Supplementary Material

Table S1. Confirmatory factor analysis (CFA) results for the Science Motivation Questionnaire II (SMQ II).

Factor	Item	Standardized model results		
		Factor loading (λ)	*p*	R^2
Intrinsic Motivation (IM)	SMQ_IM_01	.614	< .001	.377
	SMQ_IM_03	.647	< .001	.419
	SMQ_IM_12	.759	< .001	.576
	SMQ_IM_17	.726	< .001	.527
	SMQ_IM_19	.752	< .001	.565
Career Motivation (CM)	SMQ_CM_07	.748	< .001	.560
	SMQ_CM_10	.795	< .001	.632
	SMQ_CM_13	.840	< .001	.706
	SMQ_CM_23	.747	< .001	.558
	SMQ_CM_25	.763	< .001	.582
Self-Determination (SD)	SMQ_SD_05	.642	< .001	.412
	SMQ_SD_06	.589	< .001	.347
	SMQ_SD_11	.697	< .001	.486
	SMQ_SD_16	.733	< .001	.537
	SMQ_SD_22	.774	< .001	.599
Self-Efficacy (SE)	SMQ_SE_09	.693	< .001	.480
	SMQ_SE_14	.743	< .001	.552
	SMQ_SE_15	.700	< .001	.490
	SMQ_SE_18	.704	< .001	.496
	SMQ_SE_21	.739	< .001	.546
Grade Motivation (GM)	SMQ_GM_02	.411	< .001	.169
	SMQ_GM_04	.765	< .001	.585
	SMQ_GM_08	.800	< .001	.640
	SMQ_GM_20	.784	< .001	.615
	SMQ_GM_24	.832	< .001	.692

Table S2. Confirmatory factor analysis (CFA) results for the Science-K Inventory (SK-I).

Factor	Item	Standardized model results		
		Factor loading (λ)	*p*	R^2
Experimentation				
Conclusive test	SK_I_EX_01	.321	< .001	.103
	SK_I_EX_02	.638	< .001	.408
	SK_I_EX_03	.610	< .001	.372
	SK_I_EX_04	.613	< .001	.375
Control of variable strategy	SK_I_EX_05	.543	< .001	.295
	SK_I_EX_06	.645	< .001	.416
	SK_I_EX_07	.787	< .001	.619
	SK_I_EX_08	.809	< .001	.655
	SK_I_EX_09	.713	< .001	.509
	SK_I_EX_10	.599	< .001	.359
Data interpretation				
Covariation data (perfect, non-covariation)	SK_I_DAT_01	.651	< .001	.424
	SK_I_DAT_03	.723	< .001	.523
	SK_I_DAT_08	.660	< .001	.436
	SK_I_DAT_10	.717	< .001	.514
Confounded data	SK_I_DAT_04	.762	< .001	.581
	SK_I_DAT_05	.747	< .001	.558
	SK_I_DAT_06	.480	< .001	.231
	SK_I_DAT_07	−.237	< .001	.056
Covariation data (imperfect)	SK_I_DAT_02	.680	< .001	.462
	SK_I_DAT_09	.743	< .001	.552
Understanding the nature of science (NOS)				
NOS (do)	SK_I_NOS_01	.494	< .001	.244
	SK_I_NOS_02	.621	< .001	.385
	SK_I_NOS_03	.241	< .001	.058
	SK_I_NOS_04	.914	< .001	.835
	SK_I_NOS_05	.544	< .001	.296
NOS (ask)	SK_I_NOS_06	.367	< .001	.135
	SK_I_NOS_07	.534	< .001	.285
	SK_I_NOS_08	.657	< .001	.432
	SK_I_NOS_09	.651	< .001	.424
	SK_I_NOS_10	.743	< .001	.552

Table S3. Second-order confirmatory factor analysis (CFA) results for the Science-K Inventory (SK-I).

First-order factor	Standardized model results		
	Factor loading (λ)	**SE**	***p***
Conclusive test	.528	.027	< .001
Control of variable strategy	.852	.017	< .001
Covariation data (perfect, non-covariation)	.757	.020	< .001
Confounded data	.253	.029	< .001
Covariation data (imperfect)	.085	.031	.007
NOS (do)	.826	.020	< .001
NOS (ask)	.852	.019	< .001

Table S4. Item fit statistics (infit and outfit mean-square statistic [MNSQ]) for the Science-K Inventory (SK-I).

Factor	Item	Infit	Outfit
Conclusive test	SK_I_EX_01	1.091	1.125
	SK_I_EX_02	1.024	1.025
	SK_I_EX_03	1.026	1.028
	SK_I_EX_04	1.020	1.032
Control of variable strategy	SK_I_EX_05	0.974	0.970
	SK_I_EX_06	0.937	0.919
	SK_I_EX_07	0.898	0.732
	SK_I_EX_08	0.872	0.785
	SK_I_EX_09	0.915	0.845
	SK_I_EX_10	0.945	0.882
Data interpretation			
Covariation data (perfect, non-covariation)	SK_I_DAT_01	0.946	0.904
	SK_I_DAT_03	0.936	0.920
	SK_I_DAT_08	0.941	0.902
	SK_I_DAT_10	0.936	0.910
Confounded data	SK_I_DAT_04	1.056	1.147
	SK_I_DAT_05	1.073	1.162
	SK_I_DAT_06	1.098	1.151
	SK_I_DAT_07	1.147	1.185
Covariation data (imperfect)	SK_I_DAT_02	1.143	1.200
	SK_I_DAT_09	1.136	1.195
NOS (do)	SK_I_NOS_01	0.999	0.997
	SK_I_NOS_02	0.958	0.925
	SK_I_NOS_03	1.105	1.137
	SK_I_NOS_04	0.872	0.687
	SK_I_NOS_05	0.993	0.992
NOS (ask)	SK_I_NOS_06	1.044	1.060
	SK_I_NOS_07	0.991	0.998
	SK_I_NOS_08	0.937	0.918
	SK_I_NOS_09	0.938	0.925
	SK_I_NOS_10	0.906	0.822

Note. MNSQ = mean-square fit statistic. Values between 0.5 and 1.5 were considered acceptable. The WLE reliability was 0.74.

