

## Abstract

Previous work (Chase et al., 2020) has shown that peer leaders in Peer-Led Team Learning (PLTL) programs not only experience immediate benefits to their learning and success as students, but also have lasting impacts throughout their career from transferable skills gained. This quantitative study builds on this work by examining the influence of past peer leader experience in one's current position as well as the impact of various program attributes such as training (frequency and format) and skill gains. These skill gains include coping with challenges (such as not having the correct answer), leadership, collaboration/teamwork, self-confidence, and problem-solving. A quantitative survey, developed based on semi-structured interviews from our previous work, was sent out to past peer leaders. Leaders who identified as underrepresented minority (URM) or Other were more likely to experience gains in all transferable skills in their current positions, except for coping with challenges. Being a peer leader in cyber Peer-Led Team Learning (cPLTL) predicted higher gains in all transferable skills, while more frequent training predicted increased gains in problem-solving skills. The number of years since being a peer leader negatively predicted gains in problem-solving. Gender and training format did not significantly predict gains in any of the skills.



## AUTHORS

Tony Chase, Ph.D.  
IUPUI

Danka Maric, M.S.  
IUPUI

Anusha S. Rao, Ph.D.  
IUPUI

Gabrielle Kline  
Indiana University

Pratibha Varma-Nelson, Ph.D.  
IUPUI

## Peer Leader Transferable Skills Survey: Development, Findings, and Implications

In recent years, educational programs not only strive to teach students disciplinary content, but also impart skills that will transfer into their professional environments. This illuminates the need for assessing the quality of educational experiences offering skills beyond content knowledge acquisition. Rigorous research has demonstrated that Peer-led Team Learning (PLTL), a widely-adopted pedagogy in science, technology, engineering, and mathematics (STEM), builds such transferable skills for students and peer leaders (Liou-Mark et al., 2018; Gafney and Varma-Nelson, 2007; Wilson and Varma-Nelson, 2016). Quantitative and qualitative studies have shown that peer leaders in a PLTL program gain in addition to content knowledge and acquire skills which transfer into their professional environments (Gafney and Varma-Nelson, 2007; Chase et al., 2020). Previous work (Chase et al., 2020) expands these findings by demonstrating that peer leaders acquired skills that transferred into the workplace regardless of field, location, and specific role within one's organization. Specifically, leadership, problem-solving, collaboration, self-confidence, and coping with challenges emerged as top transferable skills through a qualitative analysis of interviews with ten former peer leaders from various disciplinary backgrounds and professional contexts.

Although past work on PLTL has demonstrated that students develop transferable skills through peer leadership, to our knowledge, a formal quantitative survey assessing these skills has yet to be created and examined for its psychometric properties. This is important because in STEM fields, we often focus on the ability of various instructional

## CORRESPONDENCE

Email  
pvn@iupui.edu

[I]n STEM fields, we often focus on the ability of various instructional interventions to solidify further course concepts and content knowledge within the students. Although this is a crucial outcome ... more work must also address the longevity of other skills learned in STEM courses.

interventions to solidify further course concepts and content knowledge within the students. Although this is a crucial outcome across all STEM fields, more work must also address the longevity of other skills learned in STEM courses. Skills developed such as leadership and collaboration abilities of students are not often addressed within instructional interventions in STEM (Akdere et al., 2019; Micari et al., 2010), leaving a gap in the research. This gap is important to fill because many students with STEM educational backgrounds diversify their career choices into fields that may only tangentially relate to STEM, if at all (Chase et al., 2020). Thus, assessing these skills can illuminate how much students can gain from studying STEM and engaging in STEM pedagogies such as PLTL, even if they do not pursue a direct STEM field. To this end, we aim to create such a survey and use it to assess peer-leader skill development.

### The Current Study

The goal of the current study is twofold. First, we aim to build on previous qualitative work (Chase et al., 2020) by quantitatively assessing the psychometric properties of the transferable skills survey. Specifically, we will examine internal structure validity through a confirmatory factor analysis (CFA) and internal consistency using the Cronbach's alpha coefficient. Secondly, our objective is to build on and contribute to the PLTL literature by using the transferable skills survey to assess the long-term impact of peer-leaders experiences in their current professional contexts using regression analyses. Thus, we wish to create a robust survey with a strong internal structure and consistency that can be used in the context of PLTL leadership as well provide unique evidence on peer leader professional development.

