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Relevance and usefulness of leadership, management and governance training to malaria health workers in nine African countries: Online survey

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Abstract

Background: Malaria programs workers demonstrate significant gaps in governance and leadership capacity, while the national malaria programs experience insufficient investment in addressing the gaps. This study examined the views of malaria health workers, who had undertaken and completed the leadership, management, and governance (LMG) training; this was with a view to assessing the relevance and usefulness of the training in their malaria work.

Methods: Using Kirkpatrick framework, a web-based survey instrument, English and French versions, examined selected elements considered to play a significant role in assessing the relevance and usefulness of the LMG training to the malaria elimination work of the alumni. Principal component analysis was combined with factor statistical analysis as a dimension-reduction technique to reduce the measured indicators of the relevance and usefulness of respondents' satisfaction with the contents into a more straightforward and meaningful construct.

Results: Relevance of LMG training to malaria work was rated very high with *"Training useful in current practice"* and *"Enjoyed the training topics"* ranking as first and second relative importance respectively among six relevance indicators. Secondary, health facility and district level alumni reported high relevance. Female and anglophone alumni demonstrated higher relevance and usefulness scores than their counterparts. Practicum was found most useful of the training outputs followed by step-down training. Participants were mostly equipped in data utilization and monitoring among programmatic competence indicators of usefulness of LMG training. On-

site training method was most very impactful followed by mentoring and practicum; though mentoring method was a significant determinant of programmatic competence.

Conclusion: Relevance and usefulness of LMG training to the malaria work of the alumni were established, though with few gaps across gender, professional level of practice, training methods and countries. Future LMG trainings should give considerations to these gaps to ensure inclusivity and even exposure in order to achieve desired competence.

Key words: LMG training, relevance, usefulness, health workers, malaria-endemic countries

BACKGROUND

The countries in the WHO African Region accounted for about 93.6% of cases and 95.4% of deaths from malaria globally in 2022; 78.1% of all deaths in this region were among children aged under 5 years in 2022 (1). Specifically, Nigeria, Democratic Republic of the Congo, Uganda, Burkina Faso, United Republic of Tanzania and Niger are among the top 10 countries contributing more than a half of global malaria cases and more than a third of the deaths due to malaria, mostly among children and pregnant women. Malaria contributes about 25 to 30 percent of childhood mortality and about 60% of hospital attendance. Malaria is a major cause of absenteeism from schools, markets, and workplaces as well as a major out-of-pocket expense for most households in Africa (1).

It is increasingly recognized that governance, leadership, and leadership capacity building are crucial ingredients for advancement toward malaria eradication (2,3,4). Malaria eradication requires leaders and managers who can ask the right questions, mobilize the right resources, make the right decisions, communicate the right messages, and create the right networks that can drive malaria control efforts from elimination to eradication (2,3). These skills require the capacity of relevant stakeholders to drive the effectiveness and efficiency of existing interventions, and leadership and governance are at the center of it all.

However, national malaria programs (NMP) suffer significant gaps in governance and leadership capacity, and insufficient investment in leadership capacity building (5). Yet leadership cannot operate within a vacuum but within the organizational system and culture of NMP and Ministries

of Health (MoH) that are open to change and adaptation to innovative, evidence-driven, and emerging strategies specific to country contexts. In response to Gates Foundation's call for grant applications to address the gap in governance and leadership development in the fight against malaria, African Leadership and Management Training for Impact in Malaria Eradication (ALAMIME) consortium developed and implemented a leadership, management and governance (LMG) and data-driven decision-making training program for malaria health managers and policymakers at mid-level and district-level management from 2022 to 2025; this was to increase their analytical and problem-solving skills as well as their capacity to implement evidence-based approaches that adapt to changing malaria landscape, which is required to support the transition from malaria control to elimination. ALAMIME training program comprised a structured in-service curriculum of two components: four taught modules collectively lasting 180 contact hours and three self-learning outputs (aimed at extending learning beyond the classroom) conducted with reports submitted as individual tasks (6). The first module introduced trainees to leadership, management and data use for malaria elimination; the second exposed trainees to broad issues in leading and managing programs; the third explored the science and art of malaria elimination; while the fourth taught trainees on data use and evidence for decision-making. Training was delivered online fully for cohorts 1 and 2 trainees while on-site alternated with online mode for cohorts 3 and 4 trainees. The three self-learning outputs were case study, step-down training and practicum. The case study made trainees to examine and analyze a malaria program challenge; step-down training at workplace focused on creating a mechanism for cascading knowledge and skills to colleagues and other stakeholders; while practicum allowed trainees to use routine data in identifying a real malaria-system challenge, conducting root cause analysis,

designing and implementing counter-measures, and documenting results with support from academic and field mentors over a period of three months. The primary outcome of this study was to provide evidence on the relevance and usefulness of LMG training in country-level malaria programs derived by malaria health managers and middle-level policymakers.

METHODS

Study design

A cross-sectional online survey deployed a quantitative method of data collection using the Kirkpatrick framework (7,8). This framework comprises four levels ranging from the relevance of the program to the needs of the respondents (Level 1) to the real difference that the program has made in the malaria elimination efforts (Level 4). Level 2 is related to the knowledge that the malaria health staff gained from the program, and Level 3 indicates the application of the knowledge gained during the program to practice.

Study setting

Countries in the ALAMIME consortium contribute significantly to the burden of malaria in Africa. LMG training of ALAMIME consortium is a capacity development program funded by the Gates Foundation. ALAMIME is a collaboration between the Makerere University School of Public Health (MakSPH) and Schools of Public Health and the National Malaria Control Programs in six (6) malaria endemic countries in Africa at the first instance and later expanded to nine (9) countries. There are eleven Schools of Public Health in the consortium located in

Makerere University, Uganda (Lead); University of Kinshasha, Democratic Republic of Congo; Muhimbili University of Health and Allied Health Sciences, Tanzania; University of Ibadan, Nigeria; University of Joseph Ki Zerbo, Burkina Faso; Abdou Moumouni University, Niger; University of Nigeria, Nigeria; Ahmadu Bello University, Nigeria; University of Sierra Leone, Sierra Leone; University of Lome, Togo; and Regional Institute for Public Health, Benin.

Study population

To date, the training program had undertaken and completed training with four cohorts and have 923 alumni as follows: Cohort 1 – 184, Cohort 2 – 188, Cohort 3 – 230 and Cohort 4 – 321. All the alumni at the national, mid-level/state and lower levels, both from government/public and private were targeted.

Data collection instrument

A web-based survey instrument was designed and examined selected elements considered to play a significant role in assessing the relevance and usefulness of the leadership, management, and governance training in the malaria elimination practices of the alumni. The questions included in the survey form were guided by a similar study with appropriate adaptation where necessary (9). The initial part of the survey form sought for a brief profile of the respondents such as ALAMIME registration number, current designation, number of years of practice on the malaria work, level of practice, and workplace. Their socio-demographic characteristics were retrieved from ALAMIME data base. The survey form also consisted of questions on what the

respondents provide or do routinely on their malaria work. Subsequently, the survey form collected information on the participants' agreement or otherwise on several statements related to the relevance of LMG training in the malaria elimination practices on a 5-point Likert scale (1: strongly disagree, 2: disagree, 3: neutral, 4: agree, 5: strongly agree). The survey form also sought information on their perceived impact of training modes, their views on the core competences expected to be derived from the module contents and deliverables in relation to their current work in malaria. The survey form and informed consent document were developed originally in English language and were translated to French version using DeepL Translator (10); the French versions were back-translated to English language using Google Translate (11 and Claude Opus 4.6 (12) and achieving a degree of agreement of 85 and 95%.

