



THE NECESSITY OF REVISING PRIMARY SCHOOL CONTENT OF PROBABILITY IN EGYPT TO ENHANCE STUDENTS' PROBABILISTIC REASONING

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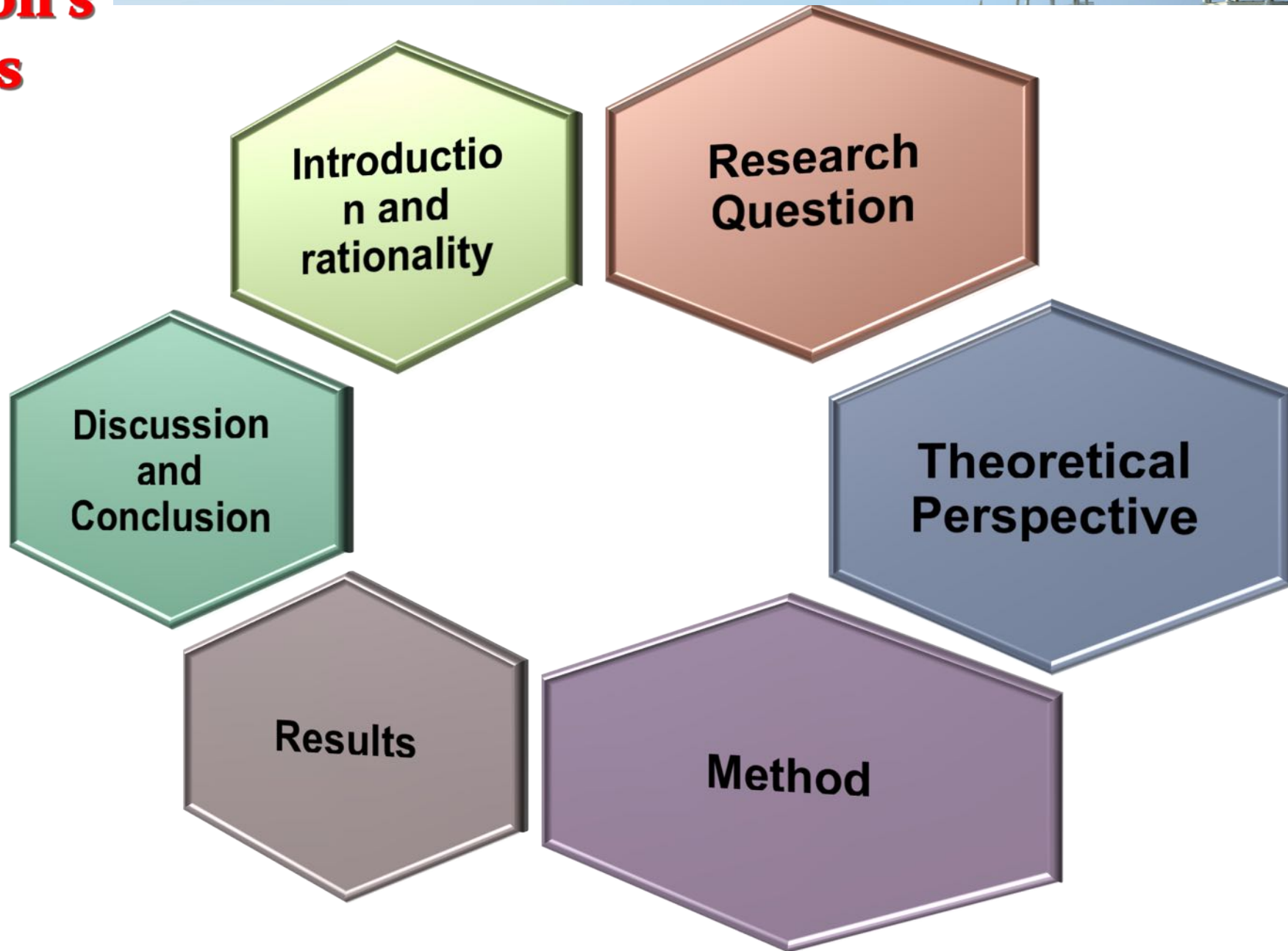
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Presentation's Outlines





- According to Hacking (1990), “the most decisive conceptual event of the twentieth century has been the discovery that the world is not deterministic”.
- The term “**probabilistic revolution**” signals a shift from a deterministic conception of reality, phrased in terms of universal laws of stern necessity, to one in which probabilistic ideas have become central. Besides, viewing chance as an integral part of natural phenomena (Kruger, Daston & Heidelberger, 1987).

▪ Although, long discussion through mathematics education platform tends to focus on developing students’ mathematical thinking that has deterministic and logical characteristics. **Enhancing students’ probabilistic reasoning is the central concern in the case of probability education.**

▪ **Probabilistic reasoning** refers to make a decision under uncertainty whenever the randomness and variability are recognized (Falk and Konold, 1992; Savard, 2014). Hence, teaching probability seeks to **overcome students’ deterministic**



- Many challenges in the area of probability education have been stated through literatures. While many researchers agrees on lack of teacher preparation to teach such content (Batanero, *et al.*, 2004; Pecky and Gould, 2005; Ainley and Monteiro, 2008). other aggravating factors relevant to the **school textbooks has been identified, for example:**

- It sometimes **presents a too narrow view of probability**, applications are mostly restricted to games of chance, and some of the stated definitions for the probabilistic concepts are incorrect (Batanero *et al.*, 2004 as cited in Chernoff and Sirirman, 2015).

- Batanero *et al.*, (2016) have stated; although, the probability content has been authorized in many different stages from primary to teacher education curriculum. Including a topic in the curriculum does not automatically assure its correct teaching and learning; the specific characteristics of probability, such as a multifaceted view, or the lack of reversibility of random experiments, are not usually found in other areas. this

- Moreover, **the connection among mathematics, statistics, and probability** has been identified as one challenge, which cause a difficulty for students to separate between the idea of chance and the deterministic reasoning that mostly employed in other

□ Rationale of the resear



- This aforementioned situation is crucial in the **context of developing countries, Egypt as well, wherein substantial importance is always assigned to address the textbook activities.** Particularly the case of statistics education as stated by Innabi (2014, p.3) **“Very little research on statistics has been conducted in the Arab world”**. Moreover, the study identified the need to change the educational community perception towards understanding statistics and its importance. Therefore, paying attention to statistics research can be an endeavor to shed light on this area within the discussion of Mathematics education community.

How is the situation within the Egyptian context...



