

# Statistical Literacy

Presentation to CASS

March 18, 2022

## **Acknowledgement of Territory**

"The University of Alberta acknowledges that we are located on Treaty 6 territory, and respects the histories, languages, and cultures of First Nations, Métis, Inuit, and all First Peoples of Canada, whose presence continues to enrich our vibrant community."

## **Reconnaissance des territoires**

"L'Université de l'Alberta reconnaît qu'elle est située sur les terres du Traité 6 et respecte les histoires, les langues et les cultures des Premières Nations, des Métis, des Inuits et de tous les peuples autochtones du Canada, dont la présence continue d'enrichir notre communauté si vivante."

# Today:

- Introduction to Project
- What is Statistical Literacy?
  - What do you know about probability
- Research Literature and Statistical Literacy
- Tasks and Interview Questions
- Early Findings: Principals Knowledge, attitude and uses of statistics
- Future activities
- Conclusion





# Who are we?

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# What is the project?



Four - year national project to examine Canadian school principals' statistical literacy in Alberta, British Columbia, Ontario

20 principals interviewed twice via Zoom, with transcripts and recordings for professional development

Both English- and French-speaking school administrators participate anonymously

Study of statistical literacy, not an examination of mathematical skills. Overlaps with numeracy and data fluency

# What are our assumptions?



## Presumptions:

- language is important when interpreting numbers - it is not all about mathematics
- numbers are central to classroom assessment, survey results, student enrollment figures
- numbers are represented through graphs, charts and a variety of other visual displays
- school principals are leaders who read and model numeracy before staff, teachers, parents, communities

# What do you know about probability?

In a class, there are 12 boys and 16 girls. One of them is called out by an enrollment number. What is the probability that the one called is a girl?

- A.  $\frac{1}{4}$
- B.  $\frac{2}{5}$
- C.  $\frac{5}{12}$
- D.  $\frac{4}{7}$



# What does the research literature say?

- What is probability?
- What is statistical literacy?
- How does language affect statistical reasoning ?
- How are statistics used in reasoning?





# Probabilité



- Processus d'**évaluation** et de **jugement** en vue de prendre des **décisions**.
- Pas seulement les mathématiques mais aussi la philosophie (Scheemaekere, 2012).

**Vision épistémique** (degré de croyance rationnelle).

**Vision fréquentielle** (observation d'un événement stochastique).

**Vision bayésienne** (degré de croyance subjective).

# Littératie statistique et raisonnement statistique



La littératie statistique d'après Pierce, Chick, Watson, Les et Dalton (2014):

- Interpréter et évaluer des données statistiques.
- Discuter des significations, des implications et des préoccupations.
- Déduire des actions pédagogiques.

**Trois niveaux du raisonnement:**

- Niveau inférieur
- Niveau intermédiaire
- Niveau supérieur

# La langue et le raisonnement



- Difficile de parfois traduire certains concepts de probabilité dans le langage quotidien et vice versa.
- Impact des variations linguistiques sur le raisonnement statistique.
  - Français belge : 71 % (**Septante et un** pour cent).
  - Français canadien: 71 % (**Soixante et onze** pour cent).
- Séparateur des milliers et des décimal qui diffère d'une langue à l'autre.
  - Exemple: 3,900 km vs 3.900 km

# What is Statistical Literacy?

A model of statistical literacy from Watson (1997) includes three levels:

- basic understanding of terminology;
- statistical understandings when embedded in societal contexts;
- and being able to have a questioning attitude about statistical claims (cited in Gal & Murray, 2011).

# What is Probability?



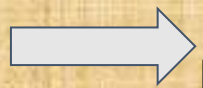
Probability has two basic meanings & types:

- *stochastic* models-based frequency-type understandings of chance and randomness; eg rolling a die
- and *non-stochastic* models based on belief-type understandings of degrees and reasonableness of outcomes “devoid of statistical background” eg. placing a bet (Liu & Thompson, 2007)

# How do we use statistics when deciding?



- Senior policy makers require “objective empirical information to reach optimal decisions” (Gal & Murray, 2011)
- Mid-level (i.e.school) administrators typically need “statistical information at the finest level of detail available” (Ibid. p.191)



Do people actually use the data? or do they first of all interpret it?