Data collection procedure

The survey was conducted in English and French languages for the anglophone and francophone participants respectively. A pre-test was conducted among 20 anglophone and francophone participants and findings were used to validate the internal consistency and reliability of the instrument in assessing respondents' perceived indicators of relevance and usefulness of the capacity building training, and satisfaction with learning materials. The final version of the survey form was administered through Google Form links (Google Inc., CA, USA) repeatedly shared online via Social, WhatsApp, and LinkedIn platforms for four weeks.

Data processing and management

The MS Excel-generated dataset from online platforms was analyzed. Analysis commenced with data cleaning to ensure completeness and consistency. Independent variables considered were socio-demographics and professional characteristics; relevance and usefulness of LMG training in malaria work-related program were considered as dependent variables.

Statistical data analysis I – Relevance of LMG training

Descriptive statistics including mean, standard deviations and percentages were used to describe the distributions of the respondents and training program relevance items. Principal component analysis (PCA) with factor analysis was conducted to assess the reduction of the measured indicators of the relevance of participants' perception on LMG training into a more straightforward and meaningful construct. Prior to PCA, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett's test of sphericity were conducted to indicate if the data were appropriate for PCA. The number of factors to retain and the items loaded on such factor were determined using eigen value >1 and the scree plot. Items are said to load strongly on a factor where the uniqueness (unexplained variance) < 0.4. Additionally, parallel analysis was applied to test whether the items on the relevance of the LMG training contained unidimensional scores. The relative importance index (RII) was also calculated to reveal the relevance of the LMG training to malaria work of ALAMIME alumni, with a 50% considered substantive (9). Having confirmed non-normality and the skewness of the outcome variable using Shapiro-Wilky test statistic ($W=0.6112$, $p<0.001$; Appendix I), Wilcoxon rank-sum and Kruskal–Walli's equality-of-

214 populations rank tests were conducted to ascertain the relationship between each of the
215 independent variables and the outcome. Crude and adjusted robust regression models were
216 thereafter conducted to determine the influence of selected socio-demographic and other
217 participants professional characteristics on perceived relevance of LMG training. Because the
218 data were collected from respondents nested within nine countries, non-independence of
219 observations at the country level was accounted for. All analyses were conducted at 5% level of
220 significance using STATA version 17.
221

222 **Statistical data analysis II – Usefulness of LMG training**

223 Twelve indicators were used to assess the usefulness of LMG training: Training outputs (3 items)
224 and Programmatic competence (9 items). The training outputs were Case report success,
225 Step-down training impact and Practicum application items. The three items were measured on
226 a 5-point Likert scale (1 = strongly disagree, …, 5 = strongly agree). The programmatic competence
227 indicators, measured on a 3-point Likert scale (1 = Less equipped, 2 = Equipped, 3 = Highly
228 equipped) were Defining malaria challenges, Strategy setting, Monitoring trends, Program
229 planning, Resource management, Coordination efforts, Effective implementation, Data
230 utilization and Technical integration.

231 Because the training output items (1–5 scale) and competence items (1–3 scale) were measured
232 on different ranges, all variables were standardized prior to analysis to ensure comparability. This
233 procedure rescales each item to mean = 0 and standard deviation = 1. Principal component
234 analysis (PCA) was conducted. An oblique promax rotation was applied to allow for correlated
235 factors. Eigenvalues greater than 1 and scree plot inspection guided component retention.

Component scores were generated using "predict" Stata command. Reliability of item groups was assessed using Cronbach's alpha. To confirm the dimensionality suggested by PCA, a confirmatory factor analysis (CFA) was performed, comparing a one-factor model (all items loading on a single latent construct) with a two-factor model (Training Outputs vs. Programmatic Competence). Model fit was evaluated using χ^2, CFI, TLI, RMSEA, SRMR, CD, AIC and BIC indices. Cluster analysis (k-means) was performed to the two principal components, classifying respondents into profiles.The optimal number of clusters was determined using the elbow method and confirmed with silhouette analysis. Cluster stability was checked by repeating the analysis with multiple random seeds and subsamples, yielding consistent results. Crude and adjusted regression analysis was conducted to explore determinants of the PCA component(s). All analyses were conducted at 5% significance level using Stata 17.

RESULTS

Participants' characteristics and their relationships with LMG training relevance indicators

Of the 923 alumni, 380 (41.2%) completed the online survey form. Of these, most were males (60.0%) and from cohort 4 (42.6%). Nearly all the respondents worked in the public sector (96.1%) and most worked at district/local level of government (47.6%). Most participants had 4-6 years of working experience (31.6%), less than half reported opportunity for continuing education in malaria program and 97.6% reported acquiring new skills (Table 1). The proportion of respondents confirming *"agree or strongly agree"* to the relevance of the LMG training as measured by the six items were generally high (Table 2). Precisely, the percentages were more than 90% of the total responses per item. Overall, participants' mean perception of the relevance

of the LMG training to their work in malaria program was 27.05±5.43. This amounts to 90.2% average collective rating of the LMG training relevance, suggesting a high level of perceived relevance of the LMG training program. Of note, *"Training useful in current practice"* (RII=91.6%) was ranked the highest, followed by *"Enjoyed the training topics"* (RII=91.2%), while *"Facilitators effectively taught all modules"* (RII=88.8%) received the lowest ranking to relative importance of LMG training relevance (Table 2). In Table 3, participants reported on-site mode of training (85.3%) as the most very impactful, but online mode (20.8%) as the least very impactful. Participants also reported monitoring and evaluation (55.3%), followed by prevention (48.7%) and case management (47.9%) as their most routine work in malaria program. Of the selected background characteristics, gender, country, level of professional practice, opportunity for continuing education in malaria and each of the training modes were associated with perceived training relevance ($p<0.05$) (Table 1).

Table 1. Background characteristics of respondents and their individual relationship with the perceived LMG training relevance scores (N = 380)

Characteristic	n	%	Mean± SD	p-value
Gender				0.013*
Female	152	40.0	28.11±3.64	
Male	228	60.0	26.34±6.26	
Country				<0.001***
Benin	23	6.1	25.78±6.71	
Burkina Faso	37	9.7	27.00±6.56	
Democratic Republic of the Congo	46	12.1	25.28±7.17	
Niger	27	7.1	23.30±8.56	
Togo	46	12.1	25.17±6.69	
Nigeria	105	27.6	28.77±1.95	
Sierra Leone	17	4.5	27.41±2.37	
Tanzania	45	11.8	27.98±3.83	
Uganda	34	9.0	29.15±1.18	
Cohort				0.171
Cohort 1	39	10.3	26.46±5.37	
Cohort 2	70	18.4	26.77±6.07	
Cohort 3	109	28.7	27.21±5.09	
Cohort 4	162	42.6	27.20±5.41	

Level of professional practice				0.003**
Health facility	25	6.6	27.44±2.33	
District/Local Government	181	47.6	26.92±5.71	
Secondary	79	20.8	28.46±3.08	
Federal or Central	64	16.8	25.06±7.39	
Other	31	8.2	28.00±4.27	
Years of experience				0.917
1 – 3 years	74	19.5	26.66±5.96	
4 – 6 years	120	31.6	27.18±5.32	
7 – 10 years	90	23.7	27.11±5.36	
> 10 years	96	25.3	27.14±5.27	
Sector				0.209
Private	15	4.0	26.00±6.15	
Public	365	96.1	27.09±5.40	
New skill acquired				0.137
No	9	2.4	24.78±7.55	
Yes	371	97.6	27.11±5.37	
Opportunity for continuing malaria education				0.003**
No	217	57.1	27.06±4.78	
Yes	163	42.9	27.04±6.20	

