Growth Patterns in Subject Scores based on Customized Assessment Services (CAS) Exams and its Relationship with USMLE Step 1

SHARED DISCOVERY CURRICULUM

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Background

Shared Discovery Curriculum (SDC)

- Organized around patient chief complaints and concerns with students working independently.
- “Flipped classroom” design with small groups and a weekly large group session.
- Feedback and assessment is accomplished through progress testing.

Background

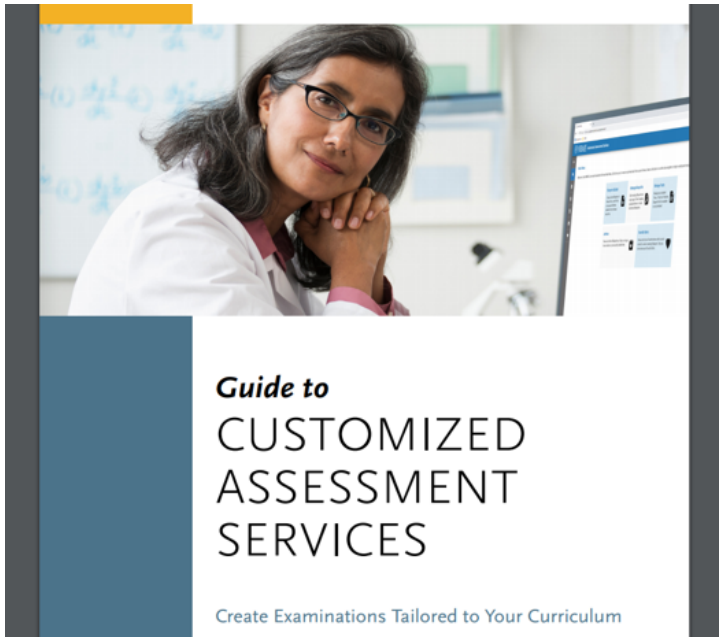
Evaluation is largely based on progress testing

- Written examinations developed by the National Board of Medical Examiner's CBSE (Comprehensive Basic Science Examination) and CAS (Customized Assessment tests) programs.

- Eight station clinical skills examination assessing AAMC Core Entrustable Professional Activities (EPAs).

Background

NBME Customized Assessment tests (CAS)



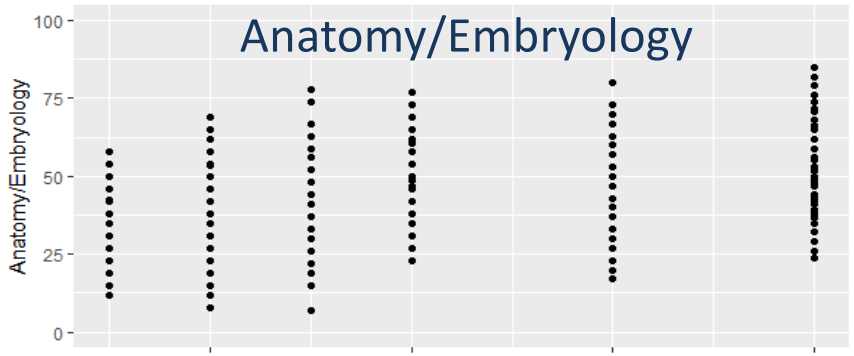
Subjects with >20 items in all CAS tests

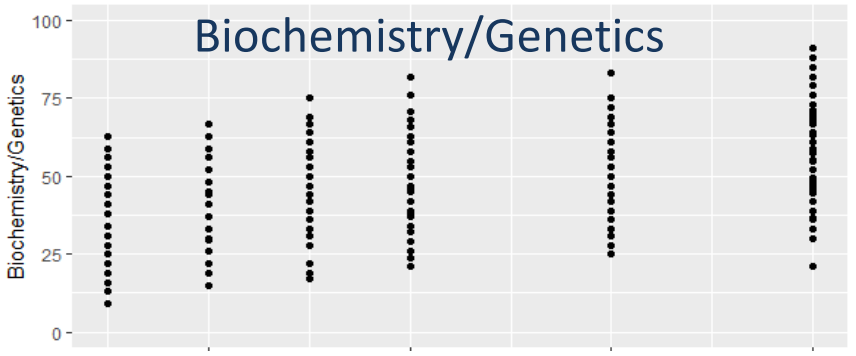
- **Anatomy/Embryology**
- **Biochemistry/Genetics**
- **Pharmacology/Toxicology**
- **Microbiology/Immunology**
- **Histology/Cell Biology/Pathology**

