Random-Sampled Exams for Better Learning

Kaili Vesik & Kathleen Currie Hall
University of British Columbia

June 4 - CLA Conference 2021

Roadmap

1) Who we are
2) Our goals
3) Architecture of the system
4) Details and examples
5) Results
6) Discussion and conclusions

Who we are

Kaili Vesik

- PhD student & Teaching Assistant, UBC Linguistics
- Trained teacher (BEd, MMT) with experience teaching secondary mathematics
- Software development background

Kathleen Currie Hall

- Associate professor, UBC Linguistics
- Some training in linguistic pedagogy as a graduate student at Ohio State, but otherwise self-taught

Science of successful learning

Brown, Roediger, and McDaniel (2014)

- Effortful retrieval practice
- Interleaving of concepts
- Elaboration in own words
- Connection to prior knowledge

Goals

1) Improve student learning in line with the above principles
2) Conduct exams in virtual interface

Basic architecture

- exams consist of 2-6 short questions, randomized for each student
- exams are open-note, open-book
- exams are timed and can be either oral or written
- questions are based on the material available to students in class (quizzes, handouts, homework)
- sample questions are posted every class day
- questions focus on *explanations* of concepts

Why does it work?

- Effortful practice
  - the exam questions themselves require student practice (including practicing material we don't discuss in class -- e.g., extra questions on handouts)
- Interleaving of concepts
  - exam questions available throughout, so students are naturally going back to previous topics
  - encourages students to specifically re-examine assignments once they've been graded
- Elaboration in own words
  - exam questions require students to *explain* concepts
- Connection to prior knowledge
  - student explanations will be better if they link concepts from one to the other

Post-class email

Sample Exam Questions:

- [I give you a word from Question 11 of Quiz 3.] Does the morpheme 'eye' occur in this word? Why or why not?
- [I give you one of the items in Question 2(iii) of the Week 4 handout, Part II.] Explain how you would figure out the meaning of this word in Swahili.
- [I give you one of the items in Question 2(iv) of the Week 4 handout, Part II.] Explain how you would figure out how to say this phrase in Swahili.
- [I give you a morpheme that occurs in Question 3 of the Week 4 handout, Part II.] Explain how you would figure out the form of this morpheme in Luiseño.
- [Based on Question 4 of the Week 4 handout, Part II.] Explain how you could do morphological analysis on a signed language.

Post-class email

Sample Exam Questions:

- [I give you a word from Question 11 of Quiz 3.] Does the morpheme 'eye' occur in this word? Why or why not?

- [I give you one of the items in Question 2(iii) of the Week 4 handout, Part II.] Explain how you would figure out the meaning of this word in Swahili.

- [I give you one of the items in Question 2(iv) of the Week 4 handout, Part II.] Explain how you would figure out how to say this phrase in Swahili.

- [I give you a morpheme that occurs in Question 3 of the Week 4 handout, Part II.] Explain how you would figure out the form of this morpheme in Luiseño.

- [Based on Question 4 of the Week 4 handout, Part II.] Explain how you could do morphological analysis on a signed language.

Post-class email

Sample Exam Questions:

- [I give you a word from Question 11 of Quiz 3.] Does the morpheme 'eye' occur in this word? Why or why not?
- [I give you one of the items in Question 2(iii) of the Week 4 handout, Part II.] Explain how you would figure out the meaning of this word in Swahili.
- [I give you one of the items in Question 2(iv) of the Week 4 handout, Part II.] Explain how you would figure out how to say this phrase in Swahili.
- [I give you a morpheme that occurs in Question 3 of the Week 4 handout, Part II.] Explain how you would figure out the form of this morpheme in Luiseño.
- [Based on Question 4 of the Week 4 handout, Part II.] Explain how you could do morphological analysis on a signed language.

Post-class email

Sample Exam Questions:

- [I give you a word from Question 11 of Quiz 3.] Does the morpheme 'eye' occur in this word? Why or why not?
- [I give you one of the items in Question 2(iii) of the Week 4 handout, Part II.] Explain how you would figure out the meaning of this word in Swahili.
- [I give you one of the items in Question 2(iv) of the Week 4 handout, Part II.] Explain how you would figure out how to say this phrase in Swahili.
- [I give you a morpheme that occurs in Question 3 of the Week 4 handout, Part II.] Explain how you would figure out the form of this morpheme in Luiseño.
- [Based on Question 4 of the Week 4 handout, Part II.] Explain how you could do morphological analysis on a signed language.

Behind the scenes - database

	Topic	Difficulty	Source	Instructions_latex	Data1_latex	Data2_latex
5	Alternations	easy	Quiz 7, Question 2	Explain why these statements about assimilation either are or are not true.	\begin{itemize} \item The process is driven by articulatory factors, namely ease of articulation. \item Assimilation only applies to consonants. \end{itemize}	
6	Phonological Feature	medium	Day 10 Discussion	Explain what the given feature's value is for this class of sounds, and why.	[approximant]	nasals
7	Phonological Feature	medium	Day 10 Discussion	Explain what the given feature's value is for this class of sounds, and why.	[consonantal]	glides
8	Phonological Feature	medium	Homework 5, Question 1	Explain which sound should be removed to make this a natural class, and what the minimum set of features would be to describe the resulting natural class.	[b], [d], [z], [r], [n], [l], [ɹ]	
9	Phonological Feature	medium	Homework 5, Question 1	Explain which sound should be removed to make this a natural class, and what the minimum set of features would be to describe the resulting natural class.	[i], [ɪ], [ɛ], [u], [ʊ]	
10	Acoustics	medium	Day 8 Handout, Question 4	Explain how each component of the description below gives you information about the sound being described.	This consonant is characterized by having the adjacent second and third formants "pinched" together; that is, F3 moves down and F2 moves up if you go from a vowel into this consonant. There is often a clear voice bar, but there's no evidence of formants in the consonant itself. In fact, there's not much energy during the consonant at all.	

...plus columns for image names / captions, instructor notes about answers, and flags like 'omit'

Behind the scenes - Python[1] script[2]

Criteria	.tex	.pdf

- Topics
- Difficulty levels
- Date ranges
- Avoid overlap

- 1 file per exam
  or 1 per day

[1] https://www.python.org/   [2] https://github.com/kvesik/examgeneration

Behind the scenes - Configuration file

```
 4  ⟹  questions: samplequestionbank.tsv
 5  ⟹  signups: none sample_student_ids.tsv
 6     course: LING 200
 7  ⟹  exam type: midterm 2021-02-28
 8  ⟹  student groups: 00000,00001;00002,00005,00010;
 9     random seed: not currently used
10  ⟹  topics: Topic1; Topic2; Topic3; Topic4; Topic5; WILD
11  ⟹  difficulties: easy; medium; medium [Topic2]; hard; easy; medium
12  ⟹  wildcard topics: Topic2; Topic4; Topic6
13  ⟹  ordering: 1
14     rubric: Excellent (3) ~~~ Good (2.2) ~~~ Fair (1.7) ~~~ Poor (0)
```

