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How does studying abroad affect engineering students' intercultural competence: A longitudinal case study

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Abstract

We investigated the development of intercultural competence (IC) among engineering students participating in an international study program (GoLaSalle). IC was measured using the Multicultural Personality Questionnaire (MPQ) by Van der Zee & Van Oudenhoven (2001), and the Expanded Cultural Intelligence Scale (E-CQS) by Van Dyne et al. (2012). Data were collected from 293 French engineering students before and after participating in the semester abroad. In line with previous studies, we found that study abroad plays a central role in the acquisition and development of IC. However, such IC development differs across dimensions and gender. While almost all women's IC dimensions gained from studying abroad, men's IC showed less malleability. Our results demonstrate the value of integrating a study abroad semester into the curriculum of engineering students. We discuss ways in which students' IC could be further improved.

Keywords

Intercultural competence; engineering students; study abroad; cultural intelligence; longitudinal study

1. Introduction

Engineers are increasingly exposed to cross-cultural cooperation. Whether as expatriates or members of multinational teams, engineers are expected to work effectively in intercultural environments (Gash et al., 2009). As a result, intercultural competence (IC), "the complex abilities that are required to perform effectively and appropriately when interacting with others who are linguistically and culturally different from oneself" (Fantini, 2009, p. 458), has become key to an engineer's success in today's global society (CTI, 2022; Rico-García & Fielden Burns, 2020). Helping engineering students develop their IC has thus taken on increased importance in engineering education (CTI, 2022; Weisser, 2015). Study abroad is generally considered one of the most effective means for increasing IC (e.g. Deardorff, 2006). Foreign language acquisition and the development of intercultural communicative competence are regarded as the two major benefits of studying abroad (Guo, 2015). Through international academic mobility, students also improve their self-efficacy (Cushner & Mahon, 2002; Petersdotter et al., 2017) and their tolerance of ambiguity (Dewaele & Wei, 2013). They

demonstrate a greater intercultural awareness (Anderson et al., 2006) and openness to cultural diversity, resulting in globally-minded individuals (Clarke et al., 2009).

Even though study abroad programs have recently taken on increased importance in engineering education, engineering students have historically been underrepresented in such programs (Davis & Knight, 2018). Therefore, research is still scarce about how a period of studying abroad influences the development of engineering students' IC (Berka et al., 2021; Chédru & Ostapchuk, 2023; Ortiz-Marcos et al., 2021). To fill this gap, this study investigates the effect of a study abroad semester on the development of engineering students' IC. The objective is to examine whether there is a significant increase observed in students' IC after their study abroad semester compared to pre-departure.

2. Literature review

2.1. Intercultural competence: definition and assessment tools

2.1.1. Defining intercultural competence

Trompenaars and Woolliams (2009) define IC as the "capability of successful communication and effective collaboration with people of other cultures through recognition of differences and respect for other points of view" (p. 443). Due to its complexity, countless frameworks were used to grasp the notion of IC. The terms used to refer to this concept vary by discipline and approach (Deardorff, 2011). For example, from a review of the literature on cross-cultural adaptability and intercultural relations (Van der Zee et al., 2013), Van der Zee and van Oudenhoven (2001) identified five personality dimensions that make up IC: cultural empathy, open-mindedness, social initiative, emotional stability, and flexibility. From another perspective, Earley and Ang (2003) introduced the concept of cultural intelligence (CQ) based on contemporary theories of intelligence (Ang et al., 2007). CQ refers to an individual's capability to deal effectively in situations characterised by cultural diversity. It comprises four primary factors: metacognitive, cognitive, motivational, and behavioural CQ.

While cross-cultural adaptability and CQ both relate to IC, they, however, highlight different aspects of this construct. Thus, by attending to the different facets of IC, this study aims to gain a more comprehensive understanding of engineering students' IC development during their study abroad experience.

2.1.2. Assessment of intercultural competence

In their review of measures for assessing cross-cultural competence, Matsumoto and Hwang (2013, p. 867) identified the Multicultural Personality Questionnaire (MPQ) by Van der Zee and van Oudenhoven (2001) and the Cultural Intelligence Scale (CQS) by Ang et al. (2007) as two of the most promising instruments.

2.1.2.1. Multicultural personality and the Multicultural Personality Questionnaire

The Multicultural Personality Questionnaire (MPQ) assesses personality dimensions that are of relevance to intercultural success. It includes scales for cultural empathy, open-mindedness, social initiative, emotional stability, and flexibility.

Cultural empathy is defined as “the capacity to clearly project an interest in others as well as to obtain and to reflect a reasonably complete and accurate sense of another’s thoughts, feelings, and/or experiences” (Ruben, 1976 cited in Van der Zee & Van Oudenhoven, 2001, p. 279). Open-mindedness refers to an “open and unprejudiced attitude toward cultural differences” (Van der Zee et al., 2013, p. 118). Social initiative is defined as the ability to take initiative and be active in social situations (Van Oudenhoven & Van der Zee, 2002). Emotional stability reflects an ability to remain calm in new and stressful situations (Van der Zee et al., 2013). Flexibility refers to “interpreting novel situations as a positive challenge and adapting to these situations accordingly” (Van der Zee & Van Oudenhoven, 2000, 2001 cited in Van der Zee et al., 2013, p. 118). It can be regarded as the ability to deal with lack of control (Van der Zee & van Oudenhoven, 2013). Flexibility facilitates adaptation to a new intercultural situation, and is particularly important when individuals’ expectations of the situation in the host country do not correspond to reality (Van Oudenhoven & Van der Zee, 2002).