***p<0.001; **p<0.01; *p<0.05; SD – standard deviation

Table 2: Distribution of the relative importance of the indicators measuring the perceived relevance of LMG training

Statement	Mean ± SD	Disagree n(%)	Neutral n(%)	Agree n(%)	RII (%)	Rank
Overall (total) perceived relevance of ALAMIME training	*27.05 ± 5.43*				*90.2*	
Training useful in current practice	4.58 ± 0.98	25 (6.6)	1 (0.3)	354 (93.2)	91.6	1
Training materials relevant to malaria work	4.49 ± 0.96	23 (6.1)	6 (1.6)	351 (92.4)	89.7	4
Enjoyed the training topics	4.56 ± 0.95	23 (6.1)	1 (0.3)	356 (93.7)	91.2	2
Should be a curriculum module in tertiary institutions	4.53 ± 0.99	25 (6.6)	8 (2.1)	347 (91.3)	90.7	3
Facilitators effectively taught all modules	4.44 ± 0.97	24 (6.3)	7 (1.8)	349 (91.8)	88.8	6
Certificate is a valuable asset for malaria work	4.44 ± 1.01	28 (7.4)	9 (2.4)	343 (90.3)	88.9	5

Table 3. Distribution of participants according to training modes impact and thematic area of work in malaria program, including their relationships with the LMG training relevance score

Characteristic#	n	%	Mean± SD	p-value
Training mode – very impactful				
On-site	324	85.3	27.22±5.52	0.001***
Online	79	20.8	27.80±5.84	<0.001***
Practicum	231	60.8	27.62±5.32	<0.001***
Mentoring	258	67.9	27.39±5.43	<0.001***

Participants' area of work in malaria programme				
Program management	164	43.2	27.31±5.19	0.289
Vector control (IRS/PID)	101	26.6	27.23±5.22	0.732
Case management	182	47.9	26.70±6.01	0.280
Advocacy/Communication/Social mobilization	163	42.9	26.80±5.66	0.206
Monitoring and evaluation	210	55.3	26.95±5.73	0.817
Prevention (ITN, CPS/SMC)	185	48.7	26.82±5.91	0.797
Scientific staff	74	19.5	27.30±5.26	0.409
Laboratory work	51	13.4	27.51±4.81	0.521
Other	11	2.9	27.55±2.11	0.330

***p<0.001; # - multiple choice; SD – standard deviation

Outcome of Principal component analysis

The sample adequacy test showed that the analysed sample of ALAMINE alumni was sufficient at KMO=0.94. This supports the appropriateness of conducting principal component analysis. All the training relevance indicators strongly loaded (0.88-0.95) into the single latent factor perceived relevance of the LMG training, with low uniqueness values (<0.22) confirming that the variables were highly correlated and measured the same underlying construct (Appendix II). Additionally, parallel analysis indicated that only the first eigenvalue (5.15) exceeded the corresponding random eigenvalue (1) and Cronbach's alpha (0.97) demonstrated high internal consistency (Appendix III). Bartlett's test of sphericity was significant (χ^2_{20}=2811.95, p<0.001), indicating that the correlation matrix was not an identity matrix (Appendix III). Along with scree plot analysis (Appendix IV), the findings suggest a unidimensional factor structure, supporting the use of a single composite score (latent factor). The single latent factor solution explained 85.8% of the shared correlations (covariances) between the indicators of participants perceived relevance of LMG training to their malaria work-related program (Appendix III).

Regression analysis

The unadjusted and adjusted regression with cluster-robust standard errors coefficient of participants' perception of relevance of the LMG training, in relation to background characteristics including their professional skill traits, are presented in Table 4. Because these models included only country indicators and clustered on a small number of groups, the standard errors collapsed to near zero, producing identical lower and upper bounds for the confidence intervals. Although crude coefficients were reported descriptively, the adjusted model was relied on for statistical inference. The findings showed that alumni's skill competencies gained influenced how training relevance was perceived; participants who rated the practicum training mode as very impactful reported lower relevance (β = 4.12; 95% CI: 0.25 to 7.99; p = 0.048). However, these effects became non-significant after controlling for other variables.

After adjusting for covariates, participants' gender, country, level of professional practice, reported achievements following the training, significantly influenced relevance ratings. Specifically, males rated training relevance significantly lower than females, with an average difference of about 0.41 points (aβ = -1.15; CI: (-2.29,-0.01; p=0.048). On average, participants from Sierra Leone reported a 1.12-point reduction in relevance scores, whereas those from Burkina Faso rated the training 1.01 points higher compared to participants from Benin. Each unit increase in reported achievements attributed to the utilization of acquired skills significantly increased perceived relevance scores by 3.51 points. Participants who had professional practice outside healthcare facilities were associated with lower relevance rating compared with those who practiced at healthcare facilities. The inclusion of country fixed effects highlights baseline differences across countries, while clustering of standard errors provides conservative inference that accounts for within-country correlation. While participants from Burkina Faso, DR Congo and

321 Uganda respectively had a significant higher relevance score compared to Benin, those from

322 Niger and Togo had a significant lower relevance score.

323 **Table 4. Crude and adjusted robust regression models of factors associated with perceived relevance**
324 **of the LMG training**

Characteristics	β (95% CI)	p-value	aβ (95% CI)	p-value
Gender				
Female	0		0	0
Male	-1.77(-2.86,-0.68)	0.006**	--1.15(-2.29,-0.01)	**0.048***
Country				
Benin	0		0	0
Burkina Faso	1.22(1.22,1.22)	0	0.23(-0.40,0.86)	0.417
DR Congo	-0.50(-0.50,-0.50)	0	0.26(0.07,0.46)	0.014*
Niger	-2.49(-2.49,-2.49)	0	-2.59(-2.82,-2.36)	<0.001***
Togo	-0.61(-0.61,-0.61)	0	-0.75(-1.32,-0.18)	0.016*
Nigeria	2.99(2.99,2.99)	0	0.59(-0.28,1.47)	0.157
Sierra Leone	1.63(1.63,1.63)	0	0.22(-0.55,0.99)	0.532
Tanzania	2.20(2.20,2.20)	0	0.65(-0.20,1.50)	0.117
Uganda	3.36(3.36,3.36)	0	1.21(0.20,2.22)	0.024*
Cohort				
Cohort 1	0			
Cohort 2	0.31(-2.49,3.11)	0.805		
Cohort 3	0.75(-2.25,3.75)	0.580		
	0.74(-2.20,3.69)			
		0.577		
Cohort 4				
Level of professional practice				
Health facility	0		0	
District/Local Government	-0.52(-2.38,1.35)	0.540	-2.09(-3.52,-0.65)	0.010**
Secondary	1.02(0.00,2.03)	0.050*	-1.47(-3.04,0.10)	0.062
Federal or Central	-2.38(-5.04,0.29)	0.074	-2.16(-3.82,-0.51)	0.017*
Other	0.56(-1.74,2.86)	0.590	-2.71(-4.56,-0.86)	0.010**
Years of experience				
1 – 3 years	0			
4 – 6 years	0.51(-1.86,2.88)	0.631		
7 – 10 years	0.45(-1.70,2.59)	0.642		
> 10 years	0.47(-2.24,3.19)	0.698		
Sector				
Private	0			
Public	1.09(-1.29,3.47)	0.321		
New skill acquired				
No	0			
Yes	2.33(-3.8,8.45)	0.406		
Continuing education opportunity				
No	0			
Yes	-0.01(-1.86,1.83)	0.988		
Post-training achievement score	3.96(2.80,5.12)	0.001***	3.51(1.98,5.04)	0.001***
Training-induced skill score	4.62(3.41,5.84)	0.001***	0.99(-1.01,2.99)	0.285
On-site mode impact				
Slightly impactful	0			

