

Mixed Effects Regression

Test name: Mixed Effects Regression

Dataset: D:\DATA ANALYSIS\H Regression Tests and Models\Mixed Effects Regression\dataset.csv

Rows in original dataset: 649

Columns in original dataset: 33

Repeated grade columns used: G1, G2, G3

Long-format repeated rows used: 1947

Student clusters: 649

Model formula: $\text{grade_score} \sim \text{grade_period} + \text{studytime} + \text{failures} + \text{absences} + \text{age} + \text{Medu} + \text{Fedu} + \text{traveltime} + \text{C(school)} + \text{C(sex)} + \text{C(address)}$

Random effects: random intercept for student_id.

Estimation method selected: lbfgs

Log likelihood: -3808.5268

Residual scale variance: 1.1909

Intraclass correlation (ICC): 0.8169

Pseudo R-squared from fitted values: 0.9073

Interpretation: fixed effects estimate average grade-score changes after accounting for repeated observations within students.

Decision guide: $p < 0.05$ and a confidence interval not crossing 0 indicate stronger evidence for a fixed effect.

Mixed model guide: a larger ICC means student-level clustering accounts for a larger share of grade variation.

Charts generated: 9

Fixed effects

term	coefficient	standard_error	z_value	p_value	ci95_lower	ci95_upper	decision_alpha_0_05
Intercept	9.4579	1.4576	6.4886	0.0000	6.6010	12.3147	Statistically significant
C(school)[T.MS]	-1.2595	0.2234	-5.6384	0.0000	-1.6973	-0.8217	Statistically significant
C(sex)[T.M]	-0.5811	0.1992	-2.9166	0.0035	-0.9716	-0.1906	Statistically significant
C(address)[T.U]	0.2844	0.2279	1.2477	0.2121	-0.1623	0.7310	Not statistically significant
grade_period	0.2535	0.0303	8.3680	0.0000	0.1941	0.3128	Statistically significant
studytime	0.4639	0.1195	3.8814	0.0001	0.2297	0.6982	Statistically significant
failures	-1.5051	0.1722	-8.7377	0.0000	-1.8427	-1.1675	Statistically significant
absences	-0.0672	0.0211	-3.1768	0.0015	-0.1086	-0.0257	Statistically significant
age	0.0452	0.0826	0.5465	0.5848	-0.1168	0.2071	Not statistically significant
Medu	0.2741	0.1125	2.4374	0.0148	0.0537	0.4945	Statistically significant
Fedu	0.1579	0.1129	1.3991	0.1618	-0.0633	0.3791	Not statistically significant
travelttime	0.0086	0.1384	0.0619	0.9506	-0.2628	0.2799	Not statistically significant