# How does this lead to data collection?

Step 1: Deciding on data display

Step 2: Developing interview prompts

Step 3: Recruiting participants



# What reading material was provided?



Four tasks:

Class level student performance data	mock data
School level health data	mock data
Line graph from PISA 2018 report on reading scores in AB, BC, ON and CN from 2009 to 2018	actual
Boxplot which represent student performance in reading in different countries	mock data



Look at the math column. What is the probability that James, Mary B, Richard will fail? How do you know?



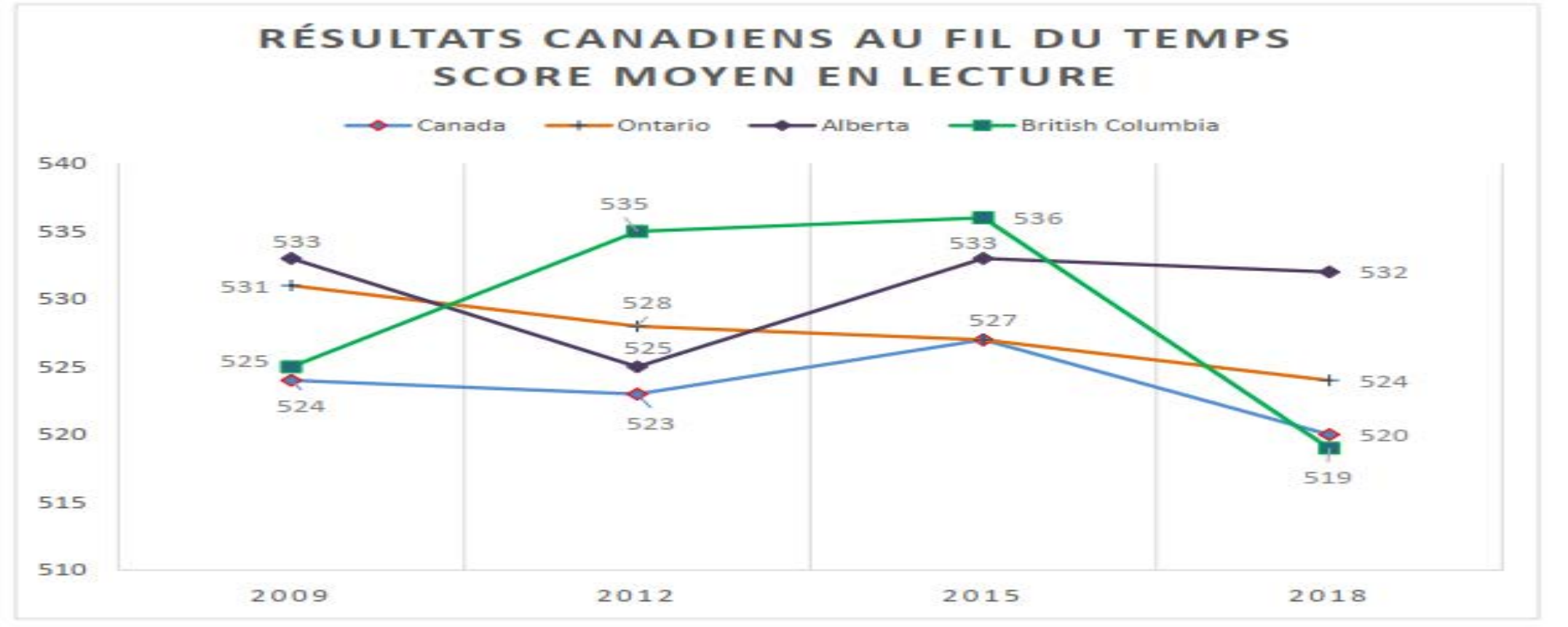
Regardez la colonne 'mathématiques'. Quelle est la probabilité que les élèves James, Mary B et Richard échoueront? Comment le savez-vous ?