samplewithoutsignups.cfg ✕

Behind the scenes - Running the script
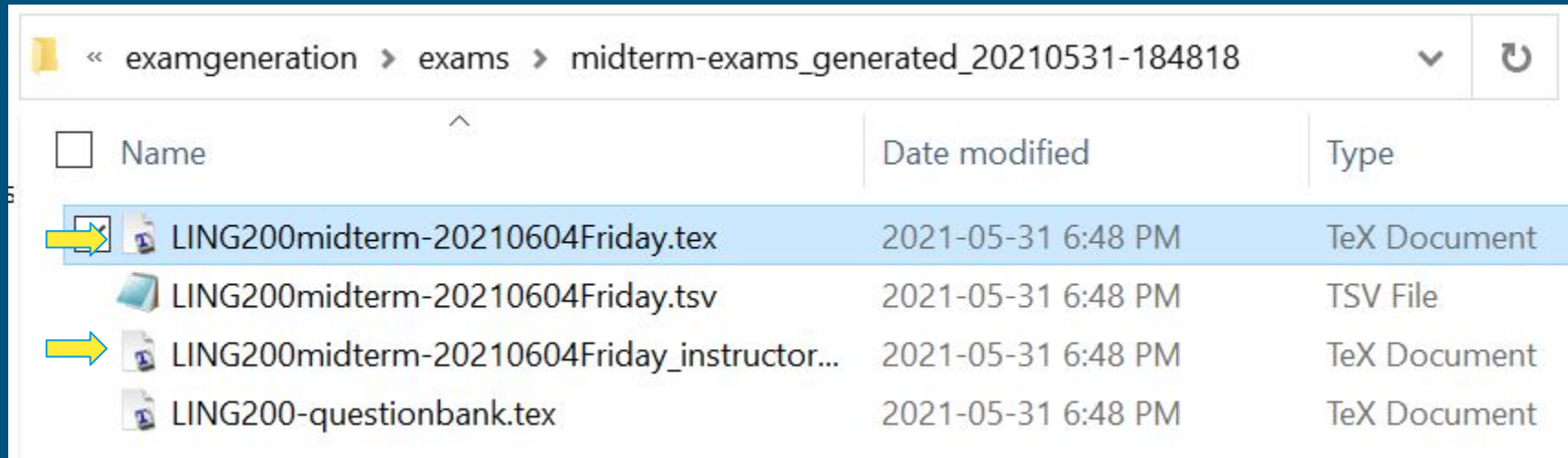
Run script

Behind the scenes - Generated exams

Exams generated locally

Behind the scenes - Python script

Exam editing utilities

Exam - student view

24

Exam - st...

Question 2

Source: Day 6 Handout, Question 11

What do the two signs below tell you about the phonological status of <u>handshape</u> in ASL, and why?
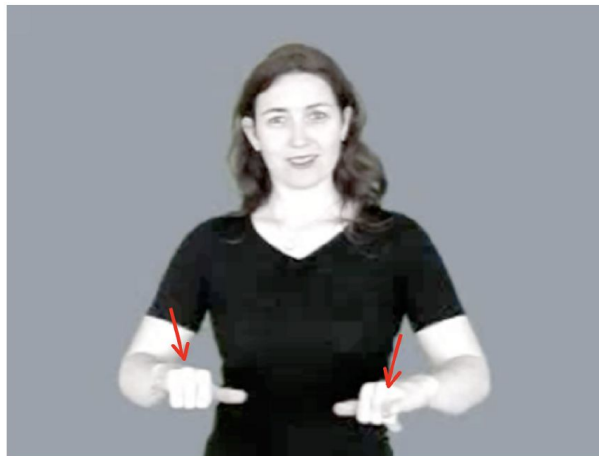

(a) STAY   (b) AWKWARD

25

Exam - student view

Question 2

Source: Day 6 Handout, Question 11

What do the two signs below tell you about the phonological status of handshape in ASL, and why?

Excellent (3)   Good (2.2)   Fair (1.7)   Poor (0)

Excellent (3)   Good (2.2)   Fair (1.7)   Poor (0)

26

Grading scale

Each question worth 3 points; based on UBC's grading scale:

- **Excellent** (3 pts / 100% = A+)
  - no errors; clear presentation; fully explained in own words; no prompting
- **Good** (2.2 pts / 73% = B)
  - only small errors / omissions; explained in own words; minimal prompting
- **Fair** (1.7 pts / 57% = C)
  - mix of correct / incorrect or missing information; or not original wording; or burying correct answer in other information; or a fair bit of prompting
- **Poor** (0 pts / 0% = F)
- in-between grades also used (1.95 = halfway between Good & Fair)

Exam - instructor view

Question 4

Source: Day 6 Handout, Question 11

What do the two signs below tell you about the phonological status of handshape in ASL, and why?

(a) STAY   (b) AWKWARD

INSTRUCTOR NOTES: nothing, because both handshape and movement are different

INSTRUCTOR NOTES: nothing, because both handshape and movement are different

Excellent (3)   Good (2.2)   Fair (1.7)   Poor (0)

27

29

Results

- used 2x so far
- introductory phonetics & phonology course

- Summer 2020:
  - 41 students
  - 2 oral exams
    - midterm -- 15 min / 5 Q
    - final -- 20 min / 6 Q

- Fall 2020:
  - 130 students
  - 2 written exams
    - midterm -- 30 min / 5 Q
    - final -- 45 min / 6 Q
  - 1 oral exam
    - 5 min / 2 Q

Results

- Impressionistically, the system does promote 'good learning strategies' in the students
- On average, scores *relatively* comparable to scores on 'regular' exams in previous semesters
- Both oral and written exams show broad range of scores
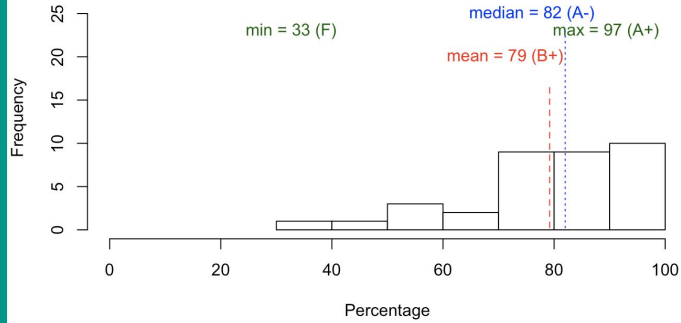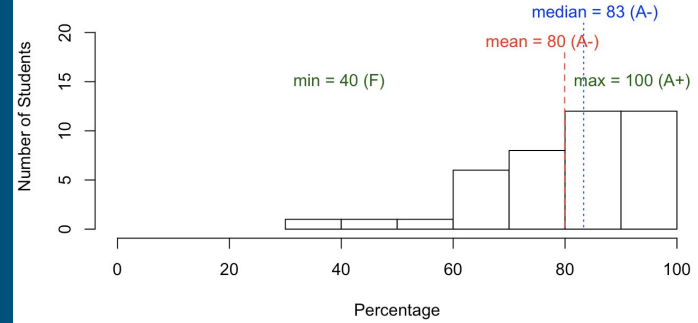
Traditional: / Randomized:
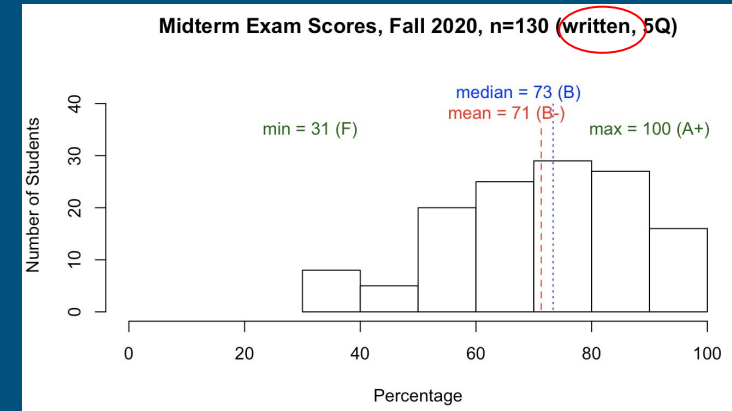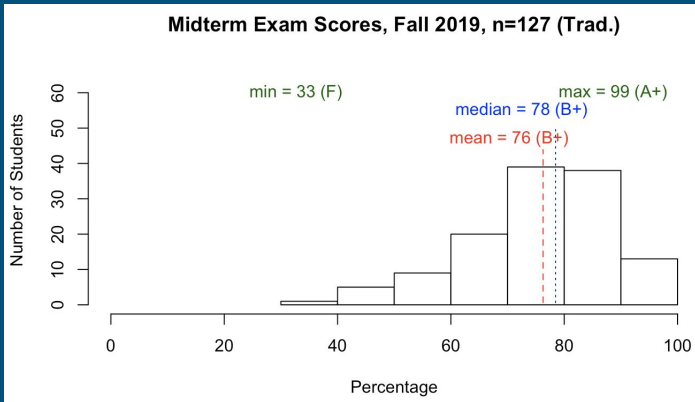
Summer: / Fall:

Midterm Exam Scores, 2019 (Traditional) vs. 2020 (Randomized)

Midterm Exam Scores, 2019 (Traditional) vs. 2020 (Randomized)

33

Traditional:

Randomized:

Summer:

Midterm Exam Scores, Summer 2019, n=36 (Trad.)

min = 33 (F)
median = 82 (A-)
max = 97 (A+)
mean = 79 (B+)
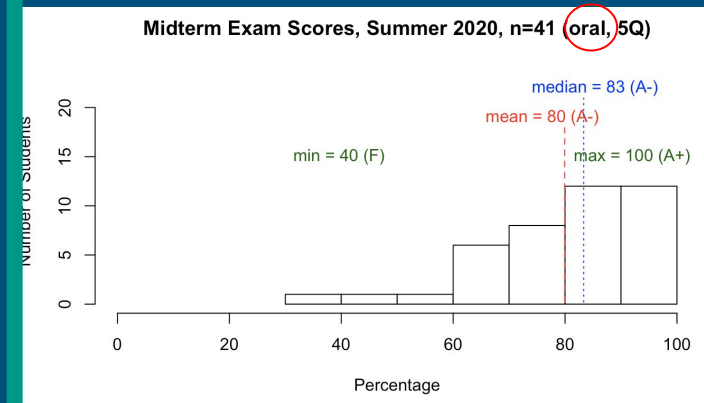
Frequency
Percentage

Midterm Exam Scores, Summer 2020, n=41 (oral, 5Q)

median = 83 (A-)
mean = 80 (A-)
min = 40 (F)
max = 100 (A+)

Number of Students
Percentage

Fall:

Midterm Exam Scores, Fall 2019, n=127 (Trad.)

min = 33 (F)
max = 99 (A+)
median = 78 (B+)
mean = 76 (B+)

Number of Students
Percentage

Midterm Exam Scores, Fall 2020, n=130 (written, 5Q)

median = 73 (B)
mean = 71 (B-)
min = 31 (F)
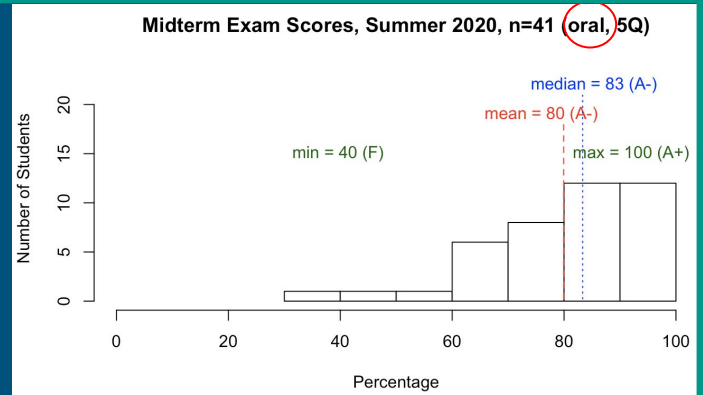max = 100 (A+)

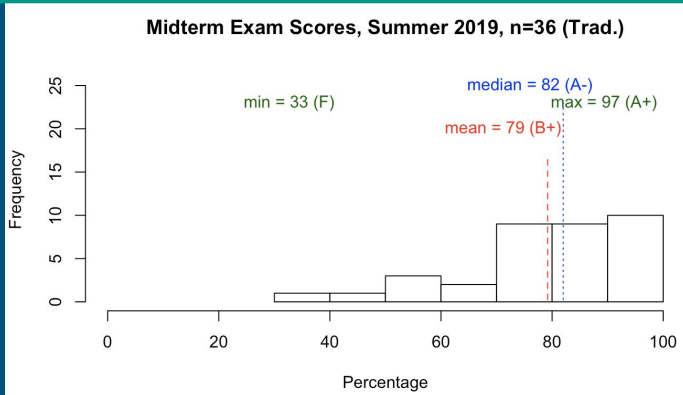Number of Students
Percentage

34

Midterm Exam Scores, 2019 (Traditional) vs. 2020 (Randomized)

Traditional: Randomized:

Summer:

Midterm Exam Scores, Summer 2019, n=36 (Trad.)

min = 33 (F)   median = 82 (A-)   max = 97 (A+)
mean = 79 (B+)

Midterm Exam Scores, Summer 2020, n=41 (oral, 5Q)

min = 40 (F)   median = 83 (A-)
mean = 80 (A-)   max = 100 (A+)

Fall:

Midterm Exam Scores, Fall 2019, n=127 (Trad.)

min = 33 (F)   max = 99 (A+)
median = 78 (B+)
mean = 76 (B+)

Midterm Exam Scores, Fall 2020, n=130 (written, 5Q)

min = 31 (F)   median = 73 (B)
mean = 71 (B-)   max = 100 (A+)

35

Midterm Exam Scores, 2019 (Traditional) vs. 2020 (Randomized)

Traditional: Randomized:

Summer:

Midterm Exam Scores, Summer 2019, n=36 (Trad.)

Midterm Exam Scores, Summer 2020, n=41 (oral, 5Q)

Fall:

Midterm Exam Scores, Fall 2019, n=127 (Trad.)

Midterm Exam Scores, Fall 2020, n=130 (written, 5Q)

