Social-cognitive leadership theory of SHPE's premier leadership conference for undergraduates and professionals in the STEM workforce

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Abstract

The rapid growth of Hispanics in collegiate engineering disciplines over the past decade has spurred the Society of Hispanic Professional Engineers (SHPE) to accelerate the sophistication of its leadership development and annual chapter programming infrastructure. SHPE aligns this effort towards its mission fulfillment of advancing Hispanics as valued contributors and leaders in the Science, Technology, Engineering, and Mathematics (STEM) workforce. To this end, the National Institute for Leadership Advancement (NILA), SHPE's premier leadership development conference, and annual chapter programming cycle was mapped to McCormick's socio-cognitive leadership model due to its incorporation of domain-specific leadership and self-efficacy. We measured NILA attendees gained self-efficacy through pre- and post-conference surveys. The survey questions and assessment validity are presented. The survey results show a growth of attendees' self-efficacy and preparation to interface with their leadership environment (i.e., STEM collegiate system and workforce). Given McCormick's leadership model and no specific approach to leadership self-efficacy, the programming and chapter-based organizational infrastructure is widely applicable to other chapter-based organizations.

Nomenclature

EFA	Exploratory Factor Analysis
CCLP	Certified Chapter Leaders Program
CMT	Chapter Management Tool
KMO	Kaiser-Meyer-Olkin
KSA	Knowledge, Skills, and Abilities
NILA	National Institute for Leadership Advancement
NRP	National Reporting Program
OGSM	Objective, Goals, Strategies, and Measures
PA	Parallel Analysis
RLDC	Regional Leadership Development Conference
SHPE	Society of Hispanic Professional Engineers
STEM	Science, Technology, Engineering, and Mathematics

1. Introduction

In the past decade there has been a rapid growth of Hispanics in collegiate engineering disciplines[1-3]. However, challenges remain in terms of Hispanics successfully completing their degrees and entering the workforce. To meet these challenges the Society of Hispanic Professional Engineers (SHPE) has gradually increased the sophistication of its leadership development in alignment towards the mission fulfillment of advancing Hispanics as leaders in the Science, Technology, Engineering, and Mathematics (STEM) workforce. Hispanic leadership, outside of the context of STEM, has been studied in terms of its approach and effectiveness. Studies have found that Hispanic leaders share many similar leadership values with their Euro-American counterparts but differ in that Hispanic leaders significantly value compassion and community servanthood [4, 5]. Regardless of these differences, the effectiveness of Hispanic leadership was perceived as equal in relation to their Euro-American peers [6]. These studies indicate the positive outcomes from Hispanic leaders and indicate the potential for similar outcomes from Hispanic leaders in the STEM workforce. Within the context of STEM, leadership has been investigated because of its additive value to STEM advancement to the extent that it has been proposed as a staple in engineering education curriculum [7, 8]. Currently, STEM leadership studies focus on specific case studies, highlighting the successes of specific programs [9, 10]; however, there is still a need to create a standard method to assess the effectiveness of STEM leadership curriculum [11]. Moreover, amongst these STEM leadership studies; many have focused on women and the presence of a gender-specific experience [12-15]. These studies provide valuable examples of the intersection of STEM, leadership, and a minority group which can be useful in contextualizing Hispanics within STEM and leadership.

The dynamics of Hispanics in STEM have been extensively explored; however, these studies are commonly outside of the context of leadership. Studies have broadly looked Hispanics in STEM at the collegiate level [16-23], K-12 [24], and advanced degree education [25, 26]. Moreover, studies on the role of gender and its influence in altering Hispanic students' experience have also been conducted [27-31]. In addition to the student experience studies, institutional studies have been conducted on exploring the role of Hispanic Serving Institutions (HSIs) and Hispanic serving organizations in STEM education and academic development [22, 32-36]. However, to the authors' knowledge, limited to no research has been done at the intersection of Hispanics, STEM, and leadership. Due to its history of serving and educating Hispanic students and professionals in STEM on workforce development skill sets, such as leadership, SHPE is in a unique position to study this intersection.

SHPE is a national, non-profit organization serving Hispanic leaders in STEM fields. SHPE's mission is to change lives by empowering the Hispanic community to realize its fullest potential and to impact the world through STEM awareness, access, support, and development. Since 1974, SHPE has grown from one professional member chapter with ten members, to more than 250 SHPE collegiate and professional member chapters across the United States with more than 11 thousand members. For more than 30 years, SHPE organized and hosted its premier, three-day leadership conference in the first week of August, known today as the National Institute for Leadership Advancement (NILA). As part of NILA, SHPE chapters send one of their elected representatives, typically the chapter president, to be developed into a leader. After attending NILA, the representatives, now leaders, would lead their chapter leadership and members toward a successful post-graduation transition into the STEM workforce (students) and career upward-mobility and positive impact within the Hispanic community (professionals).

Throughout the first half of the past decade, NILA's curriculum and overall design has steadily evolved to be focused on a leadership education approach. At the turn of the decade in 2010 to 2013, NILA consisted of historical curriculum based on best practices. On the Thursday of the conference, attendees went through a series of workshops focused on SHPE organizational, programs, and educational resources with the evenings focused on a team-based case study challenge. Friday programming consisted of leadership and workforce skill development with the continued case study challenge in the evening. As a capstone learning exercise to the case studies, on Saturday the attendees presented the outcomes of their case student challenge in a competition format. Competition awards and closing took place on Saturday evening. In 2014, the NILA curriculum was developed to have comprehensive learning objectives and desired attendee outcomes, supplementary pre- and post-NILA curriculum, and evaluation strategy of attendees' gained knowledge and socio-emotional development. After three years of refinement, the curriculum's implementation had improved the attendees' experience and preparation to lead their chapters which was reflected across inter-organization metrics (e.g., membership, national event attendance, survey data). However, NILA remained limited in its ability to achieve one of its intended aims: to align its SHPE's strategic, tactical, and operational infrastructure to the overall SHPE mission longitudinally, particularly in terms of local, long-term chapter programming.

