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# Cross-cultural communication across STEM disciplines

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Collaboration across cultures in Science, Technology, Engineering, and Math (STEM) fields has become increasingly common. This means many STEM professionals in US-based companies now work with professionals from other cultures. In this global context, cross-cultural knowledge is crucial for effective communication. Without this knowledge, there can be misunderstandings and discomfort. Different cultures use different communication styles, which has been studied by the field of communication. The concept of high and context low-context culture is used to discuss the role of contextual cues in communication. High-context cultures rely on implicit language and contextual and situational cues, while low-context cultures use explicit language. Although no culture is strictly high or low context, this concept is important as it helps us understand how our communication style can be influenced by cultural characteristics. There is a growing need to support and encourage students to become interested in pursuing careers in STEM fields. Many STEM programs in the United States have emphasized the importance of collaboration to meet this need. However, effective collaboration requires effective communication, and students often lack opportunities to explore how they can communicate effectively with collaborators from other cultures and countries. To bridge this gap, this article proposes incorporating communication into STEM courses for undergraduate students. The course will include learning opportunities about low and high-context cultures and guest speakers. This article aims to provide insights into how communication content can prepare undergraduate students to become culturally competent STEM professionals.

KEYWORDS

**communication, context theory, high-context culture, low-context culture, global collaboration, stem education**

## 1 Introduction

Today's world is interconnected, and global collaboration has become more and more common in the Science, Technology, Engineering, and Math (STEM) industry (Bremer, 2008; Grandin and Hirleman, 2009). As the STEM industry seeks engineers who are able to communicate and collaborate effectively with engineers of diverse cultural backgrounds, the need to educate a culturally competent future STEM workforce has emerged (Davis and Knight, 2018). Some countries, such as Hong Kong, have been implementing courses on cross-cultural communication in STEM (Gilleard and Gilleard, 2002). Nevertheless, educational institutions in the U.S. have provided relatively fewer educational opportunities to help students equip themselves with cross-cultural communication skills and knowledge (Del Vitto, 2008; Mauduit and Gual Soler, 2020). The lack of opportunities to cultivate such skills may lead students to experience miscommunication and further hinder them from having tolerance and building positive relationships with people of diverse cultural and linguistic backgrounds.

To solve a problem, it is vital to expose students to the importance of cross-cultural communication, while being at college. In other words, incorporating cross-cultural communication into STEM curriculum is needed (Del Vitto, 2008). Proficiency in a foreign language does not automatically mean cultural competency (Del Vitto, 2008). Cross-cultural communication is an area that explicitly needs to be taught. Regarding cross-cultural communication, it is critical to learn about context theory, proposed by Hall (1976). Hall (1976) viewed that different cultures have different ways of delivering messages and engaging in conversations, and he introduced the concept of high-context (HC) and low-context (LC) cultures. People in HC cultures prefer to communicate with the implicit use of language, while people in LC cultures prefer to communicate with the explicit use of language (Nishimura et al., 2008). Although this theory was introduced a long time ago, it is still widely cited in recent literature. In particular, this theory is still used in research when addressing various intercultural issues and contexts in the field of international business (Kim et al., 1998; Hornikx and Le Pair, 2017), communication (Nishimura et al., 2008), and counseling psychology (Park-Saltzman et al., 2012).

While Hall's context theory has been influential in humanities, it appears that this theory has not received much attention in STEM education. Some researchers provided insights into how the content on cross-cultural communication can be addressed in STEM classrooms (Davis and Knight, 2018). Yet, the use of Hall's theory is not explicitly mentioned. To address a gap, this article illustrates how the concept of HC and LC cultures can be incorporated into STEM curriculum in the context of higher education. If engineering students are introduced to this important concept as part of the engineering curriculum, they will be able to leverage this knowledge when collaborating with people of diverse backgrounds.

This article is divided into four sections. The first section introduces the concept of HC and LC cultures, discussing their definitions and characteristics. The second section discusses how Hall's theory has been cited in the humanities. The third section explores cross-communication in STEM, identifying some STEM courses in the context of higher education. Finally, based on all the sections, a course entitled Cross-Cultural Communication in STEM is proposed in the last section. This article aims to contribute to developing the STEM curriculum in higher education.