2.1.2.2. Cultural intelligence and the Expanded Cultural Intelligence Scale

Earley and Ang (2003) conceptualised CQ as a multidimensional construct consisting of four primary factors: metacognitive, cognitive, motivational, and behavioural CQ. The Expanded Cultural Intelligence Scale (E-CQS) includes subdimensions for each of the four primary factors and is especially useful for focusing on specific CQ capabilities. Van Dyne et al. (2012) reviewed psychometric evidence supporting the E-CQS and proposed that the next wave of CQ research should be guided by a deeper understanding of each of the four factors of CQ. It should facilitate more focused action steps for personal development plans aimed at improving CQ (Van Dyne et al., 2012, p. 308).

Metacognitive CQ refers to “an individual’s level of conscious cultural awareness and executive processing during cross-cultural interactions” (Ang & Van Dyne, 2008 cited in Van Dyne et al., 2012, p. 298). It comprises planning, awareness, and checking. Planning is defined as “strategizing before a culturally diverse encounter” (Van Dyne et al., 2012, p. 299), awareness as “knowing about cultural thinking and knowledge of self and others in real time” (Van Dyne et al., 2012, p. 299), and checking as “reviewing assumptions and adjusting mental maps when actual experiences differ from expectations” (Van Dyne et al., 2012, p. 299).

Cognitive CQ reflects “knowledge of the norms, practices and conventions in different cultures acquired from education and personal experiences” (Ang et al., 2007, p. 338). Cognitive CQ includes culture-general knowledge and context-specific knowledge. Culture-general knowledge corresponds to “declarative knowledge of the major elements that constitute the cultural environment” (Van Dyne et al., 2012, p. 299), and context-specific knowledge is defined as “declarative knowledge of how cultural universals are manifested in a specific domain and procedural knowledge of how to be effective in that domain” (Van Dyne et al., 2012, p. 299).

Motivational CQ reflects the “capability to direct attention and energy toward learning about and functioning in situations characterized by cultural differences” (Ang et al., 2007, p. 338). The three sub-dimensions of motivational CQ are intrinsic interest, extrinsic interest, and self-efficacy to adjust. Intrinsic interest is defined as “valuing culturally diverse experience in and

of itself because it is inherently satisfying” (Deci, 1975 cited in Van Dyne et al., 2012, p. 303), extrinsic interest as “valuing the tangible, personal benefits that can be derived from culturally diverse experiences” (Ryan & Deci, 2000 cited in Van Dyne et al., 2012, p. 304), and self-efficacy to adjust as “having task-specific confidence in culturally diverse situations” (Van Dyne et al., 2012, p. 304).

Behavioural CQ reflects the “capability to exhibit appropriate verbal and non-verbal actions when interacting with people from different cultures” (Ang et al., 2007, p. 338). The three sub-dimensions of behavioural CQ are verbal behaviour, non-verbal behaviour, and speech acts. Verbal behaviour is defined as “flexibility in vocalization (e.g. accent, tone)” (Van Dyne et al., 2012, p. 305); non-verbal behaviour as “flexibility in communication that is conveyed via gestures, facial expressions, and body language, rather than through words” (Knapp & Hall, 2010 cited in Van Dyne et al., 2012, p. 305), and speech acts as flexibility in ways of communicating specific types of messages such as requests, invitations, apologies, gratitude or disagreement (Van Dyne et al., 2012, p. 305).

Van Dyne et al. (2012) pointed out that, by definition, CQ dimensions are malleable abilities that can be improved through active engagement in education, travel, international missions, and other cross-cultural experiences.

2.2. Intercultural competence and engineering education

The accreditation bodies for engineering degrees describe the ability to work in an international and multicultural context as an essential element of engineering education (CTI, 2022). Future engineers have to master one or more foreign languages and to demonstrate cultural openness. They have to adapt to international contexts and to cooperate on collective global issues (CTI, 2022, p. 21). In order to succeed within any multicultural environment, engineers have to develop IC. According to Grandin and Hedderich (2009, p. 364), engineers are expected to demonstrate: (i) open-mindedness and tolerance; (ii) knowledge of different cultures around the world; (iii) cultural awareness and acceptance of difference; (iv) multilingualism; (v) awareness of differences in terms of engineering cultures. Grandin and Hedderich (2009, p. 368) highlighted that the basic predispositions necessary for the successful development of IC are curiosity, openness and tolerance of ambiguity, as well as a willingness to interact with host country nationals. They argued that for engineers in particular, IC includes the ability to collaborate with people who define problems differently (Downey et al., 2006) and use different technical and management approaches to solve those problems (Grandin & Hedderich, 2009, p. 368). According to Messelink et al. (2015), educators should consider intercultural learning as a path towards greater employability.