Variance components

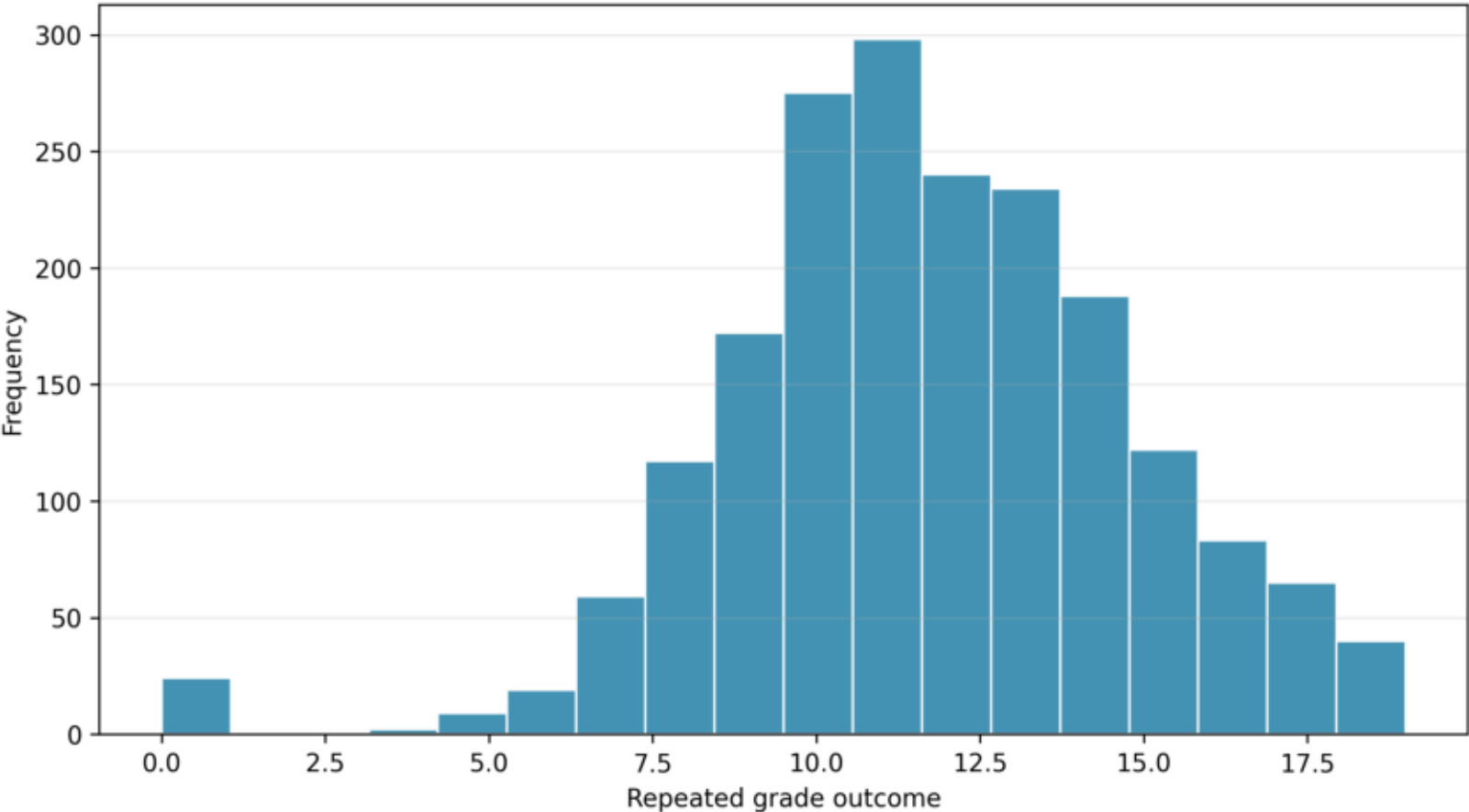
component	variance	proportion_of_total_variance
between_student_random_intercept_variance	5.3139	0.8169
within_student_residual_variance	1.1909	0.1831
total_variance	6.5048	1.0000

Fit statistics

model	estimation_method	n_long_rows	n_student_clusters	observations	log_likelihood	aic	bic	scale_residual	icc_between	pseudo_r_squared	formula	effects
Random-intercept	lbfgs	1947.0000	649.0000	3.0000	-3808.5268			1.1909	0.8169	0.9073	grade_score ~ 1	

