ASEE'S VIRTUAL CONFERENCE
At Home with Engineering Education JUNE 22 - 26, 2020 #ASEEVC
Paper ID #30150

(Mis)match of Students' Country of Origin and the Impact of Collaborative Learning in Computer Science

Prof. Nicholas A Bowman, University of Iowa

Nicholas A. Bowman is a professor of Higher Education and Student Affairs, the director of the Center for Research on Undergraduate Education, and a senior research fellow in the Public Policy Center at the University of Iowa. His research uses a social psychological lens to explore salient issues in higher education, including student success, diversity, undergraduate admissions, college rankings, and research methodology.

Lindsay Jarratt, University of Iowa

Lindsay Jarratt is a PhD candidate in Educational Policy and Leadership Studies. Her research follows from fifteen years of experience in student support and equity roles in higher education, and is focused on the dynamics of equity and belonging in educational institutions.

Dr. KC Culver, University of Southern California

KC Culver is a postdoctoral scholar at the University of Southern California. Her research focuses on the core academic mission of postsecondary institutions with an emphasis on access, equity, and inclusion; she studies faculty careers, pedagogy and the curriculum, and the experiences and outcomes of students from diverse backgrounds.

Dr. Alberto Segre, The University of Iowa

Alberto Maria Segre is Professor and Chair of the University of Iowa Computer Science Department, where he is also the Gerard P. Weeg Faculty Scholar in Informatics. Professor Segre holds secondary appointments in the Program in Applied Mathematical and Computational Sciences and the Interdisciplinary Genetics Program. He received a B.A. in Music Theory and a B.S., M.S. and Ph.D. in Electrical Engineering, all from the University of Illinois at Urbana-Champaign. His research interests focus on distributed algorithms for discrete optimization problems, with emphasis on algorithmic problems in the biological and health sciences. Most recently, his work has focused on epidemiological simulation and modeling.

(Mis)match of Students' Country of Origin and the Impact of Collaborative Learning in Computer Science

Abstract

Considerable research has demonstrated the educational efficacy of active and collaborative learning in various postsecondary contexts. However, group composition and intergroup dynamics have the potential to shape the quality of student experiences and the outcomes of collaborative learning. Previous studies have extensively examined the impact of interactions across some forms of difference (e.g., race/ethnicity), but very little research has explored the role of college students' country of origin or language in collaborative learning contexts. This issue is particularly important within increasingly international and multicultural societies throughout the world. Therefore, the present study randomly assigned partners to students for participation in pair programming, which involves close collaboration to complete a computer science coding task. Within a sample of 819 responses from 369 undergraduates in the United States (US), non-US citizens benefitted from having a partner from another country (primarily the US) in terms of the amount of lab assignment completed, belief that the assignment was virtually error-free, and confidence in quality of the submitted assignment; however, these students were also less involved in writing code during pair programming when they had a partner from a different nation than from their own nation. In contrast, the national origin of US citizens' partners generally did not affect their outcomes. These findings support the use of mixed-nationality partners in pair programming and potentially other collaborative learning contexts, which diverges from prior studies that suggest facilitating similarity between partners in terms of demographics, personality, and prior programming experience.

Introduction

Scholars have explored the impact of active and collaborative learning on college student outcomes for decades. Relative to passive learning approaches, active and collaborative learning strategies often provide notable benefits for learning, academic achievement, and retention in college (for reviews, see [1] – [5]). However, collaborative learning is certainly not a monolithic activity, and its effectiveness may vary depending on the type of approach, the quality of the facilitation, and the characteristics of students within these groups.

The present study explores a dimension of collaborative groupwork that has received little attention to date: the national origin of students. Over one million international students are studying in the United States alone, and international students in the US are most strongly represented in engineering and in computer science/math [6], so the potential for cross-national interaction in these contexts is quite high. This study focuses on a particular form of collaborative learning that involves a high degree of interdependence. Pair programming is a common form of collaborative learning in computer science (CS) in which two students work simultaneously on the same programming task; this approach is also used in industry settings as a form of eXtreme Programming that is designed to improve the quality of the resulting code. One of the programmers serves as the driver who writes the code, whereas the other programmer serves as the navigator who reviews the code with an eye toward promoting coding accuracy and making strategic decisions to accomplish the overall task; the programmers switch these roles periodically [7]. Collaboration across difference by country of origin—which often corresponds with linguistic and cultural differences—has the potential to shape the success of pair programming and other groupwork in terms of both short-term assignment completion and more general or long-term outcomes.

