are respectful of each other there's no stupid question, always feel free to ask anything among your group." (FG 9); "Being able and being willing to try things like not hold too strong opinion on how things get done." (FG 5)
engaging in self-reflection	✓		Reflecting on actions, behaviors and thoughts related to multicultural interactions.	"I think there is this ongoing self-realization about, you know, there are things that you do, that are just so ingrained, so unconscious that you, that you don't really realize that you don't like think about it, but that you come to that realization after talking to these different people." (FG 3); "Fostered a lot more like self-reflection and a lot of those kind of psychological skills of kind of putting yourself outside of the situation to look inward or look at something from maybe a different angle. It's definitely

				been one of those skills that's kind of helped me be able to kind of self-moderate." (FG 8)

B. How do these specific strategies mentioned by engineering students and professionals align with the developmental orientations on the Intercultural Developmental Continuum?

Since the data we analyzed was based on focus groups with students and interviews with professional engineers, our ability to make direction comparisons between the two is limited. However, we observed that both students and professionals discussed strategies that corresponded to all of the IDC stages, ranging from denial to adaptation, thus reflecting a mix of ethnocentric and ethnorelative approaches. Additionally, every student focus group and professional interview discussed strategies that represented at least three of the five IDC orientations. A large majority of strategies reflected minimization and acceptance. Below we provide representative examples of strategies for each developmental orientation.

1) Denial

Although less common, some strategies suggested a Denial orientation in which the respondent forgoes the effort to learn about cultural differences or suggests a lack of awareness of deeper patterns of cultural difference. Some examples included avoiding learning about differences for fear of confrontation, as illustrated by this example from a student focus group:

> "You shouldn't bring a conflict, that isn't related to the project, to any team meetings, so during the team meeting I would just try to stay away from polarizing topics." (Student Group 7)

The example above illustrates a tendency of withdrawing or avoiding differences, which is a feature of the denial orientation. Another example can be found in one of the professional interviews, where the participant explained:

> "We always judge people on getting the job done, and I think in engineering and my company, there is a very high level of professionalism so such that there wasn't any racial bias or anything like that, and as a result, we very much appreciated the job that people did regardless of where they came from." (Professional 21)

This quote reflects a results- or performance-based view of collaborative work, while explicitly disregarding individual cultural differences or other kinds of diversity, which is framed only as "where they came from." This effort to downplay and simplify difference is a hallmark of the denial orientation.

2) Polarization

The polarization orientation reflects a judgmental view towards cultural differences. Some notable examples of strategies in the Polarization orientation involved learning about other cultures for the sake of gaining pragmatic advantage, or framing difference as a challenge that needs to be overcome. For example, as one student explained:

> "I would advise them to … attend the other cultural events, because when you were a student it's a great time to … understand other culture, people but, once you graduate … you will be working with a multicultural team. Okay, and if you don't understand what the other cultural people do, how they behave or what they mean when they say something, it will be very difficult for you to be successful in your career ... So what I can advise is do all the mistakes that you want on your own because we are all students so it's very easy for you to rectify that but, if you do a similar kind of mistakes when you go in in industry or in other workplace, it will be very bad for you." (Student Group 8)

This example may reflect a fear of the unknown when interacting with other cultures, coupled with an us-versus-them dynamic. Moreover, the second part of this quote about making mistakes suggests there is some need for awareness of cultural differences, but acknowledging that action might be taken without needing to more fully understand such differences.

Other strategies classified as polarization suggested a strong commitment to one's own or another group's cultural view of the world such, as in the following example:

> "If you tell people up front what's going to make you kind of go a little loco they're less likely to do it. Say I don't like it when a team member waits until the last minute to submit something for our project. If I convey that up front, like when we're just getting to know each other, then they probably won't do it because they know it'll tick me off." (Student Group 7)

This respondent seems to propose a strong "my way" mentality, which is a characteristic of "defense polarization," often focused on defending or promoting one's own cultural preferences.