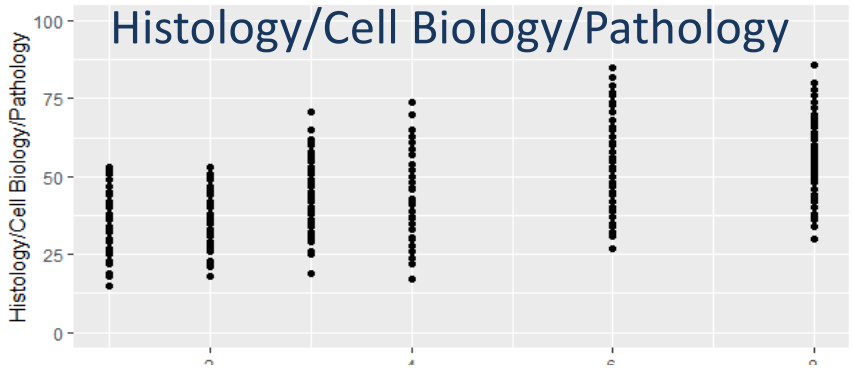
Difficulty of CAS tests for 2016 matriculants

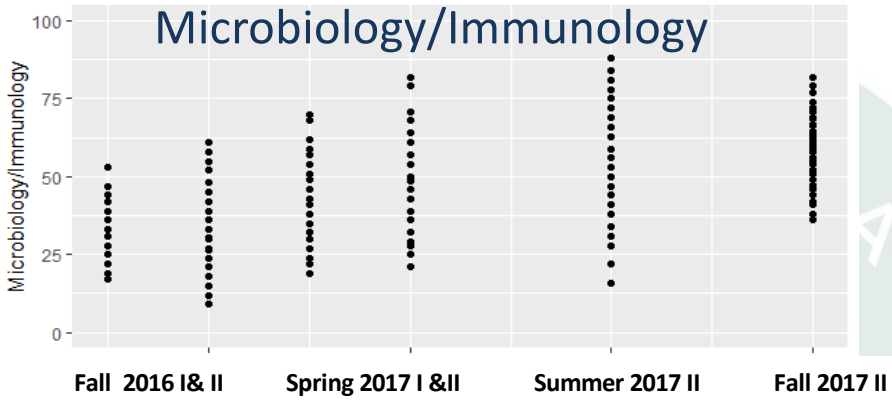
Fall I 2016	Fall II 2016	Spring I 2017	Spring II 2017	Summer II 2017	Fall II 2017
0.75	0.76	0.77	0.78	0.76	0.76

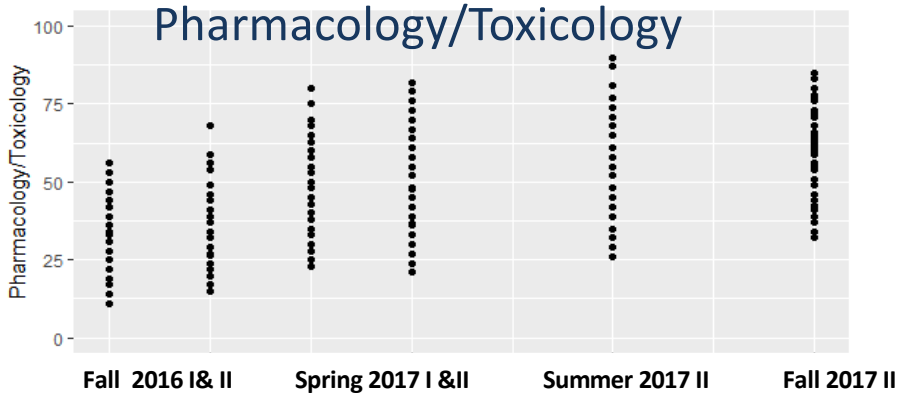
Six NBME CAS test scores in five subjects