The national textbook activities has been categorized based on the correspondence between the activity's objective and the **Fundamental Statistical Ideas in School Curriculum** that have been identified by Burrill and Biehler (2011)

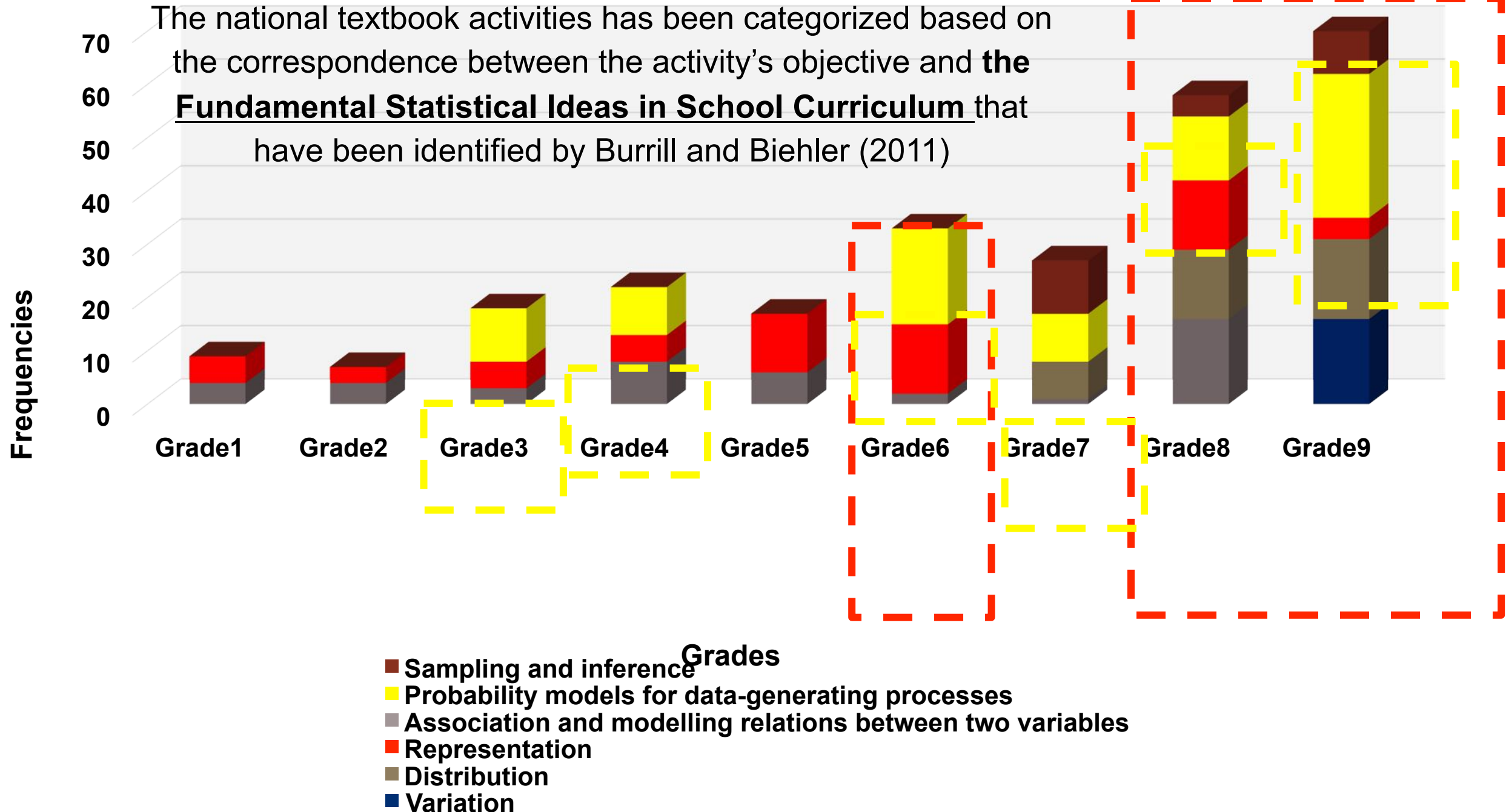


Figure 1. Distributing of the fundamental statistical ideas among elementary school grades

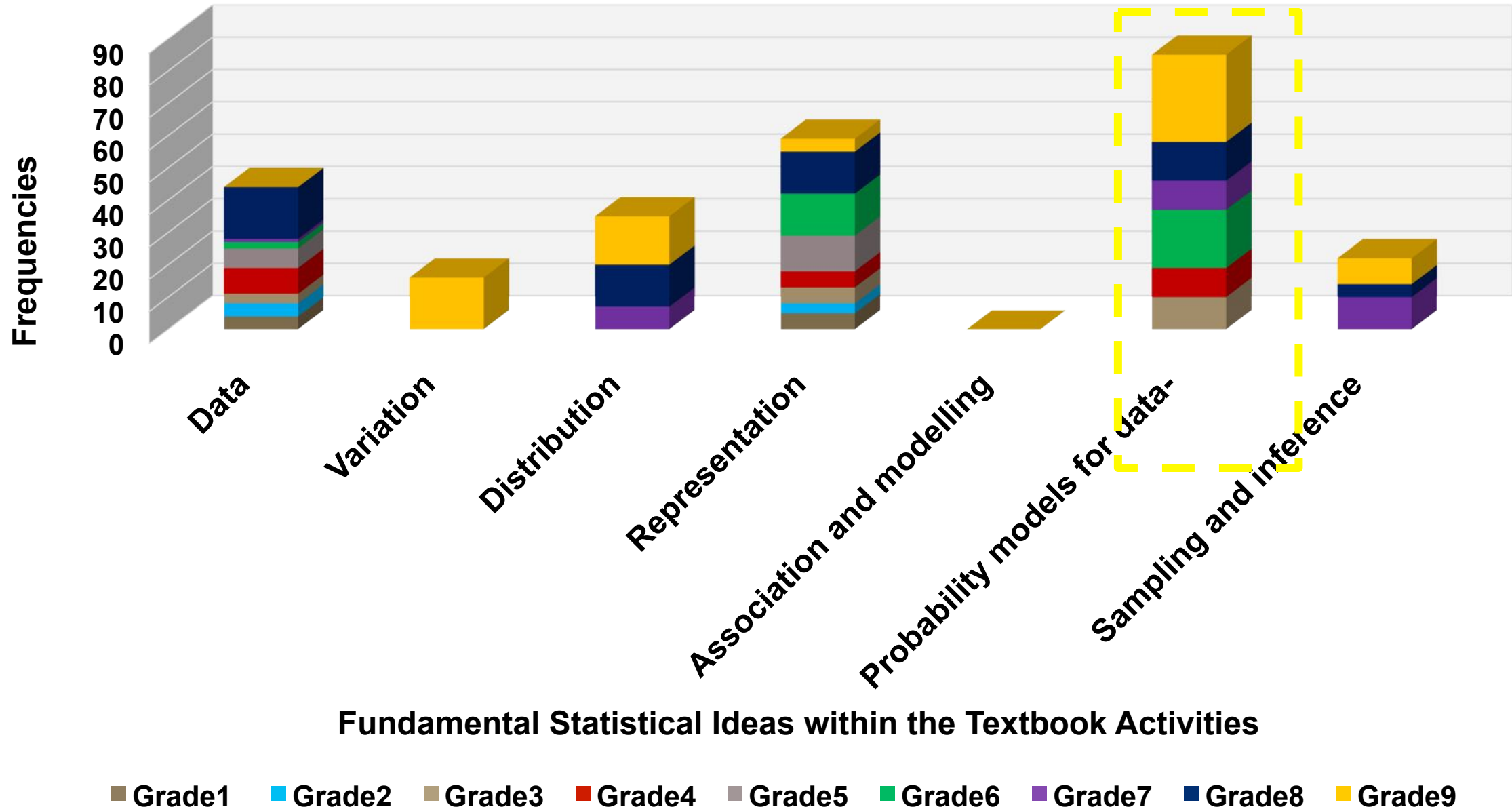


Figure 2. Distributing of the Egyptian textbook activities based on their objectives



Exhibit 3.1: Average Achievement in Mathematics Content Areas

MATHEMATICS
Grade 8

Countries	Average Scale Scores for Mathematics Content Areas				
	Number	Algebra	Measurement	Geometry	Data
Egypt	421 (3.0)	408 (3.9)	401 (3.3)	408 (3.6)	393 (3.2)