Following an exploratory sequential mixed-methods design (Creswell and Creswell, 2017), we used the qualitative study results to develop a quantitative survey. We then used this survey to address three core research questions:

1. What do former peer leaders identify as transferable skills from their experiences in the program years later?
2. Which factors of the PLTL program influence those skills?
3. How do those transferable skills develop or change over time?

Participants were surveyed anywhere from less than one year up to 16 years upon serving as peer leaders. The first research question has been addressed in previous work (Chase et al., 2020) in which ten peer leaders reflected on their leader experience and identified the following transferable skills: *Leadership, Collaboration, Problem-Solving, Coping with Challenges, and Confidence*. This paper describes the use of quantitative methods to understand the impact of those skills over time. Qualitative data, while delving deeper into the purpose and reasoning behind outcomes or phenomena, lacks large scale summarization, statistical validation, or predictive modeling, which are often only obtained through larger, quantitative studies. Hence, we have developed and validated a quantitative instrument to examine which factors significantly impact the developed skills. The instrument can be broadly adopted in new and existing PLTL programs and used in their evaluation.

## Method

### Participants

We identified former peer leaders as indicated either in their LinkedIn profile or by their PLTL program coordinator. We recruited participants via email and had a final sample size of  $N = 141$  (28.54% response rate). Participants had attended 26 different universities. Most participants identified as White (52.50%), female (63.10%), and were between 18 and 25 years of age (73.00%). Most were in-person peer leaders (91.50%), in a single discipline (88.70%), had two to three years of leader experience (36.20%), and reported currently working in industry (48.90%). Full demographic information is in Table 1.

Table 1  
Demographic Characteristics of Participants

Variable	<i>n</i>	%
Gender		
Female	89	34.80
Male	49	63.10
Non-Binary	3	2.10
Race		
Caucasian	74	52.50
Hispanic/Latino	21	14.90
Black/African American	12	8.50
Asian/ Pacific Islander	32	22.70
Other	2	1.40
Age		
18-25	103	73.00
26-34	34	24.10
35-44	4	2.80
Current Position		
Medical Student	17	12.10
Graduate Student	22	15.60
Academia (faculty)	3	2.50
Industry	69	56.60
<i>Other</i>	22	9.00

*Note:* The other category includes participants who are still undergraduate students, recently graduated, or currently unemployed.

## Measures

### Demographics

Participants self-reported their gender, race/ethnicity, and age. We collapsed gender (Female, Male, Non-binary), race [underrepresented minority or URM (African American/Black, Hispanic/Latino or Other), Asian/Pacific Islander, White], and age (18-25, 26-34, 35-44) based on responses and group sizes. We used free-response questions to get information on college/university attended and their current position. The college/university variable was coded such that each college/university was represented with one category and the current position was coded as indicated in Table 1. We transformed the demographic variables into dummy-coded indicators.

### Peer Leader Training

Using free-response questions, we asked participants the format/type and frequency of peer leader training which were coded and collapsed into categorical variables. Training format coding mostly follows the options outlined in the PLTL implementation guidebook (Gosser et al., 2001) (*series of meetings between instructor and leaders, series of training meetings, and a credit-bearing course*), although categories that differed from the guidebook recommendations were added (i.e., *short-term training course* and *course/meeting combination*). The training type final coding schema is as follows: long-term training (which includes regular training meetings and credit-bearing courses); short-term training (including one- or two-day orientations and workshops); meetings (group or with supervising professor); course/meeting combination. Training frequency was coded as weekly or biweekly; monthly; once a semester; less than

Using free-response questions, we asked participants the format/type and frequency of peer leader training which were coded and collapsed into categorical variables. Training format coding mostly follows the options outlined in the PLTL implementation guidebook, although categories that differed from the guidebook recommendations were added.

We created a set of transferable skills measures consisting of five scales using CFA. Each of the scales prompted participants to indicate the extent to which they agree that being a peer leader contributed to their abilities related to the respective transferable skills in their current position.

once a semester; combination (i.e, training once a semester with weekly check-ins). We further collapsed and transformed these categorical variables into dummy-coded indicators.