For the latter part of the decade, SHPE leaders and staff focused on leadership education for alignment towards mission-fulfillment within the NILA curriculum. The NILA 2017 and 2018 curriculum focused on: (i) developing its attendees into leaders for the STEM workforce, the Hispanic community, and the nation (e.g., executive leadership), and (ii) providing the chapter leaders with the management and organizational tools necessary to effectively lead their chapters (i.e., organizational competence). Both educational aspects were integrated into the curriculum as an engineering design process of ask questions, develop hypotheses, test, analyze/discuss results, and implement changes through feedback received. The first aspect of the process model was achieved through the on-site workshops, lecture sessions being linked into the case study challenge. The latter involved the integration of SHPE's National Reporting Program (NRP); the organization's chapter growth and development program that runs continuously throughout the year. SHPE chapters participate in the NRP as part of their compliance with the organization as it provides them valuable operational and financial support throughout the year. By the end of 2018, NILA had become a leadership conference with: (i) high-value return, on-site (episodic) leadership development for attendees focusing on their long-term, long-range aim of becoming leaders in the workforce, (ii) a unified chapter management education, resources, and tools that are managed within the NRP for annual support and advancement of the chapters, and (iii) a fully-integrated evaluation framework for certifying NILA attendees and internal continuous development of the curriculum. However, the curriculum evaluation metrics did not show discernable outcomes as a transformative leadership intervention experience for the attendees. Moreover, the curriculum underlying education paradigm was based on historical best practices and not rooted in educational leadership theory and models.

At the start of organizing NILA 2019 (held in Phoenix, Arizona), SHPE leaders and staff organizing NILA developed a simple leadership concepts framework that could be integrated with a leadership model in the literature. By then, the curriculum was considered sufficiently abstract to comprehensively map the pedagogical approach to social-cognitive leadership theory with robust metrics. Among the leadership frameworks used in the engineering education contexts [37, 38], the social-cognitive, self-regulated model of leadership proposed by McCormick [38] as the most compatible with NILA's curriculum and long-term SHPE chapter programming

infrastructure (i.e., the NRP). Similar to NILA's curriculum, which is a combination of several leadership and management concepts, McCormick's model is a combination of several models of leadership effectiveness necessary to determine leadership outcomes. To the authors' knowledge, the current work is the first to test the self-efficacy construct within the model; and in the context of engineering leadership education and Hispanics. Moreover, SHPE's programming infrastructure presents a unique opportunity to validate McCormick's leadership model.

The objectives of this work are two-fold: (i) map McCormick's social-cognitive leadership model to NILA and SHPE's chapter-based annual programming cycle and (ii) apply the model in the context of Hispanics in STEM. The successful application of the model will support, in part, our hypothesis that this type of short- and long-term programming effectively develops Hispanics as leaders in the STEM workforce. Moreover, since this approach is not intrinsically specific to this group, this study can serve as an example to be leveraged by other national engineering diversity organizations as part of their leadership development programming. The manuscript is organized as follows. In Section 2, McCormick's social cognitive leadership model and NILA's curriculum framework are presented. The mappings of NILA's curriculum to McCormick's leadership cognitions as an episodic program and SHPE's annual-cycle programming, including the NRP, to McCormick's full model are presented in Section 3. In Section 4, we present the evaluation methodology, and its validity for NILA's curriculum as a social-cognitive leadership intervention conference for Hispanic STEM professionals. The results of the assessments and discussion of the applicability of leadership cognition and self-efficacy within McCormick's model are presented in Section 5. In Section 6, we conclude our findings and provide future directions of the work.

2. Leadership frameworks

2.1 NILA curriculum

The NILA curriculum is organized in terms of an Objective, Goals, Strategies, and Measures (OGSM) model as shown in Figure 1. In an OGSM model, the hierarchical components depend on each other in descending order, i.e., the objective is achieved via goals that are accomplished through strategies evaluated via measures. The progress of these components is monitored through measures that substantiate the success of the objective and goals [39-41]. The objective of NILA is to prepare Hispanics to lead and succeed in the STEM workforce and Hispanic community through a premier leadership development experience. The NILA goals are to develop attendees into (i) individual, (ii) organizational, and (iii) community leaders in the STEM workforce. Three strategies were used: (i) presented learning, (ii) practiced learning, and (iii) certification. Presented learning is introduced before the conference with pre-NILA webinars and continues with seminar-style presentations at the conference. Secondly, practiced learning is implemented through workshops, a case study-based challenge, and strategy building meetings with the elected regional leaders of the organization where attendees align their chapter goals with the organization's leadership goals. Thirdly, certification is achieved through NILA's Certified Chapter Leaders Program (CCLP). NILA's CCLP evaluates the attendee's gained knowledge of SHPE programs organizational structure, attainment and competency of workshop educational content, and knowledge of valuable chapter tools to lead SHPE members towards their personal and chapter members' success. Through the CCLP, SHPE certifies attendees as chapter leaders that successfully completed the NILA measures, including: (i) pre-NILA NRP webinar attendance and assessments, (ii) session attendance, (iii) leadership assessment (pre- and post-survey), and

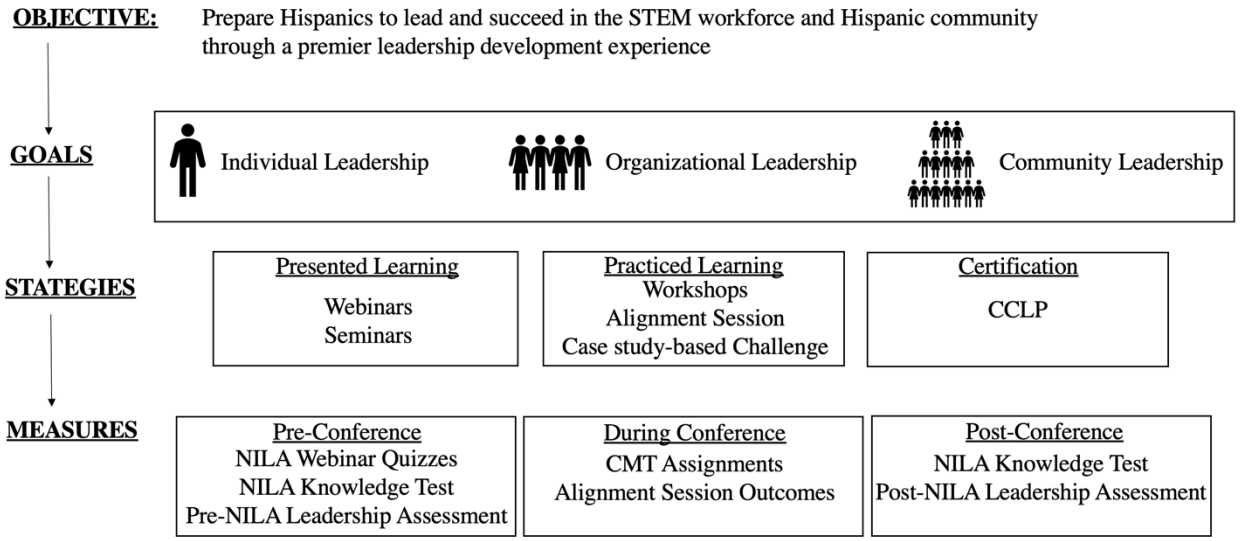

Figure 1. NILA's curriculum organized using an Objective, Goals, Strategies, and Measures (OGSM) model.