Impactful	0.73(-5.15,6.62)	0.781		
Very impactful	1.79(-4.18,7.76)	0.509		
Online mode impact				
Slightly impactful	0			
Impactful	0.98(-0.85,2.81)	0.251		
Very impactful	1.69(-0.13,3.51)	0.065		
Practicum mode impact				
Slightly impactful	0		0	
Impactful	2.94(-0.63,6.52)	0.094	0.37(-2.08,2.83)	0.736
Very impactful	4.12(0.25,7.99)	0.040*	-0.66(-3.37,2.05)	0.589
Mentoring mode impact				
Slightly impactful	0			
Impactful	1.11(-2.43,4.65)	0.490		
Very impactful	2.00(-1.82,5.82)	0.262		

***p<0.001; **p<0.01; *p<0.05; β – beta coefficient; aβ – adjusted beta coefficient; CI – confidence interval

Participants' characteristics and their relationships with LMG training usefulness indicators

Most respondents strongly agreed (51.1%) to the training output indicators as being useful to their malaria work, followed by those who agreed (37.5%). Respondents who reported *"strongly disagree"*, *"disagree"* or *"neutral"* to training outputs' items as being useful were generally low, less than 13% of the total responses per indicator (Table 5). This amounts to 88.6% average collective rating of the training outputs suggesting a high level of their usefulness to the LMG training program. Overall, participants' mean perception of the usefulness of the training outputs of LMG training to their work in malaria program was 4.29±0.89; of the three training outputs, practicum application has the highest usefulness score of 4.34±0.94 and ranked highest in relative importance index whereas case report/study success was the least ranked (Tables 5 and 6).

With respect to programmatic competence indicators of usefulness of LMG training, majority (96.3%) of the participants were reportedly equipped with *"data utilization"* and rated the indicator highest (2.61±0.56) as most useful; this is followed by *"monitoring trends"* with a mean useful indicator of 2.59±0.57 (Table 5). Ranking by relative importance, *"Data utilization"* (RII=86.9%) was the most ranked competence items, followed by *"Monitoring trends"* (RII=86.4%), while *"Strategy setting"* (RII=81.6%) received the lowest ranking to relative importance of LMG training programmatic competence gained. While *"Practicum application"* was ranked with the highest relative importance, *"Case report/study success"* was the least ranked within the training outputs after the LMG training (Table 6).

Table 5: Distributions of participants' responses to the usefulness of training outputs and programmatic competence indicators of LMG training

Indicators			**Responses (%)**			**Mean±SD**
Training outputs	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	
Case report success	3.7	3.7	4.7	40.5	47.4	4.24±0.97
Step-down training impact	4.0	2.6	5.8	35.3	52.4	4.29±0.98
Practicum application	3.4	2.9	3.4	36.6	53.7	4.34±0.94
Subtotal	*3.7*	*3.1*	*4.7*	*37.5*	*51.1*	*4.29±0.89*
Equipped Competence	***LE**	**Equipped**	****HE**			
Defining malaria challenges	4.2	41.1	54.7			2.51±0.58
Strategy setting	5.8	43.7	50.5			2.45±0.60
Monitoring trends	4.2	32.4	63.4			2.59±0.57
Program planning	4.7	34.2	61.1			2.56±0.58
Resource management	5.8	41.1	53.2			2.47±0.61
Coordination efforts	7.1	39.7	53.2			2.46±0.63
Effective implementation	4.5	39.5	56.1			2.52±0.58
Data utilization	3.7	31.8	64.5			2.61±0.56
Technical integration	6.1	36.6	57.4			2.51±0.61
Subtotal	*5.1*	*37.8*	*57.1*			*2.52±0.47*

***LE: Less equipped **HE: Highly equipped**

Table 6. **Distribution of Items loadings by factors, and sampling adequacy and reliability measure**

	Eigenvectors		Loadings					
Indicators	**Factor 1**	**Factor 2**	**Factor 1**	**Factor 2**	**uniqueness**	**α**	**KMO**	**RII**
Case report success	0.26	0.51	0.02	**0.91**	0.16	*0.90*	0.90	84.8
Step-down training impact	0.26	0.52	0.02	**0.93**	0.12	*0.87*	0.86	85.9
Practicum application	0.26	0.52	0.01	**0.93**	0.13	*0.88*	0.87	86.8
Defining malaria challenges	0.30	-0.14	**0.78**	0.04	0.36	0.92	0.95	83.5
Strategy setting	0.30	-0.14	**0.78**	0.04	0.37	0.92	0.95	81.6
Monitoring trends	0.30	-0.09	**0.73**	0.10	0.37	0.92	0.96	86.4
Program planning	0.30	-0.18	**0.83**	-0.01	0.32	0.92	0.94	85.4
Resource management	0.31	-0.16	**0.82**	0.01	0.32	0.92	0.94	82.5
Coordination efforts	0.29	-0.19	**0.82**	-0.04	0.35	0.92	0.95	82.0
Effective implementation	0.30	-0.16	**0.80**	0.02	0.35	0.92	0.94	83.9
Data utilization	0.29	-0.14	**0.76**	0.04	0.39	0.92	0.91	86.9
Technical integration	0.29	-0.14	**0.77**	0.04	0.37	0.92	0.94	83.8
Number of items	*9*	*3*	*9*	*3*				
Cronbach's alpha	*0.93*	*0.92*						
Overall						*0.92*	0.93	

Bold – items loading by component; α – Cronbach's alpha, RII – relative importance index, KMO-

Outcome of Principal Component Analysis

Aligning with the Scree plot (Appendix V), the findings revealed two dominant factors that together explained 69.9% of the total variance First component had eigenvalue of 6.86, accounting for 57.2% of the total variance. The second dominant component had eigenvalue of 1.53, accounting for 12.7% of the total variance (Appendix VI). The two factors jointly explained approximately 70% of the total variance before rotation. After rotation, a two-factor clearer structure emerged. All the nine skill competence items loaded strongly (0.73–0.83) on the first component, indicating a common underlying dimension of malaria program skills. The three training output items loaded strongly (>0.90) on second component,. Uniqueness values were

low (< 0.40), indicating that the two-factor model explained most of the variance in each variable. These two factors/components jointly explained participants' self-ratings into two broad dimensions; namely, Programmatic competence gained and Training outputs achieved, consistent with the conceptual link between skills and achievement. Cronbach's alpha, computed to assess internal consistency, indicated high reliability for training output ($\alpha = 0.92$) and competence ($\alpha = 0.93$) items. This finding confirms that items within each component measure coherent constructs. While these results support the reliability of the scales, they should be interpreted with caution, acknowledging the possibility that high internal consistency does not necessarily equate to exceptional measurement quality. This limitation underscores the importance of balancing reliability with item diversity to ensure comprehensive construct representation

Confirmatory factor analysis

To test whether the 12 indicators reflect a single latent construct or two distinct constructs, the fit indices obtained from the confirmatory factor analysis conducted are presented in Appendix VII. For the single factor model, all the 12 items were specified to load on a single latent factor (LMG training Impact), while items were specified to load on two correlated latent factors: Training outputs and Programmatic competence for the two-factor model. The findings confirm that a two-factor model ($\chi^2(53) = 165.318$; CFI = 0.965; TLI = 0.9564; RMSEA = 0.075; SRMR = 0.031) demonstrated superior fit indices compared to a one-factor model (Appendix VII). This corroborates the initial PCA findings in which Programmatic competence captures malaria program core competences gained. Consequently, training outputs and programmatic

competences should be treated as separate latent variables rather than collapsed into a single index.