Diversity in Programming Pairs: A Strength or a Drawback?

Divergent bodies of literature offer conflicting conclusions about the impact of diverse groups on student outcomes. Considerable inquiry has explored the effects of college students' intergroup interactions within and outside of coursework. This body of literature argues that diversity experiences are often novel for many college students; as a result, students' previous viewpoints may be challenged by these experiences, which then leads to learning and growth [8], [9]. Several systematic reviews have synthesized this literature. Regardless of the form of difference (e.g., race, socioeconomic status), intergroup interactions in college are associated with greater learning and cognitive growth [10], [11], more positive intergroup attitudes [12], [13], greater civic engagement [11], [14], and a host of other favorable outcomes [3], [4]. In the context of diversity-related coursework, students in more racially diverse classrooms exhibit greater declines in racial bias [15]. However, this research often examined outcomes that extended well beyond course content, so it is unclear whether these positive results for general outcomes might apply to learning and achievement within the context of the class in which such interactions occurred.

Other research has taken a group- or organization-level perspective on diversity to examine its effects on group performance, in which a group provides a single solution, answer, or product. Notably, Page [16] argues for the importance of groups that contain diverse perspectives and ways of thinking to develop the best possible solution, especially when dealing with complex and difficult problems. He further suggests that identity diversity is productive insofar as (a) it fosters this cognitive diversity, and (b) the benefits of intellectual diversity outweigh any conflict that is associated with identity diversity. Pair programming for complex coding assignments has the potential to fit these criteria.

However, research that directly explores group compatibility in pair programming often finds problems with pairs that are diverse in terms of identity and prior programming experience. For instance, same-gender pairs tend to outperform and be more satisfied with their pair programming experiences than are mixed-gender pairs; these patterns are especially pronounced among women [17] – [20]. Additional work has explored differences in prior programming experience. Although some divergent findings are present in the literature, this research has generally found better outcomes when pairs are matched in terms of prior experience, even for novice-novice pairings [18], [21] – [23]. Unfortunately, the pairings in these studies were often created through some form of self-selection, so strong causal conclusions cannot be drawn. In contrast, a large-scale study that randomly assigned pairings found overall benefits of having a female partner or a less experienced partner that were largely independent of students' own identities or prior programming experience [24], [25].

Given these previous areas of inquiry, it may be surprising that very little research has explored the matching or correspondence of students' country of origin or language, particularly in the context of collaborative learning. As notable exceptions, two studies from the United Kingdom examined students' perceptions of opportunities and challenges from engaging in collaborative learning [26], [27]. Both papers found that challenges with English skills constituted a notable barrier; moreover, in the context of cross-national interaction, this issue was often confounded with differences in culture and with stereotypes about other groups of students. International students often felt left out of fast-moving English-language conversations that sometimes delved into topics beyond the assignment [26]. Furthermore, according to a study based in the United States, international students were more likely to perceive that one person was dominating the group conversation than were domestic students [28]. These few studies were intentionally designed to understand students' experiences within pairs; they did not explore whether group composition by language or country of origin was significantly related to student outcomes. The present study therefore examined this issue in the context of pair programming in a large introductory CS course.

Method

Participants and Sample. Participants were undergraduates who enrolled in the introductory CS course designed for CS majors at the University of Iowa from Fall 2016 to Spring 2018. Students were included in the analyses if they had participated in pair programming (lab sections were randomly assigned to paired or individual programming conditions), were enrolled in the course after the fourth week of classes (i.e., they did not drop out shortly after the course began), and were taking their first introductory CS course (some students had previously enrolled in another introductory course or took the same course multiple times). Students engaged in three different randomly assigned pairings throughout the course; each pairing lasted for approximately 1/3 of the semester. Students were assigned to a trio (rather than a pair) if there was an odd number of students in the first lab section of the pairing. Given the presence of multiple partners in this circumstance, trios were not included in the analyses.

A total of 819 responses from 369 undergraduates were examined. These participants were citizens of the United States (63%), China (30%), and 13 other countries (7% combined). International students were asked to report whether English was their first language, and more than 98% said that it was not. Unfortunately, US domestic students were not asked the same question, so the study could not identify US citizens for whom English was not their first language. Given the high representation of international students within this course, 45% of all pairings involved a country of origin mismatch between the two partners. Among pairings with students from different countries, all US students were paired with non-US students (by definition), and 83% of students from other countries were paired with US students. Among the pairings with students from the same country, 81% involved both partners from the US, 18% had both partners from China, and 1% had both partners from Malaysia.

