Our Recommendations for

CourseKata

to Increase Engagement and Prevent Academic Dishonesty

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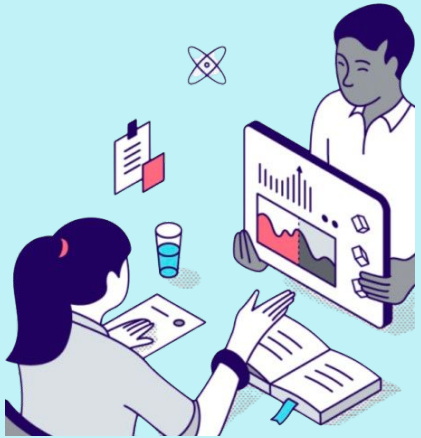
(GraphOutLoud, SMU DataFest 2024)

About CourseKata

CourseKata is an online statistics and data science textbook with interactive questions and real-world datasets. It tracks student activity to support research on learning.

About the Data

We analyzed anonymized data on question type, chapter, engagement time, and student interest ratings in three textbooks to explore patterns in learning and participation.



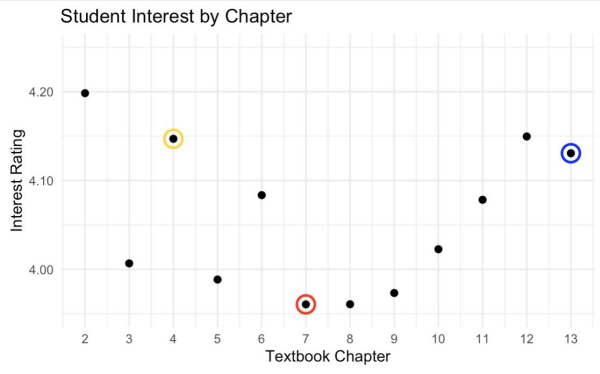
Our Methodology and Focus

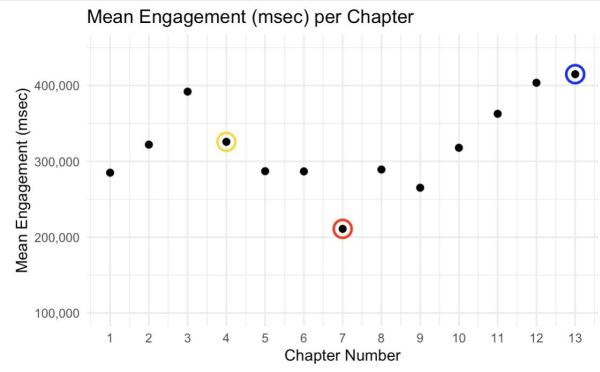
1. Optimize Question Type Selection to Boost Student Interest, Engagement, and Performance
2. Targeted Revision of Underperforming Chapters
3. Detect Academic Dishonesty Using Feature Engineering & RandomForest Modeling

Note: The six datasets contain 250 unique students across 3 online textbooks, appearing in ~246,000 activity logs (responses, page views, media, checkpoints)

Identifying Question Types to Improve Student Interest, Engagement, and Performance

Selected Textbook: College / Statistics and Data Science (ABC)





Top 3 Chapters with Highest Proportion of MCQ

Chapter	Question_Type	Proportion of Questions
1	mcq	0.942
10	mcq	0.914
13	mcq	0.883

