

Effectiveness of a Structured Curriculum-Based Developmental Network Intervention

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Developmental networks are crucial for faculty career advancement in academic medicine. However, there is a lack of randomized controlled trials (RCTs) evaluating structured developmental network interventions. This study aims to assess the effectiveness of a structured curriculum-based developmental network intervention on self-reported faculty network measures using an RCT design. The intervention was delivered via a digital community of practice (Project ECHO) model and analyzed using a mixed methods approach. The theoretical framework for mentor development is provided by the Social Cognitive Theory, developed based on research by Albert Bandura, who observed that “human behavior is influenced by a three-way, dynamic, reciprocal model in which personal factors, environmental influences, and behaviors continually interact.” A basic premise of this theory is that people learn not only through their own experiences but also by observing the actions of others and the consequences of those actions. The study was conducted across four institutions. Mentors were randomized into three groups: (1) intervention group, who completed a mentor development program followed by the structured curriculum-based developmental network intervention; (2) control group, who completed only the mentor development program; and (3) pure control group, who received neither intervention. Designated mentees were enrolled but did not receive any mentoring interventions. Data were collected at baseline, 12 months, and 24 months using the Mentoring Network Questionnaire. Most network outcomes were not significantly different between the three groups over time. Network density and gender diversity increased at 24 months in the intervention ($p=0.03$) and control groups ($p=0.02$), respectively. Network range decreased at 12 months ($p=0.02$) for the pure control group. Racial/ethnic diversity and range decreased at 12 months ($p=0.04$) and 24 months ($p=0.05$) for the intervention group. Strategic network planning and longer follow-up period may be crucial to improve the intervention impact.

Keywords: Developmental network, faculty career advancement, randomized controlled trials

Introduction

Developmental networks are pivotal for faculty career advancement in academic medicine. While a 2013 study emphasized the superiority of developmental networks over traditional dyads in providing career support and opportunities, there remains a lack of randomized controlled trials examining the effectiveness of structured developmental network interventions. A non-randomized observational study recently demonstrated an increase in self-efficacy in developmental networking among participants of a structured curriculum-based developmental network intervention (Cummings & Higgins, 2006). This study seeks to evaluate the effectiveness of structured curriculum-based developmental network intervention on self-reported network measures using a randomized controlled study design. The curriculum-based intervention was delivered via a digital community of practice (Project ECHO) model and analyzed using a mixed

methods design. Compared to those who did not participate, we hypothesized that the mentor participants of a structured curriculum-based developmental network intervention demonstrated a greater change in their developmental networks and those of their respective mentees.

Methods

Study Design and Sample

The study was conducted across four Southwest or Mountain West institutions or consortia of institutions, with the University of New Mexico (UNM) serving as the hub site and the other institutions (Arizona State University, University of Oklahoma Health Sciences Center and Mountain West Clinical Translational Research Infrastructure Network) as spoke sites. The study used a randomized controlled trial design with pre-test and multiple post-test measures. Participant mentors were randomized into three groups:

1. Intervention group: Mentors who completed a mentor development program followed by a structured curriculum-based developmental network intervention.
2. Control group: Mentors who completed a mentor development program but not a structured curriculum-based developmental network intervention.
3. Pure control group: Mentors not exposed to either intervention.

A designated mentee of each mentor was enrolled but the mentees were not offered any mentoring interventions. Longitudinal data were collected at baseline, 12 months, and 24 months.

Procedures

In addition to descriptive characteristics, egocentric data on developmental network characteristics were obtained from an electronically administered, web-based Mentoring Network Questionnaire (MNQ), our modification of the Developmental Network Questionnaire (DNQ) (Higgins, 2004) for online administration with an additional question on network intensity. Psychometric properties of the scale items used to measure psychosocial and career help from the MNQ are published (Cummings & Higgins, 2006)). The web-based data was transferred electronically to a REDCap-based database, then checked manually for quality control.

