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Contextualizing Probability Tasks: The Case of the Egyptian School Curriculum

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Abstract
This paper clarifies contexts of probability in Egyptian primary and lower-secondary school textbooks and how the students prioritize them. Through preliminary general inductive analysis, it was apparent that the implemented curriculum of probability, represented by the students' textbooks, emphasized the conventional activities that require calculations and are suitable for employing theoretical probability. On the other hand, students highlighted environmental circumstances, such as weather forecasts, as the most practical context for the probability concept. In that sense, there is a need to refine the textbook activities so that they match students' viewpoints.

Keywords: Context, Probability, School Curriculum

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INTRODUCTION

Although context signifies the core of any statistical inquiry (Wild & Pfannkuch, 1999), there is not much discussion regarding the context delivered to students to learn. This is seriously the case of probability that, on the one hand, remains the most obscure and the least advanced arena within the statistical education area; on the other hand, it offers opportunities to transfer knowledge to pupils' daily experiences (Larose et al., 2010) since they are surrounded by randomness either in their personal or school lives (Torres & Contreras, 2014). Furthermore, probability is often discussed from a mathematical decontextualized standpoint, which hardly leaves any evidence of long-term learning (Grenon et al., 2010). In that sense, it is critical to scrutinize, from a contextual perspective, probability tasks offered to students through official textbooks, specifically in Egyptian schools wherein these textbooks work as the implemented curriculum. According to the mathematics school curriculum in Egypt, students begin to learn the probability concept early in grade 3 through the intuitive terms certain, possible, and impossible (The Arab Republic of Egypt, Ministry of Education and Technical Education, Mathematics for primary 3, 2020), which mostly discussed through personal examples rooted in their daily experiences.

Considering this, the current paper aims to investigate (a) what types of probability contexts appear in Egyptian school textbooks that consider a "significant factor in determining students 'opportunity to learn and their achievement" (Robitaille & Travers, 1992, p. 706); and (b) how do the students prioritize such contexts? Thus, the consistency between the curriculum and students' viewpoints would be evident. Clarifying the extent of such consistency would explain why/why not the students can achieve their learning outcomes, wherein learners'

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characteristics, backgrounds, experiences, and preferences consider a substantial factor of what is attained in the classroom (Chaudhary, 2015).

RESEARCH METHOD

To reach a description regarding the essential themes of contexts of probability required as an answer to the first research question, the *general inductive approach*, which consolidates "extensive and varied raw text data into a brief, summary format" (Thomas, 2006, p.2), was employed. According to this approach, the researcher attempted to crystallize the probability tasks of related circumstances throughout the national school textbooks into categories. The total number of these tasks was 106, which determines the implemented activities presented within the lessons content of both primary and lower-secondary grades, starting from grade 3, in which the probability is first introduced, until grade 9 (tasks within the revisions were not addressed). Table 1 summarizes the contents of probability lessons in each grade.

Table 1. Contents of probability in the Egyptian school mathematics textbooks

Grade	Contents
G3 & G4	The probability, certain event, impossible event, possible event.
G5	Experimental probability, theoretical probability,
G6	Random experiment, sample space, event, probability of an event.
G7	Sample, systematic sample, random sample, experimental probability, theoretical probability, event, probability of an event.
G8	Inferential statistics, random experiment, sample space, event, probability of an event, prediction.
G9	Sample space, event, probability of an event, intersection, union, mutually exclusive events, complementary event, the difference between two events.

Later, a survey (see the Appendix, Elbehary, 2021) was designed based on the results of the first research question and administered to (359) students in total; they represent the available sample of (12) classes of students in various grades (see Table 2).

Table 2. Statistics of students engaged in the study to prioritize the probability contexts that appear in the school textbooks

Grade	G4	G5	G6	G7	G8	*Total*
Number of Classes	2	3	2	3	2	*12*
Number of students	59	87	67	85	61	*359*

Accordingly, those students were asked to determine which probability context is more applicable in daily life situations. Nonetheless, considering the students' diverse ages, they were bounded to select, then prioritize three settings among all the provided probability contexts in the survey.

For example, if a student has arranged three situations like in Table 3, it means, for him, the probability is frequently used to describe weather circumstances. Then, predicting the gender conveys the second context to utilize the probability, while operating games of chance implies the third situation in which the probability could be involved. In this manner, the frequencies of the students' choices were calculated by assigning the values of 3, 2, and 1 to the first, second, and third choices, respectively; thus, the second research question was answered.