Measures. Surveys were administered frequently throughout the semester. Pairings often occurred across multiple surveys and multiple paired assignments, so students' responses within the pairing were averaged to create the outcome measures when applicable. The dependent variables included the amount of the lab assignment completed (1 = 0-10%, to 10 = 91-100%), how productive they felt within their lab section (1 = not at all productive, to 5 = very productive), how interested they were in CS overall (1 = not at all interested, to 5 = very interested), and the percentage of time in which they engaged in the driver role (0-100). Participants also reported their level of agreement with several items (1 = strongly disagree, to 5 = strongly agree): they understood all concepts relevant to this assignment, they put a good amount of effort into that assignment, they believed their assignment was virtually error-free, and they were confident in this finished product. Students also rated their own skill relative to that of their partner (1 = my partner has more technical competency, to 3 = my partner has less technical competency) and their relative effort (1 = my partner invested more effort in this assignment, to 3 = my partner invested less effort in this assignment).

The primary independent variables were whether the student was a US citizen and whether the pairing involved a difference in country of origin (for both items, 0 = no, 1 = yes). An interaction term was created by multiplying these two variables by each other. Dummy variables were created to indicate the semester in which the course was taken (Spring 2017, Fall 2017, and Spring 2018, with Fall 2016 as the referent group) and the order of the pairing within the semester (second and third, with the initial pairing as the referent group). Supplemental analyses examined prior computer programming experience, which was measured via the average of nine items regarding prior experience with website design; programming mobile apps; and using BASIC, C/C++, Java, Javascript, Perl, Python, and Ruby. The items used a four-point scale (1 = none, to 4 = a lot; $\alpha = .76$). Given the right skew of the resulting distribution, the natural log of the original measure was used.

Analyses. Students' responses within a pairing were nested within two higher-order levels: participants (since each participant engaged in three pairings) and partners (since the partner also worked on the assignment and therefore shaped the outcome). However, neither participants nor partners are hierarchical to each other, since these both occur at the student level. As a result, cross-classified multilevel models were conducted to analyze this complex sample appropriately, with participants and partners crossed with each other (for more information, see [29], [30]). The key predictors were the participant's country of origin, the presence of a partner from a different country, and the interaction between the two. Variables for the semester and timing during the semester were also included in all analyses; some analyses also added prior programming experience. Because pairings were randomly assigned, the results for the matching by country of origin can be interpreted as causal effects.

Results and Discussion

The full results are displayed in Table 1. Within same-country pairings, US citizens fared better on the vast majority of outcomes than non-US citizens (virtually all of whom were Chinese citizens). These significant results included the proportion of the lab assignment completed during the lab session, feeling productive during the lab session, feeling that they understood the concepts used in the assignment, exerting good effort in completing the assignment, perceiving that the submitted assignment was virtually error-free, feeling confident in the assignment quality, and having interest in CS overall.

Table 1. Coefficients from cross-classified analyses for participants' national origin and cross-national pairing predicting college student outcomes from pair programming.