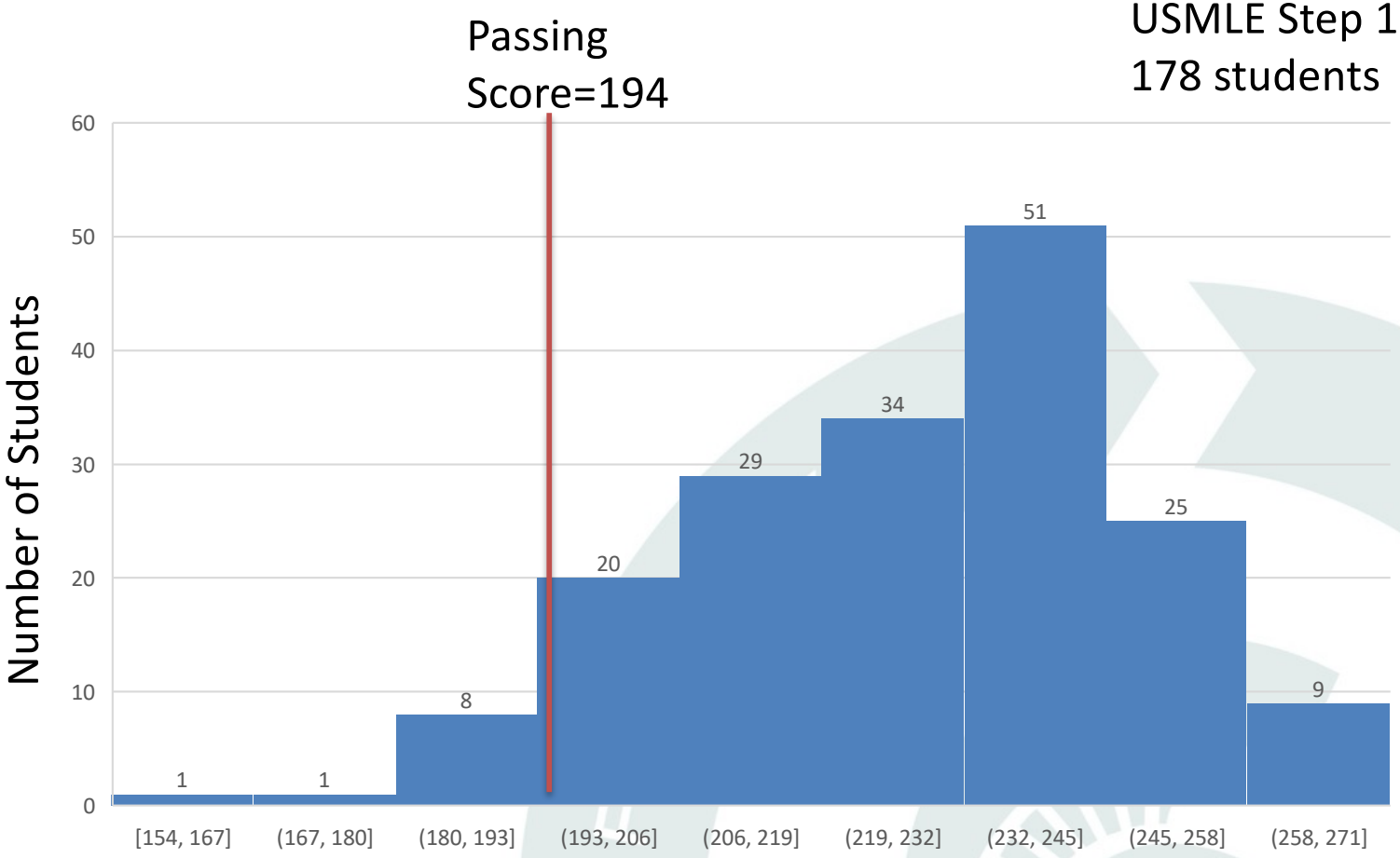




<u>178</u> students matriculated in Fall 2016

USMLE Step 1 results

Ten students failed USMLE Step 1 among 178 students



Study Purpose

In this study, we are interested in:

1. Examine the students' latent growth patterns in five foundation subjects using The National Board of Medical Examiners (NBME) Customized Assessment Services (CAS) tests.