## 2 High-context and low-context culture

Different cultures have their ways to promote communication. In cross-cultural communication, it is critical to understand the concept of high-context (HC) and low-context (LC) culture to perceive cultural features that affect one's use of language. The construct of HC and LC cultures was proposed by Edward T. Hall, who was a professor and anthropologist (Bluedorn, 1998; Kim et al., 1998). In one of the books, *Beyond Culture*, Hall (1976) explained how a message is transmitted in communication across different cultures, and he discussed the concept of HC and LC cultures, which has been widely cited over decades (Kim et al., 1998; Nishimura et al., 2008; Hornikx and Le Pair, 2017). Bluedorn (1998) had an opportunity to interview Hall, and Hall provided definitions for HC and LC communication styles, emphasizing the need to appreciate cultural differences in communication. Hall defines that in HC cultures, a message's context provides more information than the message itself, so paying attention to the context is critical (Bluedorn, 1998). In LC cultures, communication occurs oppositely, and the information comes from the message itself, rather than the context (Bluedorn, 1998). In sum, people in HC cultures tend to use expressive and often poetic language, whereas people in LC cultures tend to use direct and responsibility-related statements (Hornikx and Le Pair, 2017). While East Asian countries, such as China, Korea, and Japan, can be perceived as countries with HC culture, some European countries, such as Switzerland, Norway, and Sweden, can be regarded as countries with LC culture (Kim et al., 1998; Hornikx and Le Pair, 2017).

In HC cultures, people tend to value collectivist goals, and they employ indirect speech acts (Brew and Cairns, 2004). In other words, the content of messages is delivered through multiple contextual clues, and indirect communication styles are primarily used (Brew and Cairns, 2004; Park-Saltzman et al., 2012). Japan represents one of HC cultures. In Japan, people tend to employ indirect communication styles, leading others to elicit the message's meaning (Nishimura et al., 2008). The communication style in HC cultures has been mainly affected by Confucianism, which emphasizes politeness and the virtue of saving face. Expressing oneself with an indirect communication style is a way to show respect to others, particularly the elderly ones and authority figures (Brew and Cairns, 2004). On the other hand, employing a direct communication style in HC cultures can be perceived as an aggressive speech act, which may prevent oneself from saving face (Park-Saltzman et al., 2012).

In LC cultures, people tend to value individualism, and they communicate through direct speech acts (Brew and Cairns, 2004). People in LC cultures prefer expressing their opinions and feelings using precise and straightforward language (Nishimura et al., 2008). Due to this reason, people in LC cultures experience difficulties in understanding messages, spoken by people in HC cultures (Hornikx and Le Pair, 2017). Furthermore, people in LC cultures are allowed to use eye contact and express their feelings through facial expressions, which may be discouraged in HC cultures (Brew and Cairns, 2004). Table 1 summarizes the features of HC and LC cultures.

Table 1 provides differentiation between HC and LC communication. In HC culture, the use of symbolic and indirect language is encouraged, but in LC culture, the use of clear and direct language is preferred.

TABLE 1 HC and LC cultures.

| Culture | Characteristics |
|---|---|
| High-context (HC) culture | • Indirect, implicit, poetic communication styles<br>• Symbolic expressions<br>• Contextual/situational cues<br>• Collectivistic values (Confucianism)<br>• Saving face<br>• Asian countries |
| Low-context (LC) culture | • Direct, precise, responsibility-based communication styles<br>• Explicit expressions<br>• Facial expressions and eye contacts<br>• Individualistic values<br>• Western countries |

## 3 Cross-cultural communication in the humanities

The significance of cross-cultural communication has been pinpointed across multiple disciplines, particularly in the humanities. The field of humanities has examined similar or different communication strategies between countries. Hall's theory has been widely used to grasp a general understanding about a culture.

Researchers in the field of humanities have used Hall's theory. Nishimura et al. (2008) conducted a case study to examine communication patterns and cultural features among three countries: Finland, Japan, and India. All three countries can be seen as a HC culture, but differences exist. Finnish communication culture has displayed the features of a HC culture, but the communication style is moving toward a LC culture. Japanese communication culture is clearly a HC culture, emphasizing active listening and politeness. Indian culture is seen as more 'talkative' than Japanese culture, and people tend to keep talking. This case study informs that variations exist within the category of HC culture. Furthermore, HC and LC cultures may have different ways of refusing a request. Al-Shboul and Maros (2020) conducted a study to address different refusal strategies between Jordanian Arabic (HC) and American English (LC) speakers. It was found that Jordanian Arabic speakers tend to provide very broad and unspecific responses when refusing a boss's request. In contrast, American English speakers tend to communicate in a more specific way and provide specific reasons for refusal. The different refusal strategy was proven in this research.