Top 3 Chapters with Highest Proportion of Plaintext

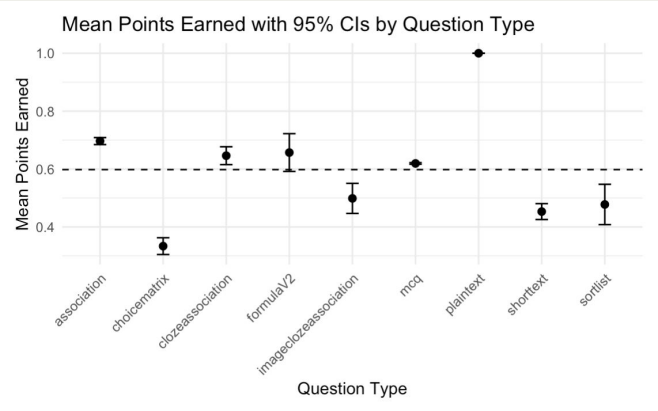
Chapter	Question_Type	Proportion of Questions
5	plaintext	0.266
4	plaintext	0.252
3	plaintext	0.230

Key Findings:

- Chapter 13 – High interest/engagement; high proportion of MCQs.
- Chapter 7 – Lowest interest/engagement; few MCQ and Plaintext.
- Chapter 4 – Moderate interest/engagement; relatively high proportion of Plaintext.

Recommendation:

- Increase the proportion of **MCQ** and **Plaintext** questions in low-interest, low-engagement chapters like Chapter 7.



Type_of_Question	Better_Question_Type	p_value
choicematrix	plaintext	1.35e-245
imageclozeassociation	plaintext	4.70e-56
shorttext	plaintext	6.53e-220
sortlist	plaintext	6.27e-34
choicematrix	mcq	4.92e-71
imageclozeassociation	mcq	6.90e-06
shorttext	mcq	9.66e-31
sortlist	mcq	8.54e-05

Shifting Focus to Performance

Key Findings:

- Students scored lower on choicematrix, shorttext, sortlist, and imageclozeassociation vs. MCQ and plaintext.
- MCQ and plaintext consistently ranked high for interest, engagement, and performance.
- Statistical testing (Welch Two Sample t-tests) confirmed these differences to be statistically significant ($p < 0.001$).

Recommendation:

- Reduce low-performing question types (choicematrix, imageclozeassociation, shorttext, sortlist) or add instructional support (guidance, explanations).

Targeted Revision of Underperforming Chapters

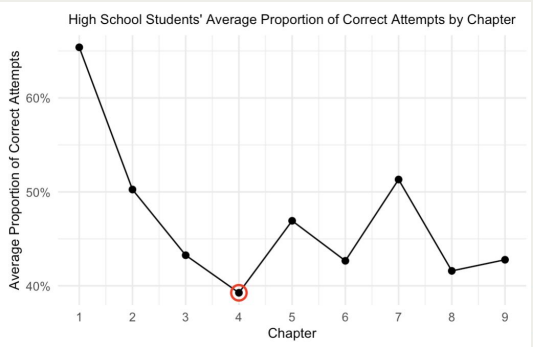
Selected Textbook: High School / Advanced Statistics and Data Science I (ABC)

Focus on Chapter 4 of the High School Textbook:

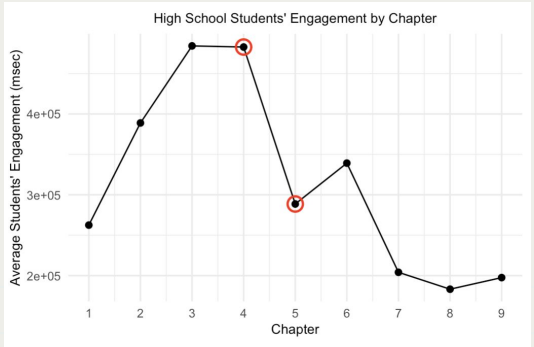
- Why? Lowest proportion of correct responses across all chapters/textbooks.
- Indicates higher difficulty for students, despite high engagement.

Observations:

- Chapter 5 → Huge engagement drop off by ~40%.
- Indicates that the difficulty of Chapter 4 may limit progress and momentum into Chapter 5.
- Identifies Chapter 4 as a prime target for content revision and added support.