Table 3. Example of a student's prioritizes of probability contexts

The situation	*An example*	*Choices*
1. Weather forecast	It is less probable to rain tomorrow.	1
2. Result of a handball match	…………… See the Appendix	
3. Gender of a newborn baby	The probability of having a baby boy equals 50%	2
4. Status of a sick person	…………… See the Appendix	
5. Your preferences	…………… See the Appendix	
6. Quality of factory products	…………… See the Appendix	
7. Winning a chance game	When rolling a die, the probability of obtaining the number 2 equals 16.6%.	3

RESULTS AND DISCUSSION

Regarding the first research question, seven different circumstances wherein the probability could be utilized were detected, as shown in Figure 1; additionally, Table 4 presents some examples for each context, copied from the Egyptian textbooks at various grades. Interestingly, these identified contexts in the Egyptian textbooks resemble the seven specific events (i.e., success in school exams, rainy weather, ace in throwing a die, win in football, head in tossing a coin, beginning of war, and road accident) that were utilized by Chassapis and Chatzivasileiou (2008) to explore children's conceptions of probability.

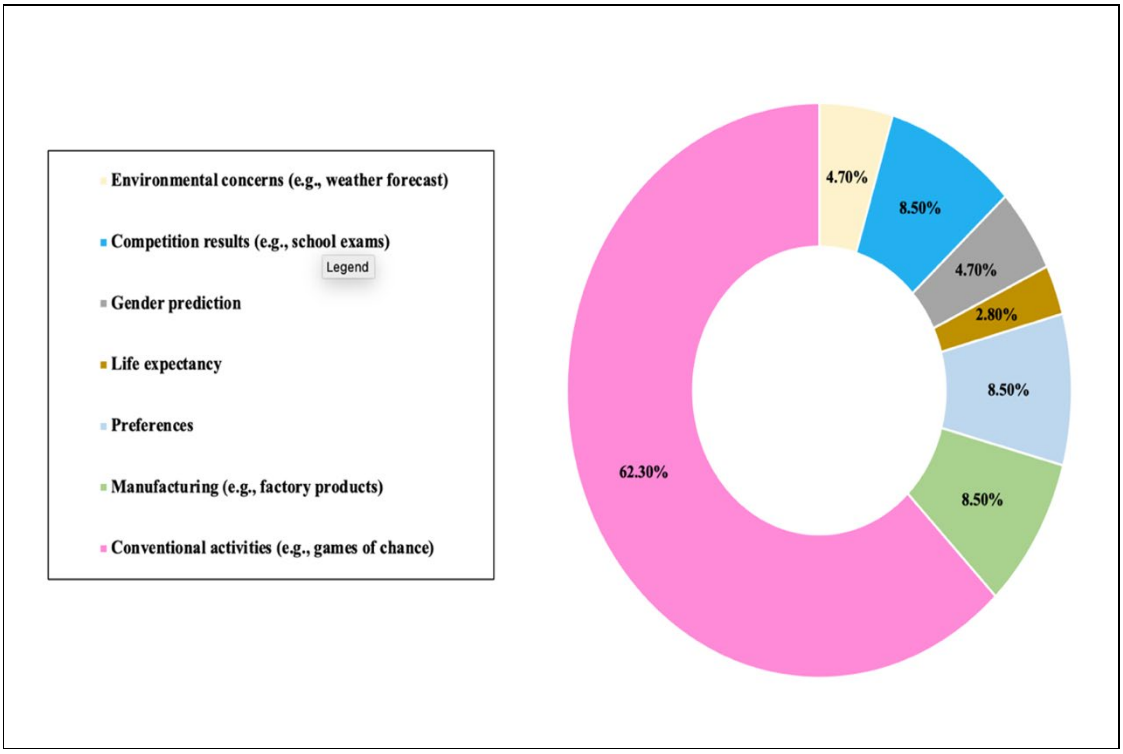

Figure 1. Probability contexts in the Egyptian school textbooks (primary and lower secondary levels)

Table 4. Examples of the probability contexts, raised in the Egyptian school textbooks