(iv) workshop knowledge test (post-test performance). The former two components, while valuable for internal purposes, are excluded from this study. The latter two were used for evaluation of NILA's leadership pedagogical approach and are the subject of this work.

2.2 McCormick's Social Cognitive Leadership Model

Figure 2 shows McCormick's model which is adapted and expanded from the social-cognitive framework of self-efficacy from Bandura [42] to be a self-regulated framework of leadership effectiveness that included self-efficacy [43]. McCormick's theoretical model consists of three interdependent concepts: leader (i) cognitions, (ii) behaviors, and (iii) environment then organized in a feedback-loop fashion. Within this framework, McCormick theorizes that leader cognitions are further detailed by the following interconnected concepts: (i) leader goals [44], (ii) leader self-efficacy [43], and (iii) leader knowledge, skills, and abilities (KSAs) [45]. Together, leader goals, self-efficacy, and KSAs are hypothesized to directly influence motivation and task strategy development, which in turn has a direct relationship with leadership effectiveness (i.e., behaviors and environment). Among the other leadership models considered by the authors (e.g., the Full Range of Leadership Model [46]), McCormick's model is best suited to describe and mechanize NILA's curriculum and SHPE's annual chapter program due to its multi-time scale (i.e., short- and long-term) cyclical (feedback-loop) continuous development approach. NILA serves as the short-term, social cognitive leadership intervention for which the leadership behaviors and environment are aptly captured by SHPE's long-term NRP throughout the year. While several internal components of McCormick's model have been validated, NILA's curriculum serves as a unique opportunity to measure self-efficacy, a challenging aspect to measure [47-50], and validate in the context of Hispanic STEM professionals.

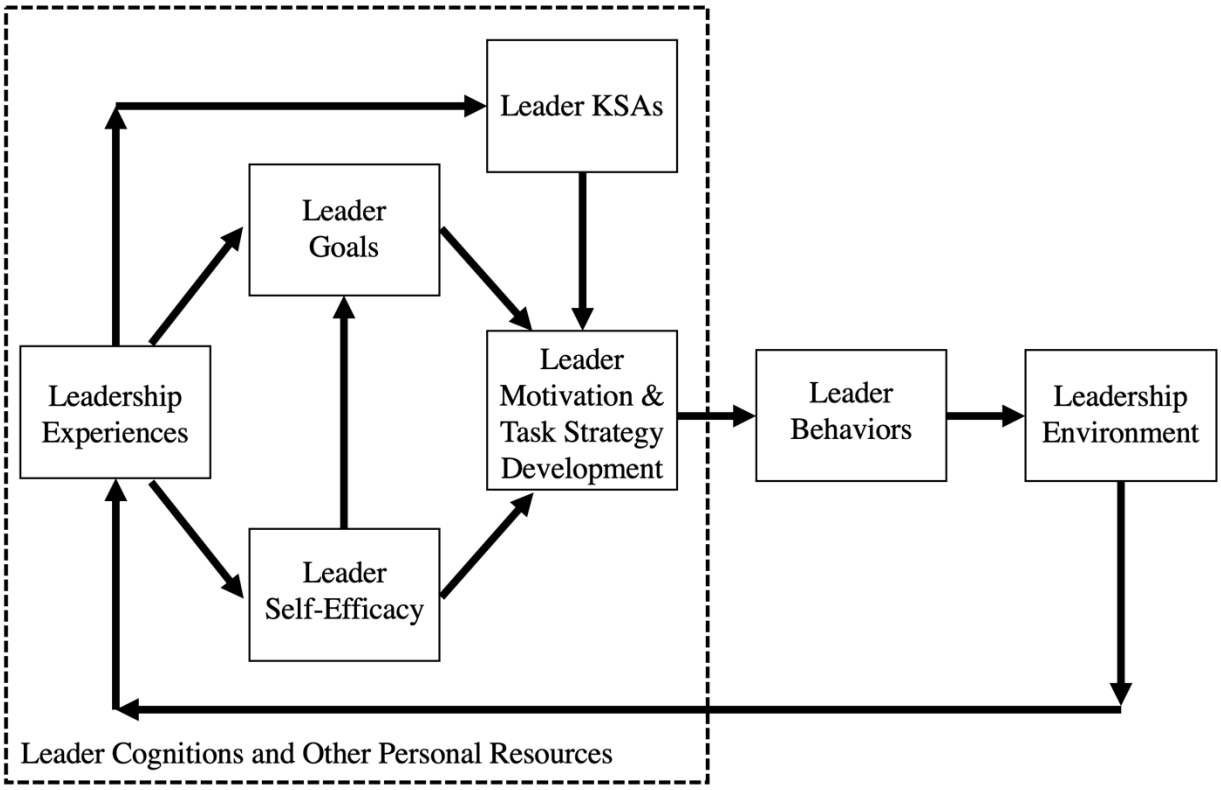

Figure 2. McCormick's Social Cognitive Model of Leadership [38], reproduced with permission from the publisher.

3. SHPE's Leadership and Chapter Programming Mapping to McCormick's Model

3.1 NILA's Curriculum Mapped to Leader Cognitions

Figure 3 shows the concept mapping of NILA's 2019 curriculum to the leader cognition portion of McCormick's model [48]. Following the OGSM model presented in Section 2.1, NILA's objective is captured by McCormick's Leaders Cognitions and is represented by the dashed line. NILA's goals are represented by the black dotted box of McCormick's Leader Goals and align with SHPE's mission and vision. Strategies and measures are represented by the arrows connecting the components of McCormick's model. Pre-NILA webinars are used as strategies to prepare participants for the goal alignment with SHPE's mission and vision. At NILA, alignment sessions, lectures, and leadership diagnostic tool are the strategies used to develop participants' goals, KSAs, and motivation.