Study abroad is an ideal program element to instil IC in students (Deardorff, 2006; Vande Berg & Paige, 2009). However, integrating such an experience into engineering curricula has proven to be a major challenge. This is largely due to the very dense and content-demanding nature of the curriculum (Lohmann et al., 2006; Maldonado et al., 2014). Short-term international experiences, such as project-based approaches, have therefore been designed to minimise their impact on already constrained schedules (e.g. Berger & Bailey, 2013; Maldonado et al., 2014). For example, Maldonado et al. (2014) argued that while immersed in a different culture

and language for a short time period (i.e. 2 weeks), engineering students experienced the challenge of interacting with culturally diverse teams.

Therefore, although traditional longer-term study abroad experiences have significant impacts on participants, engineering students have long been underrepresented in such programs. As a result, only a few studies (Berka et al., 2021; Chédru & Ostapchuk, 2023; Shoemaker et al., 2020) investigated the influence of international mobility on engineering students' IC.

Shoemaker et al. (2020) provided evidence that students' CQ scores were significantly higher after their return from international engineering programs, compared to their scores before they departed. Programs' duration ranged from three to eight weeks. Programs also varied depending on diverse characteristics: internship experiences, classes taught by home-university faculty or by local faculty, presence or number of format cultural excursions built into each program etc. (Shoemaker et al., 2020).

Using the Intercultural Development Inventory (IDI) by Hammer et al. (2003), Berka et al. (2021) investigated to what extent study abroad curricular interventions supported engineering students' development of IC. The one-year study abroad program consisted of a semester of coursework followed by a six-month internship in the host country. The three-phases curricular interventions (pre-departure, during students' year abroad and after their return) aimed to help students fully immerse themselves in the target culture. Their results showed that while curricular interventions had a clear and positive impact on the intercultural development of engineering students, the changes in students' IC after the study abroad program were not statistically significant, contrary to their expectations (Berka et al., 2021).

Chédru and Ostapchuk (2023) showed that after a study abroad semester, engineering students improved their IC. More specifically, ten out of the eleven sub-dimensions of E-CQS increased. Extrinsic interest was the only sub-dimension that remained stable (Chédru & Ostapchuk, 2023).

2.3. Hypotheses

Studying abroad implies the discovery of a new environment and usually a radical change in living conditions. While abroad, students have many opportunities to empathise with the feelings, thoughts, and behaviours of members from different cultural groups. Therefore, it is assumed that they will significantly improve their cultural empathy over this time period.

Research shows that students usually emphasise a broader open-mindedness as an outcome of their study abroad experience (Gu et al., 2010; Hadis, 2005; Weibl, 2015). They report their personal growth in terms of more respectful attitudes towards host culture and values. Through this experience they gain broadened life experiences and interests. This implies that a study abroad semester should lead to an increase in open-mindedness.

Individuals staying in a foreign country face the challenge of establishing new social relationships (Zimmermann & Neyer, 2013). Bochner et al. (1977) identified three distinct interpersonal networks in which international students are involved: the first one is monocultural, and consists of bonds between compatriots; the two others are bicultural and

multicultural, and consist of bonds with host country students. As stays abroad offer many opportunities to make new social contacts, social initiative is expected to increase during this period.

In a new cultural environment, the usual ways of dealing with the problems of everyday life are not necessarily effective. This suggests that students abroad will meet many occasions to switch from one strategy to another, and thus increase their flexibility.

For some students, studying abroad is the first opportunity to leave their home country. Being immersed in a new environment and adapting to a new culture are perceived as stressful events by many individuals (Leone et al., 2005). Higher levels of emotional stability have been associated with more effective management of acculturation stressors and better ability to cope with the challenges of mobility (Andrews et al., 1993). Although emotional stability is seen as a core feature of the successful international immersion (Leone et al., 2005), it is also considered as a relatively stable personality dimension (McCrae & Costa, 2006) which is not affected by an international experience (Bartel-Radic, 2014). It is therefore expected that emotional stability will not be significantly affected by a study abroad semester.

Thus, we predict the following hypothesis:

H1: A study abroad semester will lead to an increase in cultural empathy (H1a), open-mindedness (H1b), social initiative (H1c), and flexibility (H1d). Emotional stability will not significantly change after a study abroad semester (H1e).

Metacognitive CQ refers to the recognition and understanding of differences between cultures. As Şahin et al. (2014) pointed out, exposure to other cultures provides many opportunities to consciously examine one's own cultural assumptions and to engage in a reflective process before and during interactions. Each subdimension of students' metacognitive CQ (planning, awareness, and checking) should therefore increase after a study abroad semester.

After a semester abroad, students should have absorbed novel cultural facts, become more familiar with similarities and differences among cultures, and thus have improved both dimensions of their cognitive CQ: culture-general knowledge, and context-specific knowledge (Chédru & Ostapchuk, 2023).