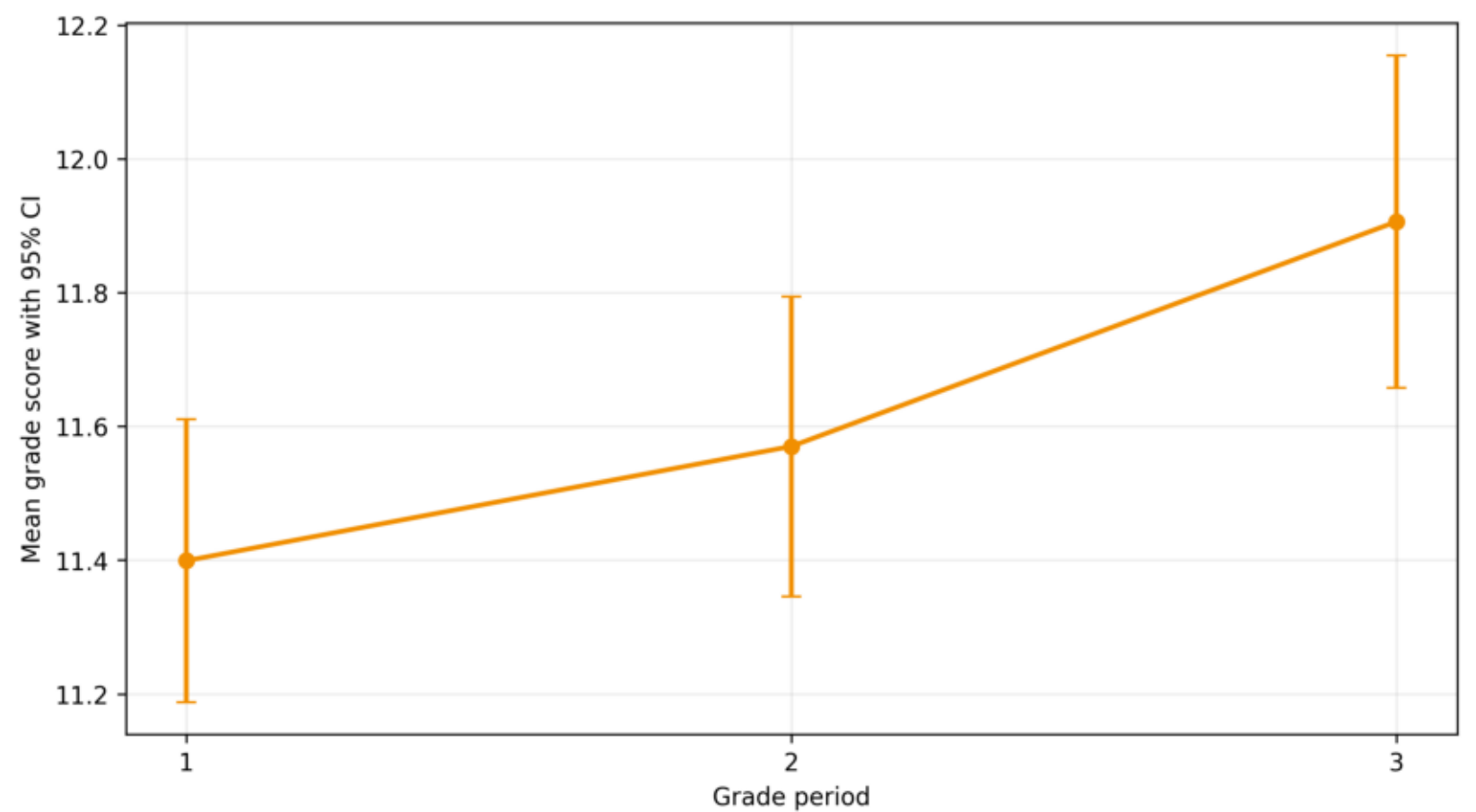
Repeated outcome distribution

Distribution of long-format grade scores used in the mixed effects model.