NILA leader goals (i.e., individual, organizational, and community) are achieved by strategies with associated measures as shown in Figure 3. Individual and community goals are achieved via strategies 1, 5 and 7, i.e., leadership diagnostic tool and alignment sessions with SHPE tactical leaders, respectively, which incorporate the building of the chapter leaders' KSAs. The organizational goal is achieved through the pre-NILA webinars (strategies 2 and 6), alignment sessions with regional leaders about their recruitment, retention and SHPE members' success (strategy 3), and NRP's Chapter Management Tool (CMT) (strategy 4). The CMT is introduced via the pre-NILA webinars strategy and used continuously throughout the SHPE year. The CMT serves as the chapter's annual mission-aligned, goal-oriented executive board-level annual plan and meeting agenda. During the pre-NILA webinars, attendees complete components of the CMT, of which their completion was used as a measure, in their alignment sessions with tactical leaders. Three question quizzes were measures for the pre-NILA webinars as internal assessment of the

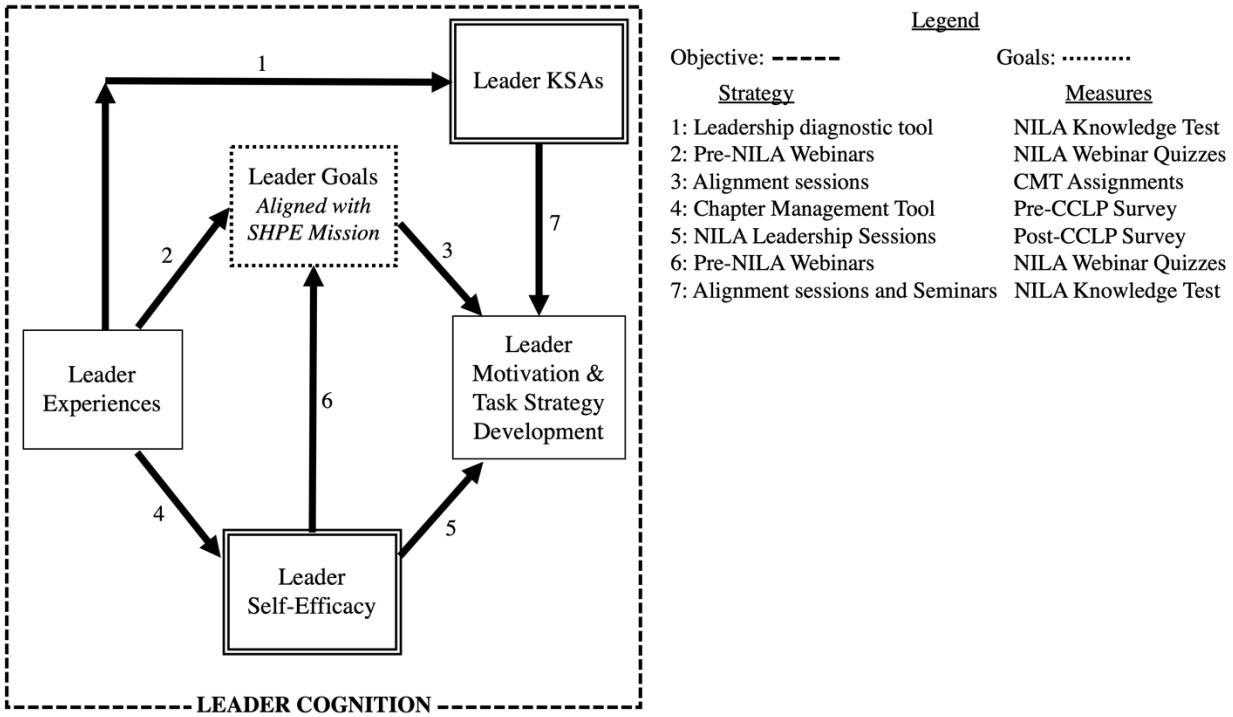

Figure 3. NILA curriculum mapping to McCormick's social cognitive model of leadership. The double border denotes the two components (i.e., Leader KSAs and Self-Efficacy) of the Leader Cognitions evaluated in the NILA 2019 curriculum.

content delivery. These two measures will not be the subject of this work as they do not directly measure self-efficacy and KSAs. The remaining two measures (i.e., the NILA knowledge test and post-CCLP survey) are discussed be discussed in further detail in Section 4.

Two leadership concepts of the McCormick model that are instrumental in the development of leaders at NILA are (i) leader self-efficacy and (ii) the leader KSAs shown in bold double-lined boxes in Figure 3. Self-efficacy cannot be taught, but rather promoted by encouraging individuals to learn new behaviors or to learn to adapt behaviors by altering their anticipated reinforcement [51]. According to Bandura [42], behaviors are learned through observation (i.e., NILA's presented learning) and taught through modeling (i.e., NILA's OGSM model as a whole). At NILA, self-efficacy was strategically influenced through an attendee's previous SHPE leadership experience coupled with the CMT and measured with CCLP surveys. Surveys measure the changes in an attendee's self-efficacy beliefs as they relate to leadership and their KSAs development. Attendees' KSAs were evaluated to determine a correlation between their leadership concepts and leadership self-efficacy. Measures employed at NILA were used to confirm NILA's effectiveness in developing a participant's self-efficacy, KSAs, and goals, which lead into a participant's motivation, influencing their leadership performance (environment and behaviors).

3.2 SHPE's Annual Chapter Activity and Programming Cycle

SHPE's annual chapter activity and programming cycle are mapped to the feedback-loop, cyclical aspect of McCormick's model (i.e., leader cognitions lead to the environment and behaviors and cognitions) in Figure 4. This feedback-loop, cyclical approach is SHPE's underpinning programming approach of continuous development/improvement of the Hispanic STEM workforce education. As shown in Figure 3, leader cognitions are mapped to the NILA

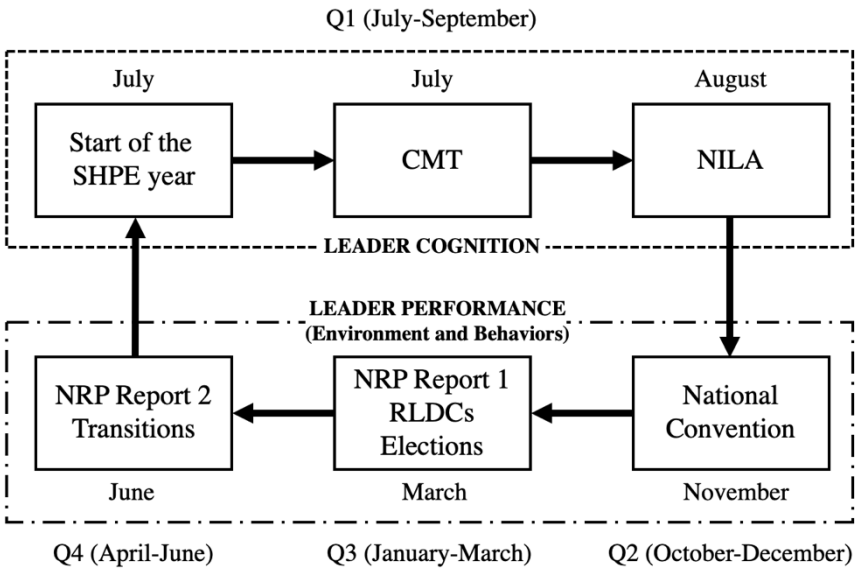

Figure 4. SHPE's annual chapter activity cycle mapped to the McCormick model.