Cluster profiles

The k-means clustering segmented the participants into 4 cluster profiles (Appendix VIII).The number of clusters was determined using the elbow method and confirmed by silhouette analysis, both supporting a four-cluster solution (Appendix ix). Profiles were described by cluster means, revealing distinct groups characterized by varying levels of achievement and skills (Appendix x). The four clusters represented distinct profiles: Cluster 2 (5.5%) comprised the least proportion of respondents with low skills and low achievement, representing minority most disadvantaged group; Cluster 1 (6.8%) reflected low skills but moderate achievement, representing relatively small group of respondents ("compensators") who achieve despite limited skill strength; Cluster 3 (32.9%) showed moderate achievement despite weaker skills, representing a "average performer" profile - not excelling in skills, but achieving somewhat; and Cluster 4 (54.7%) represented the majority with strong skills but average achievement, representing "potential achievers" - respondents with solid competencies that have not yet fully translated into achievement outcome. The clusters highlight the heterogeneity of LMG's training impact, with few individuals achieving despite weaker skills and many possessing strong skills that have not yet translated into achievement outcomes

Regression analysis

To explore determinants of the two PCA components, the adjusted regression coefficient including their respective 95% confidence interval and the associated p-values are presented in Table 7. Component 1 (programmatic competence) was significantly associated with country of residence, level of professional practice, years of experience, opportunity for continuing education, online-, practicum- and mentoring-mode of delivery. Only mentoring mode of delivery impact remained significant determinant of programmatic competence (component 1) after controlling for other variables. Participants who self-rated mentoring mode of delivery as very impactful (aβ = 1.89; 95% CI: 0.33,3.44) scored higher on programmatic competence. Unlike component 1, all the variables that individually explained component 2 (training outputs) at bivariate stage remained significant after adjusting for other covariates. Training output was significantly predicted by gender, level of professional practice and new skill acquired. Specifically, males (aβ = -0.26; 95% CI: -0.52, -0.03) had a reduced score on training outputs compared with their females' counterparts. Participants who practiced at District/local government or at Federal/Central had lower score on training outputs compared with those who practiced at Health facility. Curiously, participants who reported acquisition of new skill in malaria program (aβ = -0.59; 95% CI: -1.10, -0.09) due to the LMG training scored lower on training outputs (Table 7).

Table 7. Crude and adjusted regression models of factors associated with programmatic capacity and training outputs

Characteristic	Component 1		Component 2	
Characteristic	**β (95% CI)**	**aβ (95% CI)**	**β (95% CI)**	**aβ (95% CI)**
Gender				
Female	0		0	0
Male	-0.22(-0.74,0.30)		**-0.26(-0.5,-0.02)**	**-0.28(-0.52,-0.03)**
Country				
Benin	0	0	0	
Burkina Faso	-0.11(-1.47,1.26)	-0.64(-2.03,0.74)	0.68(-0.13,1.50)	

DR Congo	-0.59(-2.01,0.83)	-0.92(-2.32,0.48)	-0.05(-1.00,0.90)	
Niger	-0.06(-1.58,1.46)	-0.29(-1.87,1.30)	-0.07(-1.04,0.90)	
Togo	-1.03(-2.28,0.22)	-1.10(-2.42,0.21)	0.57(-0.30,1.43)	
Nigeria	**1.79(0.73,2.84)**	0.74(-0.37,1.84)	0.40(-0.40,1.19)	
Sierra Leone	**1.45(0.03,2.88)**	0.49(-0.93,1.90)	0.32(-0.55,1.18)	
Tanzania	**1.54(0.39,2.68)**	0.80(-0.35,1.96)	0.15(-0.66,0.97)	
Uganda	**1.86(0.70,3.03)**	0.81(-0.35,1.96)	0.41(-0.39,1.20)	
Cohort				
Cohort 1	0		0	
Cohort 2	0.21(-0.84,1.27)		-0.04(-0.58,0.49)	
Cohort 3	0.36(-0.62,1.35)		0.16(-0.31,0.64)	
Cohort 4	0.09(-0.86,1.04)		0.22(-0.25,0.70)	
Level of professional practice				
Health facility	0	0	0	0
District/Local Government	**1.34(0.38,2.30)**	-0.01(-1.16,1.14)	**-0.48(-0.93,-0.04)**	**-0.50(-0.94,-0.07)**
Secondary	**1.87(0.84,2.90)**	0.14(-1.14,1.43)	-0.31(-0.79,0.17)	-0.32(-0.79,0.15)
Federal or Central	0.44(-0.72,1.61)	-0.31(-1.57,0.96)	**-0.70(-1.24,-0.16)**	**-0.73(-1.26,-0.20)**
Other	**2.39(1.31,3.47)**	0.53(-0.77,1.82)	-0.39(-0.94,0.16)	-0.48(-1.03,0.07)
Years of experience				
1 – 3 years	0	0	0	
4 – 6 years	0.47(-0.35,1.28)	0.15(-0.56,0.86)	0.24(-0.14,0.62)	
7 – 10 years	**0.87(0.02,1.71)**	0.50(-0.22,1.23)	-0.11(-0.55,0.32)	
> 10 years	**0.84(0.01,1.68)**	0.42(-0.33,1.16)	0.10(-0.29,0.48)	
Sector				
Private	0		0	
Public	-0.42(-1.53,0.69)		-0.06(-0.55,0.43)	
New skill acquired				
No	0		0	0
Yes	1.05(-0.58,2.68)		**-0.51(-0.92,-0.11)**	**-0.59(-1.10,-0.09)**
Continuing education opportunity				
No	0	0	0	
Yes	**0.85(0.32,1.38)**	0.31(-0.19,0.82)	-0.17(-0.43,0.08)	
On-site mode impact				
Slightly impactful	0		0	
Impactful	0.04(-2.45,2.52)		0.80(-0.56,2.17)	
Very impactful	1.74(-0.65,4.14)		0.46(-0.87,1.79)	
Online mode impact				
Slightly impactful	0	0	0	
Impactful	0.43(-0.24,1.11)	0.03(-0.56,0.63)	0.11(-0.25,0.48)	
Very impactful	**1.75(0.94,2.56)**	0.56(-0.19,1.30)	0.12(-0.31,0.54)	
Practicum mode impact				
Slightly impactful	0	0	0	
Impactful	**1.67(-0.05,3.38)**	0.09(-1.94,2.12)	0.07(-0.69,0.83)	
Very impactful	**3.49(1.80,5.19)**	1.10(-1.02,3.22)	0.04(-0.69,0.78)	
Mentoring mode impact				
Slightly impactful	0	0	0	
Impactful	**1.96(0.55,3.38)**	1.22(-0.28,2.72)	-0.24(-0.88,0.41)	
Very impactful	**3.38(2.03,4.73)**	**1.89(0.33,3.44)**	-0.25(-0.85,0.34)	

Bold – significance at 5%; β – beta coefficient; aβ – adjusted beta coefficient; CI – confidence interval