Exhibit 3.1 Average Achievement in the Mathematics Content and Cognitive Domains (Continued)

TIMSS2007
Mathematics 8th Grade

Country	Average Scale Scores for Mathematics Content Domains				Average Scale Scores for Mathematics Cognitive Domains		
	Number	Algebra	Geometry	Data and Chance	Knowing	Applying	Reasoning
TIMSS Scale Avg.	500	500	500	500	500	500	500
Egypt	393 (3.1)	409 (3.3)	406 (3.4)	384 (3.1)	392 (3.6)	393 (3.6)	396 (3.4)

Figure 3. Grade 8 Egyptian students' achievement in TIMSS 2003 and 2007

Source: <https://timss.bc.edu/timss2003i/mathD.html> ; <https://timss.bc.edu/TIMSS2007/mathreport.html>

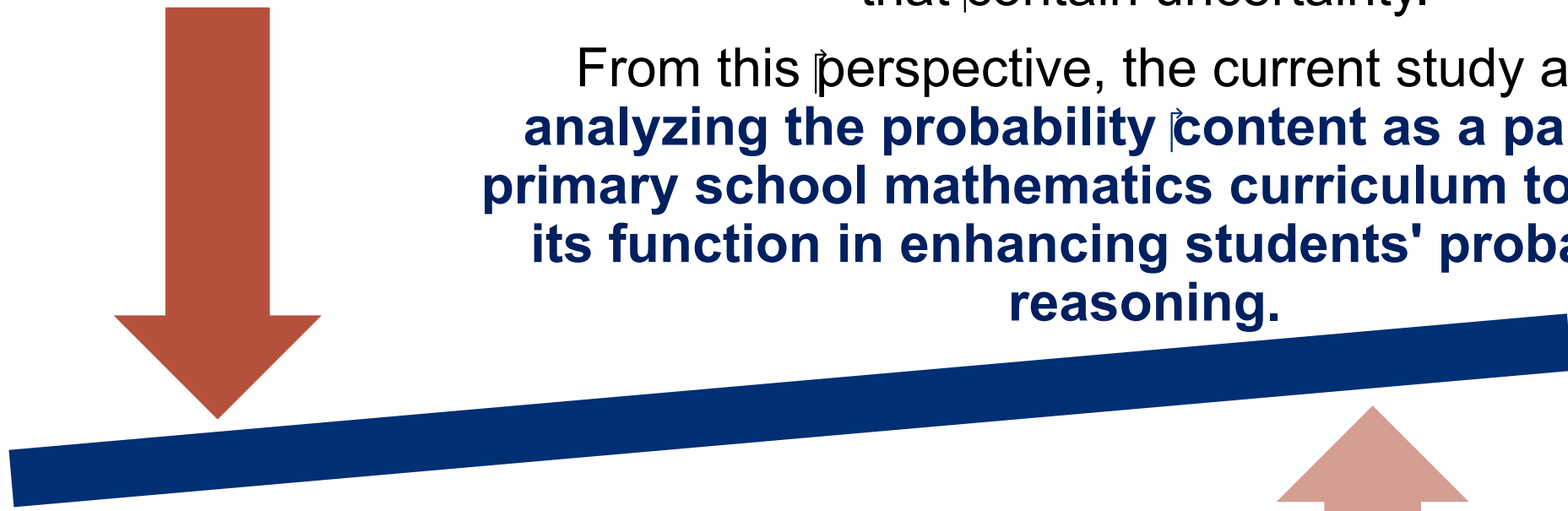
Textbooks have an important role due to their great influence on the process of teaching and learning (Levicoy, 2014). Further, Robitaille and Travers (1992, p. 706, as cited in Levicoy *et al.*, 2018) cite textbooks as a **“significant factor in determining students’ opportunity to learn and their achievement, facilitating the transfer of educative contents in the function of the current curricula guidelines, and constituting a mean to**



□ Research question

Therefore, it is important to reflect on the textbooks' discourse for identifying the possible opportunities given to students to enhance their probabilistic reasoning. Consequently, preparing them to face daily life situations that contain uncertainty.

From this perspective, the current study aims at **analyzing the probability content as a part of the primary school mathematics curriculum to interpret its function in enhancing students' probabilistic reasoning.**



To what extent does primary school content of probability in Egypt provide opportunities to enhance students' probabilistic reasoning?



□ Theoretical Perspective



Probability was conceived from two different perspectives. (1) **A statistical side of probability which is related to the objective mathematical rules that govern random processes.** Complementary to this vision, (2) **An epistemic side views probability as a personal degree of belief, which depends on the information available to the person assigning a probability** (Hacking, 1975). Those two perspectives have been reflected in the works of many authors. Recently, **Batanero et al., (2016)** have summarized the main interpretations of probability which are more suited to be taken