Experiences abroad increase students' self-efficacy (Petersdotter et al., 2017) and their interest in other cultures (Mohajeri Norris & Gillespie, 2009). Crossman and Clarke (2010) showed that students perceived clear connections between international experience and graduate employability. International experience provides many opportunities for experiential learning and networking. It also contributes to the acquisition of additional languages and the development of soft skills (Crossman & Clarke, 2010). Consequently, an increase in each subdimension of students' motivational CQ (intrinsic interest, extrinsic interest, and self-efficacy to adjust) should be observed after a study abroad semester (Chédru & Ostapchuk, 2023).

Living abroad for one semester should improve students' understanding of appropriate practices and behaviours in non-native settings, resulting in improvements in all three dimensions of behavioural CQ (verbal behaviour, non-verbal behaviour, and speech acts).

Consequently, we predict the following hypothesis:

H2: A study abroad semester will enhance the three dimensions of metacognitive CQ, planning, awareness, and checking (H2a), the two dimensions of cognitive CQ, culture-general knowledge, and context-specific knowledge (H2b), the three dimensions of motivational CQ, intrinsic interest, extrinsic interest, and self-efficacy to adjust (H2c), and the three dimensions of behavioural CQ, verbal behaviour, non-verbal behaviour, and speech acts (H2d).

3. Method

3.1. GoLasalle semester abroad

The GoLaSalle semester program (Delhoume et al., 2019) is a partnership between the engineering school UniLaSalle (France) and Lasallian Universities across the world. The program allows engineering students to take part in a study semester in one of the partner Universities present in 6 different countries (the Philippines, Colombia, Mexico, Brazil, Costa Rica, and the United States). Students' participation in the GoLaSalle mobility program is compulsory. It takes place during the fifth semester of a five-year degree.

3.2. Participants

Participants included 293 French engineering students. Males represented 54% ($n = 159$) and females 46% of the respondents ($n = 134$). All of them were studying agronomy. The average age was 19.6 years ($SD = 0.8$ years) pre-departure (T1) and 20.4 years ($SD = 0.7$ years) post-sojourn (T2). The students sojourned in the Philippines ($n = 85$), Colombia ($n = 75$), Mexico ($n = 71$), Brazil ($n = 26$), Costa Rica ($n = 22$) and the United States ($n = 14$).

3.3. Instruments

The Multicultural Personality Questionnaire

The French version of the Multicultural Personality Questionnaire (Faniko et al., 2014; Van der Zee et al., 2013) was administered. In total, the MPQ includes 37 items and consists of five factors. Items are introduced by the following question: "To what extent do the following statements apply to you?" Answers were recorded on a 5-point Likert-type scale ranging from 1 (totally not applicable) to 5 (completely applicable). Sample items from each of the five factors are the following: cultural empathy (7 items; $\alpha T1 = .82$, $\alpha T2 = .84$), "Notices when someone is in trouble"; open-mindedness (7 items; $\alpha T1 = .77$, $\alpha T2 = .84$), "Is interested by other cultures"; social initiative (8 items; $\alpha T1 = .83$, $\alpha T2 = .80$), "Easily approaches other people"; emotional stability (8 items; $\alpha T1$ and $T2 = .85$), "Keeps calm when things don't go well"; and flexibility (7 items; $\alpha T1 = .86$, $\alpha T2 = .84$), "Wants to know exactly what will happen" (reverse-scored). All Cronbach's alphas were above the recommended threshold of .70 (Nunnally & Bernstein, 1994). The subscales could therefore be regarded as reliable.

The Expanded Cultural Intelligence Scale (E-CQS)

Participants completed the 37-item French version of the Expanded Cultural Intelligence Scale (Gagné-Deland, 2017; Van Dyne et al., 2012). Answers were given on a 7-point Likert-type scale, ranging from 1 (strongly disagree) to 7 (strongly agree). Examples of items for each of the sub-dimensions are: planning (3 items; α T1 = .72, α T2 = .82), "I ask myself what I hope to accomplish before I meet with people from different cultures."; awareness (3 items; α T1 = .74, α T2 = .81), "I am conscious of how other people's culture influences their thoughts, feelings, and actions."; checking (3 items; α T1 = .73, α T2 = .76), "I double check the accuracy of my cultural knowledge during intercultural interactions"; culture-general knowledge (5 items; α T1 = .76, α T2 = .82), "I can describe similarities and differences in legal, economic, and political systems across cultures."; context-specific knowledge (5 items; α T1 and T2 = .87), "I can describe the ways that leadership styles differ across cultural settings."; intrinsic interest (3 items; α T1 = .83, α T2 = .86), "I thrive on the differences in cultures that are new to me."; extrinsic interest (3 items; α T1 = .68, α T2 = .75), "Given a choice, I value the tangible benefits (pay, promotion, perks) of an intercultural rather than a domestic role."; self-efficacy to adjust (3 items; α T1 = .81, α T2 = .86), "I am confident I can socialize with locals in a culture that is unfamiliar to me."; verbal behaviour (3 items; α T1 = .79, α T2 = .77), "I change my use of pause and silence to suit different cultural situations."; non-verbal behaviour (3 items; α T1 = .77, α T2 = .74), "I change my nonverbal behaviours (hand gestures, head movements) to fit the cultural situation."; and speech acts (3 items; α T1 and T2 = .88), "I vary the way I show gratitude (express appreciation, accept compliments) based on the cultural context.". All Cronbach's alphas were very close to or above the recommended threshold of .70 (Nunnally & Bernstein, 1994). The subscales could therefore be regarded as reliable.

