Rhetorical Numbers:
Quantitative Argument Across the Curriculum

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Engineers: 1 in 100

Managers: 1 in 100,000

"I don't know if anybody at that time understood the joint well enough to realize that the data was crucial"

"There were a whole lot of people who weren't smart enough to look behind the veil and say, 'Gee, I wonder what this means.'"

"I didn't realize the data's significance"

"It sounded like old news"

Question: **If the field joint secondary seal lifts off the metal mating surfaces during motor pressurization, how soon will it return to a position where contact is re-established?**

Answer: Bench test data indicated that the O-ring resiliency (its capability to follow the metal) is a function of temperature and the rate of case expansion. MTI measured the force of the O-ring against Instron platens, which simulated the nominal squeeze on the O-ring and approximated the case expansion distance and rate

At 100^{o}F the O-ring maintained contact. At 75^{o}F the O-ring lost contact for 2.4 seconds. At 50^{o}F the O-ring did not reestablish contact for ten minutes at which time the test was terminated.

The conclusion is that the secondary sealing capability in the SRM field joint cannot be guaranteed.

Question: **If the primary o-ring does not seal, will the secondary seal seat in sufficient time to prevent joint leakage?**

Answer: MTI has no reason to suspect that the primary seal would ever fail after pressure equilibrium is reached, i.e., after the ignition transient. If the primary O-ring were to fail from 0 to 170 milliseconds, there is a very high probability that the secondary O-ring would hold pressure since the case has not expanded appreciably at this point. If the primary seal were to fail from 170 to 330 milliseconds, the probability of the secondary seal holding is reduced. From 330 to 660 milliseconds the chance of the secondary seal holding is small. This is a direct result of the O-ring's slow response compared to the metal case segments as the joint rotates.

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Question: **If the primary o-ring does not seal, will the secondary seal seat in sufficient time to prevent joint leakage?**

Answer: MTI has no reason to suspect that the primary seal would ever fail after pressure equilibrium is reached, i.e., after the ignition transient. If the primary O-ring were to fail from 0 to 170 milliseconds, there is a very high probability that the secondary O-ring would hold pressure since the case has not expanded appreciably at this point. If the primary seal were to fail from 170 to 330 milliseconds, the probability of the secondary seal holding is reduced. **From 330 to 660 milliseconds the chance of the secondary seal holding is small.** This is a direct result of the O-ring's slow response compared to the metal case segments as the joint rotates.

Primary Seal Failure	***Secondary Seal Hold***
0-170 ms	High probability
170-360 ms	Low probability

Temperature	***Secondary Seal***
100°	Maintained contact
75°	Lost contact for 2.4 milliseconds
50°	**Did not maintain contact**

Numbers speak for themselves

There are lies, damn lies, and statistics

Students struggle with these competing fallacies

"She presents the findings of the observation in tables and graphs **so they will hardly be contested."**

"Who's gonna argue with information already sorted out into graphs and tables? I mean, come on…it *has* to be legit, right?"

"She doesn't seem to think too many people will disagree with her with all the **facts** she is giving. **It is hard to disagree with a graph."**

FACT Argument LIE

Rhetoric

Logic	Character	Emotion
Message	Speaker	Audience

Logic

Message

Character

Speaker

Emotion

Audience

Invention	Arrangement	Style
Discovery	Organization	Presentation

Invention

Discovery

Arrangement

Organization

Style

Presentation

Quantitative rhetoric involves **emotion**

Quantitative rhetoric involves **emotion**

One in 50 women over 35 will have complication

1/50 = 2/100 = 2% chance of complication

98% chance everything will be okay

98% > 97%

Quantitative rhetoric involves **emotion**

“You have a one in twenty chance of winning the raffle”

Quantitative rhetoric involves **emotion**

“You have a one in twenty chance of winning the raffle”

“You have a 5% chance of winning the raffle”

Quantitative rhetoric involves **emotion**

“You have a one in twenty chance of winning the raffle”

“You have a 5% chance of winning the raffle”

“You have a 95% chance of losing”

These statements are mathematically equivalent

- 21.3% of women and 12.7% of men have experienced depression in their lifetime.
- Over one in five women and one in eight men have experienced depression in their lifetimes.
- Women are 68% more likely than men to experience depression in their lifetime.
- Approximately six of every ten depressed individuals is a woman.
- Over 75% of women never experience significant depression in their lifetime.

Quantitative rhetoric involves **emotion**

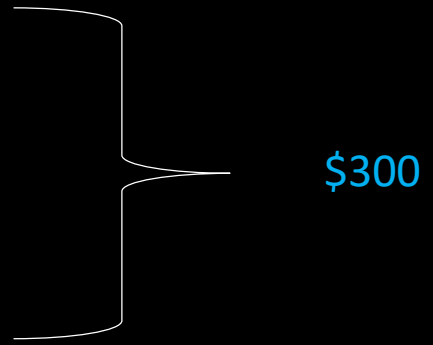
Samsung Galaxy 7	$612
Apple iPhone 7	$894

Quantitative rhetoric involves **emotion**

Samsung Galaxy 7	$600
Apple iPhone 7	$900

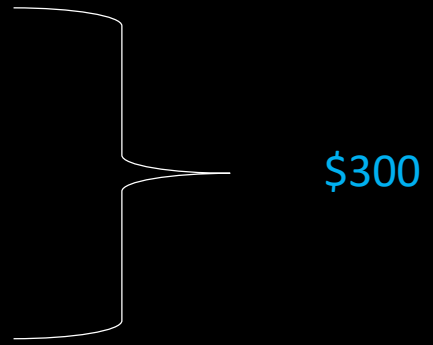
Quantitative rhetoric involves **emotion**