### Peer Leader Experience

We used free-response questions to ask participants about their peer-leader experience, including the length of their experience, courses they led, and whether they were super-leaders. Participants from different universities referred to being super leaders as being a PLTL supervisor, assistant coordinator, academic coach, etc. For the current study, we considered any response that indicated responsibilities above and beyond the peer-leader role as equivalent to being a super-leader. We also asked participants whether they were peer leaders for cyber PLTL (cPLTL), the online adaptation of PLTL (Smith et al., 2014). The cPLTL question had a binary code. The free-response questions were coded, collapsed, and transformed into dummy-coded indicators. Descriptive statistics for peer-leader experiences can be found below in Table 2.

Table 2  
Descriptive Characteristics of Participants' Peer Leader Experience

Variable	n	%
Single v. Multiple Disciplines		
Single	125	88.70
Multiple	14	9.90
cPLTL Peer Leader		
Yes	11	7.80
No	129	91.50
Years as Peer Leader		
Less than 1 year	4	2.80
1-2 years	50	35.50
2-3 years	51	36.20
3-4 years	25	17.70
4 or more years	11	7.80
Served as Super Leader		
Yes (or equivalent)	38	31.70
No	74	61.30
Unsure	8	6.70
Frequency of Leader Training		
Weekly	121	83.45
Once per semester	16	11.03
Monthly	6	4.14
None	2	1.38

Note: Super leaders are experienced peer leaders who have continued with the program, taking on additional responsibilities such as assisting with or sometimes directing leader training sessions and coordinating the workshop logistics (Gaffney & Varma-Nelson, 2008).

### Transferable Skills Measures

We created a set of transferable skills measures consisting of five scales based on a previous qualitative study (Chase et al., 2020) using CFA. Each of the scales prompted participants to indicate the extent to which they agree that being a peer leader contributed to their abilities related to the respective transferable skills in their current position. Table 3 provides descriptive details about the five scales including scale anchors and example items. The results of the CFAs

are discussed further below under “Results.” We also examined internal consistency by calculating Cronbach’s alpha in IBM SPSS (version 26) which can be found in Table 3. We created the final scales with weighted sum scores (DiStefano et al., , 2009) using the factor loadings from the CFA models with higher scores indicating higher gains in the respective skills resulting from being a peer leader.

Table 3  
*Descriptive Details about the Five Scales Measuring Transferable Skills*

Scale	Number of Items	Anchors	Example Item	Cronbach’s Alpha ( $\alpha$ )
Leadership	6	1 (strongly disagree) to 5 (strongly disagree)	<i>Made me more willing to take an active mentoring role.</i>	0.86
Confidence	5	1 (strongly disagree) to 5 (strongly disagree)	<i>Improved my ability to contribute in a team setting.</i>	0.91
Collaboration	5	1 (strongly disagree) to 5 (strongly disagree)	<i>Improved my ability to work in partnership with supervisors.</i>	0.92
Problem-Solving	8	1 (strongly disagree) to 5 (strongly disagree)	<i>Equipped me with skills to solve a complex problem.</i>	0.94
Coping with Challenges	4	1 (strongly disagree) to 5 (strongly disagree)	<i>Increased my patience when working with others.</i>	0.79

## Procedure

We sent the Qualtrics<sup>SM</sup> survey link to participants via email or as a LinkedIn message. Participants gave informed consent, completed the 10-minute survey with the aforementioned measures, and responded to open-ended questions asking for examples from their peer leader experience that influenced transferable skills development. We did not offer any form of compensation.

## Results

### Confirmatory Factor Analysis

For each of the five transferable skills scales, we used maximum likelihood estimations in STATA (version 16), proposed a single-factor model, and fixed the latent variable (transferable skill) to one.

**Leadership.** We allowed the errors between item one (“Improved my leadership skills.”) and item two (“Made me more confident to take on leadership roles in my current position.”) to covary. We found support that the model fits the data well with a statistically insignificant model chi-square value,  $X^2(8) = 13.85, p = 0.09$ . Further, the Tucker-Lewis Index (TLI = 0.97) and the comparative fit index (CFI = 0.98) were above the cutoff of 0.95 and the standardized root mean squared residual (SRMR = 0.3) was below the cutoff of 0.08 (Hu and Bentler, 1999).

For all transferable skills, we examined whether demographic variables and being cPLTL leaders predicted skill gains. Additionally, we examined whether being a super leader and years since the peer leader experience predicted leadership skill gains.

