# CHILDREN LEARNING PROBABILITY THROUGH THE "BUNNY'S RANDOM WALKS" GAME

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*The purpose of this paper was to investigate the learning of basic concepts of probability by children through a game. The design of this study was the game application "Bunny's random walks", involving the concepts of equiprobability, chance and randomness, with 17 elementary students from a public school in Brazil. The participants were asked about a 'fair' way (intuitive, informal term for equiprobable, same chance) and unpredictable (intuitive, informal term for random) to choose who would start a game but the students proposed different ways, some not equally likely (using child songs), while others, though equally probable and random. It is observed that the use of playful activities similar to this game can help build probabilistic concepts and contribute to the development of the probabilistic literacy of children. The importance of this study is to contribute to studies about teaching and learning of probability to children through games.*

INTRODUCTION

Reading and critical interpretation of information have become one of the literate man's great challenges in a modern world. People are asked to interpret and react to probabilistic messages, to make decisions and even to have the ability to identify these sorts of information, what, according to Gal (2005), would mean to consider them probabilistically literate.

We consider that Probability integrates Mathematics and Statistics, branches of knowledge which are part of modern education and as such, teaching them must aim at the preparation of students for life, provided that "a large proportion of everyday events is of random nature and it is possible to identify probable results for these events. The notions of chance and uncertainty, which show intuitively, can be explored at school, in situations in which the student makes experiments and observes events (in equiprobable spaces)" (BRASIL, 1997, p. 40).

We believe that it is necessary to develop a pedagogical practice that tackles situations in which the students engage in activities that take into account their contexts and are able to observe and build possible events, through concrete experimentation of data collection and organization. Thus, we aim in this paper to investigate the learning of basic probability concepts by children using the game *Bunny's Random Walks*. It is important to mention that the results presented here are part of Guimarães' (2015) doctorate degree research in Mathematics Education.

METHOD

The subjects of this research were seventeen fourth grade students from a public elementary school in Bahia, Brazil.

The game *Bunny's Random Walks* was composed of two activities. In the first one we asked the students to establish a fair way of starting the game, intending to approach, informally and in a contextualized manner, concepts such as: fair (in this context, more specifically used as informal substitute for the concept of equiprobable), chance, randomness, simple events, sample space, random experiment and deterministic situation which are inserted in the cognitive element that Gal (2005) named approach of great topics. Besides, we also evidenced elements of context and critical issues in Gal's (2005) model, given that the students' critical thinking was stimulated when they judged the ways to start the game.

To develop the second activity a square-shaped board was built on the classroom's floor, with red adhesive tape. This 3,6m x 3,6m square was internally subdivided in nine 1,2m x 1,2m squares, considering only the red adhesive tape as the delimited area, as shown in Picture 1.

Picture 1 - Board

This activity consisted in one member of each pair or trio carrying out a drawing, using a laptop computer and a Java software. If the emitted sound was *"pim"*, the partner should move one square North and, in case the emitted sound was *"pom"*, they should move East. Thus the student should proceed until they got out of the board, and the game ended when everyone was out, stressing that there were no winners.

Although it was not part of the activity's objective, by approaching probabilistic concepts with the students we evidenced that, in the drawing and in the experimentation, were present randomness, the concepts of simple and compound events, as well as that of sample space, when the students listened to the results of the drawing, *"pim"* or *"pom"* events, representing the dislocation throughout the board North or East, respectively.

RESULTS

In the first activity, we tried to find out whether the students recognized if the way we proposed to start the game was a fair way, and that was a nursery rhyme to pick out one member of each pair and of the trio, that is, eight children who were placed holding each other's hands.

The researcher established some rules and after that he recited the chant while pointing to each student, as we can notice in his speech.