<table>
<tr><th>Context</th><th>An example from the Egyptian school textbook</th><th>grade</th></tr>
<tr><td>Environmental issues</td><td>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?</td><td>4</td></tr>
<tr><td>Competition results</td><td>(3) If the experiment is "A student is chosen at random from a class of 40 students, 32 students have succeeded in Maths test, 35 students have succeeded in Arabic test find the probability of :
- The event A, where A is the event that he has succeeded in Arabic.
- The event B, where B is the event that he has succeeded in Maths.
- The event C, where C the event that he has failed in Maths.</td><td>6</td></tr>
<tr><td>Gender prediction</td><td>Having a baby and determining the gender of the newborn baby.
Outcomes: a boy (B) or a girl (G).
Sample Space: S = {B, G}
</td><td>5</td></tr>
<tr><td>Life expectancy</td><td>A life insurance company has found in a sample of 10000 men, between 40 and 50 years old, 67 are dead in one year.
A What is the probability of a man to die between 40 and 50 years old in one year?
B Why are these results important for life insurance companies?</td><td>8</td></tr>
<tr><td>Preferences</td><td>The opposite table shows the result of a survey of asking 40 students about their favorite breakfast.
What is the probability of choosing foul 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 foul and tamaya?
<table><tr><th colspan="2">Breakfast</th></tr><tr><td>Foul and tamayia</td><td>20</td></tr><tr><td>Pie</td><td>4</td></tr><tr><td>Cheese and dessert</td><td>16</td></tr></table></td><td>5</td></tr>
<tr><td>Manufacturing</td><td>In producing 300 electric lamps, 18 units found defective.
A What is the probability of a unit to be a defective unit?
B What is the probability of a functional unit?
C Is it possible for a unit to be a functional unit and out of order unit in the same time?
D Find the sum of the probability of a defective unit and the probability of a functional unit. What do you observe?
E If a daily production of this factory was 1600 electric lamps. Find the number of the functional units in that day.
</td><td>8</td></tr>
<tr><td>Conventional activities</td><td>(5) If we flip a coin, we get either heads or tails. Complete
▪ The probability of getting a head = $\frac{\dots}{\dots}$
▪ The probability of getting a tail = $\frac{\dots}{\dots}$
(Explain why)?
</td><td>3</td></tr>
</table>

Although the national textbooks present a variety of circumstances in which the probability can be utilized, much emphasis was given to the traditional mathematical de-contextualized activities (e.g., games of chance) by a percentage of around 62% (see Figure 1). This may hinder the students from transferring the acquired knowledge to their daily practices since such regular activities cannot provide an adequate foundation to understand subjective probability (Stohl, 2005), which treats probability as a language for describing the level of uncertainty that one feels (Liberman & Tversky, 1996). Moreover, they also lead us to believe that probability indicates empirical properties of a situation rather than a measure of our knowledge of outcomes (Devlin, 2014).

According to Musch and Ehrenberg (2002), it seems that such findings are not merely the case of the school textbooks but, further, the teacher education curriculum. Musch and Ehrenberg (2002) reported that types of activities proposed for teachers during their preparation are generally stereotyped; it brings the concept of probability to the notion of calculating the relative frequencies. Besides, probability instruction is rarely based on exploiting authentic circumstances, leaving the field open for erroneous reasoning regarding daily life situations that affect school success and daily practices.

As noted in the Method section, depending upon the prior finding that refers to the defined contexts of probability throughout the school textbooks, a survey was prepared (see the Appendix) and administered to students (see Table 2) to prioritize these contexts. As a result, the environmental concerns (e.g., rain, sun, day and night, and weather forecast) were the most commonly relevant context of probability to everyday situations from the students' perspective, followed by the preferences situations (e.g., preferable food, language, sport, newspaper, and transportation) (see Figure 2).