3.4. Procedure

As the GoLaSalle program takes place during the fifth semester of a five-year degree, participants completed all measures (MPQ, E-CQS) and demographic questions in May (T1), one to two months before the start of their semester abroad, and again in February (T2) of the following year, i.e. one to two months after their return. We made the questionnaires available online and asked the students to complete them in class so that any questions of clarification could be answered face to face. To respect the principles of the "Charte française de déontologie des métiers de la recherche", the students filled in a consent form which states that there are no right or wrong answers and that the answers are treated confidentially and anonymously.

3.5. Analysis

As the literature found mixed results regarding gender effects on the intent to study abroad (Salisbury et al., 2010; Tompkins et al., 2017), but also on MPQ (Faniko et al., 2014; Van der Zee et al., 2003; Van der Zee & Van Oudenhoven, 2000) and CQS dimensions (Varela & Gatlin-Watts, 2014), separate paired-sample t-tests for men and women were conducted to investigate differences over time. When differences were statistically significant ($p < .05$), the effect size was calculated using eta squared (η^2). With η^2 values around .01, the effect size was considered as small, around .06, it was considered as moderate, and large with values around or above .14 (Cohen, 1988).

4. Results

The results revealed significant changes over time for both MPQ (Table 1) and E-CQS dimensions (Table 2), for both men and women.

4.1. MPQ results

4.1.1. Gender differences

Before departure, independent-samples t-tests showed that women scored higher than men on: cultural empathy, $t(289) = 2.00$, $p < .05$, two-tailed, $\eta^2 = .01$ ($M = 3.95$, $SD = .62$ and $M = 3.81$, $SD = .60$, for women and men, respectively); and open-mindedness, $t(289) = 2.21$, $p < .05$, two-tailed, $\eta^2 = .02$ ($M = 3.87$, $SD = .59$ and $M = 3.69$, $SD = .62$, for women and men, respectively). Men ($M = 3.14$, $SD = .74$) scored higher than women ($M = 2.66$, $SD = .83$) on emotional stability, $t(289) = 5.22$, $p < .001$, two-tailed, $\eta^2 = .09$.

4.1.2. Differences across time

Mean scores for cultural empathy, open-mindedness, and social initiative were significantly higher post-sojourn than pre-departure for women (Table 1). The magnitude of the difference in the means was small for cultural empathy ($\eta^2 = .03$), large for open-mindedness ($\eta^2 = .17$), and moderate for social initiative ($\eta^2 = .10$). Emotional stability increased over time for both men and women but without reaching a significant level. Contrary to our expectations, flexibility decreased over time for both men and women but the difference did not reach a significant level. The only personality factor to change significantly over time for men was open-mindedness, suggesting that men became more open-minded after their semester abroad. The eta squared statistics indicated that the magnitude of the difference in the means was large ($\eta^2 = .17$). As expected, a study abroad semester positively impacted open-mindedness and had no significant impact on emotional stability. H1b and H1e were thus confirmed. The positive impact on cultural empathy and social initiative was confirmed for women only. H1a and H1c were thus partially confirmed. H1d could not be confirmed as flexibility did not exhibit a significant difference over time.

	Men (n = 145)				Women (n = 133)			
	Mean (SD)		t	η^2	Mean (SD)		t	η^2
	T1	T2			T1	T2		
Cultural empathy	3.81 (.60)	3.86 (.67)	.87		3.95 (.62)	4.04 (.63)	2.05*	.03
Open-mindedness	3.69 (.62)	3.95 (.69)	5.44***	.17	3.87 (.59)	4.13 (.57)	5.22***	.17
Social initiative	3.39 (.64)	3.47 (.63)	1.68		3.35 (.68)	3.53 (.65)	3.74***	.10
Emotional stability	3.14 (.74)	3.21 (.78)	1.18		2.66 (.83)	2.78 (.81)	1.90	

Flexibility	2.97 (.74)	2.93 (.72)	.70	2.95 (.85)	2.83 (.79)	1.88
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Note : * $p < .05$; ** $p < .01$; *** $p < .001$.

Table 1: Results of paired-sample t-tests on each of the 5 MPQ factors.

4.2. E-CQS results

4.2.1. Gender differences

Before departure, independent-samples t-tests showed that women ($M = 5.56$, $SD = .90$) scored higher than men ($M = 5.36$, $SD = .92$) on awareness, reaching almost a statistical significance: $t(286) = 1.95$, $p = .05$, two-tailed, $\eta^2 = .01$. Women ($M = 5.43$, $SD = 1.06$) also scored higher than men ($M = 5.20$, $SD = 1.15$) on intrinsic interest, but with a p-value $> .05$: $t(286) = 1.76$, $p = .08$, two-tailed, $\eta^2 = .01$.

