

A Brief Note on Geometry and Topology in Mathematics The Teaching of Probability and Statistics to High School Students Using and Applying School Gardens

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ABSTRACT

The following article aims to bring an idea of the new teaching in probability and mathematical statistics, this one with the use of school gardens. In it, the methodology of constructivism and mathematics in context will be applied in order to teach the concepts of probability and statistics with the application of the preparation of a school garden. In this process, the topics of counting, permutation, inference, and probabilities will be developed among other statistics and probability applications.

INTRODUCTION

Countless times it has been pointed out that the concept of teaching probability is an abstract and difficult one for students. Sometimes it is not taught or only some basic notions of the most relevant axioms and theorems are

given so that the student only has a basic idea without going into detail and applications. It is thought that only those students specialized in mathematics or statistics should study probability. However, probability is a concept or skill in mathematics that helps us make predictions and inferences about events and happenings, which we can predict or determine what could happen.

The idea of leading the student to learn concepts of probability and statistics with the use of school gardens is based on the theory of constructivism and mathematics in context. In which it is intended to develop abstract to concrete ideas with the application of tangible concepts or skills, as in this case are school gardens.

Taking in a secondary school and developing the idea of creating school gardens where vegetables, flowers and minor fruits are planted to teach mathematical concepts leads us to think that the application of mathematics is everywhere. Similarly, the premise that concretizing learning and mathematicization aids in the understanding of mathematical skills that may appear abstract and leads to tangible concepts has been proven. Here we will use seed, growth, and harvest in order to introduce students to mathematical concepts of probability. We will be teaching basic probability, scoring, permutation counting, factorial, data analysis and classification. We will use a series of activities in the development of the school garden where the teaching of the concepts of probability will be emphasized.

LITERATURE REVIEW

What is Probability?

The probability associated with an event or random event is a measure of the degree of certainty that said event can occur. It is usually expressed as a number between 0 and 1, where an impossible event has probability zero and a certain event has probability one.

An empirical way of estimating probabilities is to obtain the frequency with which a given event occurs by repeating random experiments under sufficiently stable conditions. In some experiments for which all possible outcomes are known, the probabilities of these events can be calculated theoretically, especially when they are all equally likely.

The theory of probability is the branch of mathematics that studies experiments or random phenomena. It is widely used in areas such as statistics, physics, mathematics, social sciences, medical research, finance, economics, and philosophy to draw conclusions about the probability of potential events and the underlying mechanics of complex systems.

Why teach probability?

Probability as a subject of the branches of mathematics gives the student the idea of being able to create predictions about events that could occur in the future given the process as they have been occurring. For this reason, point out that probability is used to model situations that arise in fields of daily life through different sciences such as physics, chemistry, economics, biology; etc [4]. It also plays an important role in technological development. In this way, mathematical knowledge can be considered as an instrument with which it is possible, through other sciences, to recognize and transform nature and society.

However, when trying to model the phenomena of nature, man has found that there are situations that obey a deterministic model and others that instead obey a random model. For example, in the case of social scientists it is more difficult to discover fundamental principles that respond to the immense complexity of the phenomena that they propose to study, than it is for researchers in the natural sciences to explain the laws of free fall. In the social

sciences, the qualitative process occurs on many occasions, which makes trying to predict it impossible at certain times.

What is math in context?

In many educational settings, it is common to see students question the importance of mathematics. Some claim the need to learn mathematical algorithms that they do not use in real life. This could be due to the fact that some teachers do not teach mathematics from a context, so that students can see the relevance of the use of mathematics in everyday life.

The Royal Spanish Academy refers to the context as "physical environment or situation, political, historical, cultural or of any other nature, in which it is considered a fact" [2]. This means that the context can be any experience that an individual may have. In this sense, mathematics in context refers to the teaching of mathematics from situations in context [3]. Considered that "the context means that domain of reality which, in some particular learning process, is revealed to the student in order to be mathematized". Likewise, mentions that the teaching of mathematics in contexts is based on the constructivist paradigm. This fact that mathematics in context is situated in the construction of mathematics from the experience of the individual [4].

On the other hand, mathematics in context has its foundations rooted in the Theory of Mathematics Education of Realistic Mathematics. This theory was originated by the Dutchman H. Freudenthal from the 60's [5]. Said Theory, as mentioned above, is of a constructivist nature, so that the student reconstructs mathematics from its reality, guided by the teacher within a process of reflection. Freudenthal, for his part, considered that mathematics is for everyone, since it is immersed in many of the activities that the individual performs in daily life [6].