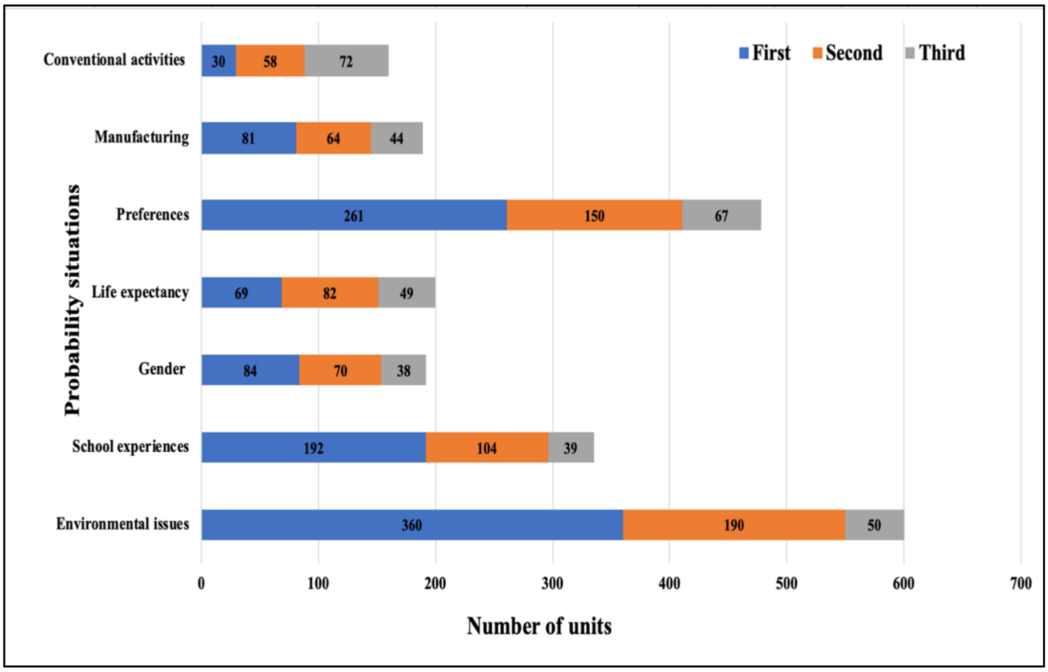

Figure 2. The priority of probability contexts from students' viewpoint

Considering these results, notable discrepancies between the curriculum and students' viewpoints were detected, which might affect the quality of the learning process. On one side, more attention was given to conventionally decontextualizing mathematical activities wherein objective probability (i.e., theoretical and experimental probability) could be operated. On the other side, the students emphasized the significance of the probability concept in approaching daily uncertain situations. For them, subjective probability, which defines the "personal expression of a degree of credibility of a statement, which forms the subjectivist counterpart of an event" (Borovcnik, 2012, p. 9), strongly exists everywhere around us. This is consistent with Kazak and Confrey (2006), who reported that students' understanding of probabilities is based on their personal and practical knowledge of the world.

Indeed, these results recommend several issues not only regarding curriculum development to be redesigned upon the students' viewpoints but also about teachers' instruction. They should be aware of students' informal knowledge of probability and how it may support or hinder the formal concepts that appear in textbooks as learning outcomes (Batanero et al., 2010). In other words, unless authentic uncertain situations related to students' social practices were included, a little transfer to other domains of learning or effect on attitudes will occur (Larose et al., 2010), and the study of probability becomes a mathematical exercise with no connection to the real world (Dollard, 2011). That is recommended by Garfield and Ahlgren (1988), as teachers should "create situations requiring probabilistic reasoning that correspond to students' views of the world" (p. 48).

CONCLUSION

Because in statistics, data defines numbers with context (Cobb & Moore, 1997), the context signifies the essential aspect of any statistical inquiry; and, further, probabilistic task. Not simply the context, but alternatively the meaningful context, which "need to be considered carefully in relation to the students that the tasks with be used with" (Weiland, 2016, p. 24). Furthermore, to promote the students' probabilistic reasoning, contextualizing probability education is crucial wherein "As the demands of probability problems become, more sophisticated the reasoning brought to them by students may change" (Watson, 2005, p. 145). Hence, teachers and curriculum developers have to be aware of students' viewpoints and preferable contexts to attain better learning outcomes.

DECLARATION

Author Contribution

All authors contribute in the research process, such as collecting the data, analyzing the data, and writing the manuscript. All authors approved the final manuscript.

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Conflict of Interest

The author declares that they have no competing interests.

Ethics Declaration

I as author acknowledge that this work has been written based on ethical research that conforms with the regulations of our institutions and that I have obtained permission from the relevant institutes when collecting data. We support the International Journal on Emerging Mathematics Education (IJEME) in maintaining high standards of personal conduct, practicing honesty in all our professional practices and endeavors.

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Appendix: The probability contexts survey (Elbehary, 2021)

Those are seven different settings at which the probability is manifested. Choose and prioritize three of them based on their importance and frequent usage in our daily life situations:

The situation	*Example*		*Arrange it*
Weather forecast	It is less probable to rain tomorrow		
Handball match scores	There is no possibility to win this handball match		
Gender of a newborn baby	The probability of having a baby boy equals 50%		
Status of a sick person	His chance to live to 70 years old equals 30%		
Express preferences	I probably prefer mathematics compared to science		
Quality of factory products	The probability of having a defective lamp produced by this factory is 3%.		
Winning a chance game	When rolling a die, the probability of obtaining the number 2 equals 16.6%.