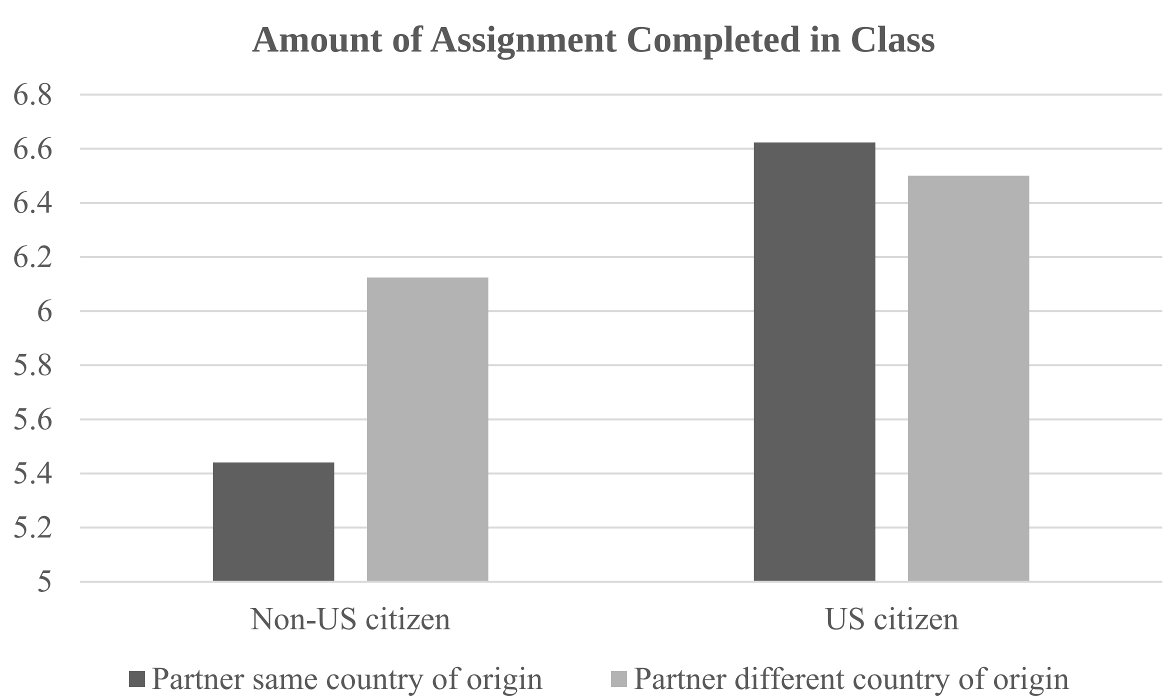
	Predictor		
Outcome	U.S. Citizenship	Partners from Different Nations	Citizen x Partner Nationality Match
Amount of lab assignment completed	1.182***	.683**	-.806**
	(.255)	(.244)	(.284)
Felt productive during lab section	.365**	.165	-.168
	(.122)	(.115)	(.140)
Exerted good effort on the assignment	.702***	.164	-.167
	(.125)	(.121)	(.148)
Believed that the assignment was virtually error-free	.722***	.340*	-.285
	(.153)	(.149)	(.176)
Confident in quality of submitted assignment	.816***	.376*	-.389*
	(.150)	(.147)	(.173)
Understood relevant lab concepts	.597***	.161	-.049
	(.151)	(.151)	(.182)
Percentage of time in driving role	-2.903	-5.735	15.504***
	(3.176)	(3.295)	(4.047)
Perceive that partner has more technical competency than you	-.007	-.210+	.380**
	(.112)	(.111)	(.136)
Perceive that partner exerted more effort than you	.087	-.110	.171
	(.088)	(.090)	(.110)
Overall interest in computer science	.478**	.136	-.171
	(.164)	(.127)	(.153)

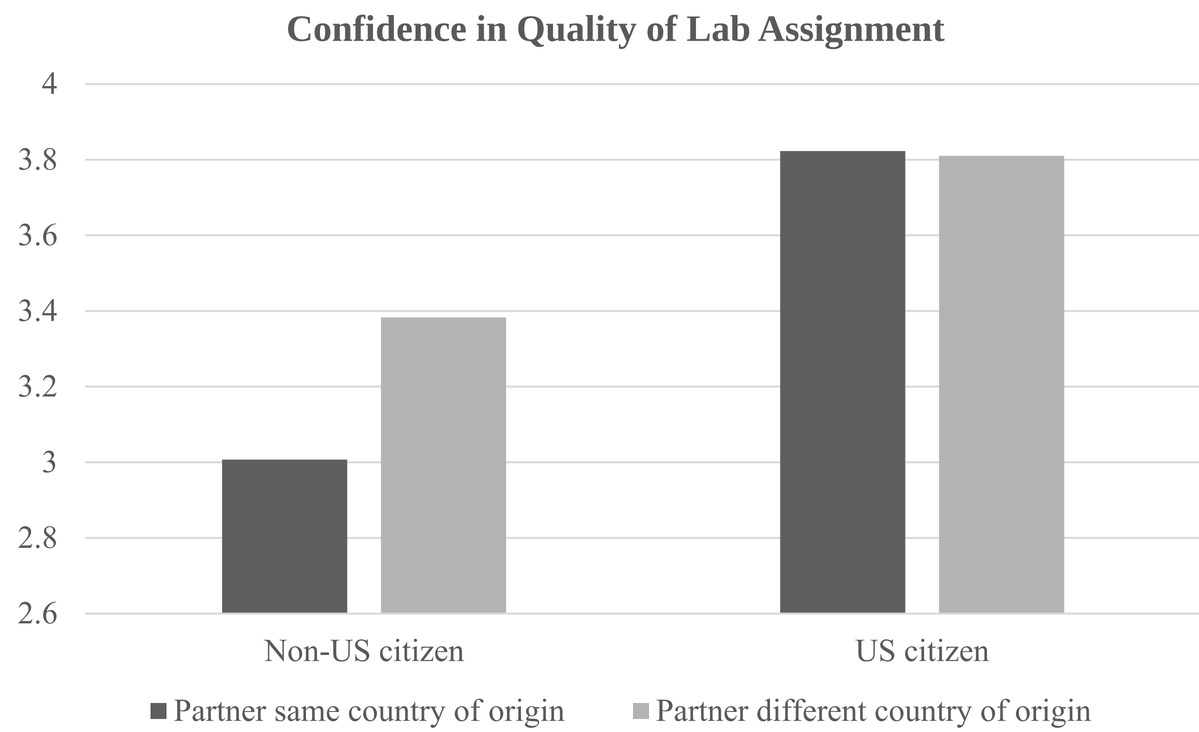
Note. Analyses controlled for the semester enrolled and the order of the pairing within the semester. $+p < .10$ $*p < .05$ $**p < .01$ $***p < .001$