Results revealed that identifying as an URM or Other (compared to Non-URM) significantly predicted a higher level of gains in all transferable skills, except for coping with challenges. This would indicate a statistical benefit towards identifying as a URM or Other.

**Confidence.** We allowed the errors between items four (“Improved my self-confidence.”) and five (“Gave me confidence to step out of my comfort zone professionally.”) to covary. Results support that the model fits the data well with an insignificant model chi-square value,  $X^2(4) = 5.14, p = 0.27$ , and the CFI = 1.00 and TFI = .99 being above the cutoff of 0.95 (Hu and Bentler, 1999). SRMR was not reported due to missing values.

**Collaboration.** We did not allow for any covariance and found support that the model fits the data well with an insignificant model chi-square value,  $X^2(5) = 7.93, p = 0.16$ , and the CFI = 0.99 and TFI = 0.99 being above the cutoff of 0.95, as well as the SRMR = 0.02 being below the cutoff of 0.08 (Hu and Bentler, 1999).

**Problem-solving.** Initially, we did not find evidence that our proposed model fits the data well for the problem-solving scale. Upon reviewing the ten items, we removed items five (“Helped me to communicate answers to a problem.”) and six (“Made me able to take a complex problem and break it down.”), ending with a final number of eight items. These items did not result in strong factor loadings (all were below 0.4) and therefore did not show as significantly predicting a similar outcome as the others. We allowed the errors of items one (“Made me learn how to problem solve.”) and three (“Equipped me with skills to solve a complex problem.”) and the errors of items eight (“Made me learn how to solve a problem independently”) and ten (“Made me able to use available resources to solve a problem.”) to covary, respectively. Although the model chi-square value was significant,  $X^2(18) = 36.55, p = 0.01$ , the CFI = 0.98 and TLI = 0.97 were above the cutoff of 0.95. SRMR was not reported due to missing values. Taken together, the model had adequate fit to the data.

**Coping.** We fixed the variance of the latent variable (coping with challenges skills) to one. We found support that the model fits the data well with an insignificant model chi-square value,  $X^2(2) = 2.14, p = 0.34$ , and the CFI = 1.00 and TLI = 1.00 being above the cutoff of 0.95 as well as the SRMR = 0.02 being below the cutoff of 0.08 (Hu and Bentler, 1999).

**Regression Analyses**

We used a series of multiple or single linear regression models in order to examine predictors of gains in transferable skills. For all transferable skills, we examined whether demographic variables and being cPLTL leaders predicted skill gains. Additionally, we examined whether being a super leader and years since the peer leader experience predicted leadership skill gains. Likewise, we examined whether training type and frequency as well as years since the peer leader experience predicted gains in problem-solving skills. Descriptive statistics can be found in Table 4 and full regression models in Table 5. The analyses were performed to identify **which factors** impacted the gains seen by peer leaders significantly. Models were run comparing interactions for all five outcomes across all relevant predictors. Regression models with significant predictors associated therein were displayed in the table. However, all regression models are subject to the F test to check if:  $H_0 = \beta_1 = \beta_2 = \beta_3 \dots = \beta_k = 0$ ; and models that fail this F test are not useful in prediction and were therefore omitted from the table (Harrell, 2015).

Table 4  
*Descriptive Statistics of Weighted Sum Scales for Transferable Skills*

Transferable Skill	<i>M</i>	<i>SD</i>
Leadership	19.30	2.28
Confidence	17.94	2.70
Collaboration	18.14	2.65
Problem- Solving	28.55	4.24
Coping with Challenges	12.21	1.55