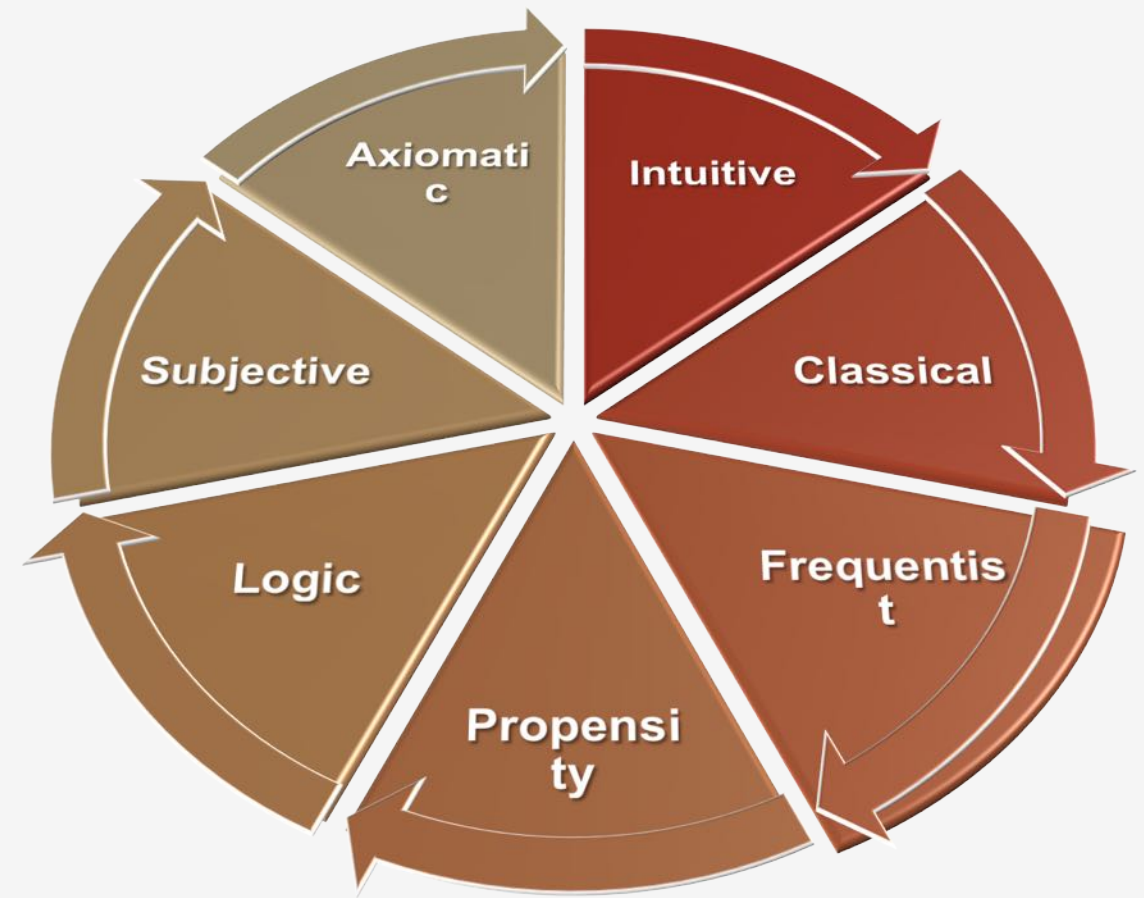
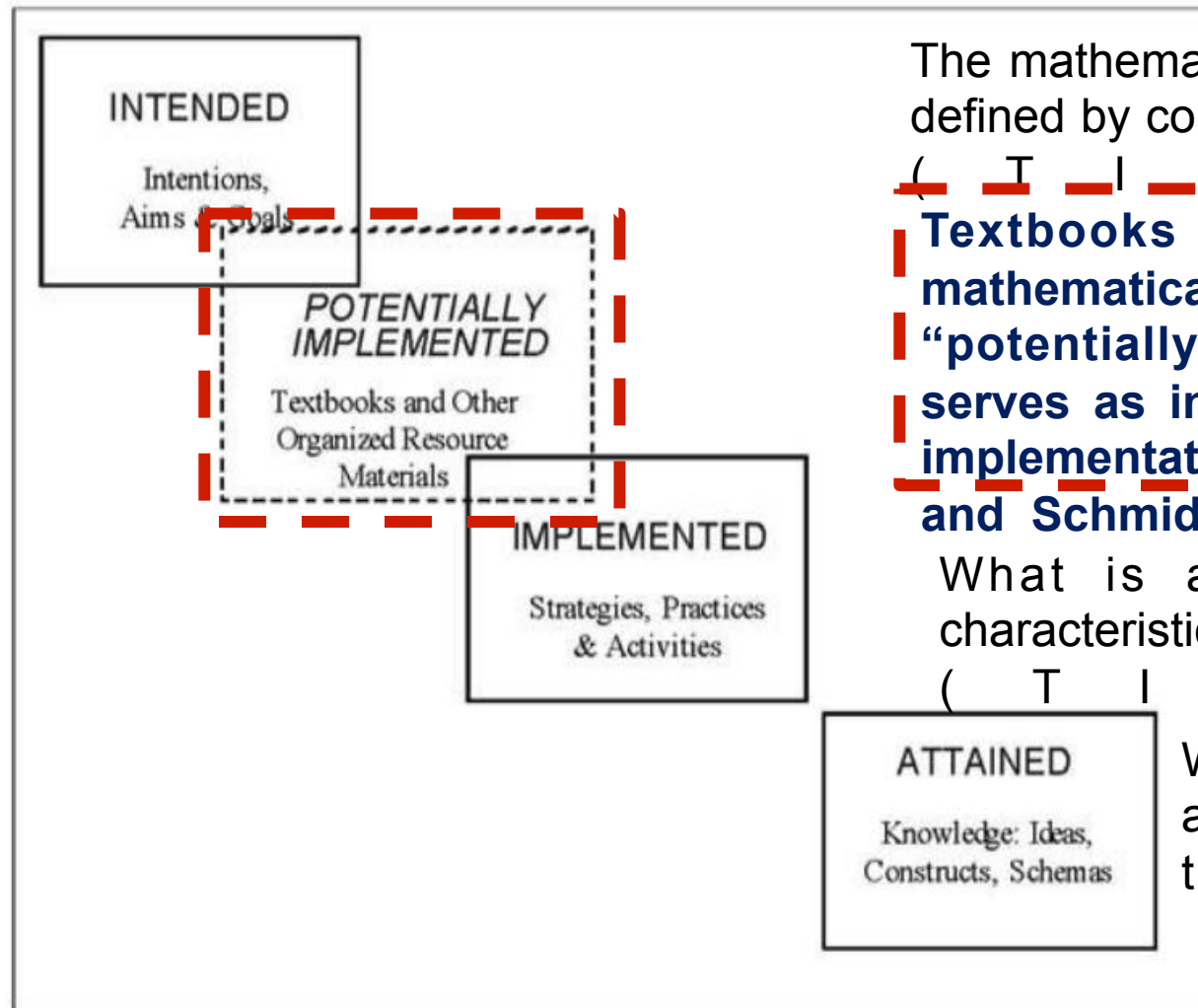


Figure 4 the main interpretation of probability

Source: **Batanero et al., (2016)**



According to TIMSS, Curriculum has been defined through Tri-Partite Model



The mathematics that students are expected to learn as defined by countries' curriculum policies and publications (TIMSS, 2019)

Textbooks provide a more detailed map of mathematical domains and topics. They are the "potentially implementable" curriculum, which serves as intermediaries in turning intentions into implementations ((Schmidt *et al.*, 1997b; Houang and Schmidt, 2008)

What is actually taught in classrooms, the characteristics of those teaching it, and how it is taught (TIMSS, 2019)

What it is that students have learned and what they think about learning these subjects (TIMSS, 2019)

Figure 5. Textbooks, the Potentially Implementable Curriculum.

Source: Schmidt et al., (1997b)



1. Determine primary school content of probability

Lesson 2 Probability

Probability

Certain/Possible/Impossible

(1) Complete by writing "certain", "Possible" or "impossible":

- It is to rain gold.
- It is that the sun will rise in the morning.
- It is that I will get a high grade in mathematics.
- It is to find a man three metres high.

(2) What do we expect?

Imagine that you closed your eyes and stirred the balls in each container very well and drew one ball out of each.

What do you expect the colour of the drawn ball to be in each case?

- The first container:
Complete: It is certain that the ball drawn from the first container will be in colour.
 It is impossible that it will be in colour
- The second container: It is possible that the ball drawn from this container will be in colour.
 It is also possible to be in colour
 It is impossible to be in colour
- The third container:
 It is certain that the ball drawn from the third container will be in colour.
 It is impossible to be in colour

Mathematics 83

Lesson 2

The Probability

Chance for occurrence of a definite event

We learnt that events are either certain, impossible or possible. Also, probability expresses the chance of occurrence of an event. Let the probability of occurrence of a certain event be 1, then the probability of occurrence of a possible event lies between 0 and 1.

Drill 1:
Complete and choose the correct answer (✓) as the example.

Event	Probability degree	Probability of occurrence
Example: Sun rises from east	Certain	Zero, 1, between 0 and 1
Pupil rides a bike to school	Possible	Zero, 1, between 0 and 1
Family visits the seashore every year	Zero, 1, between 0 and 1
Man lives on earth forever	Zero, 1, between 0 and 1
Day comes after night	Zero, 1, between 0 and 1
Weather is sunny tomorrow	Zero, 1, between 0 and 1

Drill 2:
The weather forecast bureau expected that there will be a chance of a sunny day tomorrow with ratio 0.8 and that ratio will change for after tomorrow with a ratio $\frac{3}{4}$. Which of the two days will be of greater probability of being sunny, tomorrow or after tomorrow?