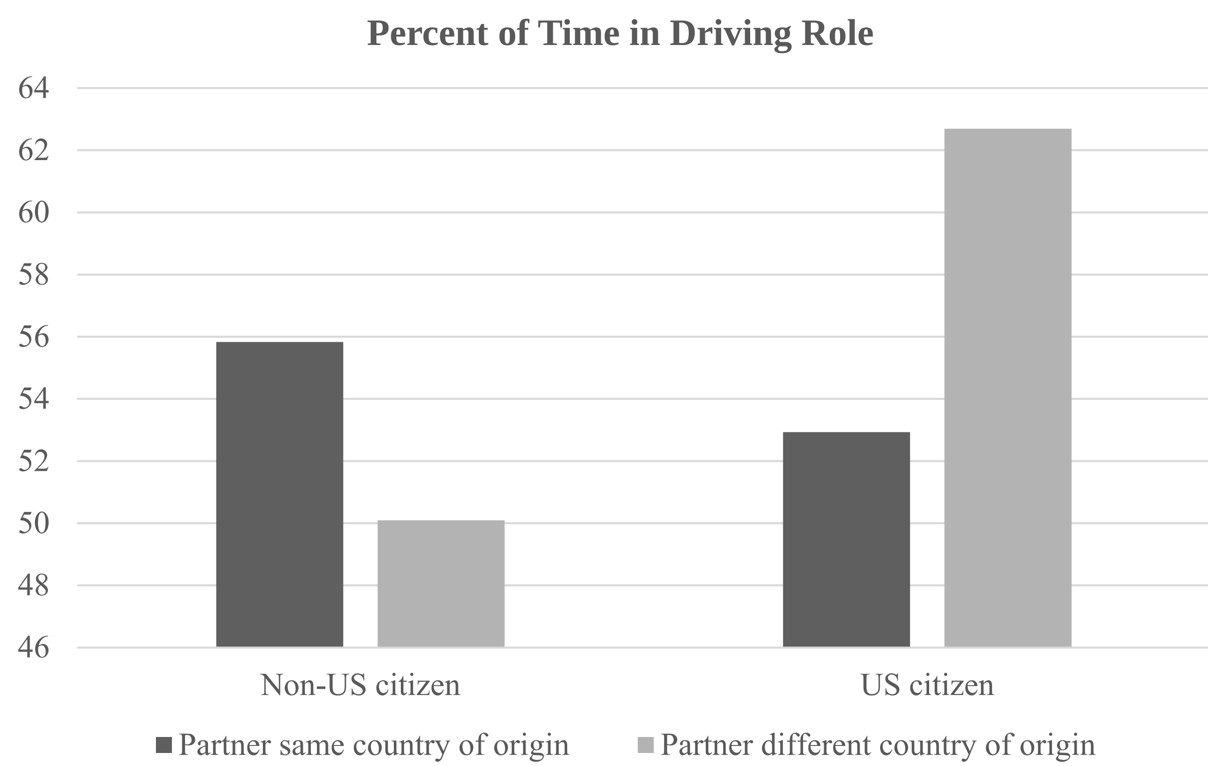
Among non-US citizens, students who had a partner from another country completed a greater proportion of the lab assignment during the lab session, were more confident that the assignment was virtually error-free and more confident overall in the finished product than students who had a partner from the same country. However, non-US citizens with a different-country partner also spent less time in the driving role and were more likely to rate their partner's technical competency as greater than their own. Interestingly, for four of five of these significant patterns, a significant interaction for US citizenship x country of origin difference in the opposite direction was also present. The lone exception was for believing that the submitted assignment was virtually error-free, but the nonsignificant result for this interaction was actually equal in size to the main effect for country of origin difference. Feeling productive during the lab session contains a main effect and interaction that are both nonsignificant but fit this same pattern.