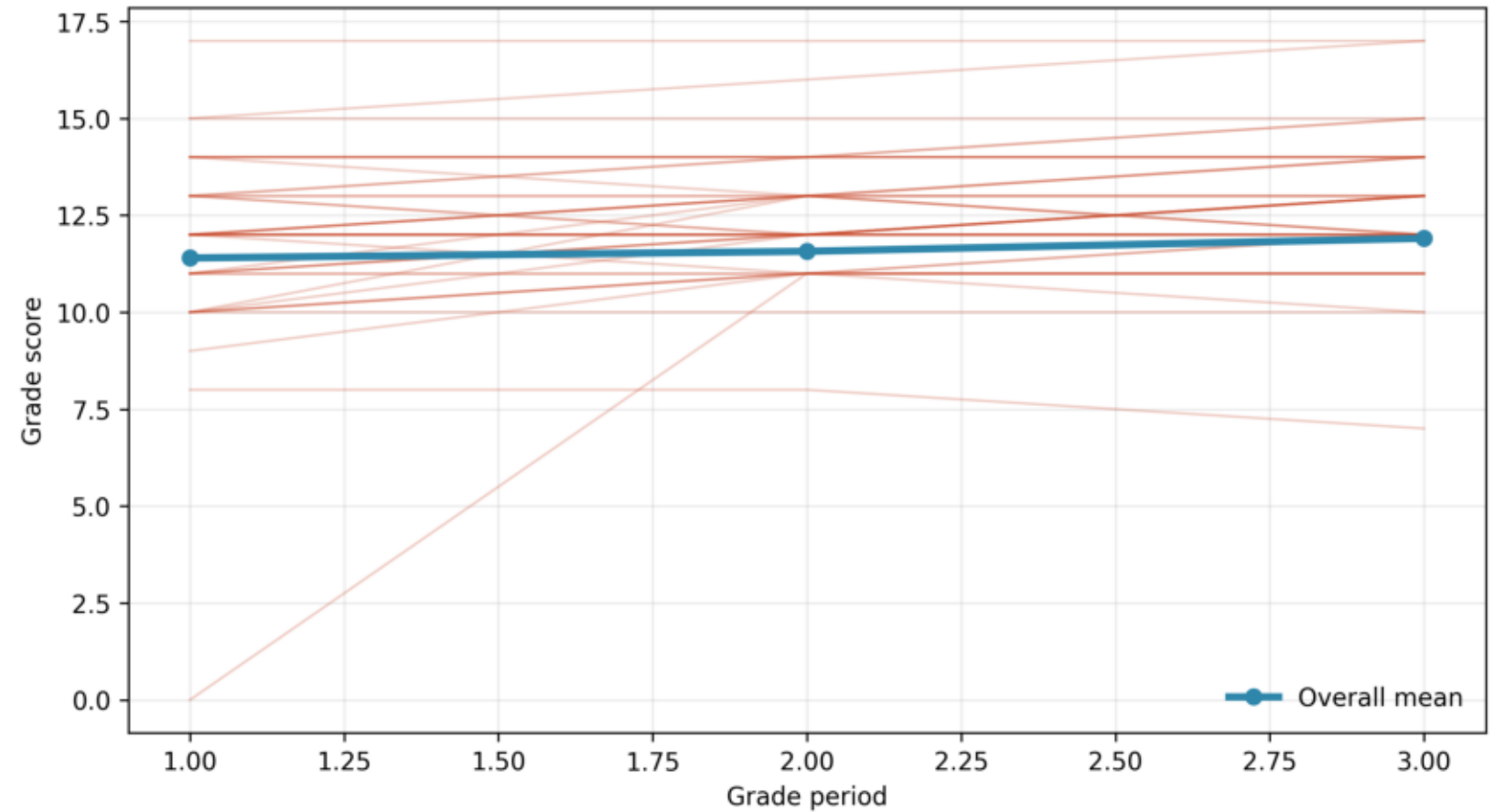
Mean grade trend across periods

The fixed period effect describes the average change across repeated grade measurements.