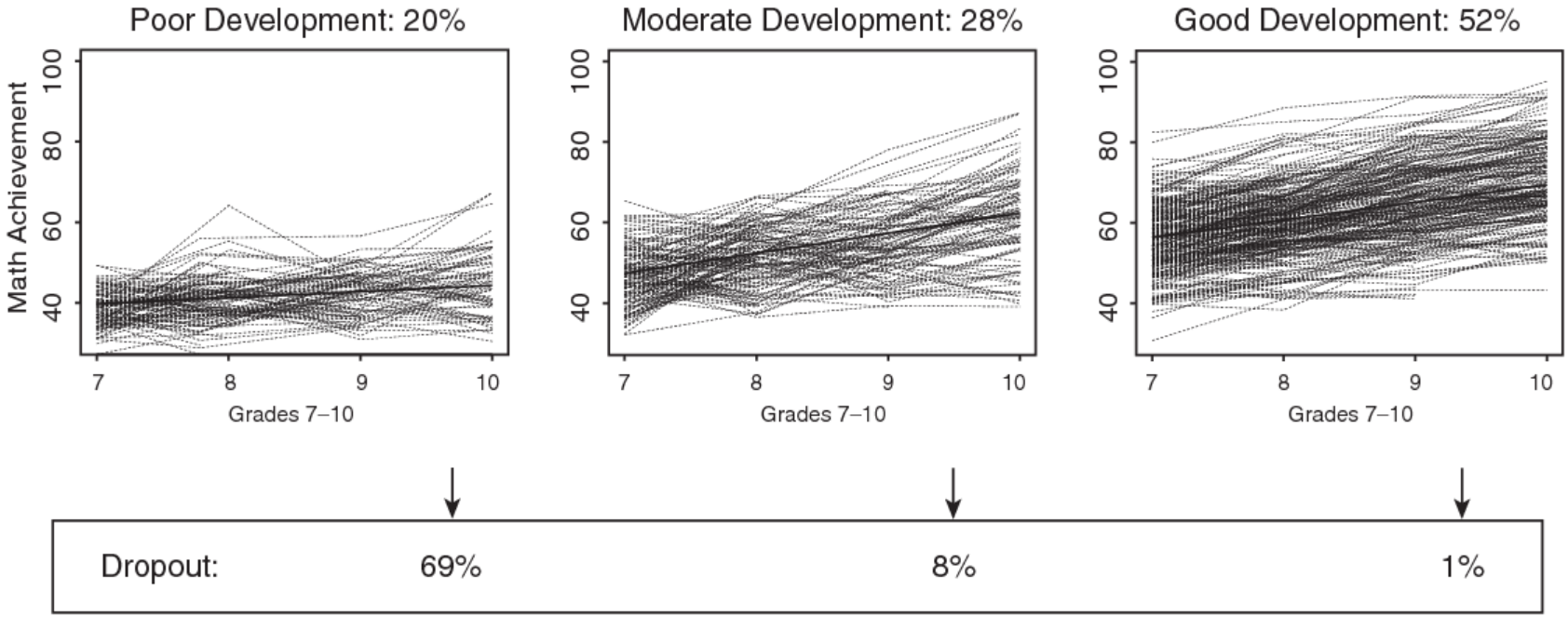
2. Identify the association between growth patterns with United States Medical Licensing Examination (USMLE) Step 1 results at the end of second year medical school.

Sample in this study included 178 students matriculated in Fall 2016 with USMLE Step 1 results (first-time try) in summer 2018.