The exact nature of these 2 x 2 relationships can be difficult to discern through these tables, so Figure 1 provides graphs for some outcomes with significant interactions. Being paired with someone from a different country is beneficial for non-US citizens in terms of multiple assignment-related outcomes (e.g., amount of assignment completed in class and confidence in the quality of the lab assignment), but this cross-national pairing appears to have no effect on US citizens. The positive main effects of cross-national pairing for non-US citizens may be surprising, since the vast majority of same-nation pairings involved Chinese students who are likely to share a common language and/or culture. To the extent that this commonality exists in the present sample, Chinese students may be able to communicate in ways with which they are likely more familiar, which could be viewed as likely contributing to desired outcomes. However, in the context of this US course, the pair programming assignments require English skills in order to understand the course material in the form of lectures and assigned readings, to understand the lab assignment itself, and to complete the lab assignment to some extent (since the coding uses English characters and is based on the English language). Therefore, using English when working on the lab assignments in pairs may be helpful for promoting students' success in this domain. Memory and performance are highly dependent on relevant context [31], so having conversation in English may provide an advantage in English-language classrooms.

Figure 1. Pair programming outcomes by participants' country of origin and match with partner's country of origin.




Confidence in Quality of Lab Assignment
4
3.8
3.6
3.4
3.2
3
2.8
2.6
Non-US citizen
US citizen
Partner same country of origin
Partner different country of origin


Percent of Time in Driving Role
64
62
60
58
56
54
52
50
48
46
Non-US citizen
US citizen
Partner same country of origin
Partner different country of origin

As an alternative explanation, US citizens reported having far more experience with programming before the class than did non-US citizens (Cohen's $d = .52$, $p < .001$), so any improvement in outcomes for non-US citizens may be explained by the greater experience of their partner. To explore this possibility directly, follow-up analyses used prior programming experience as an additional variable in the model to determine whether this construct could explain the observed main effects and interactions. As shown in Table 2, virtually all of the significant results persisted in these modified analyses; the only changes in the pattern of statistical significance were that the nonsignificant trend for the interaction term predicting the belief that the assignment was virtually error-free became significant, whereas the relationship between US citizenship and overall interest in CS became nonsignificant. Therefore, although prior programming experience is sometimes strongly related to student outcomes, the results in this study do not appear to be driven by any such differences by country of origin.

In contrast to those favorable results for cross-national pairings, citizenship and cross-national pairing exhibit a significant interaction for predicting the allocation of pair programming roles, such that US citizens spent more time in the driving role when paired with a non-US citizen than with another US citizen. Non-US citizens who are paired with students from another country also experience declines in their relative assessment of their own technical competency versus that of their partner. These results seem consistent with prior research about linguistic and cultural difficulties experienced by domestic and international students during group work and collaborative learning [26], [27], but the lack of negative results among both US and non-US citizens is notable. An interesting question that these results do not address is whether cross-national interactions led to any overall declines in non-US citizens' self-efficacy or self-confidence about their CS knowledge and skills (as opposed to comparisons with one's partner).

With the exception of driving role, the lack of effects of partners' national origin among US citizens is also noteworthy. Any linguistic or cultural challenges that US citizens encountered may been balanced out by the benefits of potentially different perspectives that non-US citizens brought to these collaborations. It is also possible that the work of communicating cross-culturally might heighten students' focus on clarifying concepts and ensuring shared interpretations, thereby leading to better understanding and confidence.

Table 2. Coefficients from cross-classified analyses for participants' national origin, cross-national pairing, and prior programming experience predicting college student outcomes from pair programming.

	Predictor			
Outcome	U.S. Citizenship	Partners from Different Nations	Citizen x Partner Nationality Match	Prior Programming Experience
Amount of lab assignment completed	1.076*** (.259)	.667** (.245)	-.832** (.287)	.766* (.298)
Felt productive during lab section	.323** (.124)	.177 (.116)	-.206 (.142)	.350* (.156)
Exerted good effort on the assignment	.698*** (.128)	.176 (.123)	-.199 (.150)	.047 (.157)
Believed that the assignment was virtually error-free	.644*** (.153)	.353* (.149)	-.301+ (.176)	.766*** (.174)
Confident in quality of submitted assignment	.745*** (.151)	.402** (.148)	-.418* (.173)	.683*** (.168)
Understood relevant lab concepts	.452** (.154)	.182 (.153)	-.074 (.182)	1.131*** (.172)
Percentage of time in driving role	-3.628 (3.260)	-5.844 (3.333)	14.607*** (4.106)	4.129 (3.822)
Perceive that partner has more technical competency than you	-.070 (.111)	-.203+ (.110)	.343* (.134)	.612*** (.132)
Perceive that partner exerted more effort than you	.074 (.088)	-.109 (.090)	.145 (.111)	.167+ (.100)
Overall interest in computer science	.230 (.157)	.159 (.126)	-.232 (.152)	1.910*** (.219)