As for the professional engineers, polarization strategies more often involved strategies based on a stereotype or judgment of a cultural group, as in this example:

> "It has really helped to have, for example, not Norwegians actually in charge, because they are not very good at taking fast decisions and maybe overworking when it's needed. The team he put together to go on site and solve the problems, it was basically an old Brazilian and a French lead and most of the people that weren't going there were either from Southern Europe, Eastern and South America who were eager to take decisions and maybe to take the extra mile if needed." (Professional 18)

In the statement above, the speaker makes a distinction between Norwegians and other cultural groups, and implies that Norwegians are not good at making fast decisions. This kind of categorization, involving blanket assumptions about performance or behavior based on nationality, demonstrates a polarized and judgmental view of cultural differences.

3) Minimization

A majority of the strategies discussed by both students and professional engineers were classified as minimization. Minimization highlights cultural commonality and masks deeper recognition of cultural differences. Accordingly, we noted that minimization strategies emphasized thinking of people from different backgrounds as alike, thus focusing on similarities between cultures and downplaying differences. As a representative example from a student, one suggested:

> "Trying to not have pre-existing ideas of what somebody's going to be like because of their cultural differences, because we're probably more the same than different." (Student Group 0)

And as one of the professional participants similarly stated:

> "I think as the summer developed and I got to know these people more outside of work, it was really important that we didn't really see those differences anymore, and just kind of went about our day as human beings." (Professional 20)

Both of these examples suggest a masking or downplaying of deeper cultural differences, with efforts to avoid stereotyping by treating each team member as an individual without regard to cultural identity. This characteristic of minimization to ignore the cultural grounding of behavior was evident in many strategies coded as minimization. Yet in contrast to other strategies coded as denial or polarization, these examples suggest more nuanced views of culture consistent with a minimization orientation. The student quote above suggests an attempt to avoid bias ("not have pre-existing ideas") while the professional leans into the fact of shared human experience.

4) Acceptance

A significant number of strategies corresponded to the Acceptance stage, with a particular emphasis on gaining exposure to other cultures through training or first-hand experience. Interestingly, we observed that more acceptance strategies were coded for the students as compared to professionals, and we discuss possible reasons for this below. Examples for acceptance often acknowledged the importance of cultural differences along with similarities. As one student explained:

> "What's worked best in the past, for me, is to acknowledge that there's both similarities and differences because I think early on, like as a freshman or sophomore, my groups wouldn't talk about our differences, and if we found something that was similar, we stuck with it and ran with it. I feel like that was detrimental in the long run, because you're kind of just choosing to not accept what makes you different and that creates more tension between group members and the team dynamic." (Student Group 2)

This example suggests the need for a more nuanced knowledge of cultural differences, which may be easily overlooked, especially in a team oriented toward similarities (minimization orientation). Another student described how taking the IDI assessment increased their understanding of personal biases and increased their self-awareness:

> "I took a class called Global Leadership, where there was a whole unit on cognitive flexibility where we took an IDI assessment which showed your personal attitudes toward different cultures and cultural diversity. You were able to see and talk about your personal biases after." (Student Group 0)

In a similar vein, a professional described the importance of having knowledge or awareness of possible differences in behavior or approach based on cultural background:

> "Understanding and acknowledging that, you know, a person is coming from a different background and we have to give some flexibility or some consideration or some acknowledgement that you are open to do what you are, you're doing culturally." (Professional interview 3)

This passage nicely reflects an emphasis in the acceptance orientation of understanding and valuing difference, but it stops somewhat short of proposing specific bridging strategies or behaviors (adaptation).

5) Adaptation

We noted a large number of adaptation strategies among students and professional engineers. Two compelling examples from students involved using non-dominant languages to conduct team meetings, which aligned with a key characteristic of adaptation, namely adopting behaviors or approaches that favor or respect the preferences of another cultural group:

> "We specifically ran the meeting in Mandarin because we really needed to have the input from our team members in the Asia region." (Student Group 0)

> "We had Chinese conversations and all five or four or five of us there obviously speak English and would have probably a much more elevated conversation if we were speaking English, but just using that Chinese and trying to at least get some points across so that we would be more confident in our skills so that when it comes time to actually use it with somebody who may not speak English will be better prepared for it." (Student Group 5)

The second quote in particular highlights the use of a diversity of language practices to match those of another culture. Additionally, one of the professional participants made an even more direct suggestion aligned with an adaptation orientation, namely to "learn the language" (Professional 3).