Table 5  
Regression Models

Model	$\beta$ Values	F	R <sup>2</sup>
Leadership = Gender + URM	$\beta_1(\text{Gender}) = 0.64$ ; $\beta_2(\text{URM}) = 1.10^*$	3.35*	0.09
Confidence = Gender + URM	$\beta_1(\text{Gender}) = 0.32$ ; $\beta_2(\text{URM}) = 1.52^{**}$	2.15*	0.06
Collaboration = Gender + URM	$\beta_1(\text{Gender}) = 0.01$ ; $\beta_2(\text{URM}) = 1.53^{**}$	3.29*	0.09
Problem- Solving = Gender + URM	$\beta_1(\text{Gender}) = 0.15$ ; $\beta_2(\text{URM}) = 2.65^{**}$	2.33*	0.07
Coping with Challenges = Gender + URM	$\beta_1(\text{Gender}) = 0.36$ ; $\beta_2(\text{URM}) = 0.53$	1.36	0.04
Leadership = Superleader + Years Since PLTL	$\beta_1(\text{Superleader}) = 0.87$ ; $\beta_2(\text{YearsSince}) = -0.17^*$	4.31*	0.07
Problem- Solving = Years Since	$\beta_1(\text{YearsSince}) = -0.29^*$	4.13*	0.03
Problem- Solving = Training Format + Weekly Training	$\beta_1(\text{TrainingFormat}) = -0.44$ ; $\beta_2(\text{WeeklyTraining}) = 2.39^*$	2.94*	0.03
Leadership = cPLTL	$\beta_1(\text{cPLTL}) = 1.70^*$	5.79*	0.04
Confidence = cPLTL	$\beta_1(\text{cPLTL}) = 1.52^*$	2.15*	0.06
Collaboration = cPLTL	$\beta_1(\text{cPLTL}) = 1.89^*$	5.28*	0.04
Problem- Solving = cPLTL	$\beta_1(\text{cPLTL}) = 2.93^*$	2.33*	0.07
Coping with Challenges = cPLTL	$\beta_1(\text{cPLTL}) = 1.03^*$	4.60*	0.03

Note: \* $p < 0.05$ . \*\* $p < 0.01$ .

Results revealed that identifying as an URM or Other (compared to Non-URM) significantly predicted a higher level of gains in all transferable skills, except for coping with challenges. This would indicate a statistical benefit towards identifying as a URM or Other. We further probed this pattern by examining whether leaders in this group already had a significantly higher level of coping skills than their non-URM counterparts. Indeed, a one-tailed, two sample t-test showed that leaders that identified as an URM or as Other ( $M = 12.60$ ,  $SD = 1.50$ ) had a significantly higher level of coping skills than those that identified as Non-URM ( $M = 12.08$ ,  $SD = 1.54$ ),  $t(136) = -1.68$ ,  $p < 0.05$ . Results further showed that being a cPLTL peer leader (compared to in-person leader) significantly predicted a higher level of gains in all five transferable skills. Gender did not significantly predict gains in any of the transferable skills.

For leadership, we unsurprisingly found that the number of years since being a peer leader emerged as a significant predictor of leadership gains,  $B = -.17$ ,  $t(90) = -2.03$ ,  $p < 0.05$ , indicating that the more years had passed since being a leader, the less likely they were to experience leadership gains. Being a super leader did not significantly predict gains in leadership skills, although only 25 out of 141 participants identified as super leaders.

Finally, for problem-solving, training frequency emerged as a significant predictor of gains in problem-solving skills, with more frequent (weekly and biweekly) training predicting more reported gains in problem-solving skills compared to less frequent training frequencies. Training format did not significantly predict problem-solving skills gains. We, likewise, found that the number of years since being a peer leader negatively predicted gains in problem-solving skills, indicating that the more time has passed since being a peer leader,

For leadership, we unsurprisingly found that the number of years since being a peer leader emerged as a significant predictor of leadership gains, indicating that the more years had passed since being a leader, the less likely they were to experience leadership gains.

While cPLTL has been shown to produce student learning outcomes that are comparable to in-person PLTL workshops, our findings show that this modality produced increased gains in all transferable skills.

the less gains participants attributed to being a peer leader. This would indicate that having regularly scheduled meetings with a faculty instructor has positive impact on outcomes from peer leadership.

**Open-ended responses.** We analyzed open-ended responses which included examples of peer leaders' experiences that influenced transferable skills development. Responses ranged from generic comments (e.g., "PLTL made me more open-minded in approaching people... It also showed me the value of openness and honesty...") to specific incidents (e.g., "I had one class where the students just did not want to focus on the problems that day...I had the students try and do one problem - then we'd take a break and look at career fair tips for a few minutes, and would cycle through this work and conversation flow..."). These responses mirrored the interviewees' responses in our qualitative study (Chase et al., 2020).

## Discussion

Leaders who identified as URM or Other were more likely to experience gains in all transferable skills in their current positions, except for coping with challenges. Furthermore, these leaders reported higher levels of coping skills than non-URM leaders; although the open-ended questions did not explain this pattern. This pattern aligns with previous research which has shown no group differences in overall coping between URM and non-URM students (Park et al., 2019). However, the differences are more nuanced as the same study demonstrated a stronger relationship between cognitive-emotional coping and persistence in a STEM program in URM students compared to non-URM counterparts.

