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Examining the Role of Conference Participation to Enhance Research Self-Efficacy and Science Identity of Undergraduates in a Research Training Program

Kim-Phuong L. Vu[1], Hector Ramos[1,2], Chi-Ah Chun[1], Panadda Marayong[1], and Jesse Dillon[1]

[1]California State University Long Beach, Long Beach, CA 90840, USA
[2]University of California Los Angeles, Los Angeles, CA 90095, USA

ABSTRACT

Research training is important for workforce development in Science, Technology, Engineering, and Mathematics (STEM). The STEM higher education literature has identified various components critical to the success of research training programs such as research mentoring and training. Less work has been conducted on other research training activities such as conference participation even though it is an interactive activity that can allow students to develop science self-efficacy and science identity. Yet, the costs associated with conference attendance may be a barrier for students, especially those who already have financial concerns about funding their education. This paper evaluates how conference participation (i.e., conference attendance and/or presentation) contributes to students' development of research self-efficacy and science identity within a STEM research training program at California State University Long Beach (CSULB) called the Building Infrastructure Leading to Diversity (BUILD) Scholars program. Data were collected from students enrolled in the departments engaged in health-related research across four colleges (natural sciences, engineering, health and human services and liberal arts) at CSULB. This study used propensity score matching and Ordinary Least Squares (OLS) regression to predict research self-efficacy and science identity from exposure to the BUILD intervention and conference participation. Results indicate that both participation in the BUILD Scholars program and conferences have a strong positive association with research self-efficacy and science identity. Overall, the results of this study present a strong case for including conference attendance and presentations as a part of any STEM education research training program.

Keywords: Undergraduate research training, STEM training, Learning sciences, Conference presentations

INTRODUCTION

Research training is important for workforce development in Science, Technology, Engineering, and Mathematics (STEM). In fact, undergraduate

research is associated with long-term career success and higher academic achievement (Arruda et al., 2025; Winterer et al., 2020). The STEM higher education literature has identified components critical to the success of research training programs, including mentoring (e.g., Atkins et al., 2020) and active research training (e.g., Vu et al., 2023). Less work has been conducted on other research training activities, such as conference participation (i.e., conference attendance and/or presentation), that have long been regarded as central for hands-on research training experiences. Preparing for a conference presentation requires that students demonstrate their competence in research and performance as researchers. For example, attending and presenting at a scientific conference requires students not only to perform scientific tasks in the form of preparing their research for presentation, but they must also demonstrate competence and mastery of their study, respond to questions, explore future research directions, and more. In addition, conference presentations specifically allow the opportunity for students to be recognized as a "science person" by people inside and outside their discipline, which are essential factors in developing a science identity (Carlone & Johnson, 2007). Thus, the preparatory activities associated with conference presentations should provide the appropriate context for students to develop and/or sustain their science identity.

Prior studies with first-year students show little impact of conference presentations on research self-efficacy and science identity (e.g., Cobian et al., 2021; Eagan et al., 2023). However, first-year students are just beginning to explore research at the start of undergraduate studies. As such, a first-year presentation experience is likely to be hosted by a university as a showcase of student research. Students' research presentations at professional conferences instead reflect a culmination of their research efforts. Because preparing for a professional conference presentation requires students to demonstrate their competence in research and performance as researchers, these presentations are typically made by students later in their undergraduate studies. Consistent with this notion, Casad et al. (2017) surveyed juniors and seniors who attended the Annual Biomedical Research Conference for Minoritized Scientists (ABRCMS) and found a positive relationship with frequency of attending and science self-efficacy, research confidence, sense of belonging in science, and intentions to pursue a research degree.

Although there are potential benefits of conference attendance, registration and travel costs can be a barrier for students from underserved backgrounds, especially those already having financial concerns. To overcome this financial constraint, many student research training programs provide funding for student conferences [e.g., NIH's Building Infrastructure Leading to Diversity (BUILD), Research Training Initiative for Student Enhancement (RISE), and Maximizing Access to Research Careers (MARC) programs]. Thus, it will be informative for undergraduate research training programs to evaluate the benefits of conference participation relative to participation in the larger research training program. We used data from one year of the CSULB BUILD Scholars (see Vu et al., 2023 for a detailed description) program

to determine whether BUILD Scholars show higher research self-efficacy and science identity compared with non-BUILD students. We also examined whether conference participation defined as attendance and/or presentation predicts research self-efficacy and science identity.