Outcome Variables

Network characteristics included network size, range, density, gender diversity, racial/ethnic diversity, level of career support, level of psychosocial support, level of networking intensity, level of emotional closeness, and relationship type.

Predictor Variables

Analysis models included predictor variables for the study groups, study time period and the study period * intervention interaction, which was the test of intervention. Coding of predictor variables yielded tests for whether the change from baseline to 12 months and to 24 months were different for intervention and the two control groups.

Statistical Approach

Summaries of each outcome variable indicated high missing proportions over time. Multiple imputation for longitudinal data was conducted to correct the missingness. A randomized controlled trial design with baseline, 12-month, and 24-month measures was used to evaluate the intervention's impact. Each outcome variable had longitudinal missing data in each study arm. We conducted multiple imputation to correct the missingness and applied the multiply-imputed data into the mixed-effect models. Mixed-effects models were used for repeated measures analysis for each outcome variable over time, controlling

for baseline characteristics. Custom contrasts of linear mixed model parameters were made that estimated the within-group change from baseline and tested whether the change from baseline was the same for study arms (difference in differences tests). A p -value < 0.05 was considered statistically significant. Institutional Review Board (IRB) approval was obtained (UNM HRPO 19-464). Preliminary power calculations assumed a sample size of 64 intervention mentors vs. 64 control mentor orders would be able to detect a Cohen's effect size of 0.5 in network outcomes with power of 80% and $\alpha=0.05$.

Results

A total of 94 mentors and 92 mentees participated in the study. These included 44 pure control, 25 control, and 25 intervention mentors, and 44 pure control, 23 control, and 25 intervention mentees. Table 1 shows summaries for network outcome variables by study arms and periods. Table 2 reports the results of mixed-effect models with predictors of intervention, time period and their interaction. The models adjust for baseline demographics, including age, race/ethnicity, gender, faculty track and faculty rank. Except for mentor network *density* (relatively increased over 24 months in the intervention arm, interaction p -value=0.03), there were no significant differences (all $p > 0.05$) in outcome variables between the three groups over time. Results from additive models with only intervention groups, period and their interaction were similar (data not shown). Table 3 in Appendix shows that the pre-post differences of outcome variables within each study arm and whether the change from baseline was the same for arms 12 months and at 24 months, estimated using custom contrasts of parameters from the adjusted linear mixed models. Results were largely not statistically significant. For mentors, exceptions were seen in the pure control group for a decrease in *range* at 12-months from baseline ($p=0.02$). Similarly, for intervention mentors, a decrease in *racial/ethnic diversity* at 12-months from baseline ($p=0.04$); a decrease in *range* at 24-months from baseline ($p=0.05$); and increase in *density* at 24-months from baseline ($p=0.01$) were noted. For control mentors, an increase in *gender diversity* at 24-months from baseline ($p=0.03$) was noted. When group differences for longitudinal differences at 12-month and 24-month were analyzed, there was a significant increase in *gender diversity* for controls, as compared to pure controls, over 24-months ($p=0.04$). On the other hand, mentees showed no significant differences.

Discussions

Strengths

This study employs a robust randomized controlled trial (RCT) design, which is considered the gold standard for evaluating the effectiveness.

Data were collected at multiple time points (baseline, 12 months, and 24 months), allowing for the assessment of changes over time. The study includes participants from multiple institutions across the Southwest and Mountain West, enhancing the generalizability of the findings. Also, the study utilizes well-validated instruments, such as the Mentoring Network Questionnaire (MNQ), ensuring the reliability and validity of the measures.

Limitations

The study experienced high attrition rates, which may have impacted the statistical power and the ability to detect significant differences. The relatively small sample sizes in each group may limit the generalizability of the findings and the ability to detect small effect sizes. Despite the use of multiple imputation techniques, the presence of missing data could have introduced bias and affected the study's conclusions. The 24-month follow-up period may not be sufficient to capture the long-term evolution of developmental networks.