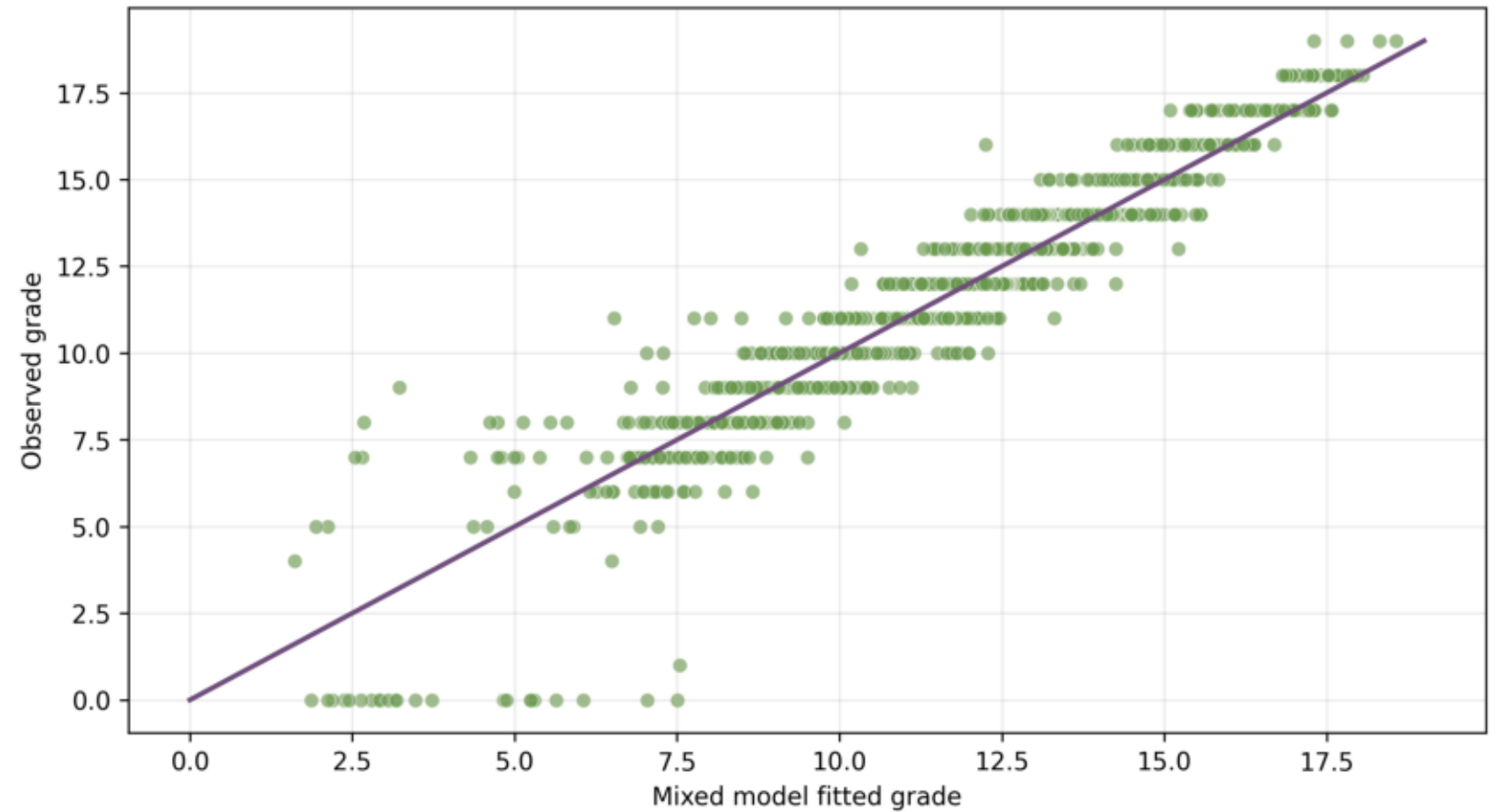
Student-level repeated profiles

Thin lines show sample student trajectories; bold line shows the overall mean profile.