METHOD

Data and Sample

This study uses survey data from CSULB collected in the Spring of 2019. The Coordination and Evaluation Center at University of California Los Angeles (UCLA) provides these data, which are from the Student Annual Follow-up Survey (SAFS) developed by the Higher Education Research Institute (HERI) at the UCLA. Items from the SAFS have been validated using item response theory (see e.g., Sharkness et al., 2002). The SAFS asks questions about various student experiences while in college. The initial sample size for this study was n = 1963, consisting of both BUILD and non-BUILD students. After applying propensity scores and trimming the sample to students with similar scores, the analytical sample size was n = 1824.

Dependent Variables From SAFS

Research Self Efficacy. This variable measures a student's confidence in conducting scientific research via the following items: use technical science skills, generate a research question, determine how to collect appropriate data, explain the results of a study, use scientific literature to guide research, and integrate results from multiple studies. The question asks students how confident they are on a five-point Likert scale from *absolutely* to *not at all*.

Science Identity. This variable uses the following items: I have a strong sense of belonging to a community of scientists; I derive great personal satisfaction from working on a team that is doing important research; I think of myself as a scientist; and I feel like I belong in the field of science. This variable asks students how confident they are on a five-point scale from *strongly agree* to *strongly disagree*.

Independent Variables

BUILD Participation. The first independent variable introduced into the multiple regression model is BUILD participation. The variable identifies students who participate in the 2-year BUILD Scholars training program and is coded BUILD Scholar = 1 and non-BUILD = 0.

Conference Participation. This variable includes conference attendance and/or presentation. It is introduced in the second step of the model. This variable is also coded as a binary variable with "Yes" they attended and/or presented at conferences = 1 and they did not attend or present at conferences = 0.

Financial Concerns. The final variable of interest is that which identifies a student's income concerns. This variable is categorical (None, Some, Major or Choose not to answer) based responses to the following items: I am confident

that I will have enough funds to complete college; I am confident that I will have sufficient funds to complete college; Not sure if I will have enough funds to complete college. The variable was dummy coded with no income concerns as the reference group.

Propensity Scores

Other essential student characteristics were addressed using propensity scores before running the multiple regression models. To accomplish this, we used binary logistic regression. Logistic regression is the most common initial procedure for research studies that use propensity scores (Leite, 2017). First, we used demographic variables to create similar groups. We controlled for gender, race, and degree aspirations and ran a logistic regression with BUILD scholar participation as the dependent variable. The logistic regression then yielded propensity scores for each individual student. Once we analysed the model, we created the BUILD and non-BUILD groups based on the overlap of their respective propensity scores. Students from the non-BUILD group with propensity scores different than those from the BUILD group were removed from the study. The final analysis included a sample size of 111 BUILD Scholars and 1713 students with similar characteristics in the non-BUILD group.

Descriptives

We first conducted descriptive analyses, including crosstabs and measures of central tendency, comparing the BUILD and non-BUILD students on variables that reflect student backgrounds, demographics, and behaviors. We show the frequencies and percentages for categorical variables and the mean and standard deviation for continuous variables in Table 1. We used Chi-square and two sample t-tests to test for differences between the BUILD and non-BUILD students. Then, we ran an unweighted multiple regression model after removing cases from the non-BUILD group that were different from the BUILD group using propensity scores and then applied a weighted multiple regression model using the propensity score weights. All covariates were added in a stepwise fashion to examine the changes in coefficients and variance for each variable that was introduced.

Multivariate Analyses

BUILD Scholars and their corresponding non-BUILD students were assigned to the BUILD group or non-BUILD group using propensity scores. Then, we calculated the Average Treatment Effect (ATE) and the Average Treatment Effect on the Treated (ATT). The ATE weight is the overall effect of the BUILD intervention on a sample of students who are BUILD eligible. The ATT weight examines the effect of becoming a BUILD Scholar among undergraduate students with a higher likelihood of selecting into BUILD. Next, we ran a multiple regression model to predict research self-efficacy for BUILD Scholars compared with non-BUILD students. We ran three models: unweighted, weighted with ATE, and weighted with ATT. This study reports the ATE

results because we wanted to evaluate the overall BUILD intervention effect (Ramos & Vu, 2024). After controlling for BUILD participation and the independent variables, the study yielded results predicting research self-efficacy.

Table 1: Descriptive statistics of the sample before and after weighting on demographic variables.