In the field of humanities, key principles of HC and LC culture have been adopted as the course content to help students generate effective communication strategies (Tseng, 2017). Although the context theory may not generalize the entire culture (Nishimura et al., 2008), it gives us an idea on standard communication practices. The use of this theory can be extended to other fields, such as STEM, as the opportunities for global collaboration are increasing.

## 4 Cross-cultural communication in STEM and gaps

More and more STEM companies seek candidates who have not only "hard" skills (discipline-related knowledge) but also "soft" skills (Del Vitto, 2008; Karimi and Pina, 2021). The examples of soft skills include creativity, listening, collaboration, interpersonal communication, and conflict adjustment (Karimi and Pina, 2021). Among various soft skills, one of the most critical abilities to develop into a global engineer is cross-communication skills (Del Vitto, 2008).

The previous research on cross-cultural communication in STEM has addressed language-related challenges (Gilleard and Gilleard, 2000, 2002; Hwang, 2013). Hwang (2013) conducted a study investigating international collaboration experiences between R & D laboratories. Engineers in the U.K. collaborated with engineers in Korea, and it was found that the language barrier added another layer of difficulty to both U.K. and Korean collaborators. Although the language barrier was a topic of inquiry, Hwang's (2013) research can further extend a discussion on what else could have been done to mitigate the language barrier and promote more effective communication at the organizational level.

Indeed, developing proficiency in a foreign language does not guarantee cultural competency. Instead, growing cultural sensitivity is a skill that must be explicitly educated. While language-related issues are critical, STEM education may view the issue of cross-cultural communication from a broad perspective.

As an effort to bridge the gap, some universities have provided STEM courses that include elements related to cross-cultural communication. Two courses were found at the graduate level and undergraduate level, respectively.

Purdue University provides a course called "Technology from a Global Perspective" at the graduate level to allow graduate students in Technology to investigate various technology issues and challenges in the global context. One of the goals for the course is to help students to understand the importance of cultural diversity in international business and STEM practices around the globe (Purdue University, 2024).

Virginia Tech offers engineering courses that help students develop cultural competence at the undergraduate level. Davis and Knight (2018) introduce a global engineering program at Virginia Tech, the Rising Sophomore Abroad Program (RASP), designed to foster cultural learning among first-year engineering students. The program includes a one-semester course followed by a two-week study abroad component. The purpose of implementing such a program is to allow students to recognize cultural diversity in engineering practices and gain hands-on experiences in global contexts.

These courses allow students to think about what it means to work in cross-cultural teams in the globalized industry. Students may benefit more if the perspectives from the humanities are further incorporated into the STEM curriculum more explicitly. Adopting Hall's theory as the course content may help students to investigate how a culture manifests one's behaviors and communication patterns. Learning about this concept eventually helps the future STEM workforce to brainstorm how they can address complex intercultural situations, such as conflicts and resolution in the real world.

## 5 Cross-cultural communication in STEM course

The findings from the previous research inform that students can be greatly benefited from explicit opportunities to address intercultural situations. Building on this, we would like to propose implementing a "Cross-Cultural Communication in STEM" course. Considering that traditional engineering programs reveal weaknesses in preparing students as a global professional (Grandin and Hirleman, 2009), this course aims to help students develop cultural sensitivity by exposing them to the concept of HC and LC communication. This course can be particularly useful for undergraduate students in STEM programs.

When developing cross-cultural curriculum, several challenges need to be addressed. First, educators need to help students to brainstorm effective ways to communicate with people in different cultures by leveraging culturally sensitive beliefs, values, and communication approaches. Educators, furthermore, need to think about how to create real-world settings for students without making them travel to other countries. Including the studying abroad component may incur issues, related to costs, making it necessary for educators to consider alternative options. This challenge is addressed by inviting guest speakers from multiple countries.