4.2.2. Differences across time

Mean scores for each of the three dimensions of metacognitive CQ were significantly higher post-sojourn than pre-departure for women (Table 2). The magnitude of the difference in the means was moderate for planning ($\eta^2 = .06$) and checking ($\eta^2 = .04$), and small for awareness ($\eta^2 = .03$). For men, two of the three dimensions of metacognitive CQ increased over time (planning and checking), but without reaching a significant level. H2a was thus confirmed for women only.

In accordance with our expectations, the two dimensions of cognitive CQ increased over time for both men and women. The magnitude of the difference in the means for culture-general knowledge was moderate for men ($\eta^2 = .04$), and large for women ($\eta^2 = .25$). For culture-specific knowledge, the magnitude of the difference in the means was large for both men ($\eta^2 = .17$) and women ($\eta^2 = .29$). H2b was thus confirmed.

Mean scores for two of the three dimensions of motivational CQ were significantly higher post-sojourn than pre-departure for women. The magnitude of the difference in the means was small for intrinsic interest ($\eta^2 = .03$) and moderate for self-efficacy to adjust ($\eta^2 = .06$). Mean score for extrinsic interest increased over time for women, but without reaching a significant level. For men, two of the three dimensions of motivational CQ increased over time (intrinsic interest and self-efficacy to adjust), but without reaching a significant level. H2c was thus partially confirmed for women only.

The three dimensions of behavioural CQ increased over time for both men and women. The magnitude of the difference in the means for verbal behaviour was small for men ($\eta^2 = .03$), and moderate for women ($\eta^2 = .04$). For non-verbal behaviour, the magnitude of the difference in the means was moderate for both men and women ($\eta^2 = .04$). For speech acts, the magnitude of the difference in the means was moderate for men ($\eta^2 = .04$), and large for women ($\eta^2 = .11$). H2d was thus confirmed.

Men (n = 143)		Women (n = 130)	
Mean (SD)	t	Mean (SD)	t

		T1	T2		η^2	T1	T2		η^2
Metacognitive CQ	Planning	4.37 (1.00)	4.44 (1.13)	0.64		4.24 (1.22)	4.56 (1.10)	2.84**	.06
	Awareness	5.36 (.92)	5.36 (1.10)	.00		5.56 (.90)	5.73 (.88)	2.11*	.03
	Checking	5.11 (.92)	5.22 (1.02)	1.22		5.22 (1.09)	5.44 (.92)	2.27*	.04
Cognitive CQ	Culture-General knowledge	4.88 (.94)	5.12 (1.01)	2.46*	.04	4.80 (.96)	5.38 (.84)	6.50***	.25
	Culture-Specific knowledge	4.01 (1.09)	4.56 (1.01)	5.45***	.17	3.80 (1.07)	4.52 (.99)	7.17***	.29
Motivational CQ	Intrinsic interest	5.20 (1.15)	5.28 (1.32)	1.00		5.43 (1.06)	5.64 (1.05)	2.04*	.03
	Extrinsic interest	4.74 (1.29)	4.72 (1.32)	.18		4.69 (1.13)	4.85 (1.24)	1.21	
	Self-efficacy to adjust	5.39 (.97)	5.47 (1.13)	.89		5.30 (1.18)	5.64 (1.06)	2.93**	.06
Behavioural CQ	Verbal behaviour	4.48 (1.19)	4.71 (1.17)	1.97*	.03	4.53 (1.27)	4.76 (1.15)	2.17*	.04
	Non-verbal behaviour	4.52 (1.13)	4.81 (1.07)	2.47*	.04	4.70 (1.36)	4.96 (1.26)	2.20*	.04
	Speech acts	4.52 (1.20)	4.83 (1.12)	2.52*	.04	4.56 (1.33)	5.05 (1.18)	3.99***	.11

Note : * $p < .05$; ** $p < .01$; *** $p < .001$.

Table 2: Results of paired-sample t-tests on each of the 11 E-CQS subdimensions.

5. Discussion

5.1. Theoretical implications

The purpose of this study was to investigate whether and, if so, how a study abroad semester impacted engineering students' IC as measured by two instruments, MPQ and E-CQS. The participants in this study were 293 French engineering students (159 males and 134 females) who spent their fifth semester of a five-year degree in either the Philippines, Colombia, Mexico, Brazil, Costa Rica, or the United States.

For females, the MPQ results demonstrated a significant increase over time on three dimensions: open-mindedness, social initiative, and cultural empathy. As expected no

significant effect was found for emotional stability and, against our expectations, flexibility showed no increase over time. For men, emotional stability remained stable as expected and out of the four other dimensions, the only one that increased significantly over time was open-mindedness.

Our results suggest a gender effect on cultural empathy and open-mindedness (with women scoring higher than men before departure) and on emotional stability (with men scoring higher than women before departure). These findings are in accordance with the results of several authors (Faniko et al., 2014; Tompkins et al., 2017; Van der Zee et al., 2003; Van der Zee & Van Oudenhoven, 2000).