Samsung Galaxy 7	$600
Apple iPhone 7	$900



Quantitative rhetoric involves **emotion**

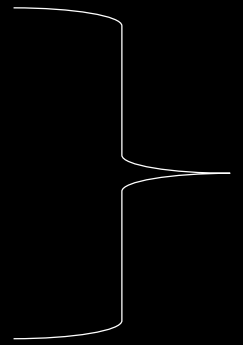
Samsung Galaxy 7	$600
Apple iPhone 7	$900



The Galaxy costs 33% less than the iPhone:

Quantitative rhetoric involves **emotion**

Samsung Galaxy 7	$600
Apple iPhone 7	$900

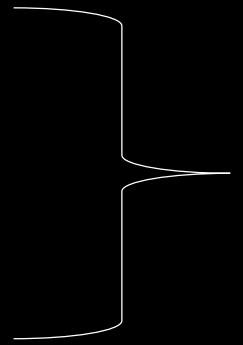


$300

The Galaxy costs 33% less than the iPhone: $300/$900 = 1/3

Quantitative rhetoric involves **emotion**

Samsung Galaxy 7	$600
Apple iPhone 7	$900



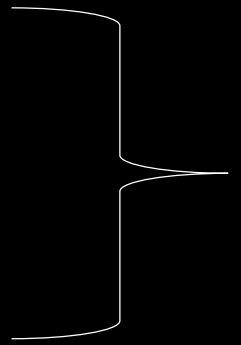
$300

The Galaxy costs 33% less than the iPhone: $300/$900 = 1/3

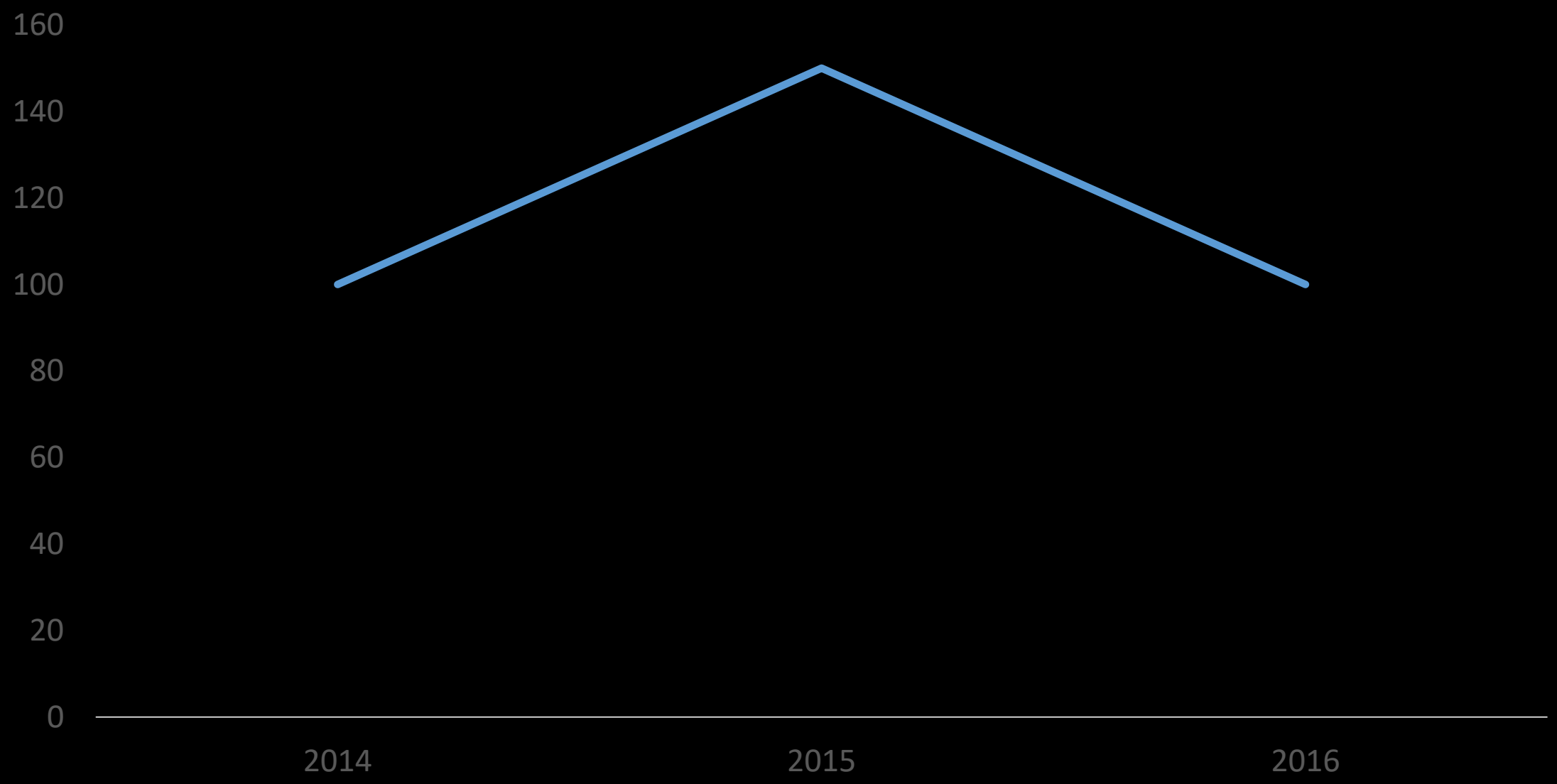
The iPhone costs 50% more than the Galaxy