Note. Analyses controlled for the semester enrolled and the order of the pairing within the semester. +p < .10 *p < .05 **p < .01 ***p < .001

Conclusion

As higher education becomes an increasingly global endeavor, pedagogical practices that assume shared linguistic frames must be re-examined for their efficacy in diverse learning spaces. This study of pair programming suggests that cross-national pairings can be beneficial for international students' confidence and assignment completion, while having no adverse effects for domestic students. These findings are based on the random assignment of partners within lab sections, which means that these appear to be causal effects of pair characteristics. This implication for creating heterogeneous groups by country of origin runs contrary to existing research on gender and prior programming experience in pair programming [17] – [23], but it is consistent with research on intergroup interactions and a broad range of desired outcomes [3], [4], [8] – [15].

The present study focused primarily on short-term outcomes that were specific to relevant coursework and content, which limits the types of conclusions that can be drawn. Future research should explore relevant dynamics in greater detail, including the longer-term effects from such experiences, outcomes that extend well beyond the scope of pair programming, the conditions under which cross-national groupwork is most effective, and the ways in which these findings may or may not be similar for other forms of collaborative learning (e.g., problem-based learning, jigsaw classrooms). Qualitative, quantitative, and mixed-method research designs would be helpful for providing an in-depth understanding of these issues.

References

[1] S. Freeman, S. L. Eddy, M. McDonough, M. K. Smith, N. Okoroafor, H. Jordt, and M. P. Wenderoth, “Active learning increases student performance in science, engineering, and mathematics,” *Proceedings of the National Academy of Sciences*, vol. 111, pp. 8410–8415, 2014.

[2] E. Kyndt, E. Raes, B. Lismont, F. Timmers, E. Cascallar, and F. Dochy, “A meta-analysis of the effects of face-to-face cooperative learning: Do recent studies falsify or verify earlier findings?,” *Educational Research Review*, vol. 10, pp. 133-149, 2013.

[3] M. J. Mayhew, A. N. Rockenbach, N. A. Bowman, T. A. Seifert, and G. C. Wolniak, with E. T. Pascarella and P. T. Terenzini, *How College Affects Students (Vol. 3): 21st Century Evidence that Higher Education Works*. San Francisco, CA: Jossey-Bass, 2016.

[4] E. T. Pascarella and P. T. Terenzini, *How College Affects Students (Vol. 2): A Third Decade of Research.* San Francisco, CA: Jossey-Bass, 2005.

[5] M. Prince, “Does active learning work? A review of the research,” *Journal of Engineering Education*, vol. 93, pp. 223–231, 2004.

[6] IIE, “Open doors: 2019 fast facts,” IIE. Report, 2019.

[7] L. Williams and R. L. Upchurch, “In support of student pair-programming,” *ACM SIGCSE Bulletin*, vol. 33, pp. 327–331, 2001.

[8] N. A. Bowman and J. W. Brandenberger, “Experiencing the unexpected: Toward a model of college diversity experiences and attitude change,” *Review of Higher Education*, vol. 35, pp. 179-205, 2012.

[9] P. Gurin, E. L. Dey, S. Hurtado, and G. Gurin, “Diversity and higher education: Theory and impact on educational outcomes,” *Harvard Educational Review*, vol. 72, pp. 330-366, 2002.

[10] N. A. Bowman, “College diversity experiences and cognitive development: A meta-analysis,” *Review of Educational Research*, vol. 80, pp. 4-33, 2010.

[11] M. J. Chang, “Quality matters: Achieving benefits associated with racial diversity,” Kirwin Institute for the Study of Race and Ethnicity, The Ohio State University. Report. Oct. 2011.

[12] K. Davies, L. R. Tropp, A. Aron, T. F. Pettigrew, and S. C. Wright, “Cross-group friendships and intergroup attitudes: A meta-analytic review,” *Personality and Social Psychology Review*, vol. 15, pp. 332-351, 2011.