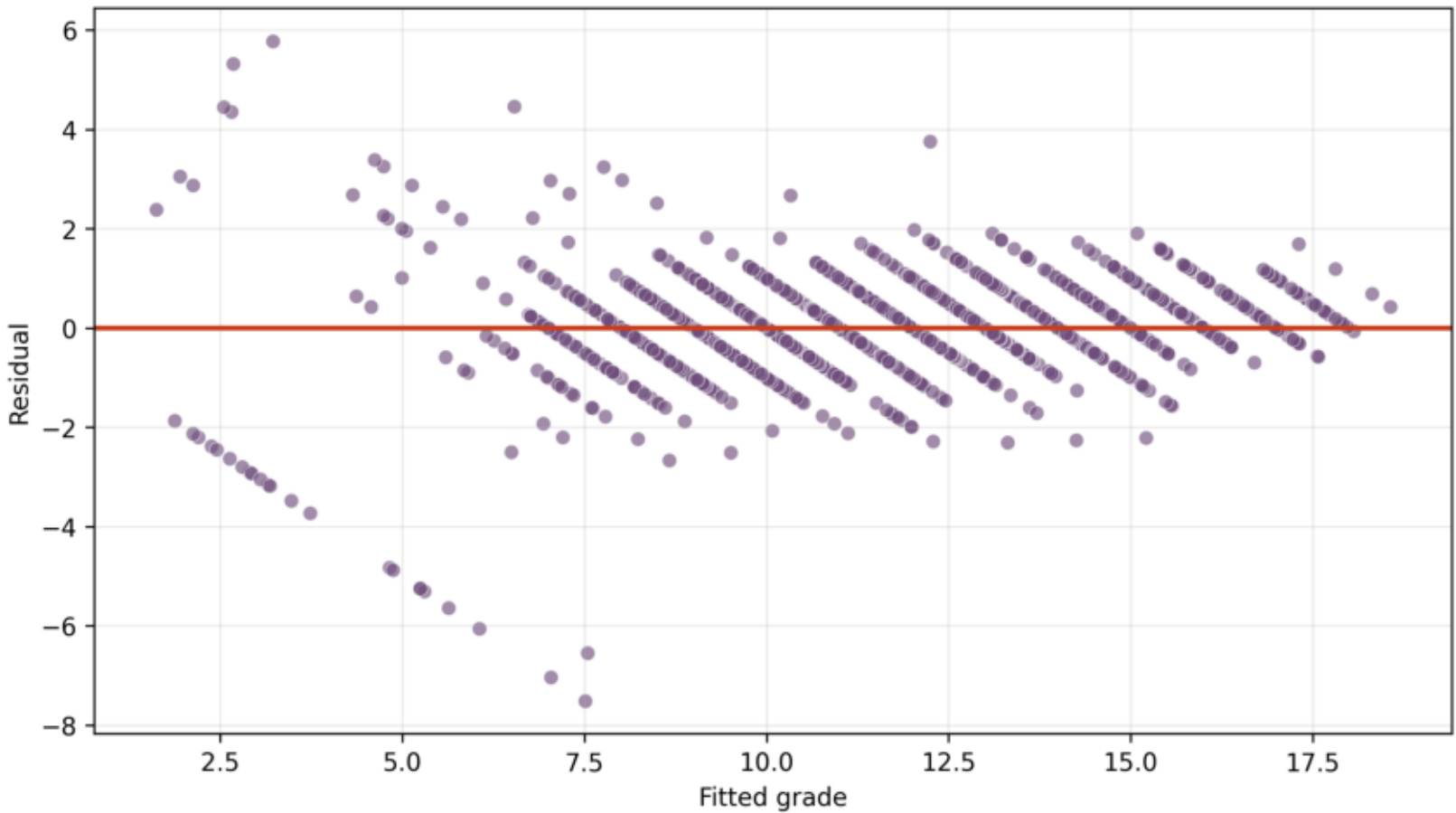
Observed vs fitted mixed-model values

Points near the diagonal indicate closer agreement between observed and fitted repeated grades.



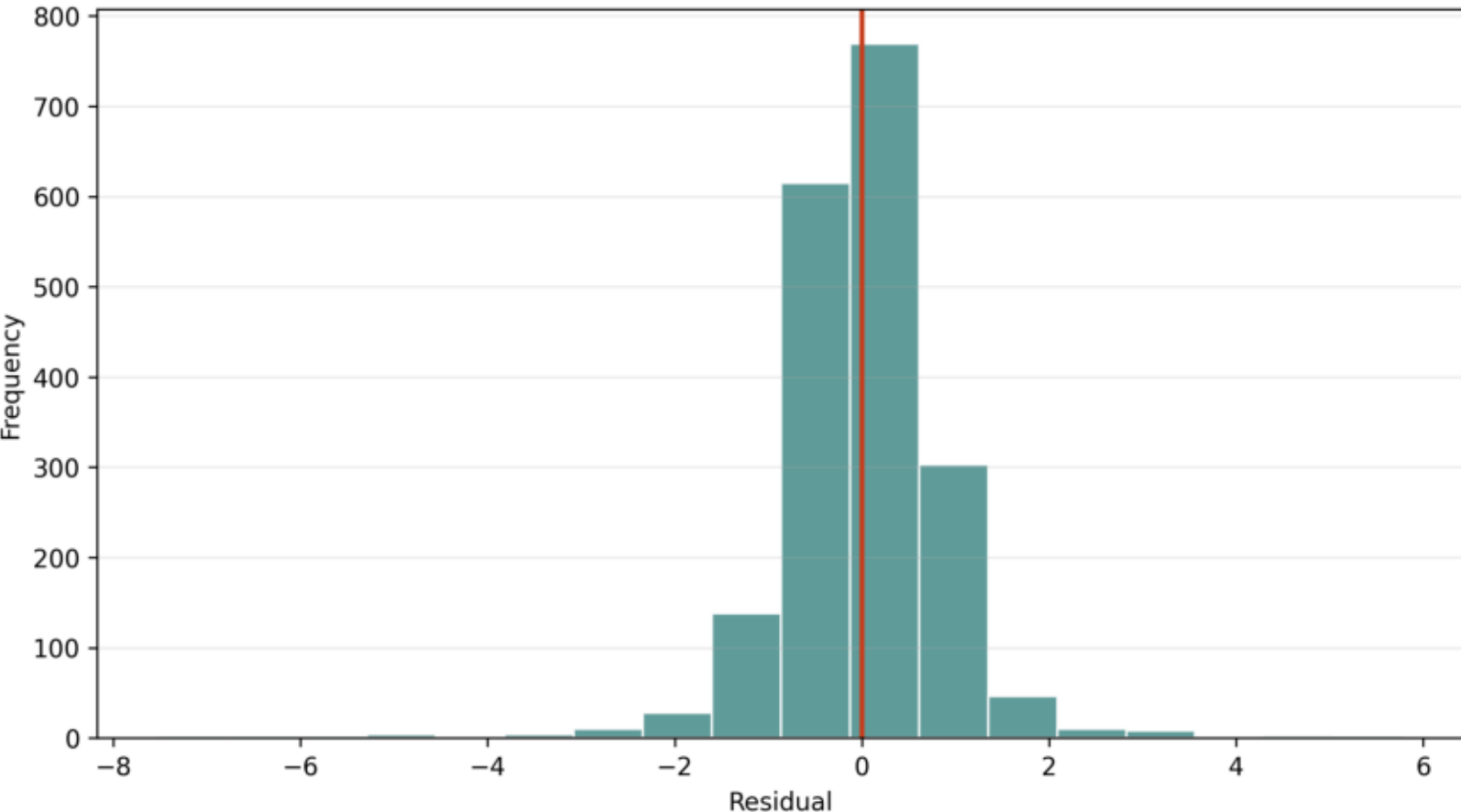
Residuals vs fitted values

A random scatter around zero supports the linear mixed effects model fit.