Mathematics education in context is based on three pillars: guided reinvention, mathematization, and didactic phenomenology. Describes guided reinvention as a subtle balance between the student's freedom within their learning and the teacher as guide. Students learn from their experience, but are guided by the teacher in a continuous reflective process. Mathematization, on the one hand, is the way in which students build mathematics from situations in real contexts [7]. Described mathematization as a process of converting a non-mathematical situation into mathematical terms. The third pillar of realistic mathematics is didactic phenomenology. Didactic phenomenology refers to mathematical structure as a matter of learning. At this point, the teacher must consider the mathematics in terms of what it was created for, so that the learning activities can be created.

In general, mathematics in context is the learning of mathematics from the construction and reasoned analysis of the properties, algorithms and rules that occur in thinking about their own learning. It is centered on the student, collaborative teamwork is carried out, the work is interdisciplinary, the integral formation of the student is favored, significant learning is favored, autonomous learning is induced, among others. The strategy that guides the didactics of Mathematics in Context, in essence, is the great approach that is used in classes; it consists of interdisciplinary work and disciplinary work in the learning environment [8]. The didactic strategy is classified into teaching strategies, those followed by the teacher, and learning strategies, those used by the student. In the didactics of Mathematics in Context, the teaching strategies are the application of contextualized events to be worked on by students as a team and the application of activities for the abstraction of concepts, using technology as a mediator of learning. While the learning strategies are the own resources of each student where it emphasizes

the performance of collaborative teamwork, the use of technology and extra-class research work. Associated with the strategies are the activities, where the didactic activities are those that enable the construction of the teaching and learning process, with the peculiarity of being intentional and oriented to the learning objectives, as well as the evaluation of learning. These are divided into teaching activities, those developed by the teacher, and learning activities, those developed by the student.

School gardens and their benefits

School gardens are a space that is used for planting products in order to harvest them and develop mathematical learning in students from the agricultural context. In this sense, it is a pedagogical tool that helps the student to understand concepts of mathematics and other subjects. This concept of teaching through the school garden is of an interdisciplinary nature and can promote self-sustainability and create in the student the idea and positive attitude towards agriculture and cooperative work ^[9]. For his part, mentions that school gardens serve as recreation and function as the classroom outside where the teacher can teach his class with nature.

School gardens promote teamwork

To create a school garden, in addition to using our hands, we need to put into practice other skills. You have to select the crops based on the conditions of the area, plan the activities necessary to achieve the objective and coordinate on the ground to carry them out. All this implies, therefore, working as a team, or what amounts to the same thing: learning to abide by and apply the guidelines set at certain times by the teaching staff and, at the same time, knowing how to coordinate with classmates, also acquiring certain autonomy ^[10]. States that one of the main things in school gardens is to encourage collaborative teamwork and that in turn promotes direct help among students. Formal learning is obtained to the extent that students promote cooperation among peers.

Allow boys and girls of different ages to work together

School gardens offer many possibilities, both in the type of crops and in the difficulty of the tasks to be carried out. And they also allow boys and girls of different ages to interact with each other and participate simultaneously in their care, adapting to the tasks appropriate for their age.

It is an activity that can be carried out by both boys and girls of all grades: preschool, primary, secondary, university. In addition, you can work with adults or any individual, respecting the abilities and limitations of each person.

School gardens can help learn math

They allow different knowledge to work simultaneously. They can be used to revise with the smallest numbers and colors, and to learn the names of vegetables in English. But, in addition, they are a perfect tool to work on basic questions of geometry or economics with students in higher courses.

How? We can start by calculating the surface of our garden or the number of carrots that fit in a row leaving a certain distance between them. Seeds are measured and prepared using counting and probabilistic conditions, making inferences to obtain the best product with the best results.

In addition, we can use school gardens to work on economic issues, such as calculating the cost of production per unit. For this we will have to take into account the total number of cultivated units, the cost of the materials used (land, fertilizers, insecticides...), the hours of work, the value of that time. The concept that we will use in this study is the teaching of probability and as a teacher you can use school gardens as a pedagogical tool for teaching all the concepts of statistics and probability.

They instill the value of effort

If you have ever cared for plants, you will have seen the satisfaction of seeing how after weeks of dedication the flowers appear. Well, the same thing happens with school gardens: they can produce many joys! In addition, they allow instilling the idea that a lot of effort is necessary to obtain results, but also that work has its reward. Eating a tomato full of flavor and grown by oneself is one of them. Being able to receive the fruit that is produced from the effort teaches the student to appreciate the work and to be able to do it by their own hands.