The open-ended responses did not reveal thematic differences across participant demographics. This was not surprising given the quantitative focus of the survey and the broad nature of the questions. However, the following examples indicate the value of future research on connections between peer leader identity and transferable skill development. In the quotes below, section leader refers to peer leader and LA refers to the Learning Assistant program (Otero et al., 2010).

*"I noticed the lack of support for minorities and the need for more Latinx Section Leaders. So, I urged the department to initiate a program to focus on recruiting minorities and motivating students that we're not as confident in their ability to be a TA and section leader. Because it really changed my outlook and confidence in my abilities."*

– Hispanic/Latino, Female

*"Dealing with students that were just like me helped boost my confidence when it comes to leading with a group of colleagues."*

– Black/ African American, Male

*"Some students, I think, viewed me as someone who didn't necessarily understand their culture or humor. This made them less likely to open up to me, so I had to work harder to make sure everyone felt comfortable."*

– Asian/Pacific Islander, Female

*"I have Borderline Personality Disorder, and definitely have moments of confidence/comfortability while also having moments of anxiety/nervousness.... I noticed that through PLTL and the LA Program, I've learned to better control these extremes..."*

– White/Caucasian, Female

While cPLTL has been shown to produce student learning outcomes that are comparable to in-person PLTL workshops (Smith et al., 2014), our findings show that this modality produced increased gains in all transferable skills. Although promising, these results remain preliminary with only 11 cPLTL leader responses. Peer leaders with commitments of full-time jobs or family needs could see similar benefits from cPLTL's flexibility (Smith et al., 2014).



We found diminishing effects for gains in leadership and problem-solving skills as more years had passed since being a peer leader. With increasing time and other leadership experiences, peer leaders may not attribute their leadership skills gain only to their PLTL experiences. However, many open-ended responses indicated how peer leader experience continues to help navigate current professional responsibilities and interactions. A respondent who was a leader in 2008 states that “...it was a good experience to be able to work as a mentor for students where you were previously in their shoes. It is helpful in my career as a teacher...I don’t want to just give students answers, I want to step them up in a way where they can collaboratively come up with an answer.” Thus, despite diminishing effects, PLTL experience can still be an integral part of leaders’ career journeys.

Leaders who had more frequent training sessions (i.e., weekly or biweekly) were more likely to experience gains in problem-solving skills, compared to leaders who had less frequent training (i.e., monthly, once a semester), aligning with recommendations outlined in the PLTL guidebook. As becoming a good leader is a developmental process, weekly workshops and courses are recommended over one-time training sessions (Gosser et al., 2001). A few open-ended responses indicated the types of leader training activities that were most beneficial to leadership development (e.g., “...we had a session called “role playing” which focused on playing different roles in different situations such as sometimes as a peer or a leader. Those training sessions give me idea about when to be a leader or when to be a follower while working with my team.”), collaboration (e.g., “I often utilized the round robin technique in my pltl sessions which would require teamwork and collaboration.” ), and problem-solving (e.g., “Both the weekly training sessions and weekly group sessions improved my ability to work independently or with others to determine solutions to problems.”).

### Limitations

Although we found a number of positive findings, they are purely relational and we cannot infer causality. However, we have triangulated qualitative findings both from the present study and from previous work (Chase, et al., 2020) to strengthen our conclusions. We also want to note that we used the definition of URM that includes African American/Black, Hispanic/Latino, and Native American/Alaska Native individuals, but had no Native American/Alaska Native leaders in our sample. We did not include Asian Americans in the URM group as they are considered overrepresented in STEM (McFarland et al., 2017; Kang et al., 2021), although their experiences are not homogeneous (Kang et al., 2021). Thus, we acknowledge that this grouping is imperfect and can miss various nuances.

### Conclusion

We developed a survey with a robust internal structure, which can be used to measure changes related to the experiences of former peer leaders when assessing PLTL program outcomes. This survey can also be used in evaluations of PLTL programs to articulate potential benefits of the role of peer leaders when recruiting students for these positions. Based on the outcomes of this study, we recommend that opportunities for serving as a peer leader should be promoted to a broad group of students from a variety of backgrounds. Specifically, the use of methods demonstrated as successful such as online training or program delivery would create opportunities for new programs to launch in a variety of settings. This would allow for enhancement of PLTL programs, particularly with giving peer leaders opportunities to gain vital transferable career skills.