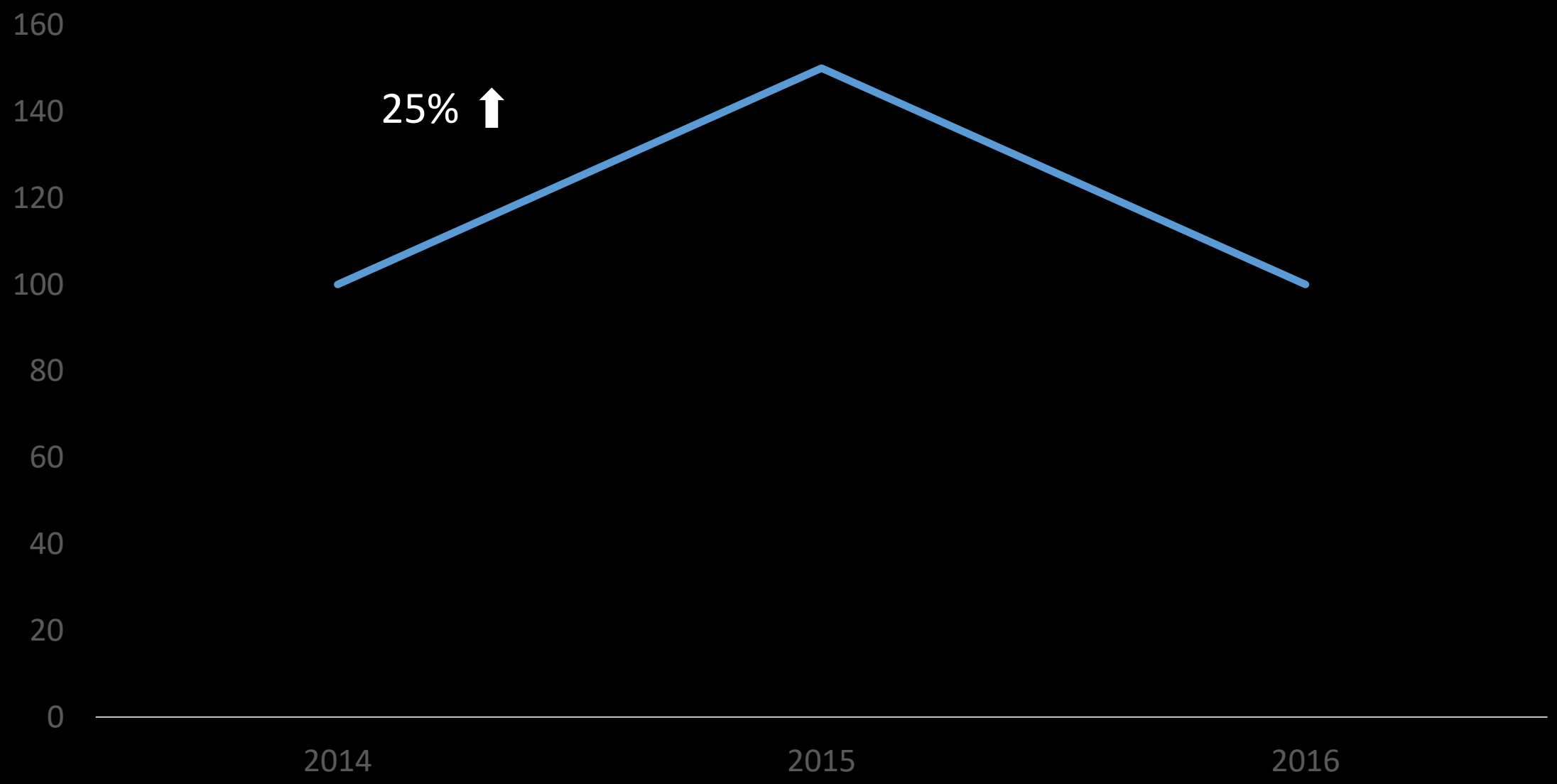
Quantitative rhetoric involves **emotion**

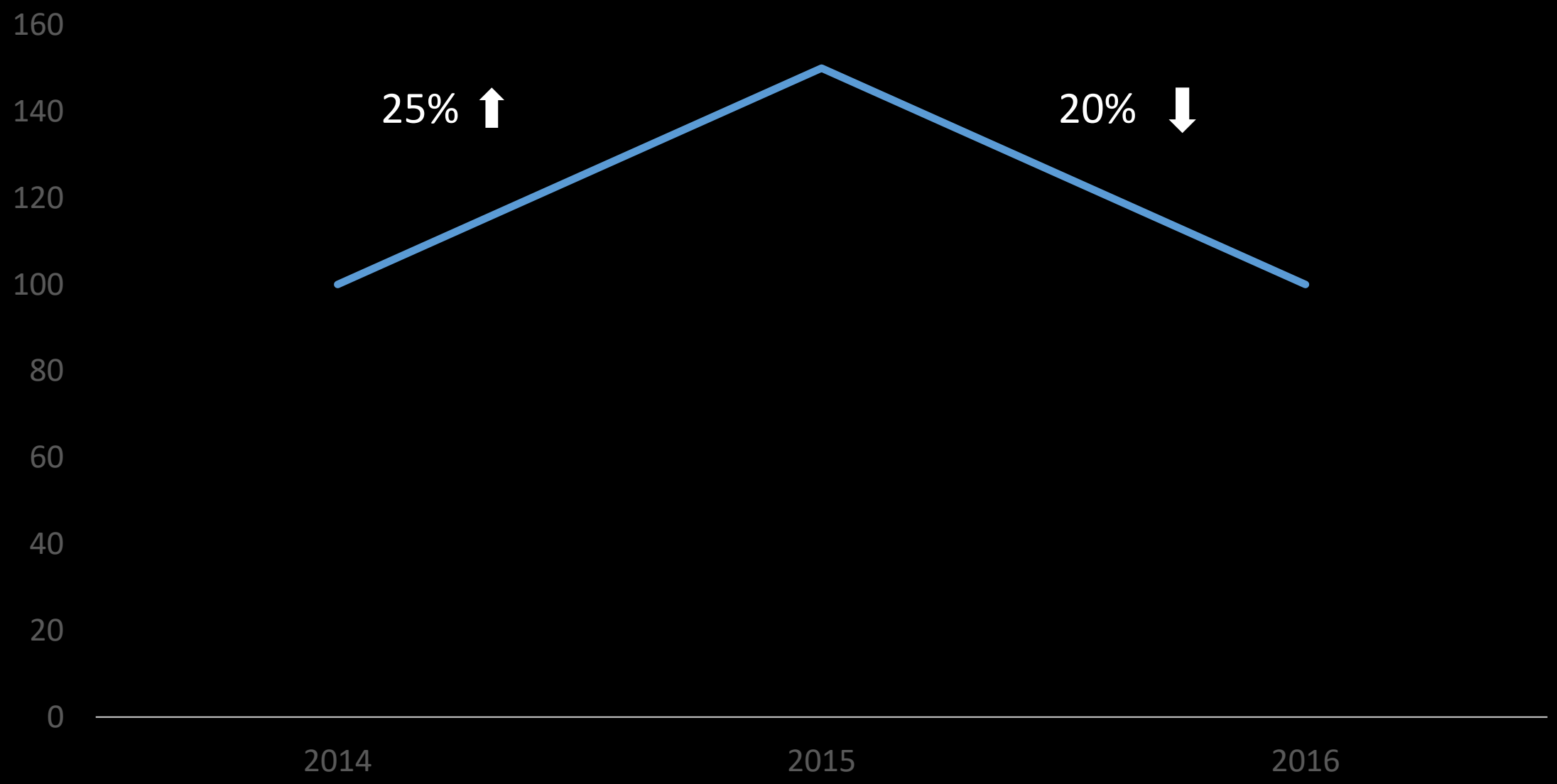
Samsung Galaxy 7	$600
Apple iPhone 7	$900