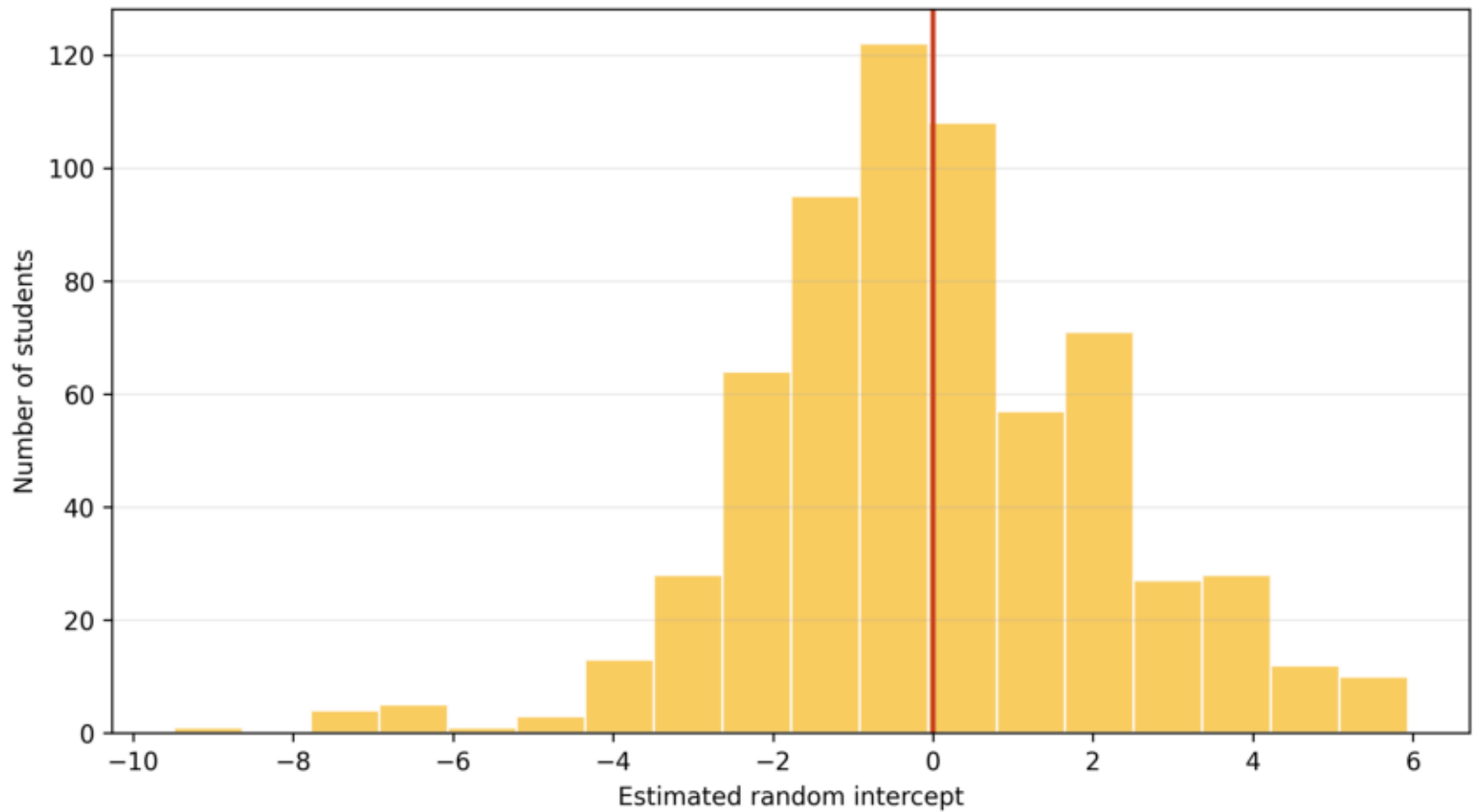
Mixed-model residual distribution

The residual distribution is used to check whether model errors are reasonably centered.