[13] T. F. Pettigrew and L. R. Tropp, *When Groups Meet: The Dynamics of Intergroup Contact*. New York, NY: Psychology Press, 2011.

[14] N. A. Bowman, “Promoting participation in a diverse democracy: A meta-analysis of college diversity experiences and civic engagement,” *Review of Educational Research*, vol. 81, pp. 29-68, 2011.

[15] N. Denson, “Do curricular and co-curricular diversity activities influence racial bias? A meta-analysis,” *Review of Educational Research*, vol. 79, pp. 805-838, 2009.

[16] S. E. Page, *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies*. Princeton, NJ: Princeton University Press, 2007.

[17] K. S. Choi, “A comparative analysis of different gender pair combinations in pair programming,” *Behaviour and Information Technology*, vol. 34, pp. 825–837, 2015.

[18] K. S. Choi, F. P. Deek, and I. Im, “Pair dynamics in team collaboration.” *Computers in Human Behavior*, vol. 25, pp. 844–852, 2009.

[19] N. Katira, L. Williams, and J. Osborne, “Towards increasing the compatibility of student pair programmers,” in *Proceedings of the 27th International Conference on Software*

Engineering, ICSE '05, St. Louis, MO, May 2005, G.-C. Roman, W. Griswold, and B. Nuseibeh, Eds. New York, NY: Association for Computing Machinery, 2005, pp. 625–626.
[20] S. Schiller, F. Nah, B. Mennecke, and K. Siau, "Gender differences in virtual collaboration on a creative design task," in *Proceedings of the 32th International Conference on Information Systems, ICIS 2011, Shanghai, China, December 2011*, C. Beath, M. D. Myers, and K. K. Wei, Eds. Association for Information Systems, 2011.
[21] E. Arisholm, H. Gallis, T. Dyba, and D. I. K. Sjoberg, "Evaluating pair programming with respect to system complexity and programmer expertise," *IEEE Transactions on Software Engineering*, vol. 33, pp. 65–86, 2007.
[22] K. M. Lui, and K. C. C. Chan, "Pair programming productivity: Novice–novice vs. expert–expert," *International Journal of Human-Computer Studies*, vol. 64, pp. 915-925, 2006.
[23] N. Z. Zacharis, "Measuring the effects of virtual pair programming in an introductory programming java course," *IEEE Transactions on Education*, vol. 54, pp. 168–170, 2011.
[24] N. A. Bowman, L. Jarratt, K. Culver, and A. M. Segre, "How prior pair programming experience affects students' pair programming experiences and outcomes," in *Proceedings of the 24th Annual Conference on Innovation and Technology in Computer Science Education, ITiCSE '19, Aberdeen, Scotland, July 2019*, B. Scharlau, R. McDermott, A. Pears, and M. Sabin, Eds. New York, NY: Association for Computing Machinery, 2019, pp. 170-175.
[25] L. Jarratt, N. A. Bowman, K. Culver, and A. M. Segre, "A large-scale experimental study of gender and pair composition in pair programming," in *Proceedings of the 24th Annual Conference on Innovation and Technology in Computer Science Education, ITiCSE '19, Aberdeen, Scotland, July 2019*, B. Scharlau, R. McDermott, A. Pears, and M. Sabin, Eds. New York, NY: Association for Computing Machinery, 2019, pp. 176-181.
[26] C. G. Simpson, "Language, relationships and skills in mixed-nationality Active Learning classrooms," *Studies in Higher Education,* vol. 42, pp. 611-622, 2017.
[27] Wicaksono, R. (2008). Assessed mixed nationality group work at a UK university: Does it get results? *The Enhancing Series Case Studies: International Learning Experience*.
[28] S. L. Eddy, S. E. Brownell, P. Thummaphan, M.-C. Lan, and M. P. Wenderoth, "Caution, student experience may vary: Social identities impact a student's experience in peer discussion," *CBE—Life Sciences Education,* vol. 14:ar45, pp. 1-17, 2015.
[29] Fielding, A., and Goldstein, H. (2006). *Cross-classified and multiple membership structures in multilevel models: An introduction and review* (Research Report no. 791). Birmingham, UK: University of Birmingham.
[30] S. W. Raudenbush and A. S. Bryk, *Hierarchical Linear Models: Applications and Data Analysis* Methods, 2nd ed. Thousand Oaks, CA: Sage, 2002.
[31] S. M. Smith and E. Vela, "Environmental context-dependent memory: A review and meta-analysis," *Psychonomic Bulletin and Review*, vol. 8, pp. 203-220, 2001.