Analysis Methods

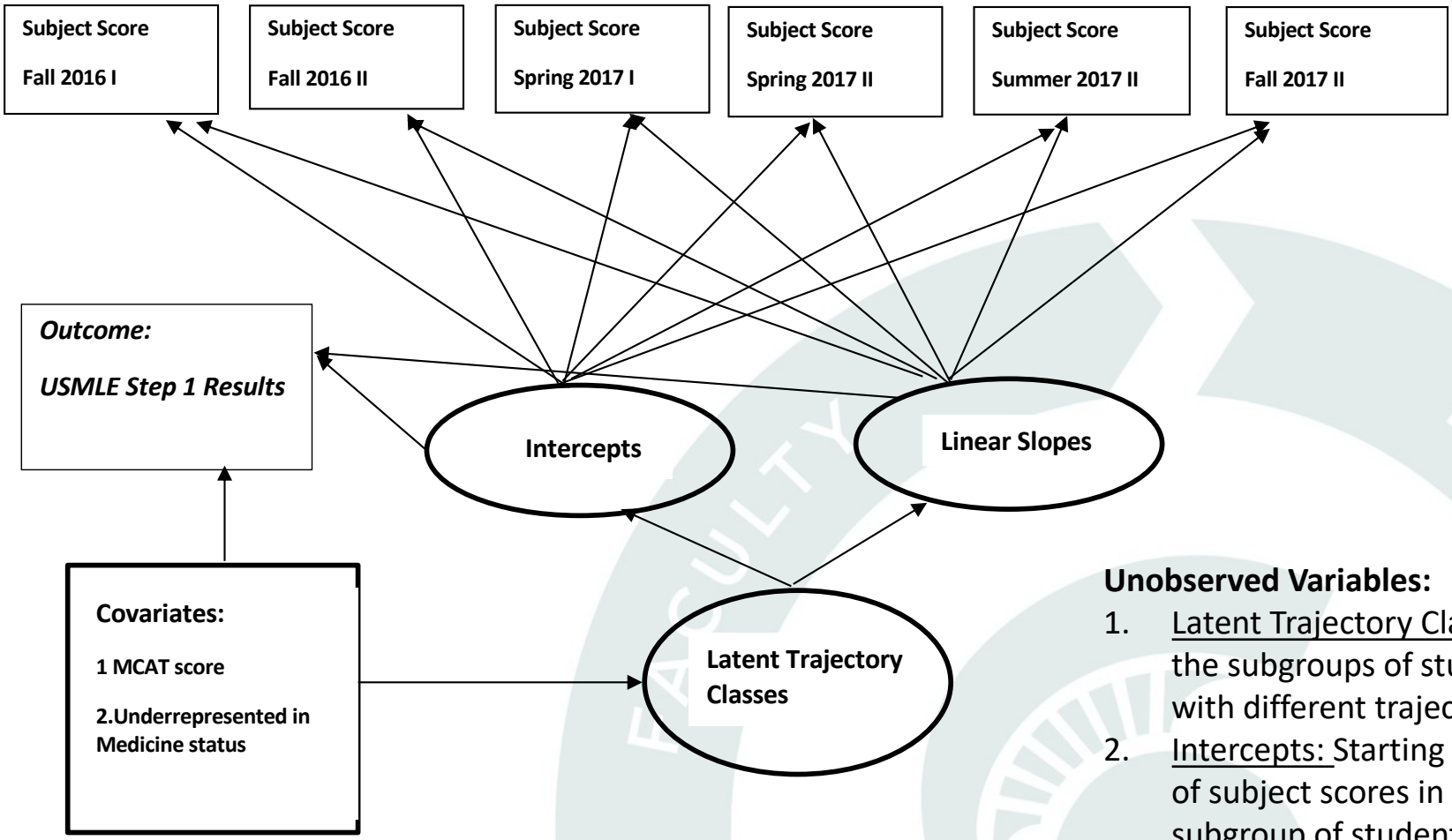
- Growth Mixture Modeling (GMM) is used to examine whether different trajectories of subject scores could explain the variance in USMLE Step 1 results.
- GMM is a hierarchical modeling technique that allows for the identification of empirically defined **subgroups** in large longitudinal datasets while testing for the associated effects of a selection of variables at multiple levels within the model.
- GMM can be implemented in R, SAS or Mplus. Sample size >=200 is preferred to obtain stable estimates.
- One application example: B. O. Muthén (2004)

GMM application (Muthén 2004)



- Three latent classes were identified: Poor Development; Moderate Development and Good Development for math achievement from Grate 7-10.
- Students in the group of poor development in math achievement had higher drop out rate of high school (69%) by Grade 12.