DISCUSSION

437 Evidence abounds that malaria elimination cannot not be achieved through technical and clinical
438 interventions alone. It requires sustained leadership, effective management, and strong
439 governance to coordinate health systems, communities, donors, private-sector actors, and other
440 sectors (2,3,13). The importance of these functions is particularly evident in countries with
441 substantial malaria burdens, including ALAMIME Consortium countries (1). This study found that
442 majority of the participants (90.2%) rated the relevance of the LMG training to their work in
443 malaria program very high, having obtained a mean relevance score of 27.05±5.43 out of a range
444 of 6 to 30. On relative ranking of importance of the six relevance indicators, *"Training useful in*
445 *current practice"* and *"Enjoyed the training topics"* ranked first and second respectively. These
446 ratings support the desirability of introducing structured LMG training either as a short certificate
447 course or diploma program for malaria program workers. The lowest ranking was ascribed to the
448 statement *"Facilitators effectively taught all modules;* this suggests that an improved
449 standardization of pedagogical methods by facilitators is required in future trainings. This study
450 also reported a significant highest mean relevance score by alumni at the secondary level; this
451 was followed by alumni at the health facility and district levels; thereby establishing the relevance
452 of LMG training among subnational study participants.
453
454 This study found that female alumni had a significant higher mean relevance score than their
455 male counterparts despite comprising 40% of the survey respondents. In addition, female alumni
456 had significant higher scores on training outputs than males. These findings contradicted
457 previous studies which have suggested that females generally report decreased self-confidence,
458 particularly over issues related to their competency compared to males (14,15). These findings

may suggest that female alumni perceived their experiences as more relevant or impactful as well as having stronger engagement or effectiveness in skill development than males. Therefore, the finding is important as it may be found useful in designing male friendly training packages which would make them appropriately targeted and take into cognizance barriers such as timing and role conflicts - all of which may prevent full participation and effective learning by male alumni.

Alumni in anglophone countries generally reported higher mean relevance scores than francophone alumni except in Burkina Faso. Similarly, anglophone alumni demonstrated higher programmatic competence than francophone alumni. This is a surprise finding because the processes of training curriculum development and delivery modes were standardized in both French and English languages; furthermore, all training sessions were held separately in French and English languages for francophone and anglophone alumni respectively. This gap requires in-depth review as the finding might arise from differences in institutional support and post-training follow-up structures rather than curriculum design itself. It might also suggest a need for tailoring curricula to francophone contexts, ensuring translation is not just linguistic but cultural and professional.

The rating of the usefulness of training outputs in LMG training to malaria work was also very high (88.6%) with practicum having the highest usefulness score of 4.34±0.94, followed by step-down training; whereas, data utilization and monitoring were rated highest among the programmatic competence indicators of usefulness of LMG training; this reflects their mostly equipped areas of malaria work. These findings corroborate the effectiveness of practicum

output in empowering alumni with skill set required to analyze and use data for decision making; thereby emphasizing the malaria program core competences gained on the training and providing evidence for desirability of decentralized decision-making capacity by malaria program officers at subnational levels as this would allow interventions to reflect local epidemiology and situations (16,17).

Leadership, Management, and Governance (LMG) training has been widely recognized as a critical intervention for strengthening malaria program capacity across endemic regions. Evidence from the ELEMMINATE project demonstrates that structured training outputs—particularly practicum application—are consistently rated by alumni as the most impactful component of their learning experience. Practicum projects, which require participants to apply theoretical knowledge to real-world programmatic challenges, have been shown to enhance analytical skills and foster evidence-based decision-making in malaria control and elimination efforts (18,19). This aligns directly with the current study's finding that practicum application achieved the highest mean score among training outputs.

Similarly, the ALAMIME consortium emphasized the centrality of practicum-based learning in its certificate program on LMG for malaria eradication (6). Alumni testimonies highlight that the practicum not only strengthened their leadership and management abilities but also improved their competence in data utilization and monitoring—skills essential for programmatic success. The consortium's reports consistently rank data analysis and evidence-based policy implementation as the most valuable competencies gained, corroborating the present study's observation that data utilization scored highest among programmatic indicators.

Further, the ALAMIME capacity-building project underscored the importance of step-down training in cascading knowledge to sub-national levels. While national-level alumni often report stronger gains in strategic leadership, sub-national participants highlight improvements in operational management and monitoring (20,21). Therefore, of note is the uneven core competences gained across the four clusters of alumni who participated in the survey. This uneven distribution of competencies across clusters mirrors the current study's finding of variability in core competence acquisition, suggesting that future LMG training designs must balance expectations across diverse participant groups. Taken together, these studies reinforce the effectiveness of practicum application and data utilization as core pillars of LMG training. They also highlight the need for adaptive training models that address uneven competence gains across alumni clusters (22). By integrating lessons learned from prior initiatives, future LMG programs can produce a malaria workforce that is not only grounded in technical expertise but also equipped with holistic leadership and governance perspectives as opined by the World Health Organization (23).

The most very impactful training mode was on-site method, though with lowest mean relevance score; this was followed by mentoring and practicum. On the other hand, mentoring mode of delivery was a significant determinant of programmatic capacity after controlling for other variables. These findings suggest that training modalities and institutional context may shape the extent to which participants benefit from LMG training. This finding aligned with a previous study which demonstrated highest percentage of respondents expressing their preference for the face-to-face learning method rather than hybrid (a mixture of face-to-face and e-learning) or distance

525 e-learning methods (9). It also emphasized the role that mentoring played in the success achieved
526 on practicum in this study. The implication of this finding is far-fetched for trainers in designing
527 and budgeting for future trainings. On the contrary, the highest mean training relevance score
528 was reported for online mode of training delivery which was reported as being least impactful.
529 Notwithstanding, the success of the LMG training is further corroborated by the reported
530 achievements attributed to the utilization of acquired skills and in the acquisition of core skill
531 competencies which significantly increased perceived relevance scores obtained by alumni.
532
533 This survey has few limitations; first the response rate is below 50% despite weekly reminders
534 through designated platforms. This might cause non-response bias and thus affected
535 representativeness and generalization of study findings. Second, full online mode of training was
536 utilized for cohorts 1 and 2 alumni whereas online mode alternated with on-site training for
537 cohorts 3 and 4. This variation coupled with recall bias might have resulted in lower training
538 relevance scores than the overall mean reported by cohorts 1 and 2 alumni. Third, the data are
539 self-reported and obtained from an online survey without control group or before/after
540 measurement; the "acquired skills" are therefore perceived, not measured, and no causal link
541 can be asserted.
542
543 **Conclusion**
544 Leadership provides the vision, political commitment, strategic direction, and motivation needed
545 to sustain malaria elimination over many years; management translates policy and leadership
546 decisions into effective program implementation while governance concerns how decisions are

made, how authority and responsibilities are distributed, how resources are controlled, and how institutions and stakeholders are held accountable. The LMG curriculum of ALAMIME project covered these functions in different methodological approaches (ALAMIME Consortium, 2022). The findings of this study documented the relevance and usefulness of LMG training to the work of the local and middle level malaria program workers and suggested some measures for improved impact. Malaria program workers at all levels desire to have capacity for decision-making which they need to tailor interventions that reflect local malaria epidemiology and situations.

Declarations

Ethics approval and consent to participate

Ethics approval for this study was given by the Institutional Review Board (IRB) of the University of Ibadan/University College Hospital, Ibadan, Nigeria with UI/UCH EC Registration number: NHREC/05/01/2008a. Research procedures were conducted in accordance with the Declaration of Helsinki. Respondents were provided with the purpose and importance of the study; informed consent was obtained electronically from all the respondents before proceeding with the survey questions. Participation was voluntary while privacy, confidentiality and anonymity of the personal information of the respondents were preserved.

Consent for publication

Consent to disseminate research findings for advancing knowledge and policy making through publications and briefs was taken from each study participant.

Availability of data and materials

The datasets analysed are not publicly available because they comprise programme data collected through the ALAMIME programme. Access to the data is subject to applicable institutional and programme data-governance requirements. Reasonable requests for access may be directed to the corresponding author and will be considered subject to the necessary approvals and data-sharing requirements.