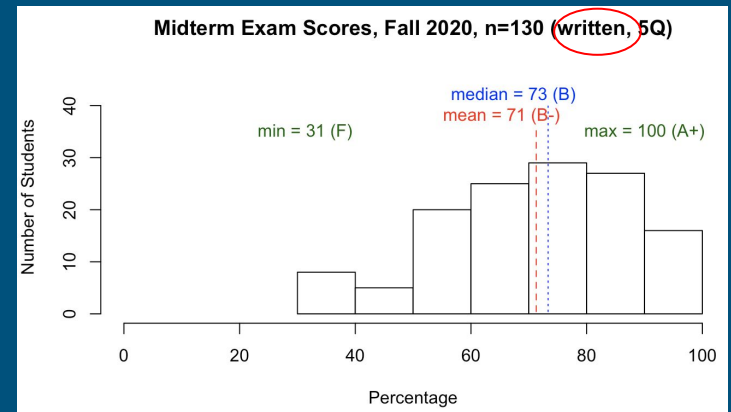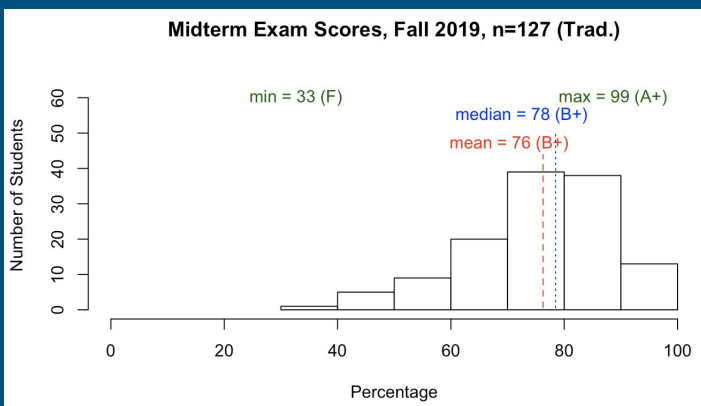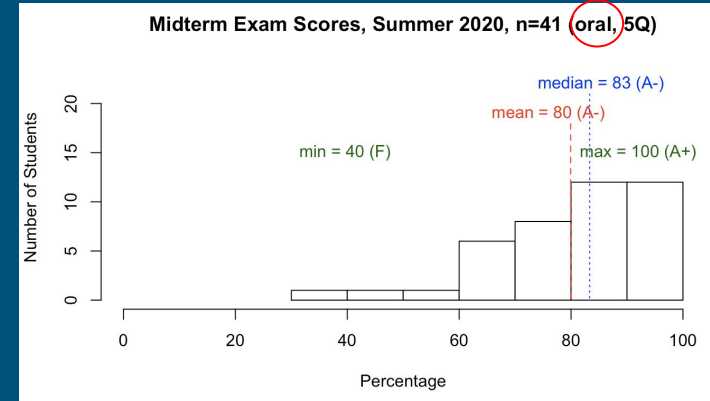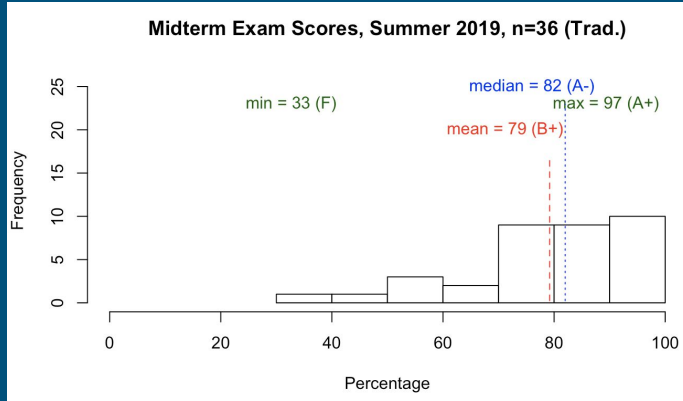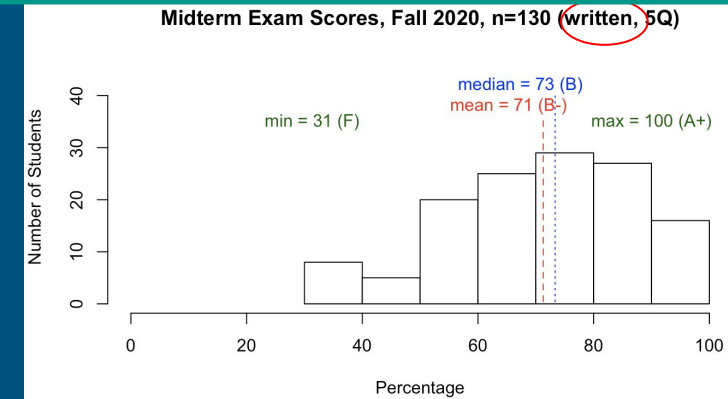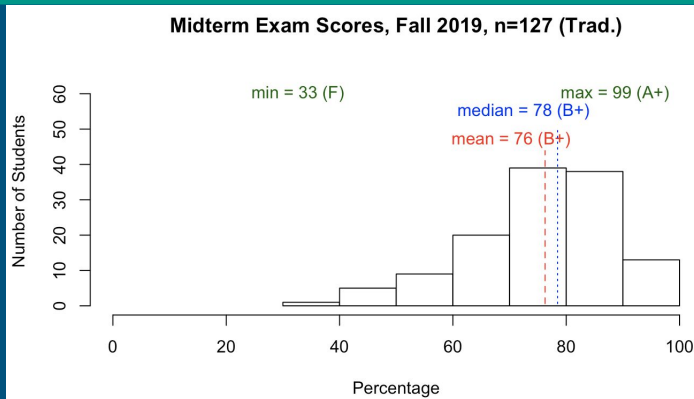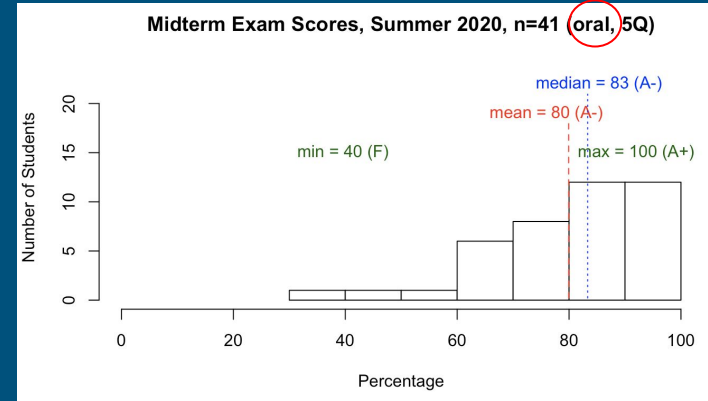**Midterm** Exam Scores, 2019 (Traditional) vs. 2020 (Randomized)

36

Traditional: Randomized:

Summer:

Fall:

Midterm Exam Scores, 2019 (Traditional) vs. 2020 (Randomized)

37
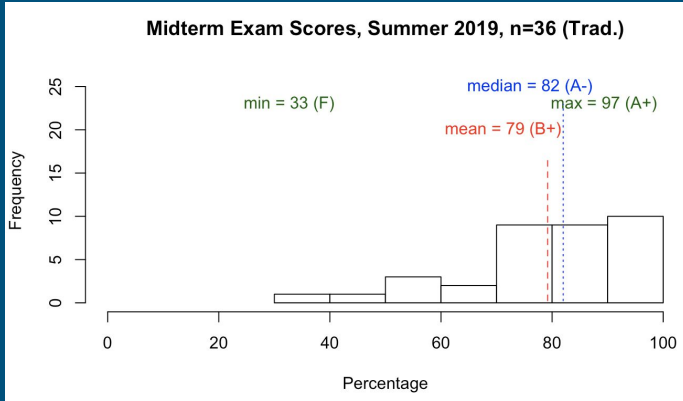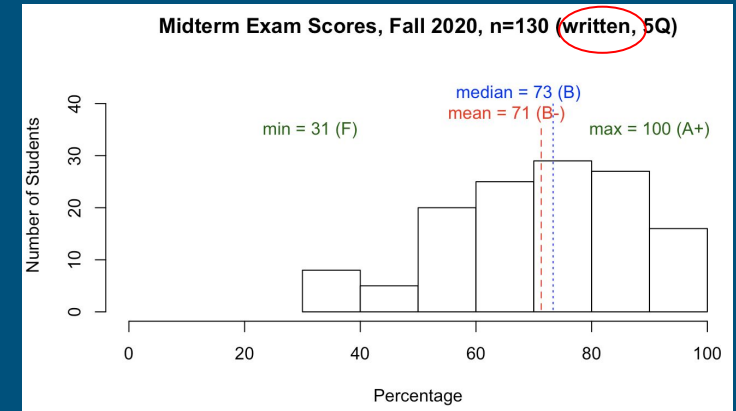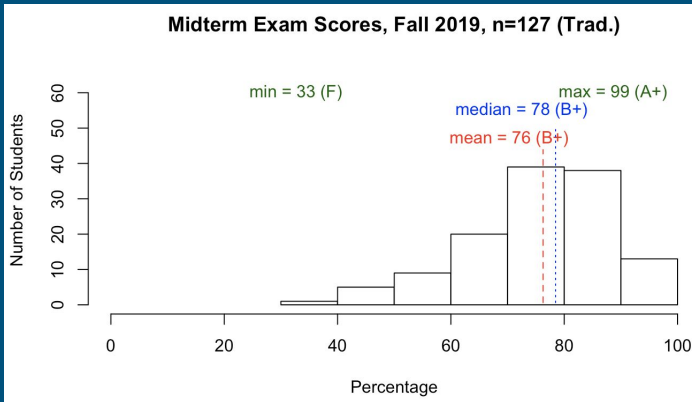
Traditional: Randomized:

Summer:

Midterm Exam Scores, Summer 2019, n=36 (Trad.)

min = 33 (F)   median = 82 (A-) max = 97 (A+)
                    mean = 79 (B+)