Chapter	Average Proportion of Correct Attempts
1	0.654
2	0.503
3	0.433
4	**0.393**
5	0.469
6	0.427
7	0.513
8	0.416

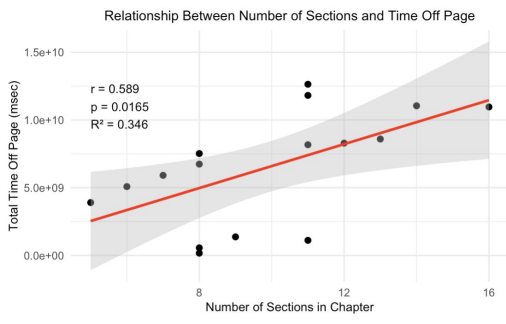


Chapter	Average Students' Engagement (msec)
1	262,518
2	388,904
3	484,214
4	**482,795**
5	**288,643**
6	339,191
7	204,154
8	183,229

High Time Off-Page in Ch. 4

Chapter	Section Count	Total Time Off-Page (msec)
1	5	3,899,528,624
2	11	11,814,752,157
3	11	12,638,270,887
4	**16**	**10,959,407,984**
5	**12**	**8,287,262,099**
6	14	11,046,648,173
7	11	8,170,126,679
8	8	6,739,870,771

Fewer sections from Ch. 4 to 5 and 24% decrease in Time Off-Page



Recommendation:

- Reduce the number of sections per chapter (shorten chapters) to minimize time spent off-page and improve engagement.

Higher Question Diversity in Ch. 4

Chapter 4

Question_Type	Count
mcq	373
plaintext	209
shorttext	23
choicematrix	22
clozeassociation	18
association	9
imageclozeassociation	6

Chapter 5

Question_Type	Count
mcq	110
plaintext	99
association	24
shorttext	18
choicematrix	4

Recommendation:

- Simplify and reduce the types of questions in each chapter (choicematrix and imageclozeassociation correlated with low student performance).

Detect Academic Dishonesty Using Feature Engineering & RandomForest Modeling

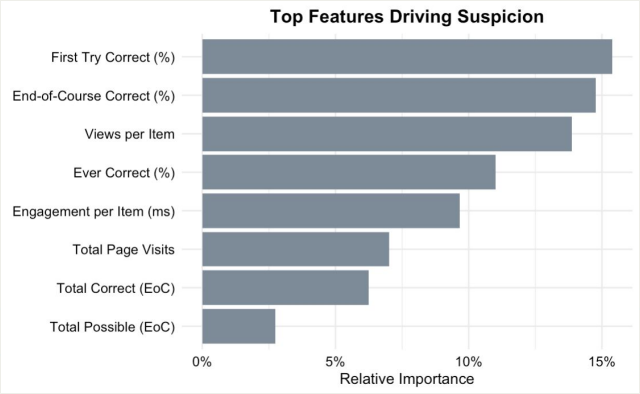
Selected Textbooks: All (College ABC, College ABCD, High School ABC)

Approach:

- Engineered ~20 predictors/signals per student (accuracy, attempts, views/question, time engaged per question, idle time ratio, % night/weekend, burstiness, and more).
- Trained a Random Forest model
  - Created a proxy suspicion score based on extreme behavior like oddly high accuracy and low engagement (top 10% most suspicions were '1', others '0').
  - Model learned to distinguish these patterns.
    - For each student, it outputs a probability of how much they resemble the suspicious group.