Competing interests

All the authors were involved in the implementation and coordination of the ALAMIME programme. The authors declare no financial or other competing interests that could have influenced the conduct, analysis, interpretation, or reporting of this study.

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Authors' contributions

KO and MK collected the data; KO, RA and AK contributed to data management, analysis and interpretation of findings; KO developed the first draft; ER provided scientific oversight and supervision; all authors reviewed all drafts and approved the final draft of the manuscript.

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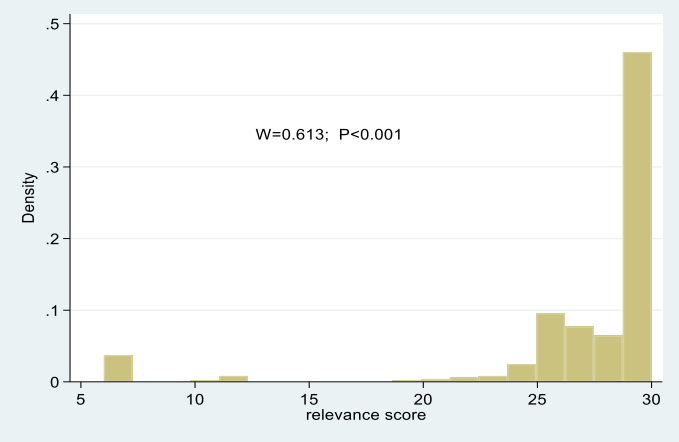
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23. World Health Organization, (2020). Leadership and governance for malaria programs: Strengthening capacity for data utilization and monitoring. Geneva: WHO Global Malaria Programme.

APPENDICES

Appendix I. Normality test

In Appendix I, the histogram showed that the relevance of the training score was negatively skewed. Corroborated by Shapiro-Wilky test statistic (W=0.6112, p<0.001), the finding suggests that the distribution of the training relevance score was non-normally distributed.



Appendix I. Histogram showing the distribution of the relevance rating scores

Appendix II: Principal components analysis matrix regarding the perceptions about the relevancy of ALAMINE training

Indicators	Eigenvectors	Loadings	Uniqueness	Alpha	KMO
Training useful in current practice	0.4155	0.9426	0.1116	0.9574	0.9367
Training materials relevant to malaria work	0.4115	0.9333	0.1289	0.9589	0.9333

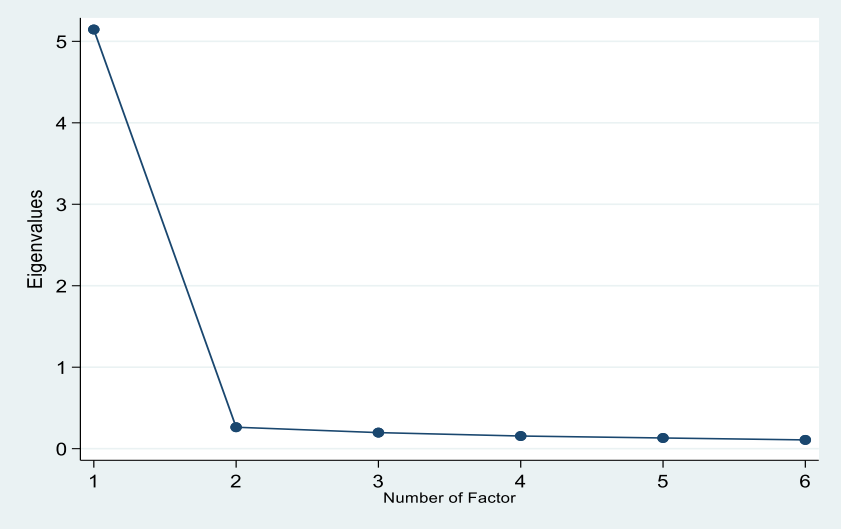
Enjoyed the training topics	0.4189	0.9502	0.0972	0.9564	0.9226
Should be a curriculum module in tertiary institutions	0.4029	0.9139	0.1647	0.9616	0.9523
Facilitators effectively taught all modules	0.4103	0.9308	0.1336	0.9592	0.9479
Certificate is a valuable asset for malaria work	0.3897	0.884	0.2185	0.9659	0.9664
Overall				***0.9664***	***0.9422***

KMO - Kaiser-Meyer-Olkin

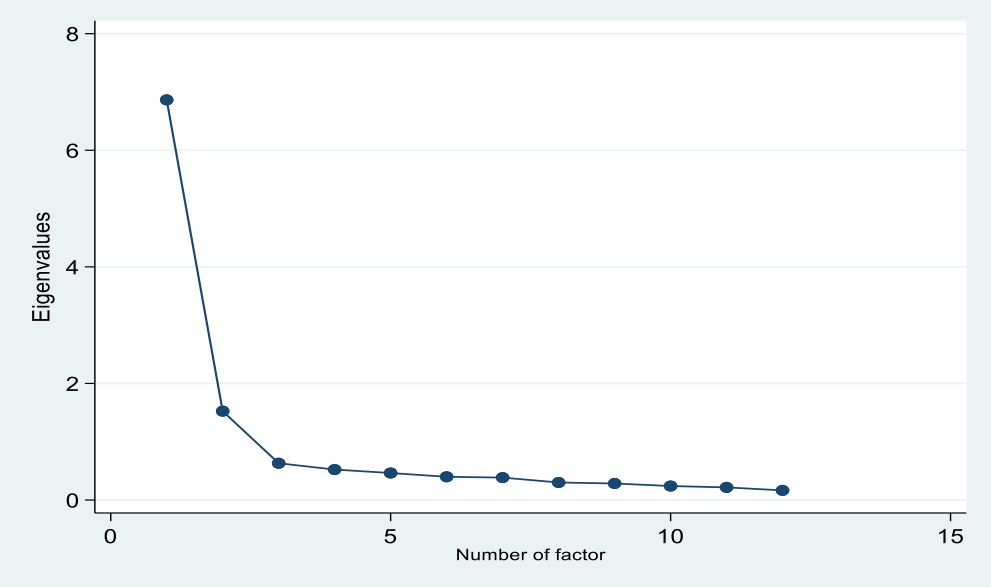
Appendix III. Explained variance by components

Components	Eigenvalue	Proportion	Cumulative	Bias
Comp1	5.145512	0.8576	0.8576	0.002334
Comp2	0.263293	0.0439	0.9015	0.003499
Comp3	0.197184	0.0329	0.9343	0.000968
Comp4	0.155208	0.0259	0.9602	−0.000176
Comp5	0.131244	0.0219	0.9821	−0.002744
Comp6	0.107559	0.0179	1	−0.003881

LR test for independence: chi2(15) = 2807.40, Prob > chi2 = <0.001
LR test for sphericity: chi2(20) = 2811.95, Prob > chi2 = <0.001



Appendix IV. Scree plot of eigenvalues showing the number of factor(s)



Appendix V. Scree plot of eigenvalues showing the number of factor(s)

Appendix VI. Explained variance by components

Components	Eigenvalue	Proportion	Cumulative
Comp1	6.86385	0.5720	0.5720
Comp2	1.52505	0.1271	0.6991
Comp3	0.631237	0.0526	0.7517
Comp4	0.52303	0.0436	0.7953
Comp5	0.463656	0.0386	0.8339
Comp6	0.399043	0.0333	0.8672
Comp7	0.385007	0.0321	0.8992
Comp8	0.301456	0.0251	0.9244
Comp9	0.284135	0.0237	0.9480
Comp10	0.240248	0.0200	0.9681
Comp11	0.217134	0.0181	0.9862
Comp12	0.166151	0.0138	1