> R: WHOEVER I CHOOSE WILL START THE GAME, OK?
> R: LOOK OUT, PAY ATTENTION TO HOW I'M GOING TO CHOOSE WHO STARTS THE GAME.
> R: *UNI DUNI TÊ, SALAMÊ MINGUÊ, A COLORED ICE-CREAM, YOU WERE THE CHOSEN ONE!*
> R: DID YOU LIKE TO KNOW HE WAS THE CHOSEN ONE?

The students answered yes, except for one, who kept silent when asked about his answer. We expected that they would recognize that this way was not fair, that they would express, even if intuitively, some knowledge of randomness and equiprobability.

The researcher encouraged the students to express their opinions.

> R: THERE'S NO PROBLEM, EVERYONE HERE CAN SPEAK, EVERYONE IS RIGHT.
> R: SO? IS IT OK?
> STUDENTS: YES, IT IS!
> R: THEN LET'S SEE IF IT'S REALLY OK.

With the students' answer, the researcher repeated the same choosing manner, starting with the same student.

> R: I'M STARTING AGAIN! *UNI DUNI TÊ, SALAMÊ MINGUÊ, A COLORED ICE-CREAM, YOU WERE THE CHOSEN ONE!*
> R: AGAIN! IS THIS RIGHT? IS THIS FAIR?

One of the students, who, in the first moment, said it was a fair manner (he answered 'yes'), expressed in the opposite way, engaging in the following dialogue with the researcher:

> STUDENT: NO. BECAUSE IF YOU START WITH HIM, IT'S ALWAYS GOING TO END IN THE SAME PERSON.
> R: BECAUSE I STARTED WITH HIM IT'S ALWAYS GOING TO END WITH THE SAME PERSON, ISN'T IT? SO, WHAT IF I START WITH HIM? (P points out a student to the left of the one he had initially chosen)

The students, before R finished the song, answered who would be the chosen one. A similar behavior was also observed in Tonouti's (2013) research, with students of the same school year and similar age group to our study's subjects:

> [...] some students pointed to the nursery rhymes as being a random way of choosing the initial player, but after we made three simulations starting with the same person, we observed that the selected person would always be in the same position and thus they could notice that the quantity of people always corresponded to the quantity of verses in the song, therefore they could determinate in advance who would be the selected person. (TONOUTI, 2013, p. 67).

Reflecting on our results and Tonouti's (2013), an important aspect to be observed is the participation of the researcher in conducting an activity like this, stimulating the students to build a more pragmatic conception, as a result of their experiences acquired with the development of the activity. Moving on with the activity, R says:

> R: IS THERE ANY WAY OF CHOOSING WHO STARTS OTHER THAN THIS *UNI DUNI TÊ*?

The same student who had already spoken, asks to speak again, and answers:

> STUDENT: THAT ONE WHICH GOES LIKE THIS: ZERO OR ONE (making gestures while speaking)
> R: AH, JAN KEN PO? TAKE A LOOK AT HOW MANY PEOPLE WE HAVE HERE. ONE, TWO, THREE, …, EIGHT. IF WE DO IT THIS WAY, JAN KEN PO, HOW IS IT GOING TO BE?
> STUDENT: EVERYBODY DOES IT TOGETHER, THE ONE WHO GOES OUT, GOES OUT.
> R: DO IT TO SEE IF IT WORKS.

The students simulated this way of choosing, but soon, facing few achievements, a student commented that this way would take too long. Therefore we discarded, for the same reason, the "odds and evens", suggested by one of the students. We stressed that the students in Tonouti's (2013) research also presented several ways of initiating a game, such as "odds or evens", "jan ken po", "two or one", a nursery rhyme, among others; but, differing from our situation, as the author only had the intention of discussing fair manners of selection, giving no importance to the time spent, she made simulations so that the students could perceive which of them could privilege some participants of the game and which could not.

The researcher then continued to investigate, with the students, other ways of starting the game.