**Based on the outcomes of this study, we recommend that opportunities for serving as a peer leader should be promoted to a broad group of students from a variety of backgrounds. Specifically, the use of methods demonstrated as successful such as online training or program delivery would create opportunities for new programs to launch in a variety of settings.**

## References

- Akdere, M., Hickman, L., & Kirchner, M. (2019). Developing leadership competencies for STEM fields: The case of Purdue Polytechnic Leadership Academy. *Advances in Developing Human Resources*, 21(1), 49-71.
- Chase, A., Rao, A. S., Lakmala, P., & Varma-Nelson, P. (2020). Beyond content knowledge: transferable skills connected to experience as a peer-leader in a PLTL program and long-term impacts. *International Journal of STEM Education*, 7, 1-10.
- Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.
- DiStefano, C., Zhu, M., & Mindrila, D. (2009). Understanding and using factor scores: Considerations for the applied researcher. *Practical Assessment, Research, and Evaluation*, 14(1), 20.
- Gafney, L., & Varma-Nelson, P. (2007). Evaluating peer-led team learning: A study of long-term effects on former workshop peer leaders. *Journal of Chemical Education*, 84(3), 535.
- Gafney, L., & Varma-Nelson, P. (2008). *Peer-led team learning: Evaluation, dissemination, and institutionalization of a college level initiative* (Vol. 16). Springer Science & Business Media.
- Gosser, D. K., Cracolice, M. S., Kampmeier, J. A., Roth, V., Strozak, V. S., & Varma-Nelson, P. (2001). *Peer-led team learning: A guidebook*. Prentice Hall.
- Harrell, F. E. (2015). General aspects of fitting regression models. In: *Regression Modeling Strategies*. Springer Series in Statistics. Springer, Cham. [https://doi.org/10.1007/978-3-319-19425-7\\_2](https://doi.org/10.1007/978-3-319-19425-7_2)
- Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, 6(1), 1-55.
- IBM Corp. (2019). *IBM SPSS Statistics for Windows* (Version 26.0) [Computer software]. IBM Corp.
- Kang, C., Jo, H., Han, S. W., & Weis, L. (2021). Complexifying Asian American student pathways to STEM majors: Differences by ethnic subgroups and college selectivity. *Journal of Diversity in Higher Education*.
- Liou-Mark, J., Ghosh-Dastidar, U., Samaroo, D., & Villatoro, M. (2018). The Peer-led team learning leadership program for first year minority science, Technology, Engineering, and Mathematics Students. *Journal of Peer Learning*, 11(5), 65-75.
- McFarland, J., Hussar, B., De Brey, C., Snyder, T., Wang, X., Wilkinson-Flicker, S., ... & Hinz, S. (2017). The Condition of Education 2017. NCES 2017-144. *National Center for Education Statistics*.
- Micari, M., Gould, A. K., & Lainez, L. (2010). Becoming a leader along the way: Embedding leadership training into a large-scale peer-learning program in the STEM disciplines. *Journal of College Student Development*, 51(2), 218-230.
- Otero, V., Pollock, S., & Finkelstein, N. (2010). A physics department's role in preparing physics teachers: The Colorado learning assistant model. *American Journal of Physics*, 78(11), 1218-1224.
- Park, C. L., Williams, M. K., Hernandez, P. R., Agocha, V. B., Carney, L. M., DePetris, A. E., & Lee, S. Y. (2019). Self-regulation and STEM persistence in minority and non-minority students across the first year of college. *Social Psychology of Education*, 22(1), 91-112.
- Smith, J., Wilson, S. B., Banks, J., Zhu, L., & Varma-Nelson, P. (2014). Replicating peer-led team learning in cyberspace: Research, opportunities, and challenges. *Journal of Research in Science Teaching*, 51(6), 714-740.
- StataCorp. (2019). *Stata Statistical Software: Release 16* (Version 16) [Computer software]. StataCorp.
- Wilson, S. B., & Varma-Nelson, P. (2016). Small groups, significant impact: A review of peer-led team learning research with implications for STEM education researchers and faculty. *Journal of Chemical Education*, 93(10), 1686-1702.