Table S5. Standardized coefficients (β) and 95% confidence intervals from models examining the three SK-I components separately.

Path	Experimentation	Data interpretation	Nature of science
Motivation → SK-I component			
Intrinsic motivation	.120 [.009, .231]	.099 [−.019, .216]	.090 [−.014, .194]
Career motivation	−.249 [−.329, −.169]	−.173 [−.257, −.089]	−.231 [−.306, −.155]
Self-determination	−.257 [−.346, −.169]	−.204 [−.302, −.105]	−.129 [−.218, −.039]
Self-efficacy	.204 [.125, .283]	.134 [.049, .220]	.108 [.026, .189]
Grade motivation	.317 [.252, .382]	.222 [.149, .294]	.285 [.221, .350]
SK-I component → ACH	.305 [.268, .342]	.237 [.200, .274]	.308 [.273, .343]
Direct effects on ACH			
Intrinsic motivation	−.019 [−.119, .081]	−.005 [−.108, .098]	−.010 [−.110, .090]
Career motivation	−.235 [−.307, −.163]	−.270 [−.343, −.197]	−.240 [−.312, −.168]
Self-determination	.086 [.000, .171]	.055 [−.031, .142]	.047 [−.038, .131]
Self-efficacy	.468 [.394, .541]	.497 [.422, .572]	.497 [.424, .570]
Grade motivation	.038 [−.026, .102]	.082 [.017, .146]	.047 [−.017, .111]
Indirect effects on ACH			
Intrinsic motivation	.037 [.002, .071]	.023 [−.005, .051]	.028 [−.005, .060]
Career motivation	−.076 [−.102, −.050]	−.041 [−.061, −.021]	−.071 [−.095, −.047]
Self-determination	−.079 [−.107, −.050]	−.048 [−.072, −.024]	−.040 [−.067, −.012]
Self-efficacy	.062 [.038, .086]	.032 [.012, .052]	.033 [.008, .058]
Grade motivation	.097 [.073, .121]	.052 [.033, .072]	.088 [.065, .111]

Note. Values are standardized coefficients (β) with 95% confidence intervals in brackets. SK-I = Science-K Inventory; ACH = latent science and mathematics achievement. Each SK-I component was examined as a mediator in a separate structural equation model (N = 2,844).

Table S6. Standardized coefficients (β) and 95% confidence intervals from models examining science and mathematics achievement separately.

Path	Science	Mathematics
Motivation → SK-I		
Intrinsic motivation	.128 [.022, .233]	.128 [.022, .233]
Career motivation	−.283 [−.360, −.205]	−.282 [−.360, −.205]
Self-determination	−.250 [−.338, −.162]	−.250 [−.338, −.162]
Self-efficacy	.196 [.116, .275]	.195 [.115, .275]
Grade motivation	.356 [.292, .421]	.357 [.292, .421]
SK-I → Achievement	.300 [.268, .332]	.318 [.285, .351]
Direct effects on achievement		
Intrinsic motivation	.040 [−.047, .126]	−.124 [−.218, −.029]
Career motivation	−.195 [−.259, −.132]	−.086 [−.153, −.019]
Self-determination	.105 [.029, .181]	.045 [−.032, .122]
Self-efficacy	.404 [.340, .467]	.258 [.188, .329]
Grade motivation	−.051 [−.107, .004]	.068 [.009, .127]
Indirect effects on achievement		
Intrinsic motivation	.038 [.007, .070]	.041 [.007, .074]
Career motivation	−.085 [−.109, −.061]	−.090 [−.116, −.064]
Self-determination	−.075 [−.102, −.048]	−.080 [−.108, −.051]
Self-efficacy	.059 [.035, .082]	.062 [.036, .088]
Grade motivation	.107 [.083, .130]	.113 [.090, .137]

Note. Values are standardized coefficients (β) with 95% confidence intervals in brackets. SK-I = Science-K Inventory. Science and mathematics grades were examined separately as outcomes in structural equation models (N = 2,844).

Table S7. Standardized indirect effects (β) and 95% confidence intervals for the models with and without adjustment for school clustering.

Indirect effect through SK-I	Without clustering adjustment	With clustering adjustment
Intrinsic motivation	.051 [.009, .093]	.043 [.001, .086]
Career motivation	−.112 [−.144, −.081]	−.106 [−.142, −.070]
Self-determination	−.099 [−.135, −.064]	−.084 [−.117, −.050]
Self-efficacy	.078 [.046, .109]	.069 [.039, .098]
Grade motivation	.141 [.112, .171]	.133 [.100, .165]

Note. Values are standardized indirect effects (β) with 95% confidence intervals in brackets. SK-I = Science-K Inventory. The cluster-adjusted model used Mplus COMPLEX with WLSMV estimation (N = 2,844; 103 schools).