Second Term Primary stage - Year 4

4-1

Experimental Probability

Let's play

You will learn:

- To find the probability from an experiment or a sample.
- To predict using a given probability.

When you toss one coin there are two possible ways the coin can land either head H or tail T.

The class is divided into groups. Each group tosses a coin 10 times, 20 times, 50 times and 100 times then observe the results and record them in the following table:

number of tossing a coin	number of occurrence of heads	number of occurrence of tails
10 times		
20 times		
50 times		
100 times		

Key Terms:

- Experimental probability
- Experiment
- Sample
- Prediction

Notice: Increasing the number of tossing a coin tells the fact that the number of occurrence of heads is nearly equal to the number of occurrence of tails.

For instance, tossing a coin 1000 times the numbers of occurrence of heads may be 508 times while the number of occurrence of tails may be 1000 - 508 = 494 times.

It is said: the probability of occurrence of heads in 1000 times = $\frac{508}{1000} = 0.508$ while the probability of occurrence of tails in 1000 times = $\frac{494}{1000} = 0.494$

Mathematics - Fifth Primary

4-2

Theoretical Probability

Think and Discuss

Discuss with your teacher the following experiments, their outcomes and the sample space of each:

Experiment 1:
Tossing a regular coin and observing the outcomes.
Outcomes: There are 2 possible ways the coin can land: heads (H) or tails (T).
Sample space: S = {H, T}

Experiment 2:
Rolling a regular number cube numbered from 1 to 6.
Outcomes: All possible outcomes are 1, 2, 3, 4, 5, or 6.
Sample space: S = {1, 2, 3, 4, 5, 6}

Experiment 3:
Having a baby and determining the gender of the newborn baby.
Outcomes: a boy (B) or a girl (G).
Sample Space: S = {B, G}

Experiment 4:
Playing a football game and determining the result of a team.
Outcomes: All possible outcomes are win, or or

Sample Space: S { , }

Key - terms:

- Theoretical probability
- Outcomes of an experiment
- Sample space

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Unit Four

3 The probability

Notice and discuss:

We have studied in the previous lesson the sample space of a random experiment we knew that the sample space is the set of all possible outcomes for a random experiment.

We denote to the sample space by (S), its elements number by n (S).

Example (1):
In the experiment of tossing a regular coin and observing the appearing face, set of sample space is S = {H, T}, n(S) = 2

Example (2):
In the experiment of tossing a regular die, observing the number appearing on the upper face, set of sample space is S = {1, 2, 3, 4, 5, 6}, n(S) = 6

Example (3):
A card is drawn from 5 symmetrical cards numbered from 1 to 5 without looking at them, so the sample space = {1, 2, 3, 4, 5}, n(S) = 5

Event: Any outcomes you can get inside a random experiment are called events.

Example (4): Tossing a regular die once, observing the number appearing on the upper face, consider the following events:

The event (A) appearance of an even number on the upper face.
 The event (B) appearance of an odd number on the upper face.

Solution:
 Sample face S = {1, 2, 3, 4, 5, 6}, n(S) = 6
 Event A = {2, 4, 6}, n(A) = 3
 Event B = {1, 3, 5}, n(B) = 3

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Statistics and probability

2 Random experiment

Think and discuss:

One of the maths teachers showed his students in one of the classes of the primary six a coin (one pound) and they had this dialogue between him and his students.

The teacher: If a coin is tossed on the table or on the earth, what is the appearance face.
Adel: Either head or tail.

The teacher: well but why?
Adel: I am sure that the result is either head or tail, and not other wise.

The mathematical concept:
 Random experiment
 - Sample space or outcomes space

The teacher: Who can determine the appearance face before tossing the coin.
Hanan: No, but after tossing the coin we can be able to determine the appearance face.

The teacher: This means that, we can't predict (issuing a decision) that the result is either head or tail such experiment is called is a random experiment.

The random experiment: It is an experiment in which we can determine all its possible outcomes before carrying it, but we can't predict in certainty which of these outcomes will occur when the experiment is carried out.

Some examples for random experiments and their outcomes.

Random experiment	Possible outcomes
Tossing a coin once	Head (H), Tail (T)
Tossing a die once, observing the number of points on the upper face	1, 2, 3, 4, 5, 6
A ball is selected at random from a box which contains three symmetric balls (red, yellow, green)	Red, yellow, green
Carrying a game between your football team, other team from another school	Your team wins, your team is beaten, both of the two teams equalize

Mathematics for sixth-grade primary 2017 - 2018



2. to analyze textbooks' content of probability, **Onto-Semiotic Approach (OSA)** which is a semiotic and anthropological approach to deal with the meaning of mathematical objects in a personal and in an institutional level, has been employed to identify its primary entities. According to OSA, the primary entities of probability have defined by situations, propositions, procedures, and language (Godino, 2003; Gómez and Contreras, 2014)

Table 1. operational definition of OSA entities

Situation	Propositions	Procedures	Language
What are the probabilistic activities, tasks that has been discussed within the lesson discourse?	What are the properties, theories, relationships that connect the concepts to each other?	What are the suitable algorithms, techniques that can be applied to perform a given situation?	What are the terms, expressions, notations that has been embedded within the lesson discourse to operate a given situation?
e.g., tossing a coin	e.g., relationship between the event and the sample space	e.g., $P(H) = n(H)/n(S)$	e.g., H, T, P(A), fairness, randomness

3. Categorizing the deducted primary entities of probability through probability main interpretations (Batanero et al., 2016)