Yet another example of adaptation, also focused on enabling more effective communication, centered on a student's suggestion to adjusting the style or pace of interaction:

> "Continuing from the previous question right, like how [student] mentioned that we changed the way we communicate, right, like talk slow, repeat yourself. Like that is definitely a strategy which helped me to improve the communication." (Student Group 8)

The example highlights one way in which an individual can adapt their behavior to be better understood by another culture

instead of placing a large burden of cultural interpretation and adaptation on individuals from a non-dominant culture group.

VI. Discussion and Conclusion

The study findings are generally consistent with the IDI framework based on how it theorizes individual levels or stages of intercultural development. The preceding results provide support and examples for how strategies in each of the five stages may manifest in concrete collaborative contexts, namely those involving multicultural teamwork. The findings are also generally consistent with findings from previous studies of intercultural development among students and professionals where minimization tends to be predominant. This suggests that intercultural education and training are meaningful as they aid individuals in strategically moving along the developmental continuum; for instance, there is a need for intercultural training for engineering students to foster a more ethnorelative approach to teamwork. Additionally, it highlights the need for resources and support to effectively develop intercultural competence.

Beyond such consistencies, this study also opens up more complexities and nuances regarding efforts to understand engineering students' and professionals' approaches to navigating multicultural teamwork. Adding to past research that primarily focused on the dimensions in which individual differences emerge to predict multicultural team effectiveness (e.g., structural, managerial, relational [17] [22] [23]), the findings here revealed, at a relatively concrete and behavioral level, how individuals think they can or should navigate multicultural teamwork (e.g., being proactive and assertive, going outside one's comfort zone, seeking commonalities, being attuned to the needs of others). While most of these strategies are positive in nature, matching the strategies with the IDI framework allows us to see how seemingly positive strategies may, in fact, be detrimental to multicultural teamwork effectiveness. Representative examples include colorblind strategies seeking to "not see differences," which are aligned with the minimization stage, potentially reflecting individuals' depth of understanding of diversity issues (or lack thereof) [24] and could be undermining the kinds of social understanding and open communication [25] that facilitate multicultural team effectiveness. Yet it was encouraging and surprising to note that a high number of acceptance strategies were discussed by students, especially as compared to the professionals. This could be attributed to social desirability as the student data comes from focus groups. Moreover, their idealistic responses could be attributed to a lack of experience applying these strategies in long-term projects or actual workplace settings. Conversely, a high number of minimization strategies were reported by professionals which could be due to organizational cultures that favor a focus on similarities and aim to reduce overt intrapersonal and inter-group conflict. It could also be pragmatic for professionals to remain focused on their team output and "get along to go along," as is typical of a minimization orientation.

Additionally, given the IDC framework and IDI are created for both educational and evaluative purposes, one benefit of analyzing participants' reported strategies using the IDC framework as a rubric is that the analysis can reveal potential discrepancies between an individual's intention (or their belief about how effective their strategies were) versus the actual effectiveness of the strategies in multicultural teams. For instance, individuals may personally believe a colorblind strategy reflects one kind of acceptance, when acceptance should actually go deeper by acknowledging and integrating differences as part of what constitutes each contributor and the whole team. By highlighting this distinction, the current study has implications for both theory and practice, as it encourages researchers and educators to not only explore positive intentions and strategies in multicultural teamwork, but also investigate how positive intention may be linked to ineffective strategies. In other words, interventions focused on intercultural development and multicultural teamwork should not only focus on adaptive or model strategies but also illuminate beliefs about maladaptive strategies to help achieve sustainable, positive strategy change (e.g., see implementation intention training; [26]).