Midterm Exam Scores, Summer 2020, n=41 (oral, 5Q)

min = 40 (F)   median = 83 (A-)
                    mean = 80 (A-)   max = 100 (A+)

Fall:

Midterm Exam Scores, Fall 2019, n=127 (Trad.)

min = 33 (F)   max = 99 (A+)
                    median = 78 (B+)
                    mean = 76 (B+)

Midterm Exam Scores, Fall 2020, n=130 (written, 5Q)

min = 31 (F)   median = 73 (B)
                    mean = 71 (B-)   max = 100 (A+)
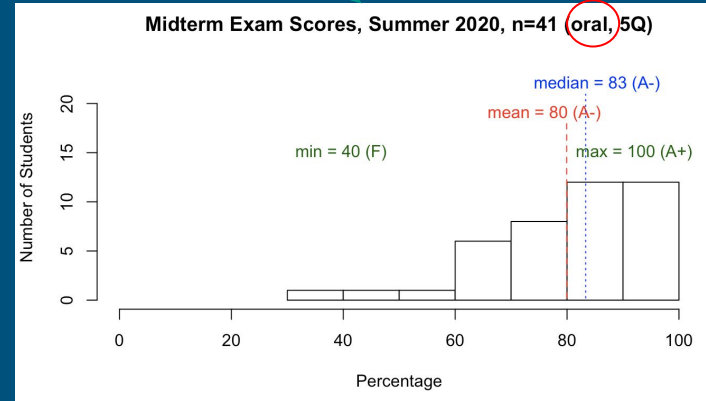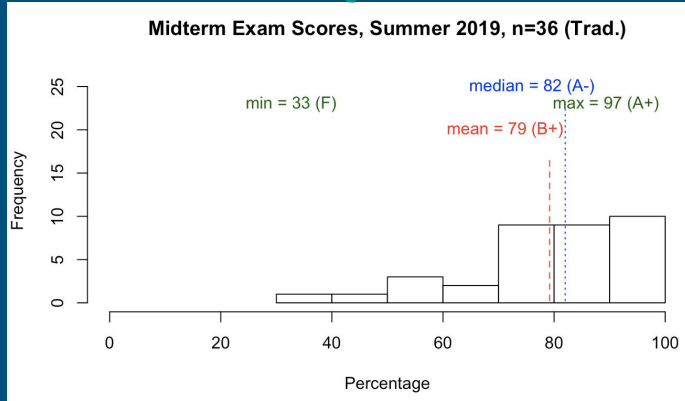
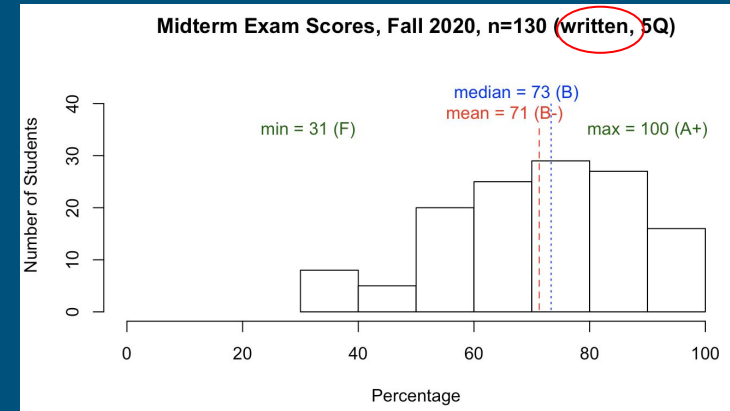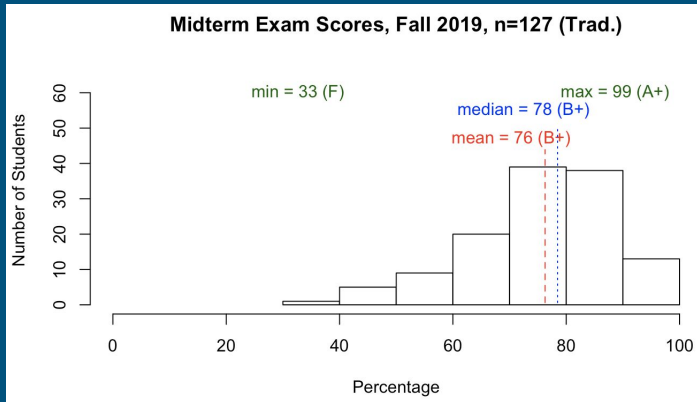**Midterm** Exam Scores, 2019 (Traditional) vs. 2020 (Randomized)
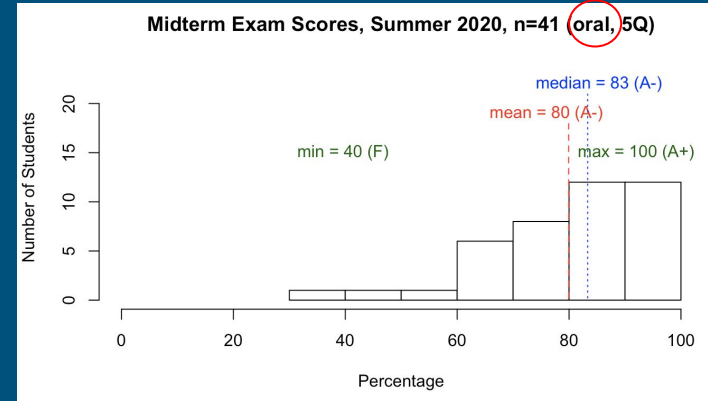
38

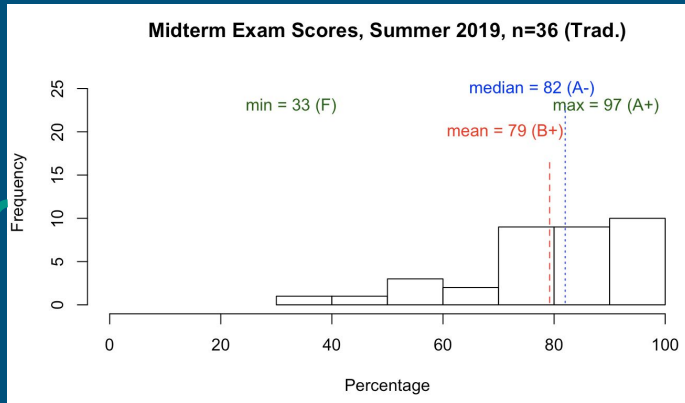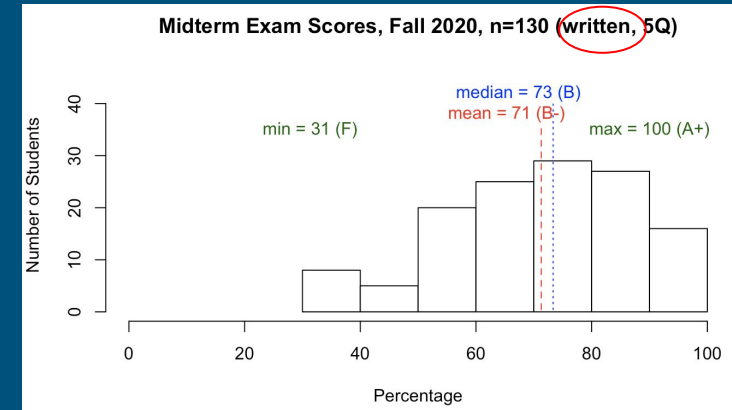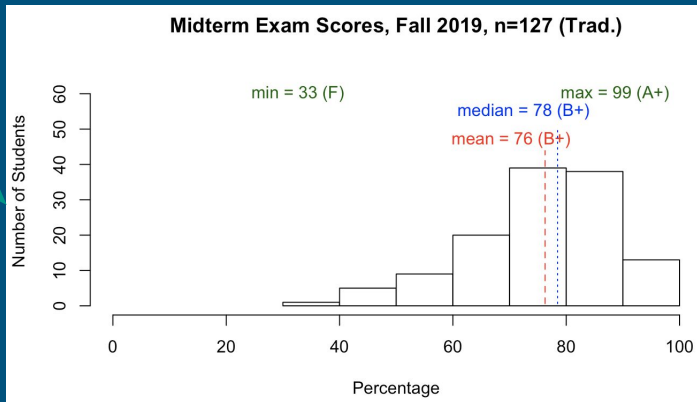Traditional: Randomized:

Summer:

Fall:

Midterm Exam Scores, 2019 (Traditional) vs. 2020 (Randomized)

Traditional:

Randomized:

Summer:

Midterm Exam Scores, Summer 2019, n=36 (Trad.)

min = 33 (F)

median = 82 (A-)

max = 97 (A+)

mean = 79 (B+)

Midterm Exam Scores, Summer 2020, n=41 (oral, 5Q)

median = 83 (A-)

mean = 80 (A-)

min = 40 (F)

max = 100 (A+)

Fall:

Midterm Exam Scores, Fall 2019, n=127 (Trad.)

min = 33 (F)

max = 99 (A+)

median = 78 (B+)

mean = 76 (B+)

Midterm Exam Scores, Fall 2020, n=130 (written, 5Q)

median = 73 (B)

mean = 71 (B-)

min = 31 (F)

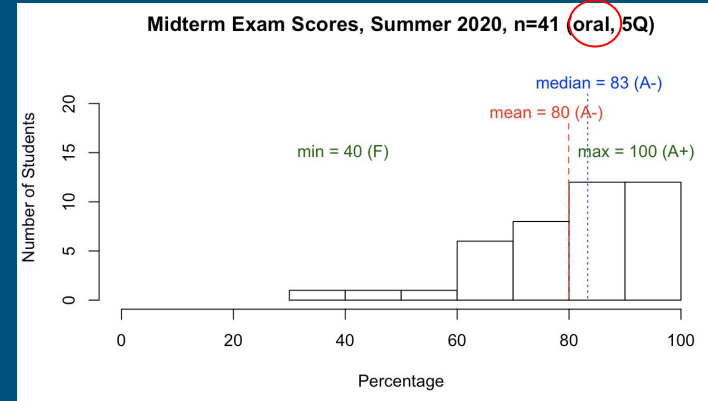max = 100 (A+)

Midterm Exam Scores, 2019 (Traditional) vs. 2020 (Randomized)

Traditional:

Randomized:

Summer:

Final Exam Scores, Summer 2019, n=34 (Trad.)

min = 0 (F)
max = 94 (A+)
mean = 65
median = 69
non-0 min. = 33 (F)

Final Exam Scores, Summer 2020, n=42 (oral, 6Q)

median = 78 (B+)
min = 22 (F)
mean = 72 (B)
max = 100 (A+)

Fall:

Final Exam Scores, Fall 2019, n=122 (Trad.)

min = 33 (F)
median = 69 (B-)
mean = 67 (C+)
max = 99 (A+)

Final Exam Scores, Fall 2020, n=122 (written; 6Q)

median = 73 (B)
mean = 72 (B)
min = 0 (F)
non-0 min = 31 (F)
max = 100 (A+)

Final Exam Scores, 2019 (Traditional) vs. 2020 (Randomized)
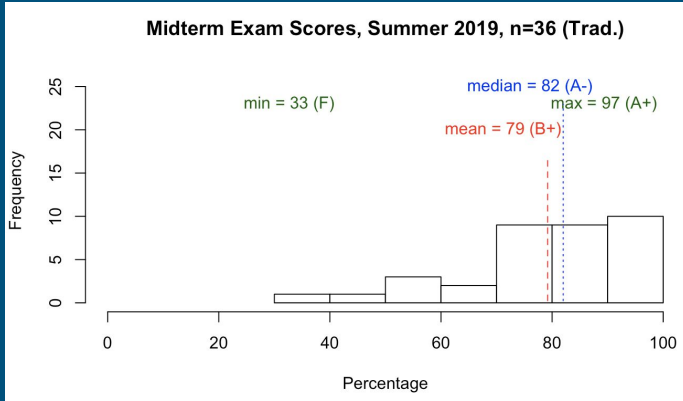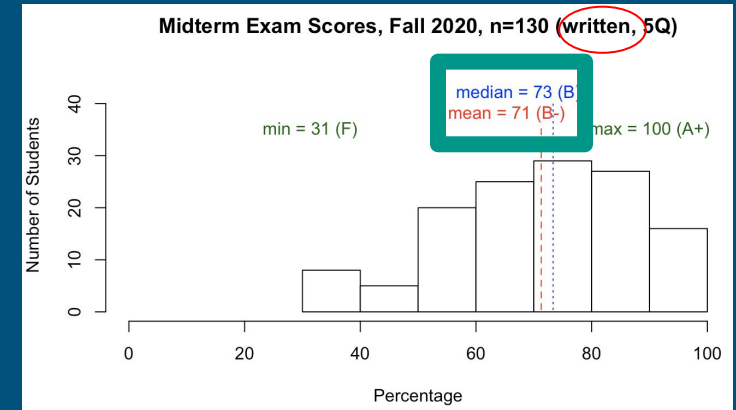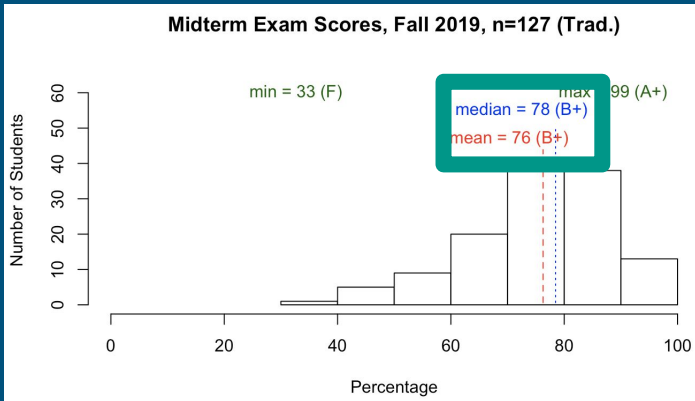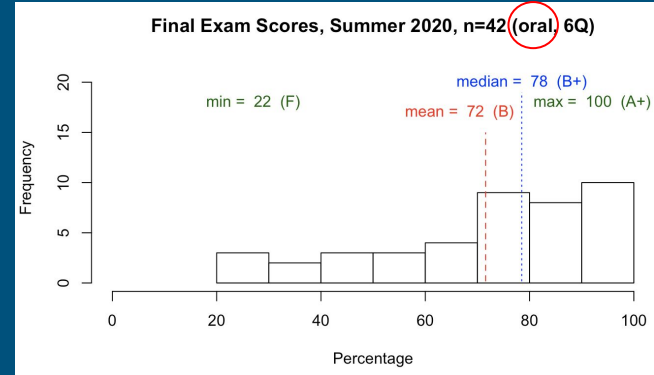
Traditional: Randomized:

Summer:

Final Exam Scores, Summer 2019, n=34 (Trad.)

min = 0 (F) max = 94 (A+)
mean = 65
median = 69
non-0 min. = 33 (F)

Final Exam Scores, Summer 2020, n=42 (oral; 6Q)

median = 78 (B+)
min = 22 (F) max = 100 (A+)
mean = 72 (B)

Fall:

Final Exam Scores, Fall 2019, n=122 (Trad.)

median = 69 (B-)
mean = 67 (C+)
min = 33 (F) max = 99 (A+)

Final Exam Scores, Fall 2020, n=122 (written; 6Q)

median = 73 (B)
mean = 72 (B)
min = 0 (F) non-0 min = 31 (F) max = 100 (A+)

Final Exam Scores, 2019 (Traditional) vs. 2020 (Randomized)