The Galaxy costs 33% less than the iPhone:	$300/$900 = 1/3
The iPhone costs 50% more than the Galaxy	$300/$600 = 1/2


160
140
120
100
80
60
40
20
0
2014
2015
2016


160
140
120
100
80
60
40
20
0
25%
2014
2015
2016


160
140
120
100
80
60
40
20
0
25%
20%
2014
2015
2016


5

PIT

AUS

PIT	AUS
AUS	PIT

PIT	DFW
DFW	AUS
AUS	DFW
DFW	PIT

3

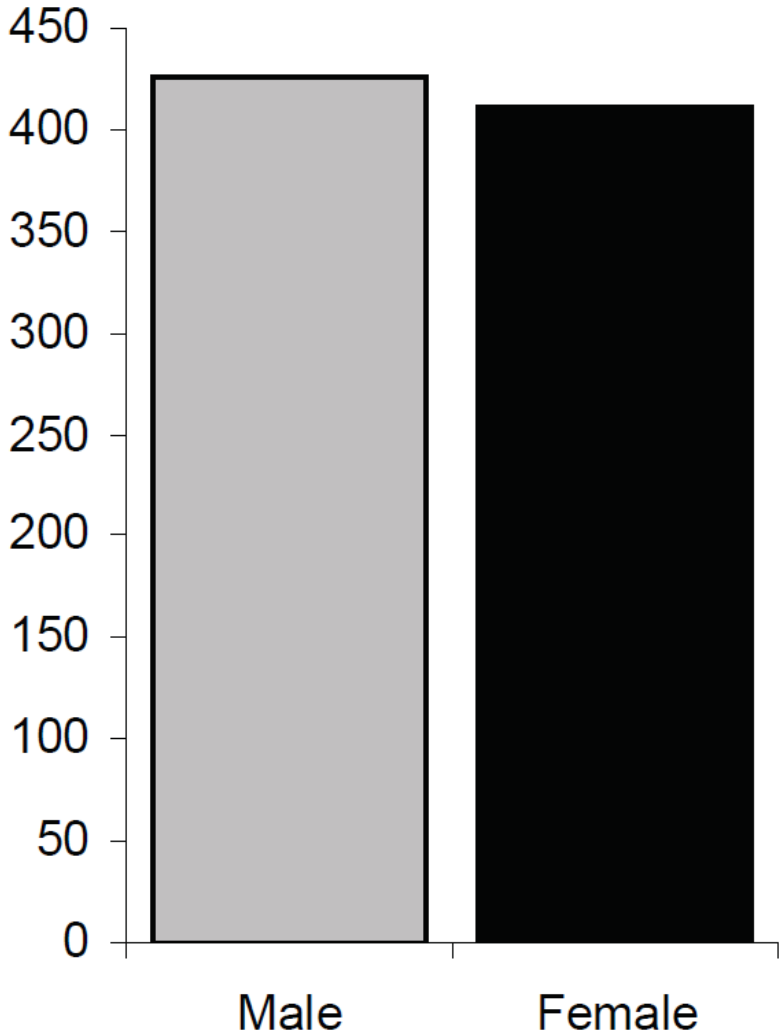
seconds

=

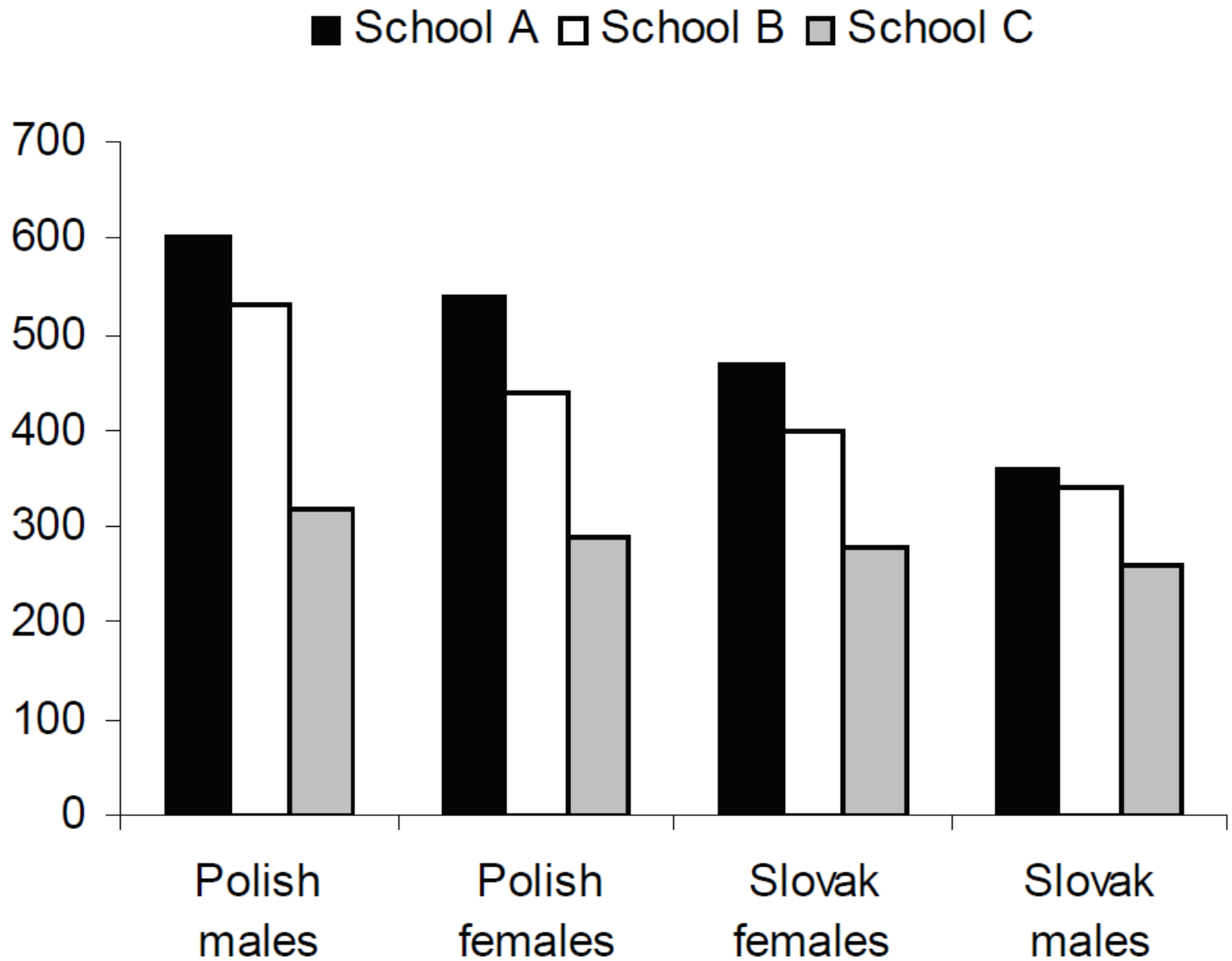
view

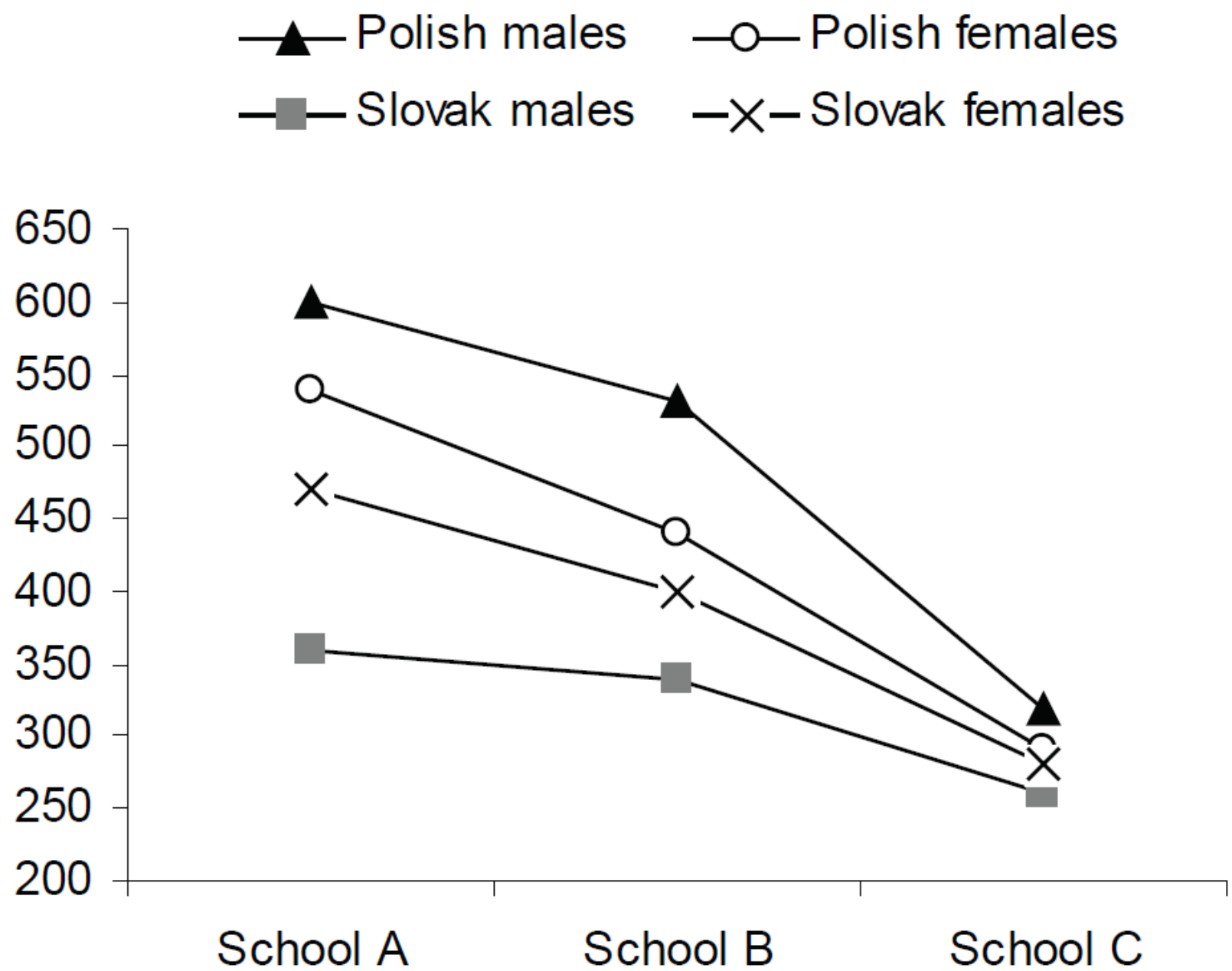
Table 1. Excerpt from Table of Fictional Test Score Data Arranged by Student ID