curriculum. The leader cognition is represented by the dashed box having the SHPE Quarter 1 (i.e., June to August), which consists of NILA programming. In this conceptual mapping, leadership behaviors and environment are combined and categorized as leader performance (environment and behaviors). The leadership environment and behaviors are represented by the dash-dot box encompassing SHPE Quarters 2 through 4 (September to June). The other two SHPE conferences (i.e., SHPE's National Convention and the Regional Leadership Development Conferences (RLDCs)) are also noted. Leadership behaviors are evaluated through the NRP, which is a continuous program through the CMT which is evaluated with two reports each year. National and chapter leadership elections take place between the end of SHPE Quarter 3 and the start of Quarter 4. The SHPE chapter transition their leadership soon after elections during Quarter 4 in preparation for the next SHPE year (starts in July) and NILA.

3.3 SHPE's Cyclical Leadership Curriculum Mapping

Figure 5 shows the combination of SHPE's annual chapter programming and activity cycle (see Figure 4) and the NILA curriculum (see Figure 3) mappings into McCormick's model. Social cognitive theory is mapped to the NILA curriculum. The chapter leaders then interface with SHPE chapter programming and the STEM collegiate and workforce environment to show their behaviors and outcomes towards their individual and SHPE chapter's members' success through participation in the NRP. The mapped model enables robust evaluation of: 1. short-term, social cognitive leadership development through NILA and 2. long-term, cyclical longitudinal studies of the SHPE chapters and leaders' performance and the efficacy of the overall programming structure towards SHPE mission fulfillment. The former short-term evaluation construct will be the subject of this work. The latter will be the subject of future studies.

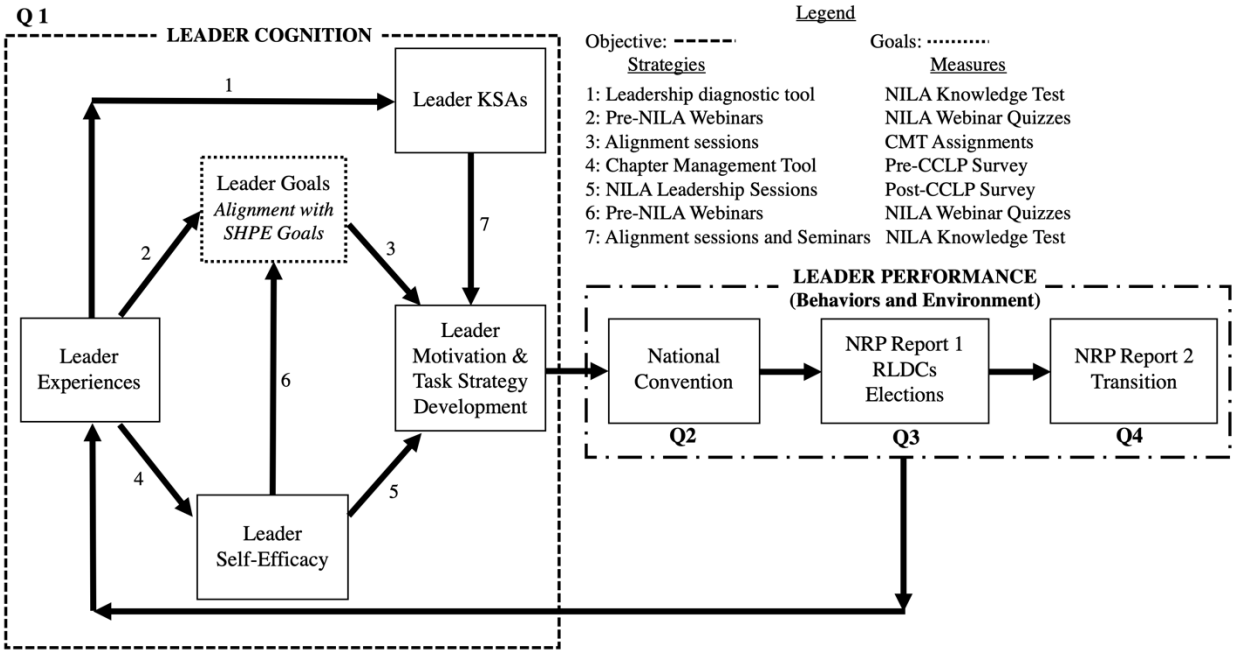

Figure 5. SHPE's leadership and annual chapter activity cycle mapped to McCormick's social cognitive leadership model. Quarters 1-4 (Q1-Q4) correspond SHPE's three-month quarters with the SHPE year starting in July.

4. Methods

The objective of this study was to assess NILA's leadership theory-based curriculum and its ability to develop the leader cognitions, self-efficacy and other personal resources of its attendees. To do so, the CCLP survey implementation and content is analyzed. The CCLP measured two of the components for certification: pre- and post-leadership assessments and the pre- and post-workshop knowledge tests. In addition to an inherent interest in leadership self-efficacy and need for continuous programming as explained in Section 1, another motivation for including the self-efficacy scale to the instrument was a concern for testing threat to the internal validity of the pre- and post-workshop knowledge tests. The shorter the timespan between pre- and post-testing, the higher the necessity to test for threats to internal validity. Given that NILA occurs over a span of three days, the addition of self-efficacy was intended as a measurement that would be less affected by this threat and more for the purposes of assessing NILA's impact. Lastly, we also sought to understand if there was a correlation between leadership self-efficacy and KSAs the curriculum develops.

The participants for this study were both incoming student and professional chapter leaders. However, only results from the student participants are presented in this paper. Exploratory Factor Analysis (EFA) and reliability tests to the responses from the professional chapter leaders will be the focus of future work. This is done separately since the professional chapter needs are different from those of student chapters, and thus professional attendees were exposed to a different curriculum as the students.