They allow learning while enjoying the sun and the outdoors

All of us need to move, to get some fresh air, to feel the sun on our faces. But, we spend too much time sitting and locked within four walls. And not only when we are adults, the same thing happens in educational centers. And in this context, school gardens offer a great alternative. A space for learning outdoors, with the physical and emotional benefits that this entails.

School gardens can be used to take advantage of waste

The school can use the organic remains of the dining room and the waste from the pruning of the garden to make compost. It is undoubtedly a way to take advantage of waste and thus contribute to caring for the environment and the objectives of sustainable development. In the same way, organic fertilizers are created in which mathematical measures, chemical and physical processes are applied.

Families can also participate

From the educational center you can also invite other people from the environment of the minors. If someone has a family member who masters gardening, they can participate in the center by training the educators or even lend tools to the center. But also those who are not experts can be encouraged to make compost at home or help with some task. The importance of school gardens lies in their educational function. These generally consist of an area of land in or near the school where vegetables, flowers, medicinal plants, trees, shrubs and many other plants are grown.

Do you dare to propose a school garden in your school? Our "A garden at school" didactic booklet can help you work on the subject in the classroom. We have prepared a series of activities which you can develop with the students. They will serve to teach probability and statistics to students with the use of school gardens.

DISCUSSION

Methodological planning to teach probability with the use of school gardens.

Activity #1 land preparation

Objective: In this activity the idea of the probabilistic uncertainty of the hypothetical idea will be put into practice.

Development: the preparation of the land is one of the primary and most important elements in the beginning of a school garden. It carries out the measurement of the land, the tests of the land and the conditioning so that it turns out to be fertile for the plants.

Activity #2 germination

Objective: Through the germination of plants, students will learn: calculate the sowing depth for seeds, calculate the probability of germination among plants, calculate water consumption, the position of the sun and the amount of food required by the plant.

Development: Students will sow the seeds in containers for germination and calculate on a sheet, the water used, the amount of food, germinated plants and show their average growth in a graph.

Activity #3 planting

Objective: In the planting of plants: probabilistic area measurement with the statistical use of averages and variances to calculate inferences of better seeds in better land.

Development: In sowing the seeds, the farmer (students) must always look for the best land and the best seed that has had the best harvest. Given this knowledge, the student can make inferences in relation to the product that will be obtained from it.

Activity #4 growth

Objective: in the growth of plants with the use of measures, averages, scales and combinatorics for the movement of measures of light and space.

Game of water and light Pass

Process of combination and permutation with fertilizers and composts where they will measure the quantities and practice the combinations that can be made and the permutations of the same for a better growth and development of the plant.

Activity #5 maintenance

Objective: to measure the development of growth and maintenance once the plant has reached the appropriate size with strength and preparation using measurements and backward experimentation.

Probabilistic inferential data, in this process growth hypotheses are established, where the student will make inferences about how the plant will grow and develop. They must be presented in tables and graphs establishing hypotheses with numerical data and simulations to later establish the answers and comparisons with real data. In them, the margin of error of the hypotheses with the real data will be found.

Activity #6 collecting and obtaining seeds

Objective: to collect the product, the Source of the final factorial and combinatorial product will be used for the best seeds.

Classification and obtaining of the product which will allow the best seed of the harvest.

What to teach about probability

The teacher must teach and apply realistic concepts in his classes in which practice is the direct method of learning probability. The important concepts of factorials, combination, inferences, and practical probability among others can be taught with the use of school gardens. In this experimentation, from the beginning of the construction of a garden, a teacher can teach all the concepts of probability until reaching extremely advanced concepts for its execution ^[11].

CONCLUSION

Students were found to be more motivated to learn probability and statistics with the use of school gardens. Similarly, they pointed out that they could see the relevance and use that they could give to statistics and probability by applying them to the process and work with school gardens.

The teachers felt comfortable with the planning and delivery of their probability and statistics classes.

The students indicated that they learned about other concepts at the same time that they learned probability and statistics.

A pragmatic and practical process was given where each student learned probability and statistics as they worked with the school garden.

RECOMMENDATIONS FOR TEACHING PROBABILITY AND STATISTICS USING HOME GARDENS

Among the recommendations that we can give to mathematics teachers who want to introduce the concepts of probability and statistics with the use of school gardens are the following:

- Create school gardens in all schools as curricular models focused on probability and statistics.
- use school gardens for the teaching of several integrated disciplines.
- Create a curriculum designing mathematics with the use of school gardens, which will give application and analysis in a practical way.

-Create study groups to evaluate the entire behaviour change process with high school students by working on mathematics and school gardens.

-perform multidisciplinary research where teachers can create new disciplines and methodologies for teaching their subjects with the use of school gardens, which develops the student's approach to nature.

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