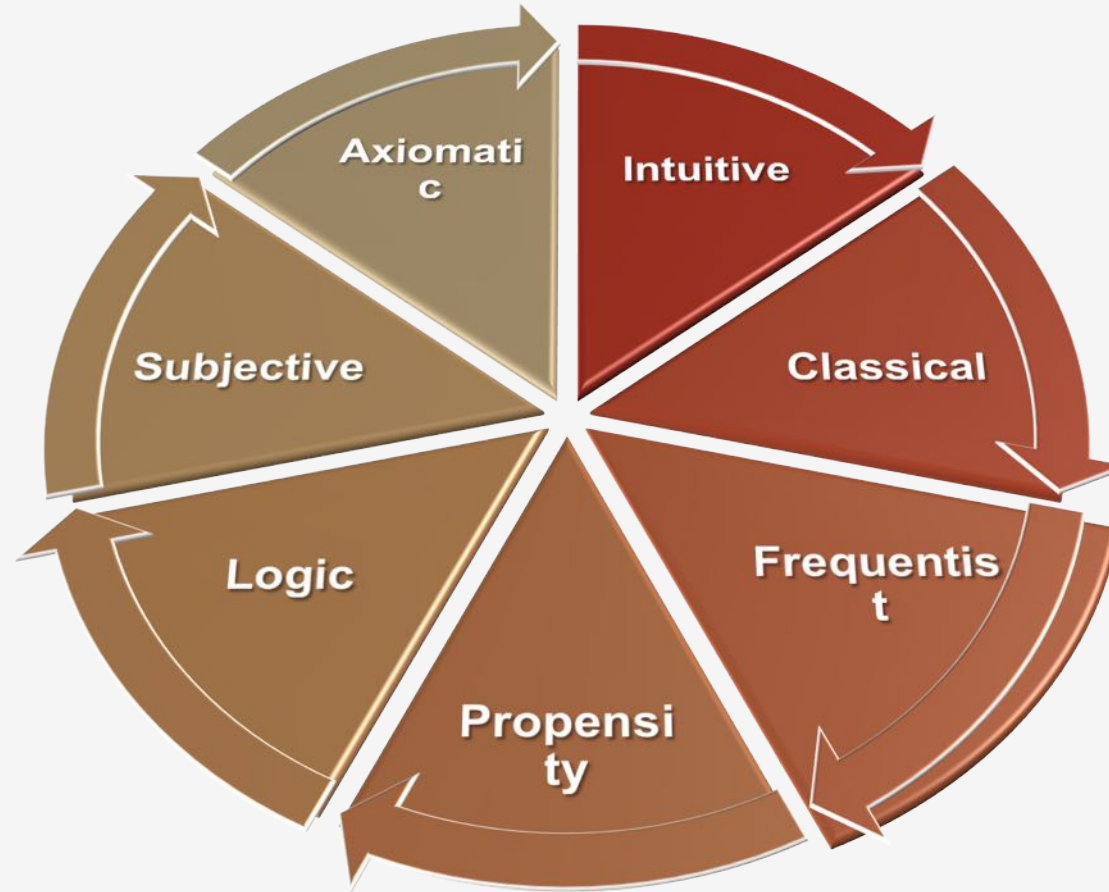




Table 2. Primarily identifies entities of probability content within the school textbook

Intuitive Meaning

Situations	Propositions	Procedures	Term and embedded concepts
<ul style="list-style-type: none"> - Use students' daily life context to grasp certain, possible, and impossible events <u>(3rd G)</u> - Discuss the meaning of great and moderate probability <u>(3rd G)</u> - Handle students' personal judgments to determine the degree of probability <u>(4th G)</u> 	<ul style="list-style-type: none"> - Relationship between possible, impossible, certain events and personal expectations <u>(3rd G)</u> - Relationship between types of events and its probability <u>(3rd, 4th G)</u> 		<ul style="list-style-type: none"> - Guess, expect, and predict <u>(3rd: 6th G)</u> - Great, moderate, less, weak and none <u>(3rd : 6th G)</u> - Certain, possible, and impossible event <u>(3rd, 6th G)</u> - Defective Vs functional <u>(5th G)</u> - Success Vs failure <u>(5th G)</u>



Intuitive meaning

Probability is an encapsulation of intuitive views of chance which leads to idea of assigning numbers to uncertain events. Therefore, in that view we use qualitative expressions (e.g., probable and unlikely) to express the degrees of belief in the occurrence of random events.

Guess and expect :

- (1) Assume (as we did previously) that someone closed his eyes and stirred the balls in every container very well and then drew one ball from each container. Can you decide the number of the container from which:



(1)



(2)



(3)

You expect to great extent that the drawn ball will be:

- (a) red (container number)
- (b) yellow (container number)
- (c) Blue (container number)

You expect to a less extent that the drawn ball will be:

- (d) blue (container number)
- (e) red (container number)



Table 3. Primarily identifies entities of probability content within the school textbook

Classical Meaning

Situations	Propositions	Procedures	Term and embedded concepts
<ul style="list-style-type: none"> - Introduce and discuss the theoretical meaning of probability $P(A)$ through some random experiments (e.g., tossing a coin, rolling a dice) <u>(4th: 6th G)</u> 	<ul style="list-style-type: none"> - Tossing two coins/dice once is equivalent to tossing one coin/dice two consecutive times <u>(6th G)</u>. - Relationship between the sample space and event $(A \subset S)$ <u>(6th G)</u>. 	<ul style="list-style-type: none"> - Apply the theoretical probability law, $P(A) = \frac{\text{number of favorable outcomes } n(A)}{\text{all possible outcomes } n(S)}$ <u>(3rd: 6th G)</u> - Determine the probability of impossible, possible, and certain events <u>(3rd G)</u> 	<ul style="list-style-type: none"> - Assume that (3rd G) - Fair coin, H, T, HH, TT <u>(3rd: 6th G)</u> - Equally likely, Same color, symmetric, identical <u>(4th: 6th G)</u> - Ratios, decimals, and percentages <u>(4th G)</u> - All possible outcomes <u>(4th: 6th G)</u> - Odd, even, prime, divisible by, greater or smaller than or between, and 2-digit number <u>(3rd: 6th G)</u>
<ul style="list-style-type: none"> - Discuss the sample space and assigned probability of some events <u>(5th G)</u>. 	<ul style="list-style-type: none"> - Relationship between the type of an event and its probability (e.g., if $A = \phi$, then $n(A) = 0$. So, $P(A) = 0/n(S) = 0$; $P(S) = 1$) <u>(6th G)</u>. 	<ul style="list-style-type: none"> - Compare among decimals, fractions and percentages <u>(4th, 6th G)</u> 	<ul style="list-style-type: none"> - Sample space (S) <u>(5th, 6th G)</u> - Theoretical probability <u>(5th, 6th G)</u> - Random experiment <u>(6th G)</u>
<ul style="list-style-type: none"> - Explain the meaning of the random experiment <u>(6th G)</u>. 	<ul style="list-style-type: none"> - The probability can be written as a 	<ul style="list-style-type: none"> - Determine elements of the sample space for one and two stages random experiment <u>(4th: 6th G)</u> 	<ul style="list-style-type: none"> - Tree diagram <u>(6th G)</u>. - $S, n(A), n(S), \%, \boxed{?}, P(A), P(\boxed{?}), P(\boxed{?} S)$ <u>(6th G)</u>
<ul style="list-style-type: none"> - Identify the 			<ul style="list-style-type: none"> - inequality $B \geq$ <u>(6th G)</u>



C l a s s i c a l / t h e o r e t i c a l m e a n i n g

Probability is a fraction of the number of favorable cases to a particular event divided by the number of all cases possible under the assumption that all possible events are equiprobable

Drill 5:

A box contains 4 blue balls, 2 red balls, and 3 green balls, all equal in size. If a ball is drawn blindly, complete.

a Probability of drawing a blue ball = $\frac{4}{\dots}$

b Probability of drawing a red ball = $\frac{\dots}{9}$

c Probability of drawing a green ball = $\frac{\dots}{\dots}$

d Probability of drawing a non-blue ball = $1 - \frac{\dots}{\dots} = \dots\dots\dots$

e Probability of drawing a non-red ball = $1 - \frac{\dots}{\dots} = \dots\dots\dots$

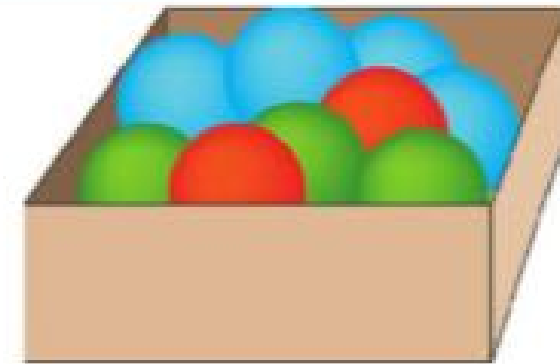




Table 4. Primarily identifies entities of probability content within the school textbook

relevant to the
Frequentist Meaning

Situations	Propositions	Procedures	Term and embedded concepts
<ul style="list-style-type: none"> - Doing a simple random experiment of tossing a coin 10, 20, 50, 100 times (5th G) - Proposing a survey to ask students about preferred sport and language (5th G) - Predicting the favorable cases through knowing the probability of a small sample (5th G) - Inference into the probability 	<ul style="list-style-type: none"> - Relationship between experimental and theoretical probability (e.g., expecting the number of times to get even number when rolling a number cube 250 times) (5th G) 	<ul style="list-style-type: none"> - Applying the experimental probability law (number of outcomes / number of trails) (5th G) - Calculate the expected times of occurrence by knowing the probability of previous trails (5th G) 	<ul style="list-style-type: none"> - Tossing a regular coin (5th G) - Survey (5th G) - Sample (5th G) - Experimental probability (5th G) - Favorable breakfast, preferred language, and favorite game (5th G)



Frequentist / experimental meaning

Probability is the hypothetical number towards which the relative frequency tends when a random experiment is repeated infinitely many times (empirical tendency).