Compared to their male counterparts, women seemed more able to use the experience abroad as a developmental tool. Women's results are consistent with the analysis made by Herfst et al. (2008) which indicates that because of their social component, cultural empathy, open-mindedness and social initiative are more easily trainable than the dimensions of emotional stability and flexibility. As these authors argue, open-mindedness is a prerequisite for the expression of the two other dimensions: "Once one has opened one's mind to an intercultural encounter one subsequently may show social initiative or cultural empathy" (Herfst et al., 2008, p. 74). As our results show, women's levels of open-mindedness and cultural empathy before departure were higher than men's ones. These characteristics predisposed women to more favourable attitudes in an intercultural context and allowed them, as in a virtuous circle, to further strengthen open-mindedness, cultural empathy, and social initiative.

For men, open-mindedness increased significantly over time, but this is the only significant variation observed. Two hypotheses can be put forward to explain this result. First, the level of open-mindedness reached by the end of the sojourn may not yet have been sufficient to trigger the processes of social interaction and cultural empathy. Second, to see significant changes, the length of the sojourn for men may have had to be longer. Indeed, according to several studies, it takes four to six months to settle down and overcome the daily issues of work, life, and social communication (Varela, 2017; Zimmermann & Neyer, 2013). This adjustment period probably fluctuates depending on the initial levels of IC dimensions. The lower the initial levels of IC dimensions, the longer it takes to adjust in a new environment.

As expected, no significant effect was found over time for emotional stability. However, we note a slight increase (without reaching a significance level) suggesting that students felt more emotionally stable as the sojourn progressed. This is in line with the results obtained by Schartner (2016) and Zimmermann and Neyer (2013). While adjustment difficulties are more important during the first four to six months abroad, they then decrease and remain stable.

The only decreasing dimension for both women and men, although to a lesser extent for men, is flexibility. Before going abroad, the participants scored rather low on flexibility suggesting they liked routine and fixed habits. While abroad, students face many challenges. They have to adapt to new local habits and rules. Instead of becoming more flexible while facing new situations, the semester abroad highlighted their intrinsic need for routine and certainty. In other words, this experience abroad confirmed that they like to stay in control of a situation.

For females, the E-CQS results demonstrated a significant increase over time on each dimension of metacognitive, cognitive, and behavioural CQ. They also showed an increase in each of the three dimensions of motivational CQ, even only one (extrinsic interest) did not reach a significant level. For men, each dimension of cognitive and behavioural CQ increased significantly over time, but contrary to our expectations, no significant effect was found for metacognitive and motivational CQ.

No significant gender effect is observed on the different E-CQS dimensions. Nevertheless, we note that women scored higher than men before departure on awareness and intrinsic interest.

Like Shoemaker et al. (2020) and Chédru and Ostapchuk (2023), our results provide empirical evidence that study abroad has a significant effect on the development of engineering students' CQ. However, the results differ depending on gender: once again, the effect of the sojourn on CQ changes has been more profitable for women than for men. Actually, upon their return, women outperformed men on almost all CQ dimensions.

When getting back, men improved their cognitive CQ. This means that their overall understanding of how cultures differ from one context to another has improved. They also refined their ability to behave suitably in different cultural contexts (behavioural CQ). Yet surprisingly, men did not improve their scores on metacognitive CQ after one semester abroad. This result suggests that, for example, the experience abroad did not help them realise that culture influences social interactions, people's thoughts, feelings or actions (awareness). Metacognitive CQ is probably the most difficult construct to conceive. It entails "slowing down long enough" to pay close attention to what is happening inside our own and other people's heads (Van Dyne et al., 2010, p. 136). Metacognitive CQ refers to our ability to "use our cultural knowledge to plan an appropriate strategy, accurately interpret what's going on in a cross-cultural situation, and check to see whether our expectations are accurate or whether our mental model of that particular person and/or culture should be revised" (Van Dyne et al., 2010, p. 136). This ability needs maturity and time for reflection. Students may have acquired such competence, but a lack of hindsight may have prevented them from realising it. To ensure that students are aware of what they are learning and achieving, authors suggest providing guidance and mentorship during the study abroad period (e.g. Berka et al., 2021). Such interventions aim to support the development of students' IC.

Having a closer look at motivational CQ, we observe that extrinsic interest proved to be the dimension least impacted by the study abroad semester. Female students gained more confidence in their effectiveness in a cross-cultural encounter (self-efficacy to adjust), and the level of enjoyment they derived from culturally diverse situations (intrinsic interest) increased after the sojourn. However, neither male nor female students' interest in the tangible benefits they can derive from culturally diverse experiences (extrinsic interest) was affected by the study abroad experience. We note that the tangible benefits mentioned in the present subscale's items for extrinsic interest (e.g. status, promotion, perks, that would be gained by living or working in a different culture) could easily attract any employee who would consider expatriating. But for students who experience a study abroad semester in the middle of their curriculum, these advantages may not meet their current concerns. Thus, like Chédru and

Ostapchuk (2023), we propose that the extrinsic interest items be changed to better address students' concerns. Advantages such as enhanced networking, career prospects, and employability, for example, could be highlighted in new items (Chédru & Ostapchuk, 2023).