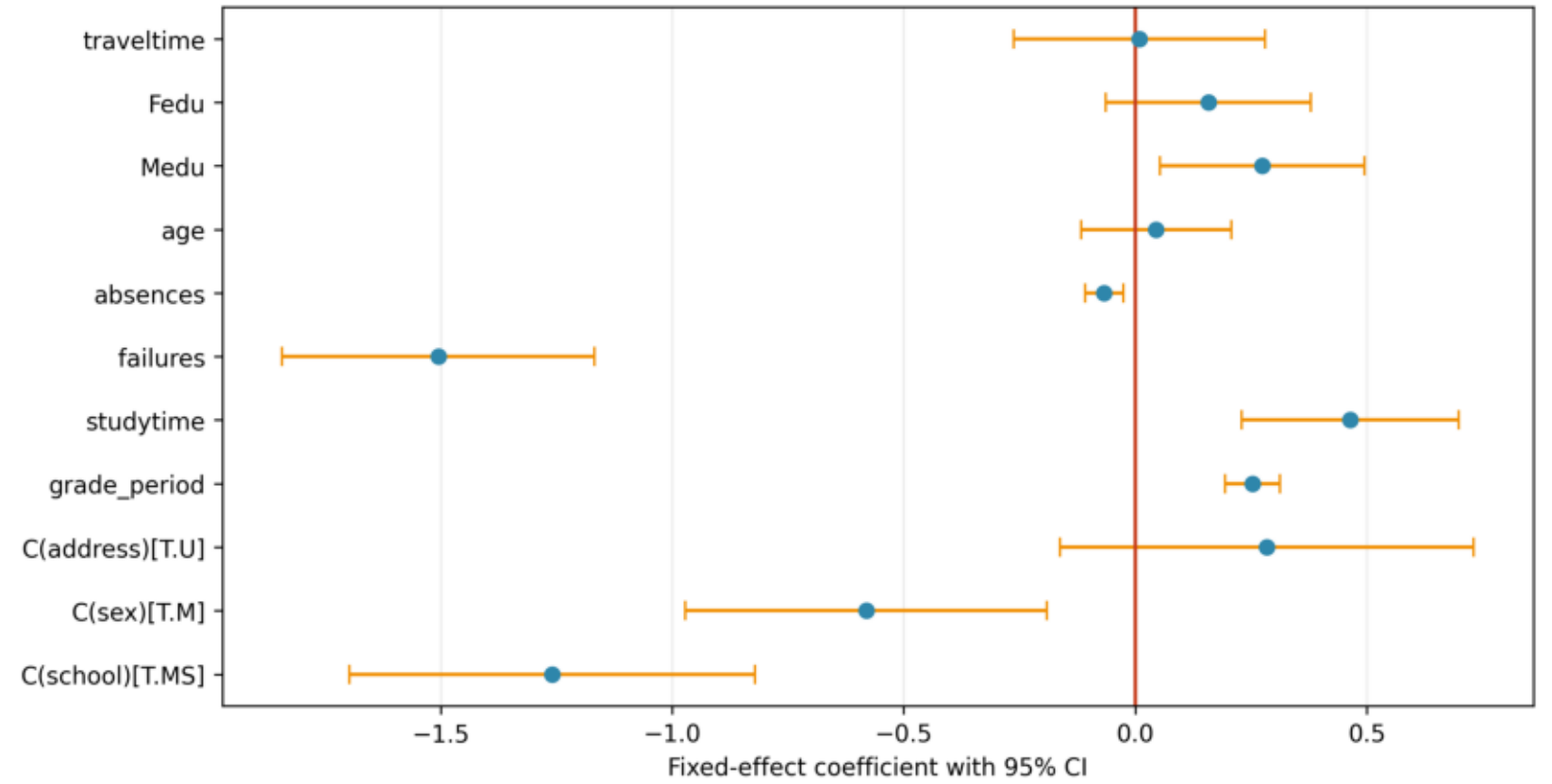
Random intercept distribution

Student-specific intercepts show between-student differences after fixed effects are included.



Fixed-effect coefficient plot

Intervals not crossing zero indicate stronger evidence for a fixed predictor effect.



Variance components

Mixed effects regression separates between-student variance from within-student residual variance.