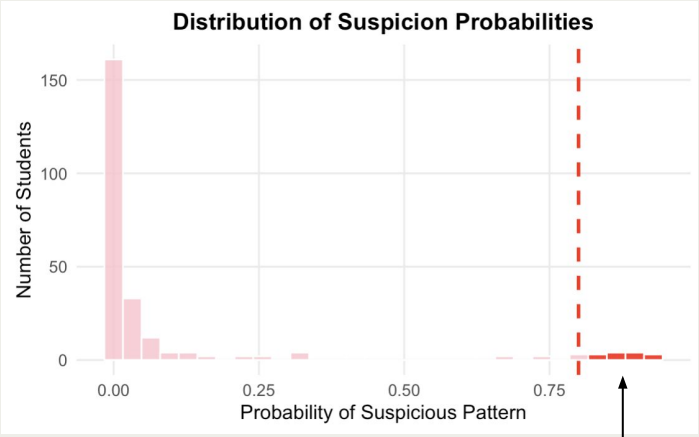
Important Note:

- Flagged students are for human review to save effort, not to be accused/punished.
- Model is not evidence of cheating → Just a triage list of students with suspicious patterns.



Distribution of Model Outputs:

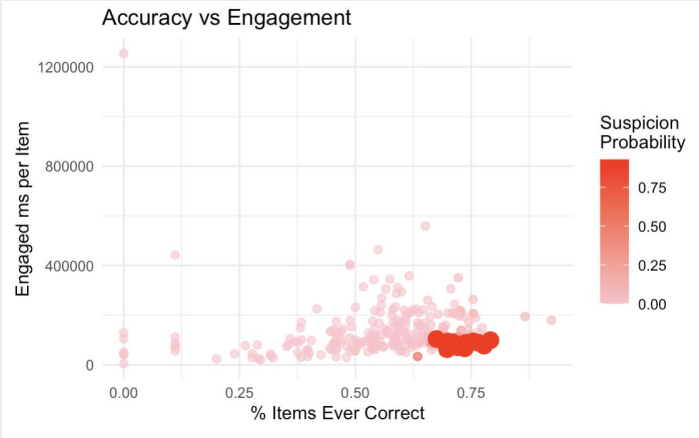
- Most students cluster near 0 with little suspicious activity.
- Small tail extends above 0.80, which is our selected (more conservative to reduce false positives) threshold for true suspicion.
    - Worth reviewing these students.



5.6% of students were flagged

A Closer Look at Flagged Students:

- Students with high % correct and very low engagement time get flagged by the model.
- Aligns with intuition!
    - Not normal to put such little effort in (might be getting external help).
- Consistent with feature importance chart



Flagged Students List:

- Shows the students with high suspicion probabilities (over 80%). 10 shown here.
- Includes important features for those reviewing the students.

Student ID	Suspicion Prob.	% 1st-Try	% Ever	Views/Item	Engaged ms/Item	Mean Attempts
a21ac54a-e190-486c-b805-c83b8…	92.9%	86%	76%	0.310	89616	1.06
ad3c8d11-b356-4b49-b6d1-1f932…	92.4%	82%	74%	0.236	89040	1.12
646acd2f-5a8b-4629-b753-faff3…	91.4%	79%	70%	0.294	79442	1.04
78ccab12-8733-4772-a2e0-17c7e…	91.2%	79%	70%	0.262	63286	1.08
1acec420-e195-4556-b6c8-a4245…	90.6%	77%	70%	0.301	84433	1.06
df3d5806-6ccb-4711-96e0-eb91f…	89.2%	79%	74%	0.265	66913	1.16
32a0c3c0-41bf-4fcd-8668-3071b…	88.2%	80%	72%	0.273	78853	1.11
2e7968fe-6970-4a4e-b800-0d38c…	87.5%	87%	78%	0.185	77530	1.06
11e431e6-8a15-491b-9185-13492…	87.2%	80%	70%	0.268	93869	1.03
8f3faf8d-8c56-4587-81c4-d6eb2…	87.1%	87%	75%	0.302	94662	1.09

CourseKata can…

- Use this as a review queue.
  - Advisors/instructors can dig into timestamps, attempts, and patterns.
  - Provides a starting point for outreach and academic support.
- Adjust the flagging threshold.
  - Tune up or down from the 80% benchmark depending on instructor needs.
- Learn general/aggregate insights.
  - Discover overall class patterns and decide if interventions are needed on an individual or class-wide basis.