Diagram of the Growth Mixture Model



Unobserved Variables:

1. Latent Trajectory Classes: the subgroups of students with different trajectories.
2. Intercepts: Starting points of subject scores in each subgroup of students.
3. Linear Slopes: Growth rate of subject scores in each subgroup of students.

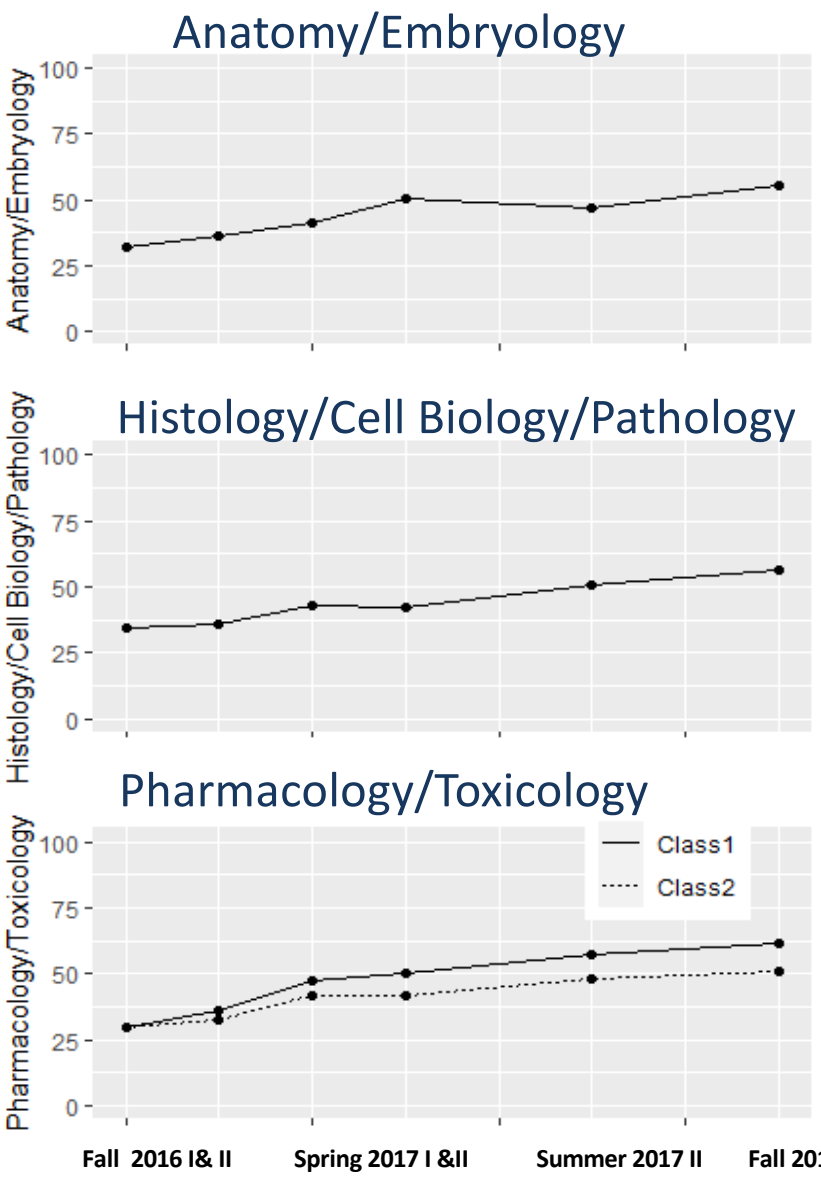
GMM fit statistics for each subject

Subjects	Model	No. of Parameters	Log-likelihood	BIC[b]	LMR[c] P-value	Entropy	BLRT[d] P-value
Anatomy /Embryology	**One class**	**20**	**-4691**	**9487**	**---**	**---**	**---**
	Two classes	28	-4673	9491	0.290	0.605	0.300
	Three Classes	36	-4661	9508	0.464	0.710	0.470
	Four Classes	44	-4651	9529	0.332	0.678	0.340
Biochemistry /Genetics	One class	20	-4654	9412	---	---	---
	Two classes	**28**	**-4633**	**9410**	**0.052**	**0.673**	**0.056**
	Three Classes	36	-4614	9415	0.526	0.691	0.519
	Four Classes	44	-4654	9536	0.565		0.572
Histology /Cell Biology /Pathology	One class	20	-4406	8917	---	---	---
	Two classes	**28**	**-4379**	**8903**	**0.010**	**0.696**	**0.011**
	Three Classes	36	-4365	8917	0.150	0.738	0.142
	Four Classes[a]	---	---	---	---	---	---
Microbiology /Immunology	**One class**	**20**	**-4624**	**9323**	**---**	**---**	**---**
	Two classes	28	-4598	9340	0.150	0.703	0.157
	Three Classes	36	-4585	9357	0.337	0.789	0.331
	Four Classes	44	-4575	9379	0.124	0.783	0.130
Pharmacology /Toxicology	One class	20	-4579	9261	---	---	---
	Two classes	**28**	**-4553**	**9252**	**0.001**	**0.657**	**0.001**
	Three Classes	36	-4537	9261	0.009	0.716	0.068
	Four Classes	44	-4515	9243	0.450	0.781	0.440

[a] Model didn't converge with stable estimates.
[b] BIC indicates Bayesian Information Criterion.
[c] LMR indicates Lo-Mendell-Rubin Likelihood Ratio test or ad-hoc adjusted likelihood ratio test.
[d] BLRT indicates Bootstrap Likelihood Ratio Test.

Smaller BIC, higher Entropy or LMR P-value<0.05 or BLRT P-value<0.05 indicate a <u>better fitting model</u>

Growth Trajectories by latent classes



Association of latent growth parameters with Step 1