Data Display : Secondary										
	English 10	Math 10	Science 10	Wellness 10	Arts Education 10	Attendance	Provincial Assessment	Division-wide test: Canadian Standardized Reading Level	Division-wide test: Canadian Standardized Math Level	Notes
Anderson, James	81	48	65	85	56	65	absent	Grade 9	Grade 5	Mother is school board chair
Amil, Tamir	51	50	65	95	44	5	not registered at time of test	Grade 2	Grade 8	Neo-immigrant ESL student
Bohach, Mary	47	47	65	88	59	87	3	Grade 6	Grade 10	Mother is mayor
Johnson, Richard	99	56	66	81	33	85	3	Grade 11	Grade 4	Local Junior B hockey star
Kennedy, Helen	88	67	63	96	61	86	3	Grade 10	Grade 9	
Mazokowski, Alicia	79	49	65	96	60	87	3	Grade 10	Grade 11	Father is Superintendent
Redman, Joan	96	55	64	89	66	87	4	Grade 12	Grade 9	
Rockford, Allison	89	68	65	87	60	80	3	Grade 7	Grade 9	
Stonechild, Ralph	65	32	0	98	87	55	absent	Grade 6	Grade 10	On reserve; attended FN school last year
Vonish, Mary	33	77	65	88	59	87	4	Grade 10	Grade 10	
	x/100	x/100	x/100	x/100	x/100	x/87 classes	x/4 point scale where 4 is high	Reading grade level	Math problem-solving level equivalent	

How would you rate the probability of an individual having a higher reading score in your province as compared to other provinces? How would you rate the probability of higher reading scores between your province and the CDN avg?



Comment évalueriez-vous la probabilité qu'une personne de votre province obtienne un meilleur résultat en lecture en comparaison avec les autres provinces ? Comment évalueriez-vous la probabilité que les résultats en lecture de votre province soient plus élevés que la moyenne canadienne ?



# What are interviews so far revealing?



The Principals we have talked to so far...

- want to know the context of the numbers : e.g. the story behind the numbers
- consider themselves to be “data driven” but not statisticians
- feel more comfortable interpreting data presented in familiar formats
- prefer to interpret data with others
- correlate participation rates with reliability
- don't reason with quantitative measures of probability (e.g.  $p < .05$ )
- don't like to compare themselves with other schools or jurisdictions

# Quote from a BC School Principal



“Les statistiques, j'ai toujours eu cette impression dans mon propre parcours en mathématiques que c'était la partie où j'étais moins confortable. C'est bizarre et finalement, j'ai moins creusé donc d'où je les tire mes concepts ? Quand je dis une chance sur deux ( $\frac{1}{2}$ ) ou 75 % de chances, c'est vraiment basé sur mon **expérience**, mon **intuition** et puis le **contexte de la personne**”.

- Directeur d'une école élémentaire en BC

# Quote from an Alberta School Principal



“Yeah. I mean probability, you know, you’re-- I guess you are tying in or tapping into your experience and saying well, the probability of that happening again is probably quite likely, where I think your statistics is you’re using actual hardcore data.”

-Alberta Elementary Principal

# Future Directions of the Project



2022/23 – Effect Size/Causality

2023/24 – Sampling Error/Representativeness

2024/25 – Common Misconceptions



# What should we be doing but still overlooking?



*“developing an understanding of school leaders', specifically principals' statistical competency, is one step toward a broader and more significant goal -- building the statistical skills of all adults. School principals are role models for students, teachers, parents, and community members. When principals understand, use and explain statistics easily and comfortably, they lead the way for their communities as a whole.” Dr. D. Hunter.*

Your feedback is appreciated on planned professional learning activities toward building statistical skills for Principals? For all adults?

Q & A







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