The course can be designed as a one-semester course with three different modules to achieve different learning outcomes. The first module aims to help students understand Hall's descriptions of HC and LC cultures. In Table 1, we summarize core elements of Hall's HC and LC cultures. The content from Table 1 can be presented at the beginning of the course. After the content is shared, students would gain opportunities to engage in discussions to share their experiences of interacting with people from other cultural backgrounds. Students may discuss any similarities and differences they have identified between learning materials and their own experiences. An instructor may choose more complex HC and LC cultural contexts for student response. For example, an instructor may facilitate discussions on how to resolve cross-cultural conflicts and how to build interpersonal relationships across HC and LC cultures. The syllabus design by Tseng (2017) article may serve as a resource for cross-cultural curriculum design.

The second module aims to help students learn from guest speakers from diverse cultural backgrounds. For this module, an instructor may identify at least three guest speakers that represent a low context culture, a middle context culture, and a high context culture. This module is designed to expose students to different cultural settings without having to travel to other countries. Including a study abroad component would be ideal to allow students to experience a specific culture and work environments in real-world settings. Nevertheless, a study abroad program involves the issue of cost, and some students may not be able to afford the traveling cost (Grandin and Hirleman, 2009; Davis and Knight, 2018). In order to overcome this challenge, the course would invite guest speakers virtually and allow students to communicate with them. It has been shown that having guest speakers contributes to increasing student motivation and engagement, resulting in positive learning outcomes (Riebe et al., 2013; Leor, 2015; Kong, 2018). In particular, inviting speakers from the STEM industry leads students to feel connected and learn about career-specific information and knowledge (Davis and Knight, 2018). Inviting guest speakers can be particularly more beneficial as students can delve into varying perspectives and professional culture within a country (Kong, 2018). After meeting with each guest speaker, students will submit a reflection paper, highlighting their takeaways.

The last module aims to help students perform a case study on a specific country, leading them to examine culturally sensitive communication approaches. In this module, students act as an expert, who can present communication approaches on a specific country. As a group assignment, students will be led to do research on a country, identifying it as HC, LC, or somewhere between the two. Based on the lecture materials, they will be required to investigate communication styles (both verbal and non-verbal language) and cultural etiquettes. An instructor will explain what a case study is, and the study, conducted by Nishimura et al. (2008), may serve as a model paper for the final project. Importantly, at the end of the presentation, students will provide tips that American STEM companies/engineers need to know to collaborate with engineers effectively in a given country. For a final assignment, students will be expected to submit a reflection paper, developing their own cross-cultural communication strategies that they like to use when they become engineers.

Cross-cultural communication is an area that needs to be explicitly taught among students. As this proposed course values cultural diversity, it would be essential for an instructor to create a more open environment, where students can freely share their personal experiences and insights. We hope that this course helps students to develop their own practical skills and knowledge to facilitate communication across different cultures.

## 6 Conclusion

The ability to communicate effectively with people from diverse cultural backgrounds is an essential skill that needs to be taught. Hall's influential theory of High-Context (HC) and Low-Context (LC) cultures explains how cultural values and norms influence one's speech acts and communication patterns. Though Hall's theory may not represent an entire culture, it is still valuable as it provides a general understanding of a specific culture.

As there are more opportunities to collaborate globally, the humanities have made efforts to develop the curriculum by adopting Hall's theory as the course content (Tseng, 2017). Global collaboration has become more common in industries utilizing STEM topics. However, the current STEM curriculum lacks educational opportunities to help future engineers develop cross-cultural sensitivity. Therefore, students need to be provided with opportunities to explore the issue of cross-cultural communication and develop their own culturally sensitive communication strategies while they are in college.

This course aims to help students develop soft skills by exposing them to real-world settings. By interacting with guest speakers from diverse cultural backgrounds, we expect that students may gain practical knowledge and develop a global engineering mindset. In addition, by conducting research on a specific country, students would further explore culturally appropriate ways to interact with others. We hope that this article contributes to the development of STEM curriculum.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note



## References

Al-Shboul, Y., and Maros, M. (2020). The high and low-context communication styles in refusal strategies by Jordanian Arabic and American English speakers. *Pertanika J of Soc. Sci. & Human.* 28, 2063–2080.

Bluedorn, A. C. (1998). An interview with anthropologist Edward T. Hall. *J. Manag. Inq.* 7, 109–115. doi: 10.1177/105649269872003

Bremer, D. (2008). Engineering the world. *Online J. Glob. Eng. Educ.* 3, 13–18.