Conclusion

This randomized control trial of a structured curriculum-based developmental network intervention was largely ineffective in changing self-reported developmental network outcomes for mentors and their mentees over 24 months. The lack of change in network outcomes, a Moore Level V outcome, in the current study, contrasts with our prior observational study that demonstrated improved participant self-efficacy in developmental networking, a Moore Level IV outcome. High attrition rates, small sample sizes, and missing data, despite multiple imputations, may have obscured effects. The 24-month followup period might be insufficient to capture longterm developmental network evolution. The translation of competence (Moore Level IV) into performance (Moore Level V) might require an add-on intervention, such as a personalized coaching intervention to help participants change their developmental networks. Our previous qualitative study had shown that a change in developmental networks is triggered by non-strategic issues such as a change in project or leaving of a mentor rather than a strategic network plan aligned with career goals and assessment of network gaps. This lack of strategic thinking may also explain this lack of intervention effectiveness.

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Appendix

Characteristic	Period	Mentor						Mentee					
		Pure Control		Control		Intervention		Pure Control		Control		Intervention	
		N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
Size	Baseline	37	4.73	23	4.39	22	4.77	38	4.71	17	5.06	17	4.71
	12 month	22	4.82	15	4.13	11	4.91	20	4.6	14	4.57	11	5.27
	24 month	17	4.59	10	4.5	7	4.29	10	4.9	9	5.22	6	5
Range	Baseline	35	2.26	23	1.91	22	2.36	36	2.03	17	2.12	16	2.63
	12 month	22	1.91	15	1.4	11	2	18	1.83	14	1.79	11	2.55
	24 month	17	2.12	9	1.44	7	2	10	1.9	9	2.33	6	2
Density	Baseline	35	0.55	23	0.69	22	0.53	36	0.6	17	0.56	16	0.52
	12 month	22	0.57	15	0.78	11	0.45	20	0.6	14	0.58	11	0.38
	24 month	17	0.6	10	0.74	7	0.75	10	0.42	9	0.57	6	0.68
Gender	Baseline	34	43.38	22	29.41	21	38.9	35	32.5	17	31.7	16	43.9
Diversity	12 month	21	43.19	15	30.93	10	45.3	19	31.2	13	24.8	10	39.6
	24 month	17	32.53	9	29.78	7	40.43	9	29.7	9	37.1	6	30.5
Racial/ethnic	Baseline	35	31.23	22	31.41	22	38.05	34	39.6	17	38.7	16	35.1
Diversity	12 month	22	35.91	15	23.87	11	24	20	46.5	14	42.3	11	6.45
	24 month	17	32.71	9	23.67	7	23.71	9	45.3	9	47.6	6	32
Psychosocial	Baseline	35	19.31	23	16.75	22	19.08	36	20.8	17	20.9	16	20.3
Support	12 month	22	18.92	15	16.08	11	18.82	20	18.4	14	18.4	11	21.6
	24 month	17	20.42	10	18.48	7	17.81	10	18.8	9	22.2	6	19.9
Career	Baseline	35	15.69	23	15.16	22	14.83	36	18.2	17	17.6	16	18.2
Support	12 month	22	15.61	15	13.84	11	13.83	20	17.5	14	17.2	11	18
	24 month	17	16.75	10	15.28	7	15	10	18	9	18.8	6	17.9
Networking	Baseline	35	5.38	23	5.48	22	5.56	36	5.47	17	5.94	16	4.95
Intensity	12 month	22	5.56	15	5.79	11	5.32	20	5.39	14	6.03	11	5.13
	24 month	17	5.71	10	5.71	7	5.76	10	5.08	9	5.6	6	4.54
Emotional Closeness	Baseline	35	2.87	23	2.73	22	2.8	36	2.93	17	3	16	2.68
	12 month	22	2.79	15	2.83	11	2.68	20	2.67	14	2.98	11	2.8
	24 month	17	2.82	10	2.86	7	2.83	10	2.61	9	2.86	6	2.63
Ally	Baseline	37	13.96	23	17.39	22	18.94	38	14.5	17	18.6	17	17.7
	12 month	22	18.94	15	16.67	11	22.73	20	15	14	15.5	11	7.58
	24 month	17	8.82	10	16.67	7	4.76	10	11.7	9	5.56	6	25
Friend	Baseline	37	22.52	23	17.39	22	25.76	38	19.3	17	24.5	17	14.7
	12 month	22	24.24	15	16.67	11	27.27	20	16.7	14	17.9	11	25.8