ID	School	Gender	Race	Verbal score	Math score
520	A	M	2	400	410
521	A	M	1	510	620
522	B	F	1	570	520
523	A	M	1	720	680
524	C	M	2	270	330
525	A	F	5	540	500
526	B	M	1	580	700
527	A	F	1	660	640
528	A	M	1	600	640
529	B	F	1	550	560
530	B	F	1	580	420
531	C	F	2	420	370
532	C	M	3	280	350
533	B	M	2	480	470

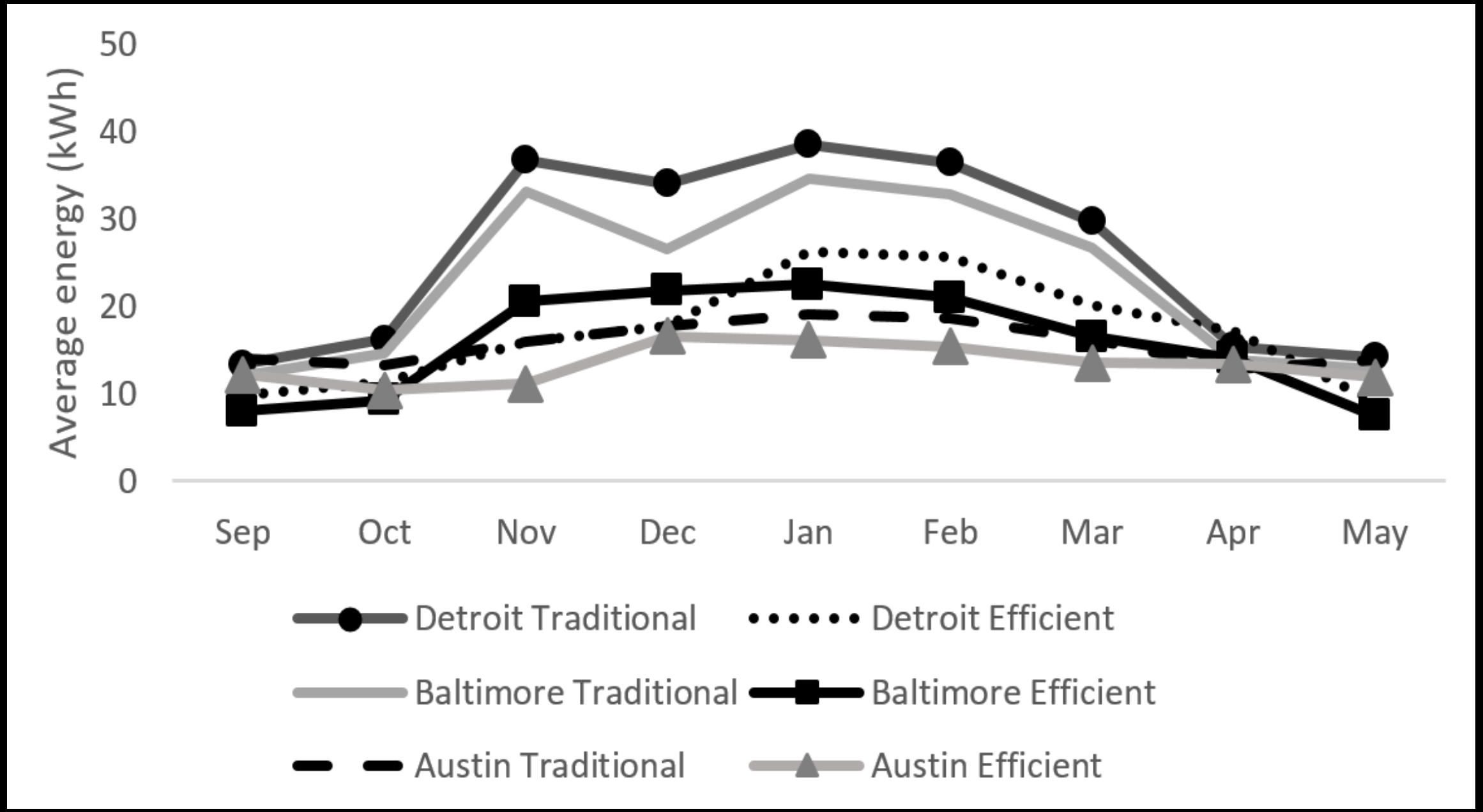

450
400
350
300
250
200
150
100
50
0
Male
Female

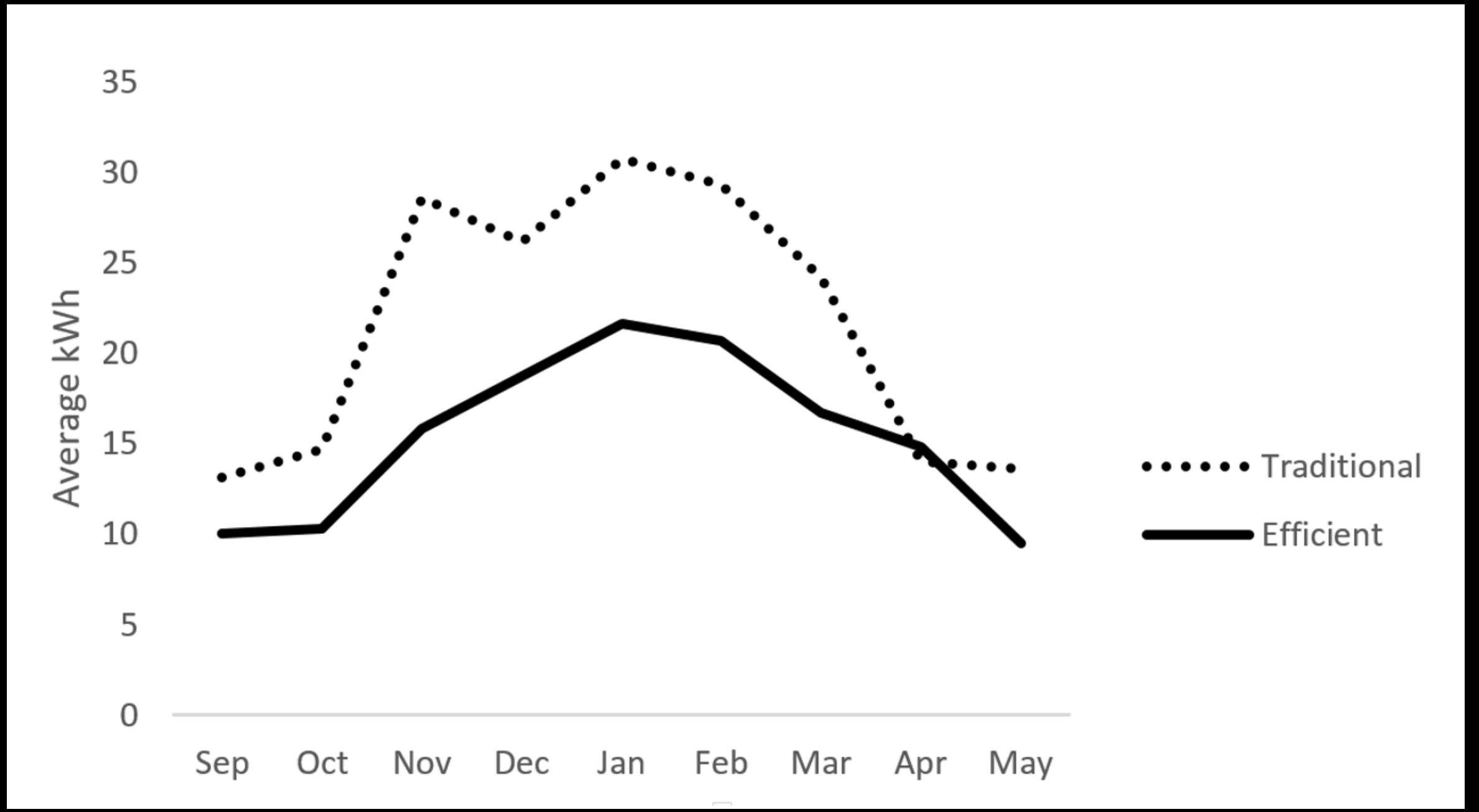
Ethnicity	*Average Test Scores*
German	507
Polish	505
Turkish	392
Slovak	319
Other	401
All Groups	*433*