> R: ISN'T THERE ANOTHER MANNER THAT COULD BE FAIR AND THAT COULD GRANT EVERYONE THE SAME CHANCE, THE SAME OPPORTUNITY OF GETTING OUT?
> R: SO, LOOK WHAT WE'LL DO TO FIND OUT WHO WILL START. GUESS WHAT IS IN HERE? (R shows a cloth bag)

A student answered that there was a die, others answered pieces of paper. R made use of the answer and showed a six-sided die and explained about the possibility of using it as a way of

making the choice, but warned about the limitation, since each student should pick a side in advance, leaving two students out.

Afterwards, another way of choosing was proposed, in which eight enumerated pieces of paper were put inside a bag, and each number corresponded to a pair or the trio, determinated in advance. Then, R asked the partners of each pair and the trio who weren't part of the circle to stand side by side and get from the bag only one piece of paper that would indicate the order of participation in the game. The first student got a piece of paper, picking out by lot Pair 2, which should start the game.

R explained to the students that this way everyone would have the same chance of being picket out, that the result of the drawing wasn't previously known, but that it would be one of those numbers that were inside the bag. We stress that this method cannot be considered completely random, given that when the student puts his hand inside the bag they choose a piece of paper rashly, but we didn't discuss with the children for that was not the objective of the activity. Thus, we considered these results as being random.

It is also to be stressed that in his explanation, the researcher informally approaches concepts such as: deterministic situation, random experiment, events, sample space, probability of simple events. The informality in this case comes from our understanding that, in this moment, the concepts don't need to be formalized in order for the students to be able to understand that to make a fair choice, the adopted method should be a random experiment, in which every participant could have the same possibility of being chosen.

According to Watson (2006), the active participation of the students during the activities can provide some information about the context in which they are inserted, so it can be the starting point for the discussion in the classroom. Besides that, it allows them to express themselves, suggesting and evaluating methods to make a fair choice, being able to make several critical questions in relation to these methods.

We consider that the activity was conducted in a satisfactory manner, dealing with the concepts in the students' understanding level. This result is in line with the Way's (2003) ideas, which point out that it is necessary to plan the activities according to the students' age range, for each one of them has a sequence of development, indicating the kind of activity that can be appropriate.

Once the order of participation in the game is determinated, we move on to the second activity in this block, in which one member of each pair and the trio was asked to proceed to a drawing, using a laptop and a Java software, and they were told that it was only necessary to press the "Enter" key to randomly emit a sound. Depending on the sound, their partner should walk one intern square North (*pim* sound) or East (*pom* sound). Thus, the member of each group performed, in order, consecutive drawings until their partner came out of the board. The game ended only when all the participants got out of the board. We stressed that there was no winning pair or trio.

Overall, they didn't show any difficulties in dealing with the computer software, but initially, due to some lack of attention and a lot of noise (which we consider normal for this age range), it was difficult for them to make the connection between the emitted sound ant the dislocation on the board. With the development of the activity, this problem was solved.

Resuming the objective of this activity, which was to familiarize the students with the type of drawing, as well as with the movements over the board to the North or to the East which would be used during the tasks of the teaching sequence that was used next, but which will not be detailed in this paper. When we analyzed the use of the bell, we noticed that even with some difficulty, they managed to end the game, which shows some coherence between the sound of the bell and the student's movement on the board, therefore showing as an adequate instrument for the subjects to make the drawings.

CONCLUSION

In the first activity, we observed that the students' participation was decisive for them to understand that to make a fair choice the adopted method should be a random experiment, in which all the participants had the same chance of being chosen. Besides that, we consider that the activity was conducted in a satisfactory manner, dealing with the concepts in the students' understanding

level. We also confirmed the presence of the cognitive elements: approaching the great topics, context and critical questions of the model of probabilistic literacy proposed by Gal (2005).

It is observed that the use of playful activities similar to this game can help build probabilistic concepts and contribute to the development of the probabilistic literacy of children. The importance of this study is to contribute to studies on teaching and learning probability to children through games.

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