4.1 Data Collection

NILA attendees were required to take both the pre- and post-CCLP surveys to obtain the CCLP certification. This requirement was made evident upon registration and in several electronic mail communications from SHPE leading up to NILA. Attendees were advised that the self-efficacy portion of the survey was voluntary and choosing not to participate in said part of the

survey did not impact their CCLP certification eligibility. Only attendees who consented to the self-efficacy portion of the survey were included in the analysis for this study. This strategy was reviewed by an external Institutional Review Board and approved for exemption.

As collected, the study follows a pre-experimental one group pre-test/post-test research design [52] and represents a cross-sectional analysis from a self-selected purposeful sample. The sampling frame was comprised of 146 incoming SHPE student chapter leaders that attended NILA 2019. A total of 131 responses were used for analysis after removing the responses from participants who did not consent to either the pre- or the post-self-efficacy portion of the survey. Moreover, SHPE professional members that attended NILA and took part in the CCLP will be subject of a future study.

4.2 Survey Development

The CCLP survey has two main sections: leadership self-efficacy and workshop knowledge test. The research team had limited-to-no influence on workshop content and knowledge test questions. For each of the workshops, SHPE provides the presenter a description of what is expected in terms of content that aligns with the NILA curriculum and goals. For the workshop knowledge test, presenters were asked to provide the research team with three (3) multiple choice questions for each workshop (total of 15 questions) that accurately represented the content delivered during the workshop. There was only one possible correct answer out of a maximum of five choices. Participant correct responses to the workshop knowledge questions were added up for an overall score. The leadership self-efficacy section was comprised of questions on a five-point Likert-scale format, with anchored responses ranging from "not at all confident" to "absolutely confident."

4.3 Leadership Self-Efficacy Scales

We developed a total of 19 questions that were believed to accurately represent underlying constructs for leadership self-efficacy as applied to NILA. Within the scale, we included three sub-scales: individual leadership self-efficacy (11 items), community leadership self-efficacy (three items), and organizational leadership self-efficacy (6 items), selected to align with NILA's goals from the OGSM model presented in Figure 1. The survey items for both the chapter and organizational sub-scales were developed to capture self-efficacy beliefs in the NILA workshop content. We note that, while other parts of the CCLP survey directly measure knowledge gained from the workshops (i.e., workshop knowledge test section), the chapter and organizational self-efficacy subscales were developed to understand participant's self-rated perceptions of their ability to exhibit behaviors and/or complete tasks covered during the workshops, regardless of their actual ability to do so. Lastly, the survey items for the individual sub-scale were adapted from an available instrument developed by Ahn et al. [11].

4.4 Individual sub-scale adaptation

Ahn et al. [11] conducted an extensive mixed-methods study to develop a survey instrument that measures engineering leadership, change, and synthesis in engineering. From that work, one factor emerged as relevant to developing individual engineering leadership: Being an engineering leader. As per their own definition, this factor is related to "enhancing individual knowledge, abilities, and personal power, which have been identified as being imperative for individual leadership development" [11]. We carefully adapted select items from the above-mentioned instrument for use in this study. Specifically, we chose items that loaded strongly into the "Being an engineering leader" factor from Ahn et al. that were also believed to map unto McCormick's social cognitive model of leadership [11]. Given that McCormick's model theorizes

leader self-efficacy as a precursor to leader goals, motivation, and task strategy, the items chosen were believed to fully represent the range of leadership self-efficacy beliefs needed for survey validation.

5. Results and Discussion

5.1 Survey Validity

An Exploratory Factor Analysis (EFA) was conducted using SPSS v26. The first tests performed were the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy [53] and Bartlett's Test of Sphericity [54] and are shown on Table 1. The KMO value of 0.86 was obtained. Values greater 0.5 show an appropriate sample size. The Bartlett's test shows that there is at least one significant correlation between two items.

Table 1: Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity for the 2019 NILA Leadership Assessment Survey in Figures 6 and 7.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.860
Bartlett's Test of Sphericity	Approx. Chi-Square	1062.381
	df	120
	Sig.	.000

We utilized the Principle Axis Factoring as the fit-model and an oblique (Promax) rotation with a Kappa value of 0.4, since it was expected that the variables were correlated [55]. Only factor loadings greater than 0.4 were considered as recommended by Costello and Osborne [56].

To determine the number of factors to include, we used Horn's Parallel Analysis (PA) [57, 58]. The EFA was first conducted to extract factors from the data based on eigenvalues greater than one [59]. This yielded a total of four factors that combined explained 66.5% of the variance. The extracted eigenvalues from the dataset were then compared to eigenvalues from a randomly generated correlation matrix, as per Horn's PA. Horn's PA results revealed that a total of four factors should be kept for the extraction. The final EFA resulted in a four-factor solution, all positively correlated to each other. The correlations amongst factors are shown in Table 2. The final EFA is shown in Table 3. Based on the final structure, the variances across the items in each factor are as follows: 42.8% (factor 1), 9.5% (factor 2), 7.7% (factor 3), and 6.4 % (factor 4). Items 6, 10, 11, and 16 did not load into any of the factors and were removed.

5.2 Survey Reliability

Based on the results from the EFA, reliability coefficients (i.e., Cronbach's alpha) were calculated for each factor and are as follows: factor 1 ($\alpha = 0.857$), factor 2 ($\alpha = 0.827$), factor 3 ($\alpha = 0.750$), and factor 4 ($\alpha = 0.764$). All coefficients are greater than 0.7 which is evidence of high internal consistency among items that belong to each of the factors. Additionally, all coefficients are less than 0.9, which is evidence that individual items are not redundant, and each contribute a slightly different aspect of the underlying construct to the factor.

5.3 Data Analysis

5.3.1 Workshop Knowledge Test

To directly evaluate the impact of NILA in developing the specific knowledge, skills, and abilities presented during the workshops, (refer to Section 4.2), we analyze the pre- and post-NILA score results as assessed by the CCLP knowledge test. A paired samples t-test was performed to determine if there was a statistically significant difference between the pre- and post-NILA scores.

Table 2: Factor Correlation Matrix. Extraction Method: Principal Axis Factoring. Rotation Method: Promax with Kaiser Normalization.