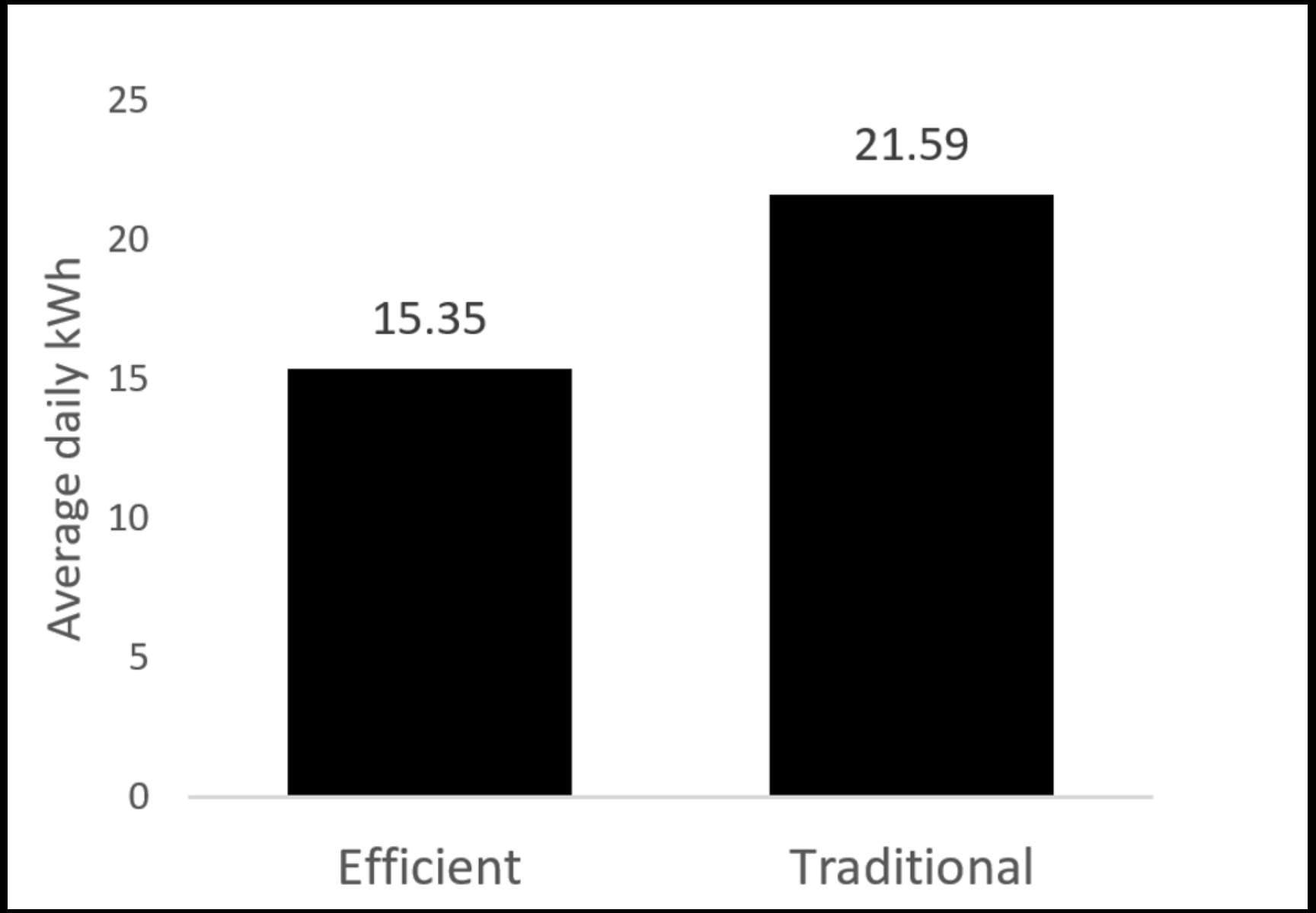

School A
School B
School C
700
600
500
400
300
200
100
0
Polish males
Polish females
Slovak females
Slovak males

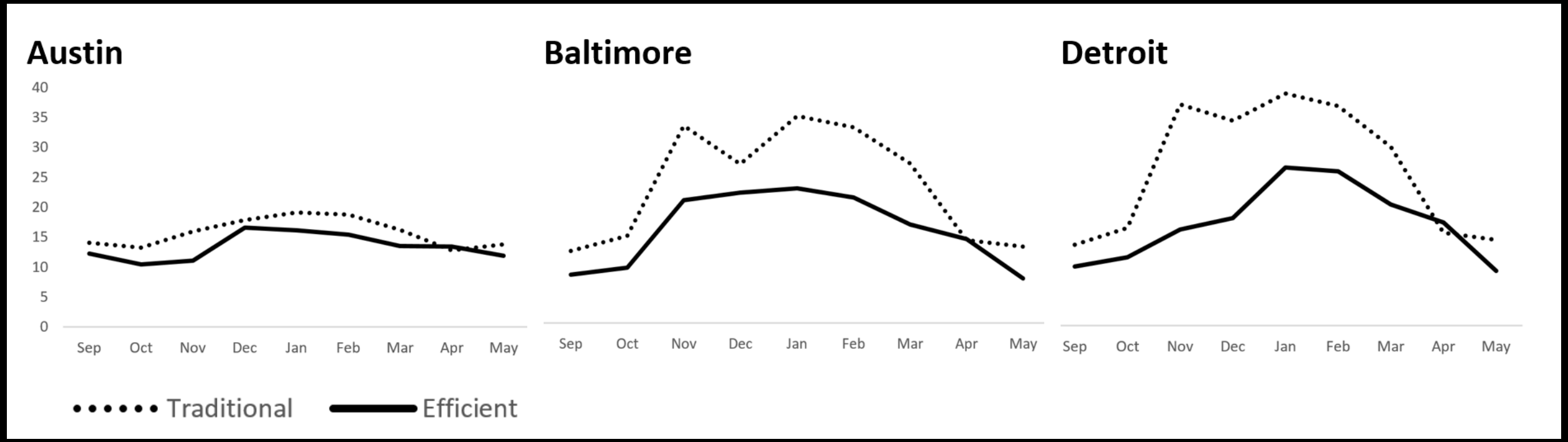

Polish males
Polish females
Slovak males
Slovak females
650
600
550
500
450
400
350
300
250
200
School A
School B
School C

Location	Classroom Type	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Detroit	Traditional	13.4	16.2	36.7	34	38.5	36.4	29.7	15.4	14.2
Detroit	Efficient	9.8	11.3	15.9	17.8	26.2	25.6	20.1	17.1	9.1
Baltimore	Traditional	12.1	14.6	33.0	26.6	34.7	32.8	26.7	13.9	12.8
Baltimore	Efficient	8.0	9.3	20.5	21.8	22.5	21.0	16.5	14.0	7.5
Austin	Traditional	14	13.2	15.9	17.8	19.1	18.7	16.2	12.8	13.8
Austin	Efficient	12.2	10.4	11.1	16.6	16.1	15.4	13.5	13.4	11.9


Average energy (kWh)
50
40
30
20
10
0
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Detroit Traditional
Detroit Efficient
Baltimore Traditional
Baltimore Efficient
Austin Traditional
Austin Efficient


35
30
25
20
15
10
5
0
Average kWh
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Traditional
Efficient


25
20
15
10
5
0
Average daily kWh
15.35
21.59
Efficient
Traditional


Austin
40
35
30
25
20
15
10
5
0
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Traditional
Efficient
Baltimore
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Detroit
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May

Country	*Gold*	*Silver*	*Bronze*	*Total*
USA	36	38	36	**110**
China	51	21	28	**100**
Russia	23	21	29	**73**
Britain	19	13	15	**47**
Australia	14	15	17	**46**
Germany	16	10	15	**41**
France	7	16	18	**41**

Country	*Gold*	*Silver*	*Bronze*	*Total*
China	**51**	21	28	100
USA	**36**	38	36	110
Russia	**23**	21	29	73
Britain	**19**	13	15	47
Germany	**16**	10	15	41
Australia	**14**	15	17	46
S. Korea	**13**	10	8	31

STEM classes need to teach students about the rhetorical choices they have in presenting data

Language classes need to prepare students for civic discussions about numbers

We need teacher training that encourages educators to cross traditional disciplinary boundaries

“In life numbers are everywhere and cannot be segregated into one subject and left out of others, as often happens when we build our academic cubbyholes.”

Robert Orril
Executive director
National Council on Education and the Disciplines

Questions? Comments?

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