SUBJECTS	CLASSES	INTERCEPT (S.E.)	SLOPE (S.E.)	COEFFICIENT OF STEP1 ON INTERCEPT (S.E.)[a]	COEFFICIENT OF STEP1 ON SLOPE (S.E.)[a]
ANATOMY /EMBRYOLOGY	------	32.19 (0.73)	4.38 (0.83)	**0.85 (0.26)**	**8.41(2.09)**
BIOCHEMISTRY /GENETICS	Class 1	35.34 (1.30)	7.91 (1.27)	0.88 (1.21)	19.46 (14.22)
	Class 2	35.13 (1.07)	3.70 (0.70)	1.33 (2.57)	31.66 (27.76)
HISTOLOGY /CELL BIOLOGY /PATHOLOGY	------	34.21 (0.54)	1.55 (0.54)	**1.30 (0.29)**	**19.61 (7.10)**
MICROBIOLOGY /IMMUNOLOGY	Class 1	31.67 (0.80)	4.72 (0.80)	**1.13 (0.21))**	**20.19 (9.23)**
	Class 2	29.95 (0.97)	2.23 (0.58)	-0.66 (1.47)	29.19 (17.74)
PHARMACOLOGY /TOXICOLOGY	Class 1	29.58 (0.82)	6.43 (0.83)	0.66 (1.28)	**5.37 (1.01)**
	Class 2	28.14 (8.13)	3.14 (1.01)	1.41 (2.48)	1.44 (1.62)

[a] **Bolded and underlined estimates are significantly different from zero at α=0.05 level.**

Summary

- Students had **homogeneous growth** patterns in some subjects (Anatomy/Embryology and Histology/Cell Biology/Pathology), while in other subjects (Biochemistry/Genetics, Microbiology/Immunology and Pharmacology/Toxicology), students showed **heterogeneous growth patterns** with different starting points and slopes.

- In Microbiology/Immunology and Pharmacology/Toxicology, higher growth rates in better performance group associated with better Step 1 performance. This indicates that comparing with other three subjects, if students excel in these two subjects their Step 1 results tends to be significantly better.

Limitations

- There may be fluctuations in the difficulty of the different CAS tests used in the study even though we tried to control the difficulty through the selection of items.

- The Students' performances in each subject can be highly correlated which were ignored in this study now.

- This study focused only on one medical school and one student cohort within this medical school.

Acknowledgement

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Questions?

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