With higher levels of openness and cultural empathy before departure, women were in a more favourable mindset than men to engage in the study abroad semester. In addition, although the difference was not statistically significant, women's intrinsic motivation before departure was also higher than that of men. Thus, if women's CQ increased more than men's CQ during the study abroad semester, it is probably due to favourable initial predispositions that made a difference.

5.2. Practical implications

This study demonstrates the importance of a study abroad semester in improving students' IC. Educators and administrators can use the results of this research to show that study abroad is a key contribution to preparing engineering students for culturally diverse assignments that await them upon graduation. Even if engineering curricula are dense, it is worth including a study abroad semester to give the students the opportunity to become culturally competent.

Before departure, our participants were prepared regarding academic and administrative aspects of their sojourn (curriculum and everyday life issues). However, more attention should be paid to the cultural aspects of this experience. Prior research has shown that students who receive pre-departure intercultural training report greater intercultural gains and a better adjustment (Berka et al., 2021; Engle & Engle, 2004; Paras et al., 2019; Young & Schartner, 2014). Formal instruction on culture shock (Ward et al., 2001) and local culture, information about the benefits students will gain from this experience and how it will increase their employability, should enhance their levels of intrinsic motivation and openness before departure which in turn should improve their intercultural efficiency.

Given the IC disparities observed between women and men prior to departure (women scored higher on cultural empathy, openness, awareness, and intrinsic interest while men scored higher on emotional stability), activities could be specifically designed to strengthen these abilities before departure. For example, stress management activities could be offered to those with low emotional stability, women in priority. Other activities (e.g. photo essays, analysis and comparison of similarities and differences between cultures, incentive to become a buddy for an international student on campus, etc.) could be offered to men in priority to improve their cultural empathy and openness. To increase men's interest in studying abroad, Tompkins et al. (2017) suggested recruiting men as study abroad ambassadors. As role models, the ambassadors would help male students become aware of the many benefits of studying abroad. As men outnumber women in most fields of study in engineering education, any strategy to motivate them to study abroad is of prime importance.

We noticed that our students had a fairly low level of flexibility. The flexibility score was the lowest among the five MPQ dimensions for men and one of the lowest (along with emotional stability) for women. In addition, we found that the semester abroad did not improve student's flexibility. This result is somewhat concerning. It is obvious that engineers need to be able to work in complex and uncertain environments. The ability of engineering students

to be flexible and to tolerate ambiguity is an asset for their future assignments (Grandin & Hedderich, 2009). If the semester abroad experience did not increase student's flexibility, this means that measures should be taken much earlier in the curriculum to develop this ability (Khan & Aji, 2022). Saarikoski and Rybushkina (2019) suggested, for example, the introduction of intensive interdisciplinary courses in engineering education to improve student's tolerance of ambiguity.

In-country mentorship and debriefing workshops post-sojourn are also recommended to help the students become aware of their achievements and translate their experience into useful competencies for their employability (Berka et al., 2021; Messelink et al., 2015). A starting point for this reflection is to ask the students to examine their own MPQ and E-CQS scores and to analyse how and why they have changed as a result of the stay abroad.

5.3. Limitations and future research

IC development is not uniform across dimensions and gender. While almost all women's IC dimensions gained from studying abroad, men's IC showed less malleability. Further research should explore why men did not benefit as much as women from this experience (Salisbury et al., 2010); this is particularly important given that men are often the majority in engineering education. One hypothesis is that openness, cultural empathy and intrinsic motivation seem to be key factors as predispositions necessary to further increase IC during an international sojourn. Thus, like some authors who investigated the moderating role of openness in the relationship between study abroad participation and CQ (Chédru & Ostapchuk, 2023; Ramirez, 2016), it would be interesting to extend this approach to other dimensions such as cultural empathy, intrinsic motivation or a combination of these dimensions.

One of the limitations of this study is the use of self-assessments to determine students' IC. Self-assessments may generate biased data, as students may feel compelled to report socially desirable outcomes of their international experience (Ogden, 2015). Thus, as recommended by Ramsey and Lorenz (2016), future research should include "multiple measurement methods" that seize both the perspectives of self and others, e.g. behavioural observations. Furthermore, our findings should be interpreted with caution because the observed changes could be due to maturation, i.e. "any naturally occurring growth or change in individuals"(Ogden, 2015, p. 10). To counter this limitation, future research should use a control group, i.e. compare differences in IC development with a group of students who stayed at home. Future studies should take into account participant's prior overseas experience to determine whether it moderates the level of IC development (Mazzurco et al., 2012). Further research is also needed to validate our findings with cohorts of students of different nationalities and from different engineering fields. Last, additional studies are required to assess how studying abroad impacts IC months and years after students return to their home country. In addition, it would be interesting to examine how studying abroad affects students' employability and career outcomes over the long run.

Findings from this study are very encouraging. They show the benefits of integrating a study abroad semester into the curriculum of engineers to enhance their IC. As engineers are more

and more expected to work effectively in diverse cross-cultural settings, study abroad is a key contribution to the successful education of “global engineers”.

Disclosure statement

No potential conflict of interest was reported by the authors.

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