	24 month	17	41.18	10	33.33	7	35.71	10	41.7	9	46.3	6	36.1
Sponsor	Baseline	37	7.66	23	12.32	22	7.58	38	7.02	17	7.84	17	11.8
	12 month	22	7.58	15	8.89	11	4.55	20	14.2	14	8.33	11	4.55
	24 month	17	4.9	10	3.33	7	0	10	11.7	9	9.26	6	8.33

Table 2
Tests for Intervention Effects Using Mixed-Effects Models Adjusting for Baseline Demographics

Characteristic	Source	p-value		Characteristic	Source	p-value	
		mentor	mentee			mentor	mentee
Size	Intervention	0.27	0.21	Networking Intensity	Intervention	0.08	0.18
	Period	0.22	0.21		Period	0.32	0.23
	Interaction*	0.23	0.34		Interaction	0.47	0.51
Range	Intervention	0.23	0.10	Emotional Closeness	Intervention	0.36	0.29
	Period	0.01	0.24		Period	0.16	0.12
	Interaction	0.43	0.17		Interaction	0.36	0.25
Density	Intervention	0.05	0.23	Ally	Intervention	0.26	0.48
	Period	0.02	0.07		Period	0.11	0.11
	Interaction	0.03	0.22		Interaction	0.31	0.09
Gender Diversity	Intervention	0.15	0.11	Friend	Intervention	0.17	0.44
	Period	0.05	0.22		Period	0.28	0.09
	Interaction	0.11	0.28		Interaction	0.38	0.38
Racial/ethnic Diversity	Intervention	0.23	0.07	Mentor	Intervention	0.25	0.08
	Period	0.23	0.08		Period	0.13	0.18
	Interaction	0.22	0.14		Interaction	0.29	0.39
Psychosocial Support	Intervention	0.21	0.10	Sponsor	Intervention	0.44	0.16
	Period	0.24	0.11		Period	0.00	0.21
	Interaction	0.10	0.20		Interaction	0.35	0.25
Career Support	Intervention	0.33	0.28				
	Period	0.06	0.17				
	Interaction	0.47	0.44				

Table 3
Pre-Post Differences of Outcomes Within each Arm and Difference from Baseline was the same for Arms 12 Months and at 24 Months