Variable	BUILD Scholars	Control Group Pre-Weighting	Control Group Post-Weighting
	%	%	%
Gender			
Female	67.8	69.9	69.5
Male	29.7	29.3	30.3
Other	2.5	.8	.2
Race/Ethnicity			
Latinx	51.3	41.1	52.2
Black	5.1	3.2	5.5
Asian	27.4	35.2	28.4
White	13.7	13.4	11.2
Other	2.6	7.1	2.6
Degree Aspiration			
Bachelor's	10.9	43.2	11
Master's	10.8	32.2	9.2
MD/PhD/JD	77.4	16.5	77.5
Other	.8	2.4	.7
Major			
BioMed	64.8	47.7	58.5
Social Behavioral	22.9	11.4	18.4
Non_Biomed/ Non-Social Behavioral	12.4	40.9	23.1
Financial Concern			
Choose not to answer	1.8	4	3.9
Major	19.5	17.9	18.7
None	18.6	23.1	19.4
Some	60.2	55	57.9

Limitations

This study has several limitations concerning data availability, which limited variable selection. Moreover, since students begin BUILD at CSULB in their junior year, it was not possible to obtain a baseline survey for a longitudinal analysis. Finally, the results may be influenced by specific characteristics of the BUILD Scholars intervention or by the characteristics of the individual university.

RESULTS

Descriptives

In Table 1, we present the descriptive statistics for the BUILD Scholars and non-BUILD students across various background characteristics. For demographic characteristics, BUILD Scholars and non-BUILD students were predominately female and had higher percentages of Asian and Latino/Latinx self-identities than Black and White students.

Unweighted comparisons of BUILD Scholars to their non-BUILD counterparts indicate that BUILD Scholars had a higher mean research self-efficacy score ($M = 51.3$, $SD = 7.74$) than non-BUILD students ($M = 44.59$, $SD = 10.7$ pre-weight). BUILD Scholars also had a higher science identity score ($M = 60.97$, $SD = 8.04$) than non-BUILD students ($M = 51.05$, $SD = 8.16$ pre-weight). Next, BUILD Scholars were more likely to report pursuing a PhD/MD/JD (77.4% BUILD vs 16.5% non-BUILD). BUILD Scholars were also more likely as non-BUILD students to select a biomedical major than non-BUILD students (64.8% BUILD vs 47.7% non-BUILD). Since BUILD Scholars had higher percentages and means for self-efficacy, science identity, and pursuit of a graduate degree, we controlled for those characteristics, as described in the next section.

Propensity Scores

Prior to running the multivariate model for BUILD Scholars and non-BUILD students, we used propensity scores from a binary logistic regression to control for selection effects based on differences identified in the descriptives (Table 2).

Table 2: Binary logistic regression predicting BUILD scholar selection.

	B	S.E.	Wald	Df	Sig.	Exp(B)
Race/Ethnicity						
Latinx	.213	.320	.442	1	.506	1.237
Black	.463	.562	.679	1	.410	1.589
Other Race	−1.041	.668	2.425	1	.119	.353
Asian	−.232	.345	.453	1	.501	.793
White (ref)						
Sex						
Male (ref)						
Female	−.340	.234	2.105	1	.147	.712
Other Sex	−1.191	.526	5.121	1	.024	.304
Degree Aspiration						
BA/BS (ref)						
MA	.711	1.061	.449	1	.503	2.035
PhD/MD/JD	2.882	.306	88.642	1	<.001	17.842
other	−.146	.390	.139	1	.709	.865
Constant	−3.675	.412	79.434	1	<.001	.025

We controlled for pretreatment covariates that show differences between BUILD Scholars and non-BUILD students. First, we ran a binary logistic regression predicting BUILD Scholar selection. The most crucial variable predicting BUILD selection is pursuing a PhD/MD/JD degree. These results are to be expected since the BUILD program explicitly targets students pursuing a PhD degree, as BUILD does not admit students not seeking graduate education. The binary logistic regression results underscore the importance of matching for similar groups since it is likely that students not pursuing graduate degrees would fall into the model and yield a much stronger BUILD effect in the final multiple regression model predicting science identity and research self-efficacy.

Outcome Modelling Research Self-Efficacy and Science Identity

Tables 3 and 4 present the results of two ATE weighted multiple regression models examining the relationship between BUILD participation and 1) research self-efficacy and 2) science identity. However, we also ran a sensitivity analysis for the unweighted and ATT weighted models. The results of the models are presented in a stepwise fashion.