Example

The opposite table shows the result of a survey of asking 40 students about their favorite breakfast.

What is the probability of choosing fowl and tamaya?

What is the probability of choosing pies?

What is the probability of choosing cheese and dessert?

If the number of student is 400 students. How can you predict about the number of students choosing fowl and tamaya?

Breakfast	
Foul and tamayia	20
Pie	4
Cheese and dessert	16





Table 5. Primarily identifies entities of probability content within the school textbook

relevant to the
Axiomatic Meaning

Situations	Propositions	Procedures	Term and embedded concepts
<ul style="list-style-type: none"> - Discuss the relationships among all possibilities of some random experiments (<u>4th: 6th G</u>) 	<ul style="list-style-type: none"> - For $A \subset S$, $0 \leq p(A) \leq 1$ (<u>4th: 6th G</u>) - the sum of probabilities for all possible events = 1 (<u>4th G</u>) - Relationship between the probability of an event and its complementary (e.g., success vs failure, defective vs functional) (<u>4th, 5th G</u>) 	<ul style="list-style-type: none"> - Calculate the probability of a complementary event (<u>4th G</u>) - Calculate the probability of event A union B (<u>4th, 5th G</u>) 	<ul style="list-style-type: none"> - Subset (<u>5th G</u>) - A or B ($A \cup B$) (<u>5th G</u>)



Axiomatics meaning

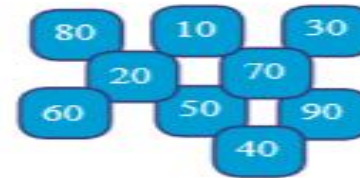
Probability is any function defined from A in the interval of real numbers $[0,1]$ that fulfils the following three axioms: 1. $0 \leq P(a) \leq 1$, for every $a \in A$; $P(S) = 1$

(a) For a finite sample space S and incompatible or disjoint events A and B , i.e., $A \cap B = \emptyset$, it holds that $P(A \cup B) = P(A) + P(B)$. (b) For an infinite sample space S and a countable collection of pairwise disjoint sets A_i , $i = 1,2, \dots$ it holds P

Example (5) :

A box contains 9 symmetric cards each carries a number from the numbers (10 to 90) they are mixed well, then one card is selected at random find the probability of the following events.

- 1 - The event A , where A is a number that is divisible by 5.
- 2 - The event B , where B is a number that is divisible by 3.
- 3 - The event C where C is an odd number.



Solution :

Samplespace is $S = \{10, 20, 30, 40, 50, 60, 70, 80, 90\}$, $n(S) = 9$.

- The event $A = \{10, 20, 30, 40, 50, 60, 70, 80, 90\}$ et $n(A) = 9$

$$, \text{ then } P(A) = \frac{\text{number of elements of the event } (A)}{\text{number of elements of the event } (S)}$$

$$= \frac{n(A)}{n(S)} = \frac{9}{9} = 1 \quad (\text{certain event})$$

- The event $B = \{30, 60, 90\} \subset S$, $n(B) = 3$

$$\text{The } P(B) = \frac{\text{number of elements of } B}{\text{number of elements of } S}$$

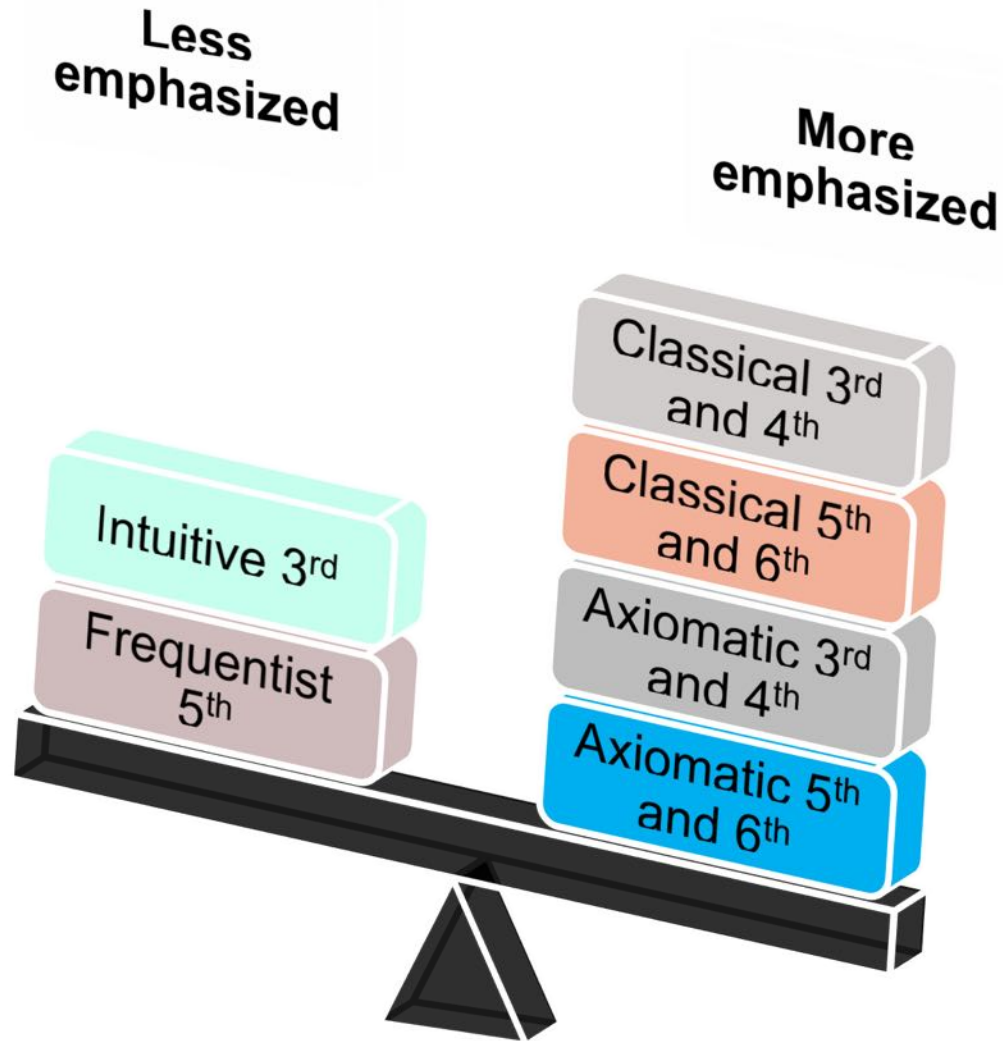
$$\frac{3}{9} = \frac{1}{3} \approx 0.33 = 33\%$$

- The event $C = \varphi$ (Impossible event) then $n(C) = 0$

$$\text{Then } P(C) = \frac{n(C)}{n(S)} = \frac{0}{9} = 0$$

In a box, there are 5 red balls, 3 blue balls and 7 green balls, equal in size. A ball is drawn blindly. Answer the following questions.