Appendix VII. Summary of fit indices for one- and two-factor models

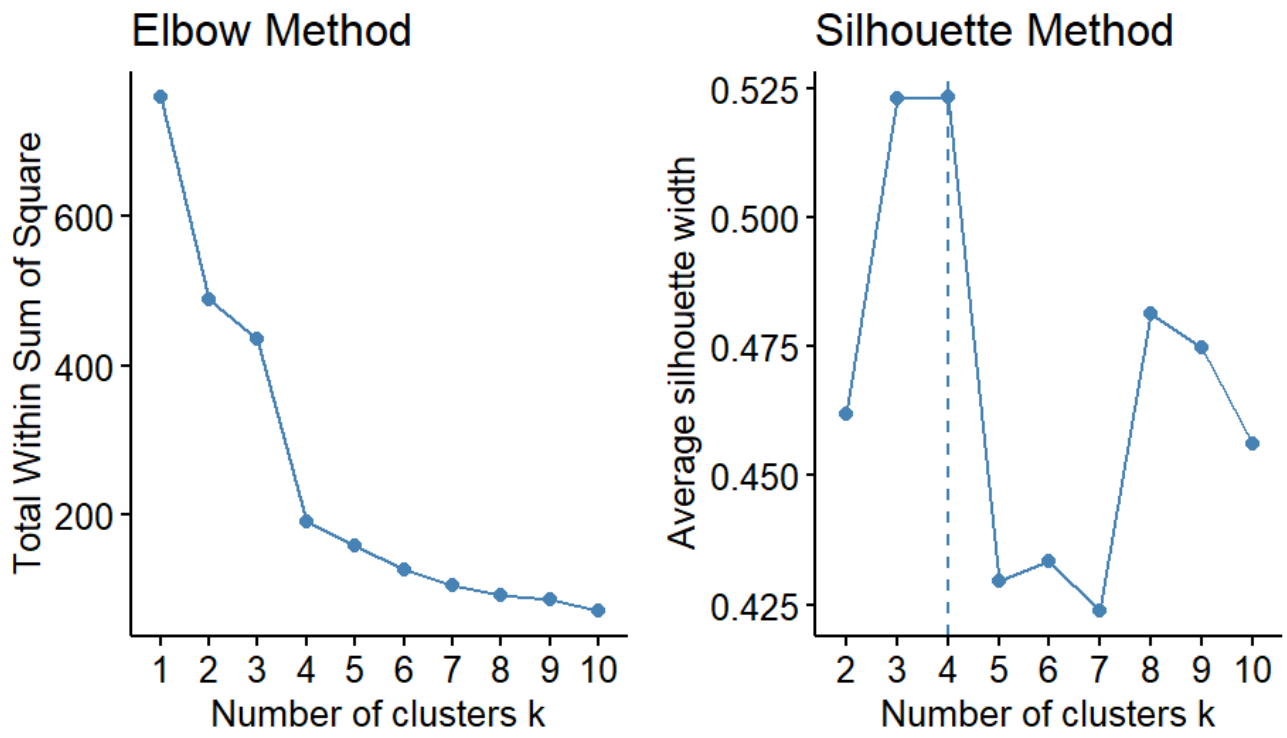
Index	One-factor	Two-factor
Likelihood ratio chi-squared test ($\chi^2_{(53)}$)	755.102	165.318
Standardized root mean squared residual (SRMR)	0.095	0.031
Coefficient of determination (CD)	0.936	0.993
Comparative fit index (CFI)	0.781	0.965
Tucker–Lewis index (TLI)	0.733	0.956
Root Mean Square Error of Approximation (RMSEA)	0.185	0.075
Akaike's information criterion (AIC)	6799.757	6211.972
Bayesian information criterion (BIC)	6941.603	6357.758

716 χ2, AIC and BIC - comparing two models, the smaller the better; CD - values closer to 1
717 indicate good fit; RMSEA and SRMR - < 0.08 adequate fit; CFI and TLI CFI > 0.90 suggests
718 good fit
719

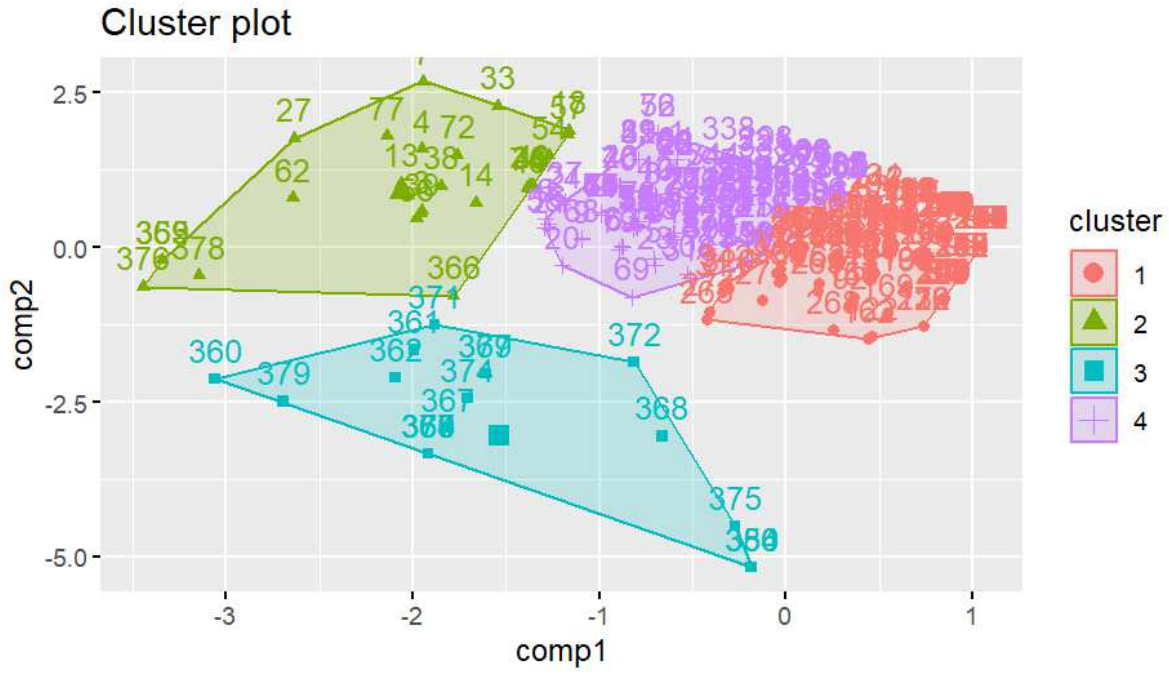
720 **Appendix VIII.** Distribution of summary statistics for across the cluster profiles

Cluster Id	Cluster profile	N	%	Mean±SD Comp1	Mean±SD Comp2
1	compensators	26	6.8	-5.40 ± 1.93	1.12 ± 1.13
2	most disadvantaged	21	5.5	-4.02 ± 2.16	-3.76 ± 1.44
3	average performers	125	32.9	-1.36 ± 1.11	0.72 ± 0.60
4	potential achievers	208	54.7	1.90 ± 0.94	-0.19 ± 0.53

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722
723
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Appendix IX. Optimal number of clusters



Appendix X. Cluster plot of participants based on two principal components. Four distinct clusters emerged: Cluster 1 (low skills, moderate achievement), Cluster 2 (low skills, low achievement), Cluster 3 (moderate achievement with weaker skills), and Cluster 4 (high skills, average achievement).