Table 3: Results of linear regression on research self-efficacy (ATE weight)

Independent Variables	Model 1			Model 2			Model 3		
	b	SE	Sig.	b	SE	Sig.	b	SE	Sig.
Constant	52.7	0.23	.000	50.19	.881	.000	34.91	1.68	.000
BUILD Scholar (ref.: control group)	8.05	0.33	.001	6.32	.357	.001	1.17	0.33	.001
Conference Participation				2.76	.230	.001	.704	.207	.001
Some Financial Concern							−.349	.352	.001
Serious Financial Concern							−2.30	.438	.001
Choose not to answer							−3.19	.994	.001

Model 1 introduced the BUILD intervention into the model predicting research self-efficacy. In Table 3, BUILD Scholars have significantly higher research self-efficacy than non-BUILD students, with an unstandardized coefficient of 8.05 and a *p*.-value of .001. In Model 2, we introduced our variable of interest, conference participation. Not only is the BUILD effect still present, but conference participation also becomes a significant positive predictor. As we progressed through every other step, BUILD participation remains a significant positive predictor for research self-efficacy

and is reflected in the final model, Model 3, which introduces financial concerns. Once financial concerns are introduced into the model, BUILD and conferences remain significant positive predictors with an unstandardized coefficient of 1.17 and p-value of .001 and .704 and *p*-value of .001, respectively. Also, students having some or serious financial concerns negatively predicts research self-efficacy compared to students with no financial concerns (*p*-value of .001). This latter finding is important because conference participation can be costly, and students, especially those from underserved groups, who are not provided with financial support to attend conferences, will be at a disadvantage.

Interestingly, although the BUILD effect remains significant throughout the entire model, it has been reduced by over 70% after all the control variables have been added ($b = 8.05$ in Model 1, $b = 1.17$ in Model 3); these results indicate that the variable selection accounts for a significant portion of the BUILD intervention. Next, we introduce a model predicting science identity from BUILD participation.

Outcome Modelling Science Identity

In Table 4, BUILD Scholars have significantly higher science identity than non-BUILD students with an unstandardized coefficient 9.45 and p-value of .001. In the second model, we introduced our variable of interest, conference participation, and parallel to the self-efficacy model, the BUILD effect also remains, and conference participation also becomes a significant positive predictor for science identity with a coefficient of 3.19 and *p*-value <.001. Throughout every other step, BUILD participation ($b = 7.45$, p <.001) and the conference variable ($b = 2.86$, p <.001) remain significant positive predictors for science identity and are reflected in the final model, which also introduces financial concerns. Once financial concerns are introduced into the model, BUILD and conference participations remain significant positive predictors, and only students with some financial concerns positively predict science identity. Students with serious financial concerns do not predict science identity.

Table 4: Results of linear regression on research science identity (ATE weight).

Independent Variables	Model 1			Model 2			Model 3		
	b	SE	Sig.	b	SE	Sig.	b	SE	Sig.
Constant	51.3	.174	.000	50.19	.881	.000	34.91	1.68	.001
BUILD Scholar (ref.: control group)	9.45	.264	.001	7.47	.275	.001	7.45	.274	.001
Conference Participation				3.19	.175	.001	2.86	.181	.001
Some Financial Concern							1.30	.321	.001

Continued

Table 4: Continued

Independent Variables	Model 1			Model 2			Model 3		
	b	**SE**	**Sig.**	**b**	**SE**	**Sig.**	**b**	**SE**	**Sig.**
Serious Financial Concern							.114	.401	.775
Choose not to answer							−3.14	.895	.726

Weighting

Notably, when we applied the ATT weights in our sensitivity analysis rather than the ATE weights, the results of the regression model varied slightly. Results of the ATT weights show no statistical significance for the BUILD intervention yet still showed conference participation as significant. The purpose of using the ATE in this study is to identify who the BUILD treatment would benefit most. Because of various results of this and other studies involving the BUILD intervention, students who may not have as high of scores as those who match students who enrolled in BUILD may benefit more from the BUILD effect. For example, students with slightly lower science identities or grade point averages might benefit more from the BUILD effect, while those with higher grades may not yield the same benefit.

DISCUSSION

This study has confirmed that participation in the BUILD Scholars program at CSULB is associated with higher research self-efficacy and science identity. Moreover, the models identify conference participation (measured as attendance and/or presentation) as a strong predictor for research self-efficacy and science identity. Overall, the results of this study present a strong case for including conference participation as a part of any STEM education research training program, which can be implemented at either the grant proposal level or embedded into the STEM education curriculum by practitioners at the corresponding institutions. Participating in conferences offers a comprehensive and accessible avenue for conducting and presenting research, making it an excellent training ground for future scientists—often more attainable than traditional academic publishing.

Furthermore, this study builds on previous work on BUILD programs nationwide that examined first-year students' experiences and outcomes across four campuses (Cobian et al., 2021). Interestingly, in contrast to first-year students, conference participation positively and significantly predicts research self-efficacy and science identity for juniors/seniors. The reason for the difference is likely that students enrolling in a research training program as juniors may benefit more from having experience presenting at professional conferences rather than simply presenting at university events or attending conferences as first-year students. However, since the conference

variable assesses both presentation and attendance, not being able to separate these factors is a limitation of the current study.

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