- a** what is the probability that the drawn ball is blue?
- b** What is the probability that the drawn ball is green?
- c** What is the probability that the drawn ball is not red?



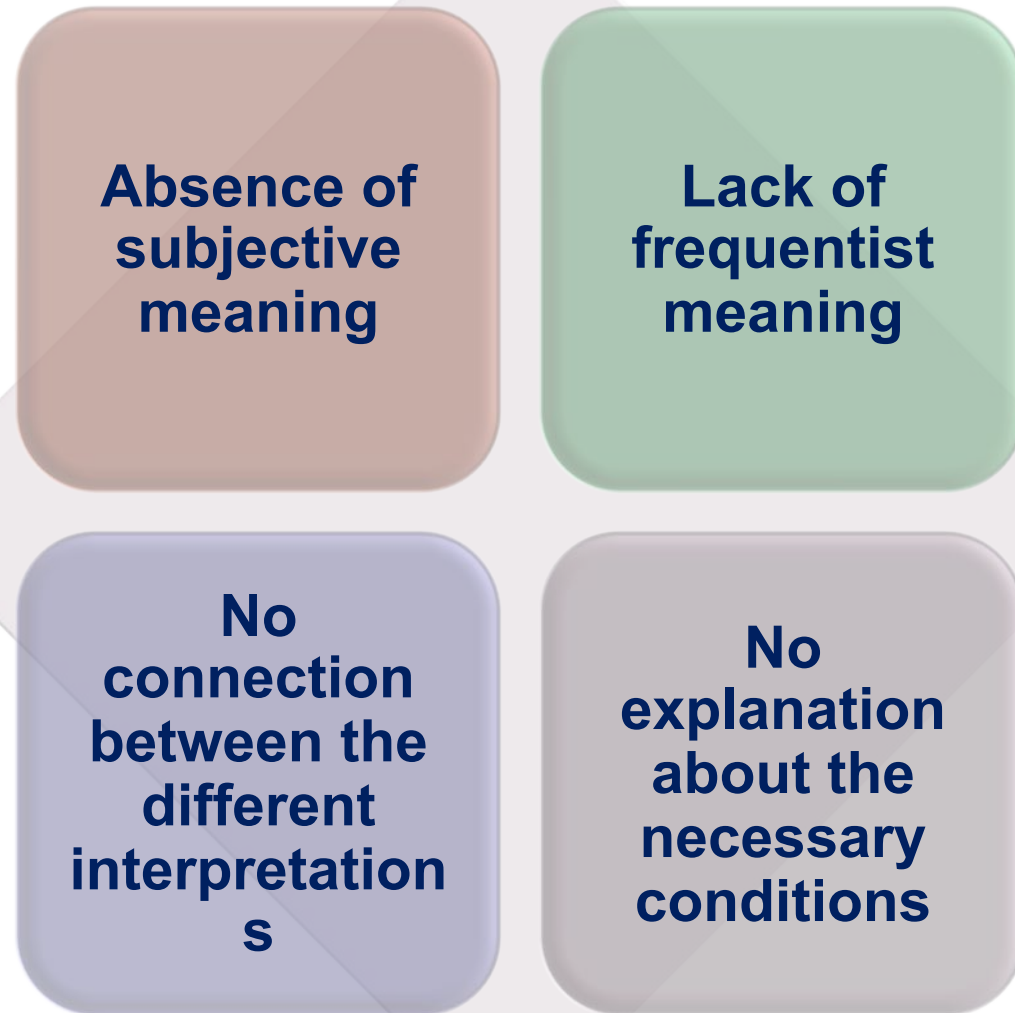
- Using Hacking's explanation to look into the revealed results wherein four interpretations of probability have been discussed through the national textbook (**intuitive, classical, experimental, and axiomatic**). it's clear that most of the textbook's arguments have considered only **the statistical side of probability through emphasizing the mathematical rules**.
- the subjective meaning that defines probability as a personal degree of belief and can be updated with new information through Bayes theorem (Batanero, 2005 as cited in Gómez and Miguel, 2014) **hasn't been approached and seems to be ignored**.

Table 6. key components of prominent probability frameworks
(adapted from Mooney et al., (2016))

Study	Probabilistic concepts	Sample	Organization of cognitive levels
Jones et al. (1997)	<ul style="list-style-type: none"> ☐ Sample space ☐ Probability of an even ☐ Probability comparisons ☐ Conditional probability ☐ Independence 	Grades 3 students in U.S.	<ul style="list-style-type: none"> Subjective Transitional Informal quantitative Numerical
Tarr and Jones (1997)	<ul style="list-style-type: none"> ☐ Conditional probability ☐ Independence 	Grades 4-8 students in U.S.	
Watson et al. (1997)	<ul style="list-style-type: none"> ☐ Chance measurements (simple events, likelihood, comparison of events) 	Grades 3,6,9 students in Australia	<ul style="list-style-type: none"> Ikonc Unistructural (U) Multistructural (M) Relational (R)
Watson and Moritz (2003)	<ul style="list-style-type: none"> ☐ Fairness 	Grades 3,5,6,7,9 students in	

- This ignorance can affect **students' probabilistic reasoning**. Wherein in the multi-structural and rational level of probabilistic reasoning, students should recognize the **conditional probability** (Mooney et al., 2014) which is considered a prerequisite for learning the **subjectivist meaning** of probability (Jones et

- **Conditional probability reasoning** is a crucial part of statistical literacy, since it helps making accurate decisions or inferences in everyday life (Batanero and Diaz, 2008). Further, Conditional probability and Bayes' theorem are important ingredients of probability and should not be left out of any standard course in probability. The concepts stand at the "border" between the two different theories of probability (White and Guvot, 2018).
- Lack of discussing the **experimental meaning**. Performing probability experiments encourages pupils to develop understandings of probability grounded in real events, as opposed to merely computing answers based on formulae (Andrew, 2009 as cited in Tsakiridou and Vavyla, 2015). As Konold (1995) stated, when teaching probability predominantly uses a theoretic approach rather than a frequentist one, pupils often develop conceptions about probability
- There is **no connection between the four stated interpretations of probability**. For example. In 3rd grade, the textbook discourse doesn't clarify the relationship between one's personal expectation of an event and how to quantify this expectation using theoretical probability.
- **the necessary conditions** for implementing each interpretation of probability has not been treated.



- This study consider an endeavor to shed light on statistics education research (probability in the current study) in the Arabian community. Furthermore, it can also give insights into the context of teacher education as Stylianides and Ball (2004) has declared understanding the content that policymakers recommend students given the opportunity to learn considers one possible approach for discussing teachers' knowledge. Consequently, deducting what teachers would need to know to successfully enact these opportunities in their classrooms.

Figure 4. Critical points of PSC of probability



thank you

tusind tak
謝謝 dakujem vám
ありがとう
ngiyabonga
dziękuję
merci
baie dankie
धन्यवाद molte grazie
suksema
danke
gracias
obrigada
obrigado
takk
teşekkür ederim
شكرا
tack så mycket
gràcies
tänan
dank u
teşekkür edire
mahalo