Outcome variable	Group	12 month				24 month				12 month				24 month			
		Difference from baseline	P-value	Difference in differences	P-value (D in d)	Difference from baseline	P-value	Difference in differences	P-value (D in d)	Difference from baseline	P-value	Difference in differences	P-value (D in d)	Difference from baseline	P-value	Difference in differences	P-value (D in d)
Size	Pure control	0.14	0.55			-0.16	0.50			-0.09	0.61			0.12	0.50		
	Control	-0.38	0.30	-0.53	0.27	0.12	0.58	0.28	0.52	-0.58	0.14	-0.5	0.31	0	0.57	-0.11	0.52
	Intervention	0.10	0.55	-0.04	0.62	-0.43	0.27	-0.27	0.51	0.25	0.47	0.34	0.45	0.07	0.52	-0.05	0.58
Range	Pure control	-0.46	0.02			-0.25	0.23			-0.25	0.26			-0.36	0.12		
	Control	-0.41	0.11	0.05	0.72	-0.22	0.37	0.03	0.60	-0.23	0.40	0.02	0.63	0.23	0.36	0.59	0.13
	Intervention	-0.32	0.24	0.14	0.56	-0.56	0.05	-0.31	0.35	-0.07	0.60	0.18	0.51	-0.53	0.13	-0.17	0.46
Density	Pure control	0.04	0.46			0.05	0.46			0.01	0.61			-0.05	0.45		
	Control	0.05	0.48	0.01	0.65	0.06	0.45	0.01	0.63	0	0.65	-0.01	0.66	0.02	0.51	0.07	0.45
	Intervention	-0.08	0.33	-0.12	0.26	0.25	0.01	0.20	0.08	-0.08	0.43	-0.08	0.46	0.14	0.22	0.19	0.17
Gender Diversity	Pure control	1.03	0.61			-13.48	0.03			-0.62	0.68			0.04	0.47		
	Control	1.36	0.62	0.33	0.63	6.16	0.38	19.64	0.04	-1.89	0.66	-1.27	0.71	3.18	0.52	3.14	0.47
	Intervention	6.58	0.34	5.55	0.42	-6.95	0.32	6.52	0.43	-3.32	0.48	-2.7	0.57	-14.61	0.12	-14.65	0.20
Racial/ethnic Diversity	Pure control	3.16	0.55			-1.82	0.61			-0.25	0.52			3.06	0.59		
	Control	-2.75	0.62	-5.91	0.49	-5.83	0.43	-4.01	0.53	-0.44	0.60	-0.19	0.59	0.3	0.77	-2.76	0.69
	Intervention	-17.27	0.04	-20.43	0.06	-8.42	0.30	-6.61	0.43	-35.38	0.15	-35.13	0.18	7.39	0.58	4.33	0.66
Psychosocial Support	Pure control	-0.81	0.56			0.47	0.58			-2.9	0.04			-3.69	0.08		
	Control	-0.88	0.61	-0.08	0.76	2.08	0.29	1.61	0.49	-3.69	0.06	-0.79	0.69	0.17	0.56	3.86	0.17
	Intervention	-0.85	0.56	-0.05	0.67	-1.21	0.48	-1.68	0.45	-0.4	0.65	2.5	0.32	-0.61	0.55	3.08	0.25
Career Support	Pure control	0.31	0.68			0.58	0.50			-0.84	0.47			-0.45	0.45		
	Control	-1.57	0.30	-1.88	0.34	-0.19	0.59	-0.78	0.51	-1.32	0.42	-0.48	0.68	1.12	0.39	1.57	0.39
	Intervention	-0.16	0.63	-0.47	0.61	-0.31	0.48	-0.89	0.53	-0.33	0.61	0.51	0.66	-0.54	0.44	-0.09	0.53
Networking Intensity	Pure control	0.16	0.50			0.37	0.15			-0.17	0.44			-0.28	0.27		
	Control	0.30	0.35	0.14	0.66	0.30	0.34	-0.07	0.67	-0.14	0.59	0.03	0.76	-0.32	0.37	-0.03	0.51
	Intervention	-0.15	0.56	-0.31	0.42	-0.08	0.51	-0.45	0.29	0.06	0.61	0.24	0.54	-0.06	0.47	0.22	0.41
Emotional Closeness	Pure control	-0.13	0.25			-0.08	0.42			-0.29	0.02			-0.23	0.15		
	Control	0.09	0.49	0.22	0.22	0.14	0.29	0.22	0.22	-0.13	0.44	0.16	0.43	-0.26	0.17	-0.02	0.53
	Intervention	0.00	0.65	0.13	0.43	-0.01	0.53	0.07	0.51	0.07	0.60	0.36	0.11	-0.18	0.33	0.05	0.44
Ally	Pure control	5.84	0.23			-2.96	0.50			-0.48	0.61			-0.85	0.48		
	Control	-1.36	0.65	-7.20	0.33	-1.90	0.57	1.06	0.66	0.08	0.66	0.56	0.63	-7.79	0.22	-6.94	0.37
	Intervention	5.36	0.40	-0.48	0.61	-9.35	0.16	-6.39	0.39	-4.7	0.43	-4.22	0.51	9.45	0.17	10.3	0.20
Friend	Pure control	1.31	0.70			-0.04	0.63			-2.09	0.60			-3.87	0.39		