It is also important to highlight some current limitations and future directions related to the research reported here. First, despite the utility of matching participant responses directly to the IDC framework, it would be helpful to also measure participants' intercultural development levels using the IDI survey instrument before interviews or focus groups to strengthen the data and triangulate the results. Second, although the study's focus is on multicultural teams, it was natural for study participants to draw on more general work situations in engineering education and practice. For instance, examples of such strategies include communicating with the professor in a university course, tracking hours working on projects, and using shared documents. These are helpful strategies that were excluded from our analysis as they were not explicitly focused on cultural differences. Third, as both a limitation and an opportunity, some of the strategy quotes did not map directly onto the IDC stages. For instance, several quotes suggested acknowledging differences but lacked information about judgment or acceptance of the differences. Other strategies suggested things like basic exposure to those from other backgrounds without much information regarding normative perceptions of other cultures/backgrounds.

Finally, building on the findings, we encourage future research in two directions to generate even deeper knowledge regarding efforts to promote collaborative and inclusive multicultural team environments. First, there is potential for further analyses of the current data to help unpack individuals' strategies as a function of their cultural identity and group membership—e.g., are they part of a domestic majority group versus foreigners or internationals working in a local multicultural team? And, is the team working in a language that is native to the person? More nuanced and disaggregated analyses could shed light on how power dynamics or privileges impact the emergence, use, and beliefs about certain strategies.

Second, there is a need for the study of strategies in multicultural teamwork to examine more closely how individuals' mindsets operate as part of the strategies and how they may influence the effectiveness of an individual's behavior in multicultural teams [27]). A growing area of research in this regard relates to the study of *cultural mindsets*

in a multicultural context, where individuals vary in their personal views about whether cultural differences in a group are malleable (i.e., whether or not culture-related characteristics of a person are innate and can change [28]). As a whole, a malleable cultural mindset has been shown to be more effective in nurturing more considerate, flexible, and positive intercultural behaviors that propel a cycle of understanding and increased performance that may be helpful in explaining the differences in the effectiveness of individuals' multicultural teamwork strategies. Overall, this research contributes to the understanding of successful strategies for working in multicultural teams, benefiting educators, practitioners, and engineering students alike.

ACKNOWLEDGMENT

This material is based upon work supported by the National Science Foundation under Grant No. 2044390. We also gratefully acknowledge the participants in our research study for their willingness to share their experiences and stories with us.

REFERENCES

[1] ABET, "Engineering accreditation commission: Criteria for Accrediting Engineering Technology Programs," Baltimore, MD: ABET, Inc., 2021. [Online]. Available: https://www.abet.org/wp-content/uploads/2022/01/2022-23-ETAC-Criteria.pdf. [Accessed 11 May 2024].

[2] L. Lynn and H. Salzman, "Collaborative advantage," *Issues in Science and Technology,* vol. 22, no. 2, pp. 74-83, 2006.

[3] J. Trevelyan, "Towards a theoretical framework for engineering practice," in *Engineering Practice in a Global Context: Understanding the Technical and the Social*, CRC Press, 2014, pp. 33-60.

[4] R. Anderl, K. Gong, N. C. Li, P. Kaminski, M. Netto, F. Kimura and B. Widdig, *In Search of Global Engineering Excellence: Educating the Next Generation of Engineers for the Global Workplace*. Hanover, Germany: Continental AG, 2006.

[5] A. G. Ball, H. Zaugg, R. Davies, I. P. A. R. Tateishi, C. G. Jenson and S. P. Magleby, "Identification and validation of a set of global competencies for engineering students," *Intl. J. of Engineering Education,* vol. 1, no. 28, pp. 156-168, 2012.

[6] H. J. Passow and C. H. Passow, "What competencies should undergraduate engineering programs emphasize? A systematic review," *J. of Engineering Education,* vol. 106, no. 3, pp. 475-526, 2017.

[7] L. Sánchez-Parkinson, N. D. Moses, G. E. Burleson, S. R. Daly, J. P. Holloway, A. Conger, K. H. Sienko and L. Meadows, "Intercultural experiences of engineering students during immersive design projects," *Intl. J. for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship,* vol. 18, no. 1, pp. 35-51, 2023.

[8] D. N. Render, H. A. Holgate and C. A Calahan, "Facilitating intercultural development: Preparing future engineers for multidisciplinary teams and multicultural environments," in Proc. 2018 IEEE Frontiers in Education Conference (FIE), San Jose, CA, Oct. 3-6, 2018.