42

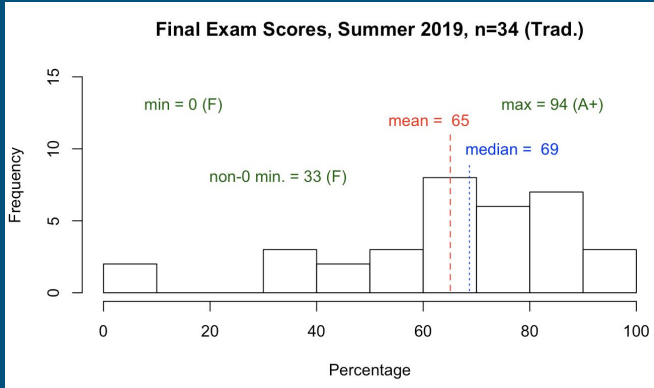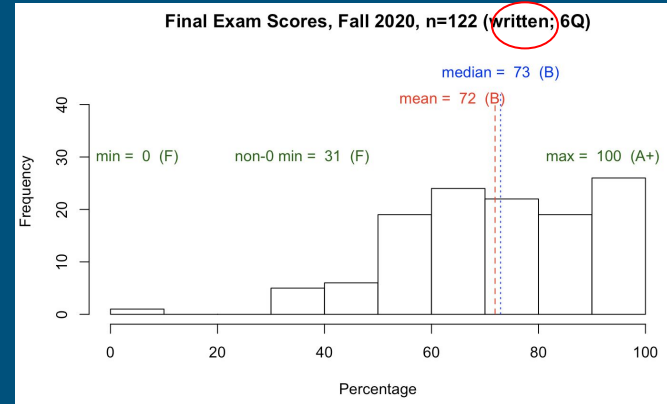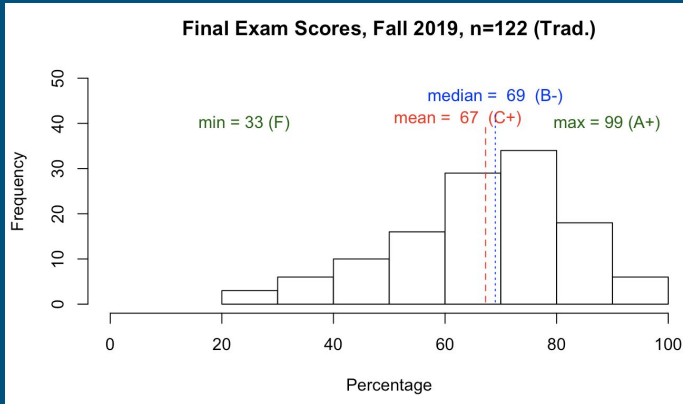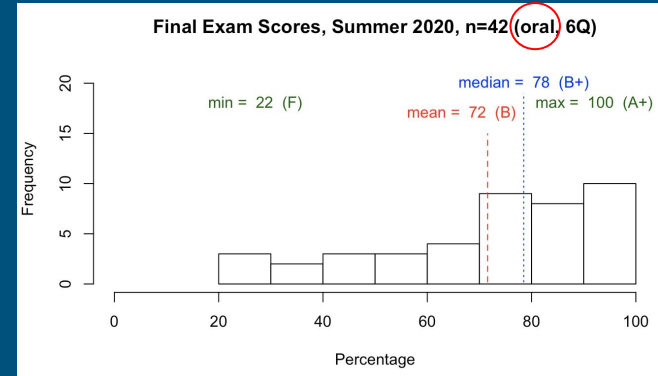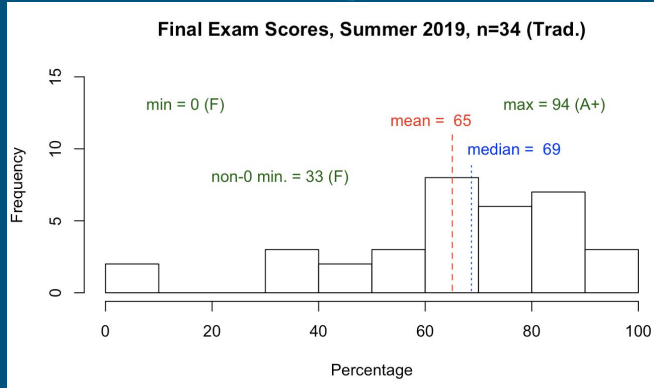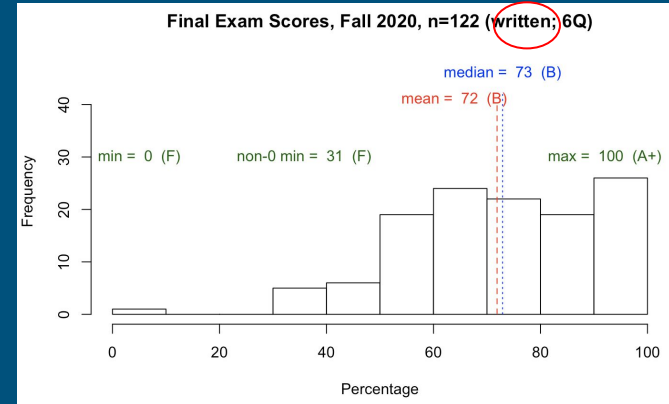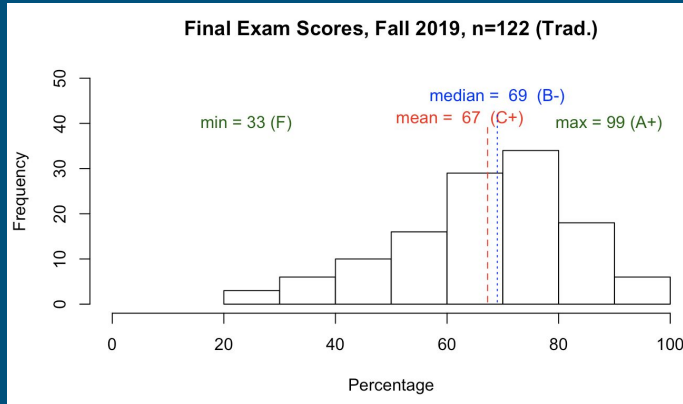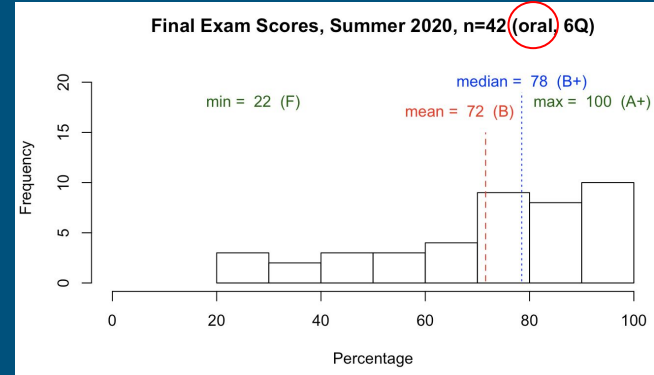Traditional:
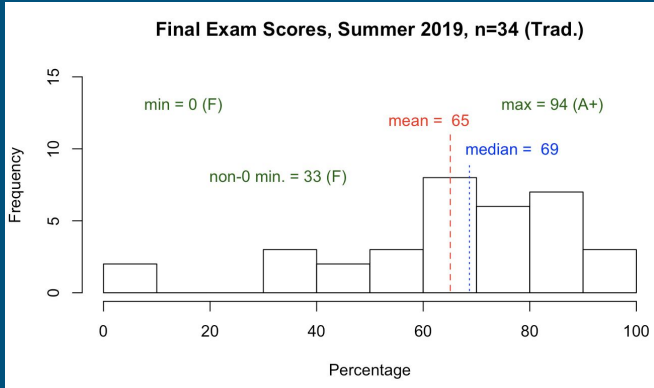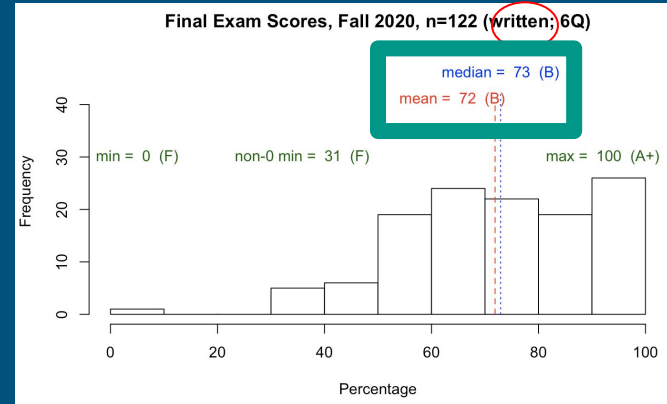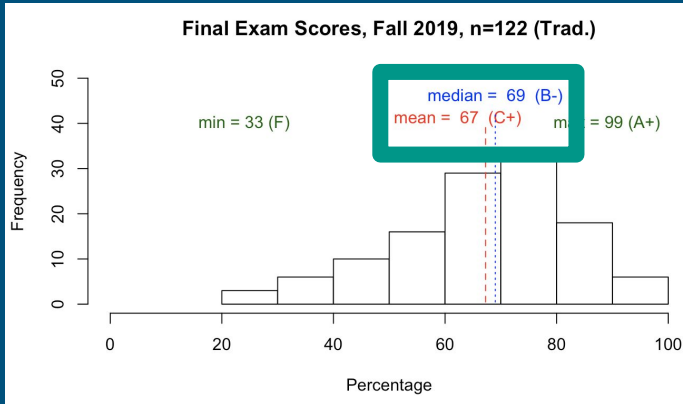
Randomized:

Summer:

Fall:

Final Exam Scores, 2019 (Traditional) vs. 2020 (Randomized)

Traditional:

Randomized:

Summer:

Final Exam Scores, Summer 2019, n=34 (Trad.)
min = 0 (F)   max = 94 (A+)   mean = 65   median = 69   non-0 min. = 33 (F)

Final Exam Scores, Summer 2020, n=42 (oral, 6Q)
median = 78 (B+)   min = 22 (F)   mean = 72 (B)   max = 100 (A+)

Fall:

Final Exam Scores, Fall 2019, n=122 (Trad.)
median = 69 (B-)   mean = 67 (C+)   min = 33 (F)   max = 99 (A+)

Final Exam Scores, Fall 2020, n=122 (written, 6Q)
median = 73 (B)   mean = 72 (B)   min = 0 (F)   non-0 min = 31 (F)   max = 100 (A+)

44

Final Exam Scores, 2019 (Traditional) vs. 2020 (Randomized)
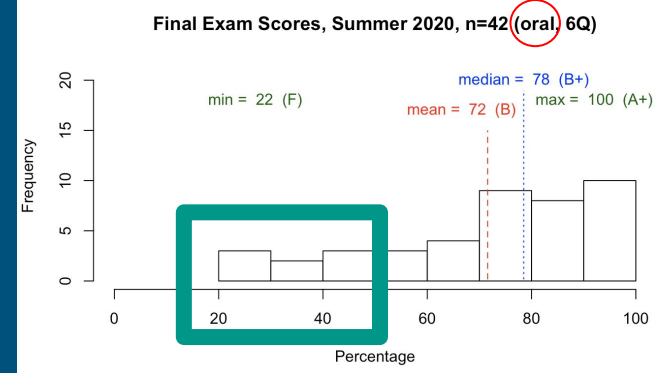
Discussion

- students naturally encouraged to follow the principles of better learning
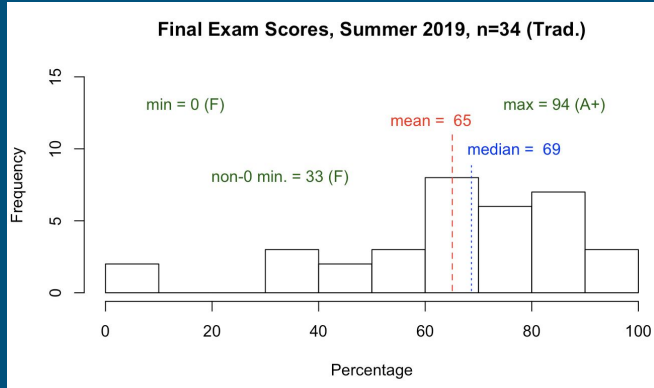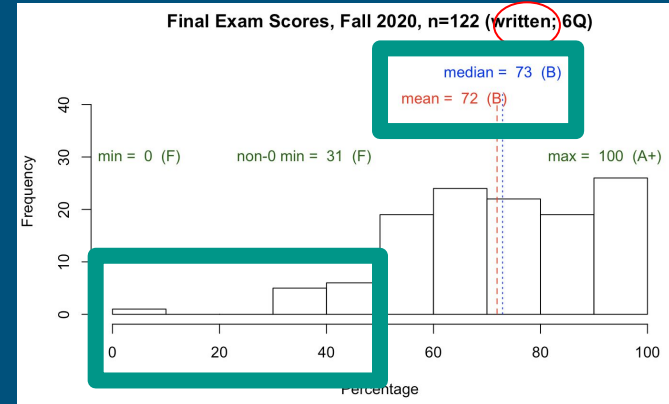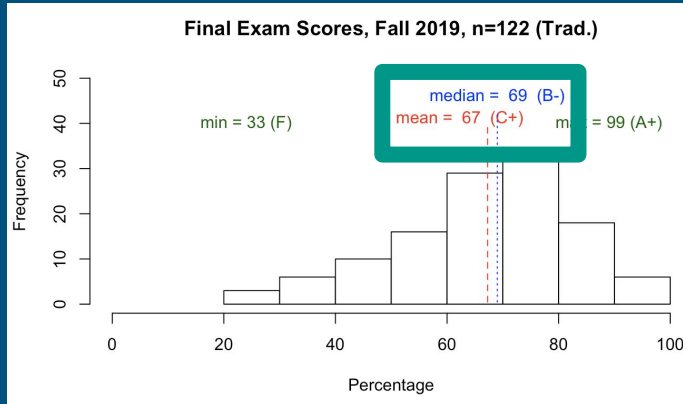 - occasional comments on how 'easy' the exams are -- which we take to be a sign of success!
- posting of questions gives an easily accessible framework for students to work together in study groups
  - especially valuable when students may otherwise be isolated from each other

Discussion

- exam integrity maintained
  - exams are randomized for each student
  - exams are intentionally open-note and open-book
  - all questions are available to all students at all times
  - oral exams >> written for being absolutely sure of integrity, at least in the online context
- oral exams can be intimidating...but also provide an alternative format for students for whom writing is a challenge
  - can *always* substitute a written for an oral exam in the case of extreme anxiety
  - other students find that oral exams are surprisingly enjoyable
  - does allow for further 'probing' of a student's understanding -- often leading to *better* results

Conclusions

- Overall, this approach incentivizes exactly the kind of behaviour we want students to have: engaging with the material as we go over it in class, reviewing it on their own, practicing new applications, asking about it in tutorials, discussing it with each other…
- It feels as though the students understand the course content better -- though tracking through upper-level courses would also be beneficial.
- We plan on using this general technique moving forward.

Thank you

- students in LING 200 for their willingness to try something new
- UBC Department of Linguistics for extra pedagogical support
- Mifield Xu for additional help in implementing written versions in Fall 2020

Reference

Brown, Peter C., Henry L. Roediger III, and Mark A. McDaniel. 2014. *Make it stick: The science of successful learning*. Cambridge, MA: The Belknap Press of Harvard University Press.