Brew, F. P., and Cairns, D. R. (2004). Do culture or situational constraints determine choice of direct or indirect styles in intercultural workplace conflicts? *Int. J. Intercult. Relat.* 28, 331–352. doi: 10.1016/j.ijintrel.2004.09.001

Davis, K., and Knight, D. B. (2018). Impact of a global engineering course on student cultural intelligence and cross-cultural communication. *J. Int. Eng. Edu.* 1, 1–38. doi: 10.23860/jiee.2018.01.01.04

Del Vitto, C. (2008). Cross-cultural "soft skills" and the global engineer: corporate best practices and trainer methodologies. *Online J. Glob. Eng. Educ.* 3, 1–9.

Gilleard, J. D., and Gilleard, J. (2000). Creating a leading edge: the link between second language proficiency, academic performance and employment leverage for engineering students. *Int. J. Electr. Eng. Educ.* 16, 472–482.

Gilleard, J., and Gilleard, J. D. (2002). Developing cross-cultural communication skills. *J. Prof. Issues Eng. Educ. Pract.* 128, 187–200. doi: 10.1061/(ASCE)1052-3928(2002)128:4(187)

Grandin, J. M., and Hirleman, E. D. (2009). Educating engineers as global citizens: a call for action/a report of the national summit meeting on the globalization of engineering education. *Online J. Glob. Eng. Educ.* 4, 1–27.

Hall, E. T. (1976). *Beyond culture*. New York, NY: Doubleday.

Hornikx, J., and Le Pair, R. (2017). The influence of high−/low-context culture on perceived ad complexity and liking. *J. Glob. Mark.* 30, 228–237. doi: 10.1080/08911762.2017.1296985

Hwang, K. (2013). Effects of the language barrier on processes and performance of international scientific collaboration, collaborators' participation, organizational integrity, and interorganizational relationships. *Sci. Commun.* 35, 3–31. doi: 10.1177/1075547012437442

Karimi, H. S., and Pina, A. A. (2021). Strategically addressing the soft skills gap among STEM undergraduates. *J. Res. STEM Educ.* 7, 21–46. doi: 10.51355/jstem.2021.99

Kim, D., Pan, Y., and Park, H. S. (1998). High-versus low-context culture: a comparison of Chinese, Korean, and American cultures. *Psychol. Mark.* 15, 507–521. doi: 10.1002/(SICI)1520-6793(199809)15:6<507::AID-MAR2>3.0.CO;2-A

Kong, K. (2018). "Chapter 13: differences voices: guest speakers as pedagogy in a culture class" in *Transnational perspectives on innovation in teaching and learning technologies* (Leiden: Brill), 262–284.

Leor, K. (2015). Guest speakers: a great way to commit to education. *J. Best Teach. Pract.* 2, 21–23,

Mauduit, J., and Gual Soler, M. (2020). Building a science diplomacy curriculum. *Front. Educ.* 5, 1–7. doi: 10.3389/feduc.2020.00138

Nishimura, S., Nevgi, A., and Tella, S. (2008). Communication style and cultural features in high/low context communication cultures: a case study of Finland, Japan, and India. in A Kallioniemi (ed.), Uudistuva ja kehittyvä ainedidaktiikka: Ainedidaktinen symposiumi 8.2.2008 Helsingissä. Osa 2. Tutkimuksia / Helsingin soveltavan kasvatustieteen laitos, 299, Helsingin yliopisto, Helsinki, *Ainedidaktinen Symp.* 8, 783–796.

Park-Saltzman, J., Wada, K., and Mogami, T. (2012). Culturally sensitive mentoring for Asian international students in counseling psychology. *Couns. Psychol.* 40, 895–915. doi: 10.1177/0011000011429831

Purdue University. (2024). *Office of the registrar*. Available at: https://catalog.purdue.edu/preview_course_nopop.php?catoid=7&coid=57032 (Accessed January 5, 2024).

Riebe, L., Sibson, R., Roepen, D., and Meakins, K. (2013). Impact of industry guest speakers on business students' perceptions of employability skills development. *Industr. High. Educ.* 27, 55–66. doi: 10.5367/ihe.2013.0140

Tseng, C. H. (2017). Teaching "cross-cultural communication" through content based instruction: curriculum design and learning outcome from EFL learners' perspectives. *Engl. Lang. Teach.* 10, 22–34. doi: 10.5539/elt.v10n4p22