[9] M. R. Hammer, "The Intercultural Development Inventory (IDI): A new frontier in assessment and development of intercultural competence," in *Student Learning Abroad: What Our Students Are Learning, What They're Not, and What We Can Do About It*, M. Vande Berg, R. M. Paige and K. H. Lou, Eds., Sterling, Stylus Publishing, LLC, 2012, pp. 115-136.

[10] OECD, *Education at a Glance 2020: OECD Indicators*, Paris, France: OECD Publishing, 2020.

[11] M. R. Hammer, "The Intercultural Development Inventory," in *Contemporary Leadership and Intercultural Competence*, Thousand Oaks, CA: Sage, 2009, pp. 203-218.

[12] Association of American Colleges and Universities (AACU), "Intercultural knowledge and competence VALUE rubric," Washington, DC: AACU, 2009.

[13] C. B. Halverson and T. S. Aqeel, *Effective Multicultural Teams: Theory and Practice*, Springer, 2008.

[14] J. M. Brett, K. J. Behfar and M. M. Kern, "Managing multicultural teams," *Harvard Business Review*, November 2006.

[15] J. J. Distefano and M. L. Maznevski, "Creating value with diverse teams in global management," *Organizational Dynamics,* vol. 29, no. 1, pp. 45-63, 2000.

[16] E. G. Ochieng and A. Price, "Framework for managing multicultural project teams," *Engineering, Construction and Architectural Management,* vol. 16, no. 6, pp. 527-543, 2009.

[17] D. Jiang, B. Dahl, and X. Du, "A systematic review of engineering students in intercultural teamwork: Characteristics, challenges, and coping strategies.," *Education Sciences,* vol. 13, no. 6, 540, 2023.

[18] M. R. Hammer, "Additional cross-cultural validity testing of the Intercultural Development Inventory," *International Journal of Intercultural Relations,* vol. 35, no. 4, pp. 474-487, 2011.

[19] B. Jesiek, S. Lapka, K. Acheson, and F. Kung, "Interpersonal intercultural adaptation orientations: A qualitative study of engineering professionals," under review.

[20] J. C. Flanagan, "The critical incident technique," *Psychological Bulletin,* vol. 51, no. 4, pp. 327-358, 1954.

[21] N. K. Denzin, "The elephant in the living room: Or extending the conversation abotu the politics of evidence," *Qualitative Research,* vol. 9, no. 2, pp. 139-160, 2009.

[22] J. J. Distefano and M. L. Maznevski, "Creating value with diverse teams in global management," *Organizational Dynamics,* vol. 29, no. 1, pp. 45-63, 2000.

[23] E. G. Ochieng and A. D. Price, "Framework for managing multicultural project teams," *Engineering, Construction and Architectural Management,* vol. 16, no. 6, pp. 527-543, 2009.

[24] E. P. Apfelbaum, R. Grunberg, N. Halevy and S. Kang, "From ignorance to intolerance: Perceived intentionality of racial discrimination shapes preferences for colorblindness versus multiculturalism," *J. of Experimental Social Psychology,* vol. 69, pp. 86-101, 2017.

[25] V. C. Plaut, K. M. Thomas and M. J. Goren, "Is multiculturalism or color blindness better for minorities?," *Psychological Science,* vol. 20, no. 4, pp. 444-446, 2009.

[26] B. Verplanken and S. Faes, "Good intentions, bad habits, and effects of forming implementation intentions on healthy eating," *European Journal of Social Psychology,* vol. 29, no. 5-6, pp. 591-604, 1999.

[27] F. Y. H. Kung, M. M. Chao, D. Yao, W. L. Adair, J. H. Fu, K. Tasa, S. Link, S. L. Yuen, and H. Kong, "Bridging racial divides: Social constructionist (vs. essentialist) beliefs facilitate trust in intergroup contexts," *J. of Experimental Social Psychology,* vol. 74, pp. 121-134, 2018.

[28] H. Huang, Z, Yang, and F. Y. H., Kung, "Employees' mindset matters: Leveraging cultural mindset to harness the benefits of organizational polyculturalism," *Industrial and Organizational Psychology,* vol. 16, no. 3, pp. 408-412, 2023.