Evolution of STEM Leadership Self-Efficacy within an NSF S-STEM Program

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Harvey Henson is Interim Director of the STEM Education Research Center and has a joint faculty appointment in Science Education and Geology at Southern Illinois University Carbondale. Henson's research focuses on STEM leadership; teacher partnerships and professional development; preservice teacher education and literacy in STEM; geohazards education; and applied geophysical investigations. Henson leads teams of STEM educators and researchers at SIU and other universities, partners with K-12 educators, and mentors graduate and undergraduate students to conduct this research and advance STEM literacy. Henson has managed in excess of $26 million in external grants from the NSF, Illinois Emergency Management Agency/FEMA, Illinois State Board of Education, Regional Offices of Education, NSTA, National Park Service, and other agencies to support these research and scholarship activities.

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Ms. Olivia Hood, Leadership Development Program

I am a Master's in Public Health student at SIUC who has been involved with the Leadership Development Program (LDP) for three years. While pursuing my passion for leadership I've had the opportunity to grow my own leadership skills, mentor over 40 students, and be a visionary for the program's development. I now serve as the Coordinator for the LDP while I use my leadership skills in my field of public health.

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An engineering leadership development program (LDP) at a major midwestern university has received NSF S-STEM grant support for the past 10 years and has achieved higher and faster time to graduation rate for engineering transfer students in a peer- comparison study (DeRuntz, et.al 2019) (DeRuntz, et. al 2017) (Palmer, et. al. 2016) (Kowalchuk, et. al 2013). Through the award of a Track 2 S-STEM three years ago, the LDP has now expanded into the STEM majors at the university and has made an important discovery regarding the evolution of Leadership Knowledge among some of the STEM leaders.

The participants in the LDP program showed statistically significant changes on Leadership Self-efficacy Survey (Bobbio & Manganelli, 2009) and the Motivation to Lead Survey (Chan & Drasgow, 2001) when compared to their peers. However, when comparing student responses over time (pre, post and post 2) in conjunction with student reflections during the focus groups, there may be effects of response-shift bias (Rohs 1999). Anecdotal evidence from students' responses to open-ended questions and focus groups suggests significant student growth not appearing in the quantitative analysis. It is possible that participants rated themselves high on the pre-test and then rated themselves lower on the post-test even though they have made tremendous gains. The most common cause of this bias is a lack of participant knowledge when taking the pre-survey. The participants "don't know what they don't know" and so they rate themselves high. After learning more about leadership and developing skills, they understand better what they "don't know" and therefore rate themselves lower. In other words, participants rated themselves higher on the pre-test and then lower on the post-test; even though they had made significant gains as measured in the other program data collected by the external evaluator. This conclusion is further confirmed by interactions and observations recorded by the program Co-PIs, coordinator, coaches, and senior leadership. Going forward, a retrospective pre-survey will be administered along with the post-survey. This is a standard method for accounting for response-shift bias.

Comparisons
Overall, LDP scholarship students demonstrated significantly higher Leadership Self-efficacy in comparison to their own pre-survey scores (p = 0.015) and, in comparison to control group findings (p = 0.047). The LDP scholarship students also demonstrated significant growth on the

Motivation to Lead Survey in comparison to their own pre-survey scores ($p = 0.039$) and, in comparison to the control group ($p = 0.042$).

Figure 1: Leadership Self-Efficacy (LSE). LDP students' post program LSE results showed increased self-efficacy compared to both pre-program and control group.

5.00 Very High Self-Efficacy

4.31

4.00 3.99

4.10

 LDP

3.00

 Control

2.00

N (pre-post) = 18
N (control) = 54

1.00 Very Low Self-Efficacy
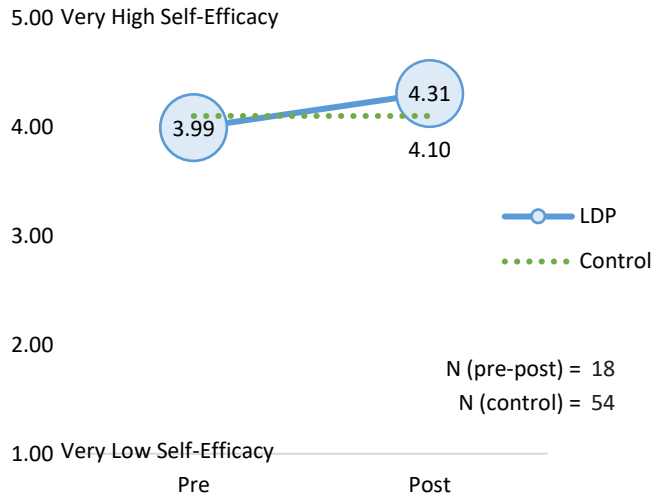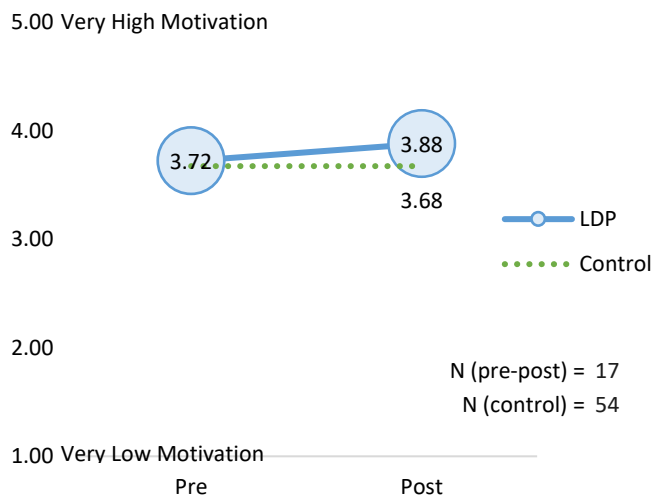
Pre   Post

Figure 2: Motivation to Lead (MTL). LDP students' post program MTL results showed a small increase in motivation compared to both pre-program and control group.

5.00 Very High Motivation

4.00 3.88

3.72

3.68

 LDP

3.00

 Control

2.00

N (pre-post) = 17
N (control) = 54

1.00 Very Low Motivation

Pre   Post

Students in some of the survey responses self-reported that they now understand better what they thought they understood before entering the program. Although it seems they regressed in their Leadership Knowledge, this new information is actually a significant indication these leaders have accomplished the first step in leadership development. By their responses they have shown an accurate self-awareness, honesty, and self- discipline. They have demonstrated that they can lead themselves.

Growth

Student's growth of their leadership was examined through instruments that measured their

Leadership Self-Efficacy (LSE) and Motivation to Lead (MTL). LDP students showed the most improvement in efficacy after one year of the program. Similarly, LDP students' motivation appear to remain consistent throughout the program.

Combining this with results from the control group, suggest that LDP students come into the program with higher motivation than their peers but develop higher efficacy because of the program. Future surveys will incorporate a retrospective pre-survey to help determine the full impact of the program.

Results

The 2019 – 2020 cohort of LDP scholarship students showed improved Leadership Self-efficacy (LSE) when their post-test scores were compared with their pre-test scores. They also demonstrated higher LSE when compared with a control group. The 2019 – 2020 cohort showed similar results and the same trends on the Motivation to Lead (MTL). Students in the LDP showed improved MTL when their post-test scores were compared with their pre-test scores. They also demonstrated higher MTL when compared with a control group.

Similar levels of growth are evident when looking at LDP students overall for all the years of the program. It is interesting that the growth on the LSE is not as drastic while the growth on the MTL is more pronounced.