Factor	**1**	**2**	**3**	**4**
1	1.000			
2	.612	1.000		
3	.485	.656	1.000	.514
4	.500	.549	.514	1.000

Table 4 shows that participants scored higher on the post-test (M=91, SD=9) than on the pre-test (M=57, SD=14). The paired samples t-test found this difference to be statistically significant ($t(129) = 23$, $p<0.01$). However, no evidence of correlation between the pre- and post-scores was found. Although the pre-test scores followed a relatively normal distribution, the post-test scores did not follow such a distribution. The histogram of the post-test scores is shown in Figure 8, where a "ceiling effect" is observable and can be attributed to a testing threat to internal validity. This effect is expected (refer to Section 4) and led to the development and inclusion of the self-efficacy scale to the instrument.

Table 3: Final EFA Pattern Matrix. Extraction Method: Principal Axis Factoring. Rotation Method: Promax with Kaiser Normalization.

Survey Item	**Factor**			
I feel confident in my ability to:	**1**	**2**	**3**	**4**
Q1. Establish goals for a project	.193	**.536**	-.095	-.014
Q2. Explain the best way to accomplish these goals to my team members	.027	**.802**	.201	-.203
Q3. Independently initiate new individual or team projects	-.095	**.580**	.060	.127
Q4. Organize and structure a group to accomplish a common goal	.117	**.480**	.180	.045
Q.5 Motivate my team members to accomplish predefined goals	.027	-.085	**.815**	.065
Q7. Effectively delegate projects and authority to other people	-.131	.231	**.565**	-.005
Q8. Actively encourage my peers to solve problems	.088	.027	**.647**	-.045
Q9. Easily explain and discuss the fundamental elements of a project with other teammates	-.033	**.824**	-.065	.019
Q12. Create SMART goals to advance my personal career	**.843**	-.046	.039	-.043

Q13. Achieve SMART goals to advance my personal career	**.993**	-.029	-.016	-.148
Q14. Use a strategic mindset with business planning skills to implement system-oriented, data-driven projects	**.606**	.313	-.093	-.037
Q15. Combine my STEM skills with an entrepreneur mindset to implement innovative solutions.	**.421**	.084	-.016	.250
Q17. Confidently speak in public with my community to inspire them about STEM	.017	-.182	.022	**.866**
Q18. Educate and inspire my community (e.g., members, neighborhood, workforce) about SHPE (e.g., mission, vision, and structure).	-.160	.251	-.019	**.635**
Q19. lead my chapter's members towards their career success (i.e., post-graduation success for students, STEM career upward-mobility for professionals).	.200	.352	-.027	**.433**

Table 4. Paired samples t-test results for pre- and post-CCLP knowledge test, *p < 0.01.

Before NILA		**After NILA**			**95% CI for Mean Difference**				
M	**SD**	**M**	**SD**	**n**	**Lower**	**Upper**	**r**	**T**	**df**
57.6154	14.21070	91.7769	9.30888	130	-37.09034	-31.23274	0.014	-23.078*	129

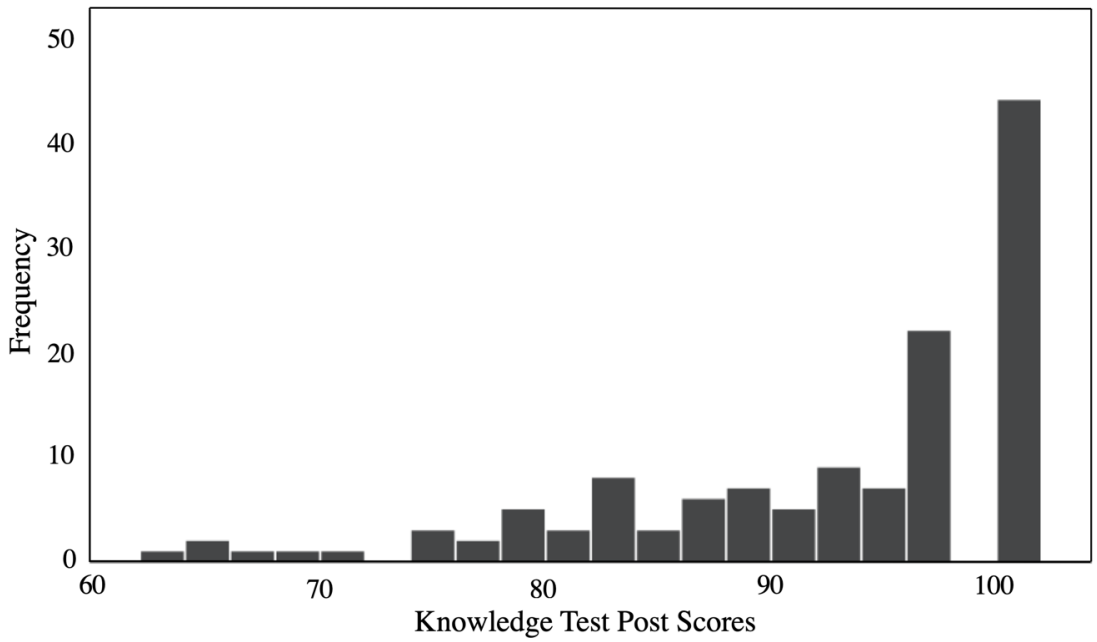

Figure 8. Histogram of NILA 2019's post-CCLP test scores. N = 130, mean = 91.78, and standard deviation = 9.3

5.3.2 Leadership Self-Efficacy

Following the EFA, we created new variables to represent the mean scores for each subscale (i.e., factor), as well as the total score for leadership self-efficacy (both pre- and post-NILA experimental conditions) to facilitate subsequent analysis. Our experimental hypothesis was that, as a result of NILA as a leadership development intervention curriculum, leadership self-

efficacy would be increased. A paired samples t-test was performed to determine if there was a statistically significant difference between the pre-and post-NILA scores, both at the subscale level (i.e., individual factors), as well as at the scale level (i.e., total leadership self-efficacy).

Table 5 shows that participants scored higher on the post-test than on the pre-test for all constructs. Specifically, the total score for leadership self-efficacy in the post-test (M=17.9, SD=1.8) increased as compared to the pre-test (M=15.5, SD=2.49). The paired samples t-test found all differences to be statistically significant, with total leadership self-efficacy ($t(129) = 12$, $p<0.01$) having an effect size of 1.07. Additionally, all constructs are shown to be positively correlated with moderate-to-low correlations at statistically significant levels.

Table 5. Pair samples t-test results for pre- and post-CCLP tests, *p < 0.01.

	Before NILA		**After NILA**			**95% CI for Mean Difference**				
	M	**SD**	**M**	**SD**	**n**	**Lower**	**Upper**	**R**	**t**	**df**
F1	3.7046	.79073	4.4338	.49939	130	-.86498	-.59348	.333*	-10.628*	129
F2	3.9169	.71822	4.4631	.51582	130	-.66305	-.42925	.443*	-9.244*	129
F3	3.9744	.76488	4.4487	.58947	130	-.60655	-.34217	.391*	-7.100*	129
F4	3.8923	.82198	4.5718	.52865	130	-.80740	-.55158	.474*	-10.510*	129
Total	15.4882	2.49363	17.9174	1.86869	130	-2.82424	-2.03422	.486*	-12.168*	129

5. Discussion

There are six threats to internal validity for the one-group pre-test/post-test design: history, maturation, testing, instrumentation, mortality, and regression. Given the timeframe in which NILA occurs (three days), and the conditions of the study design, we are confident that these threats are negligible for this study. Although testing threats are a concern in a one-group pre- and post-NILA test design, this threat is particularly common in an educational setting where both tests occur in a shortened timespan [60].

For this study, the ceiling effect observed in the post-scores for the workshop knowledge test was to be expected since NILA is designed to grant the CCLP certification with one of the conditions being that attendees score 85% or higher on the post-test. Since the attendees are aware of this requirement through the pre-NILA webinars and were exposed to the questions during the pre-test, they have become sensitized to the measurement instrument. Although there is apparent evidence to suggest that NILA has a statistically significant impact in developing the specific knowledge, skills, and abilities presented during the workshops, this conclusion is severely limited. In other words, while we have observed an increase in KSAs, there is not enough evidence to reject the null hypothesis that there is no difference in pre and post scores. This conclusion, however, does not diminish the potential impact of NILA, since the long-term effects are measured elsewhere in SHPE's long-term programming. As mapped out to McCormick model in Figure 5, leader performance (behaviors and environment) does not occur until SHPE's quarters two through four, which cover the National Convention, NRP report 1, and NRP report 2, respectively.

On the other hand, this ceiling effect was not observed for the self-efficacy scores. The temporal condition of the pre- and post-NILA scores (by design), the presence of moderate-to-low correlations between pre-and post-NILA scores, and the evidence of normally distributed data in

both the pre- and post-NILA variable provide evidence that the null hypothesis can be rejected. Therefore, we conclude that there is a statistically significant difference between self-efficacy scores because of NILA's curriculum.

It has been proven in various educational settings that self-efficacy is a predictor for motivation and has a direct impact into an individuals' willingness to engage in goal-setting behavior [61, 62]. Goal setting is also an important precursor to goal achievement. In this study, we sought to understand the interplay between goal setting and self-efficacy as it pertains to leadership in the context of NILA and as mapped to McCormick's social cognitive leadership model. Although the data is limited in its ability to fully validate this model, strong evidence was presented that NILA has a direct impact on students' leadership self-efficacy. Moreover, the emergence of four different factors in the self-efficacy scale provides further evidence that there are multiple underlying constructs in leadership self-efficacy. It has been established in the leadership literature that motivation, goal setting, are important underlying constructs [37, 63]. This study, as it pertains to SHPE also had factors emerge about community leadership specific to student self-efficacy in SHPE contexts. This suggests that in addition to transferable skills that are applicable in a variety of contexts (e.g., "I am confident I can communicate to team members"), there is also a need to develop specific skills relevant to the context in which leadership is activated.

Lastly, this study highlighted the importance of embedding leadership training within a social cognitive model of self-regulation. Intense leadership curriculum interventions such as NILA have been shown to have a significant immediate effect, but not necessarily a sustained effect after sufficient time has passed. By providing continuous leadership opportunities, the likelihood that there will be a sustained effect increases. This can be assumed to be the case for this study as NILA attendees are elected chapter leaders for the upcoming June fiscal year that will be utilizing skills learned during NILA in their local chapters.

6. Conclusions

SHPE's leadership development infrastructure was mapped to McCormick's socio-cognitive leadership model to develop leaders and have a theoretically sound roadmap for measuring and assessing the organization's impact in developing Hispanic leaders. McCormick's social cognitive leadership model was applied for the first time in the context of engineering leadership education and SHPE's programming infrastructure. NILA, SHPE's premier leadership development program, was the focus of this study. NILA was mapped and applied to the leader social cognitions part of the McCormick model because of its explicit focus on domain-specific leadership in self-efficacy. The research team developed and validated a leadership self-efficacy scale administered concurrently with already established workshop knowledge test and CCLP. The survey was deployed to student and professional chapter leaders attending NILA 2019. The results demonstrated the survey's validity and reliability and student leadership self-efficacy and gained workshop knowledge. A paired sample t-test showed that there is a statistically significant difference in self-efficacy scores for SHPE chapter leaders as a result of attending NILA. Additionally, preliminary evidence showed that NILA successfully imparted knowledge, skills, and abilities (KSAs) necessary to develop SHPE leaders, at least in the short term, was presented as measured by the workshop knowledge test. The successful application of McCormick's model supports, in part, our hypothesis that this type of short- and long-term programming effectively develops Hispanics as leaders in the STEM workforce. The model used in this work can serve as a universal leadership development framework because it was not intrinsically specific to

Hispanics. The underpinning concepts do not apply to a single culture or group and can be used as a leadership development framework for other national engineering diversity organizations.

Future work will longitudinally assess KSAs through the NRP as mapped to McCormick's model to understand if the effect observed in NILA is sustained throughout the SHPE year. Additionally, the leadership self-efficacy scale developed through this study will be used in future NILA trainings as a measure of continuous improvement of the program's effectiveness. Lastly, this work can be expanded by assessing the types of leaders that are developed through this leadership model to provide further insight into the benefits and limitations of the model.

Acknowledgments

The authors acknowledge the following SHPE volunteer leaders and staff whose diligent efforts and thousands of volunteer hours shaped NILA's curriculum and CCLP since 2010: Fernando Rosario, Beatriz Garcia, Laura Rangel, Jennifer Vasquez, Monique Herrera, Dr. Peter Rios, Jose Luis Estrada, Dr. Lucas Caretta, Dr. Edgar Peña, Davina Carboni, and Dora Maria Abreu. We thank Dr. Kimberly Douglas-Mankin, Director of SHPE Programs, for her efforts in helping logistically with the setup of this study. Lastly, the authors thank the reviewers for their thoughtful suggestions, which were incorporated in the paper.

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