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Mathematics for Every Day Living: The Cartesian Product As a Selection Tool

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Abstract: The paper is an attempt on how mathematics can be used as an instrument for everyday living. Drawing from hypothetical illustrations, the paper highlighted situations involving paired selection and the various commonly used approaches involved in the process. From these approaches, some shortcomings were observed and this created the need to explore a better and fairer alternative. This alternative was seen in the Cartesian product, a topic in Set Theory. Hypothetical illustrations were given on how the Cartesian product can be used as a fair instrument in a paired selection process. The submission is an eye opener to the mathematics teacher as the paper made some recommendations, one of which is that the teacher should strive to create a nexus, during instruction, between every topic in mathematics and its every day application.

Keywords: Mathematics; Cartesian product; selection tool.

1. Introduction

Over the years, the authors have constantly posed the question: Is there any activity of man that does not involve mathematics? The more this question is posed, the more the dawn of the reality of the imperative of mathematics in the affairs of humanity. Think of dancing, games, driving, buying and selling and other sundry activities of man. Mathematics is involved, albeit unconsciously, in all these. Then think of the role of mathematics in advanced ventures of man such as successful large scale business (Weinstraub, 2008), job performance and economic growth (Hanushek, 2013), successful entrepreneurship (Alumann and Hart, 2002; Caree and Thurik, 2002; Minniti and Lovesque, 2010), political stability (Agashi and Enemali, 2014; Hanson-Hart, 2005), waging war against terrorism (Farley, 2006) etc.

The unfortunate irony about mathematics is that it is a servant to man, yet it is dreaded by man. If man knew that there is mathematics in dancing, he would probably avoid dancing. But whether it is dreaded by man or not, the irreversible truth is that there is mathematics in everyday living. If this is consciously hammered into the consciousness of man, his negative disposition towards mathematics will take a turn for the better.

One way of achieving this is to hammer into the mathematics teacher the need to constantly explore and exploit, during instructional process, various areas and topics in mathematics that can facilitate daily activities of man. Currently, this vital instructional ingredient is lacking in Nigerian schools among many mathematics teachers. In what follows, an attempt is made on how this can be done. The topic of mathematics in focus is the Cartesian product (in Set Theory) and its application as a selection tool.

2. Sets and Cartesian Products

A set is a collection or assemblage of objects which are distinct and distinguishable. According to Beckenbach and Drooyan (1966), a set is collection of some kind. This collection can be animate or inanimate, abstract or real or tangible and intangible or numbers (real or complex numbers). Examples of sets are: (i) set of 100 level mathematics students in a given university, (ii) set of letters of the English alphabets, (iii) set of natural numbers. The first is an example of tangible objects; the second is an example of intangible objects while the 3rd is an example of real numbers.

We usually denote sets by capital letters and enclose all the objects in curly brackets, each separated by coma (,). If we use A to denote set of 100 level mathematics students in a university, then we write

A = {Amina, Yakubu, Ngozi, Peter, Oyibo}

where the elements or members are as listed. The number of elements in a set is the cardinality of the set. The cardinality of the set A above is 5.

Given two sets, the elements or members of the sets can be considered in pairs, sometimes in ordered pairs. This brings in the concept of Cartesian product. The Cartesian product of two sets A and B denoted by A x B (pronounced A cross B), is the set of all ordered pairs (x, y) such that x ε A (that is, x is a member of A) and y ε B

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(that is, y is a member of B) (Beckenbach and Drooyan, 1966). Note that A x B is not the product of A and B as in the usual sense. As an illustration, given two real numbers A and B such that

A= {2, 3, 4, 5} and

B = {6, 7, 8}, then

A x B = {(2,6), (2,7), (2,8), (3,6), (3,7), (3,8), (4,6), (4,7), (4,8), (5,6), (5,7), (5,8)}.

To illustrate the Cartesian product with respect to human entities, suppose C and D are sets of students in physics and mathematics in a certain college such that

C = {Ann, Peter, Clarus} and

D = {Oyibo, James, Divine, Patience}, then the Cartesian product is

C x D = {(Ann, Oyibo), (Ann, James), (Ann, Divine), (Ann, Patience)}, (Peter, Oyibo), (Peter, James), (Peter, Divine), (Peter, Patience), (Clarus, Oyibo), (Clarus, James), (Clarus, Divine), (Clarus, Patience)}.

Notice that in this illustration, the Cartesian product is not ordered since, for instance, there is no difference between the pairs (Ann, Oyibo) and (Oyibo, Ann).

In the next sections, we discuss situations involving paired selection and how the product can be used as a fair tool in a paired selection process.

3. Handling Situations Involving Paired Selection: Some Possibilities

There are many real life situations where paired selection is required. Let us consider the following hypothetical situation: A certain organization proposes scholarship to students of a certain college to run for some years such that for each year, two grade 'A' students in mathematics will receive the award. If there are no grade 'A' students, students on grade B are considered and so on. The organization is gender sensitive and stipulates that the two students for each year will include a boy and a girl. Let us consider another hypothetical situation. In a two-arm class, prize is to be given to one graduating grade 'A' student in each arm. Suppose there are four grade 'A' students in one arm and three grade 'A' in the other arm. How do we go about the selection? Let us consider some possibilities open to the authorities and their fairness or otherwise in the first hypothetical situation.

- Use of institutional discretion. This entails picking the boy and girl on the high grade based on some considerations such as good behaviour, neatness, outspokenness, obedience, affinity etc by the college authority. Clearly, there is no fairness in such selection as all the eligible students are not given equal chance to participate in the selection. Apart from this, there may be two or more students in each category with these attributes; how do we take care of such situation? Furthermore, the consideration of these attributes is open to subjectivity and sentimentality. Use of institutional discretion can therefore be seen as an unfair and corrupt approach in the selection process.
- Use of emergency test. The authority may decide to organize emergency test for all the eligible students and select the best boy and girl based on the performance in the test. Some pertinent questions arise from the use of this method: what happens if none of the students makes 'A' or 'B' in the test? Is the result of the test the original basis for the award of the scholarship? Clearly, this approach is unfair because the basis for the scholarship is not the test but the previous cumulative performance of the students. One of the authors of this work was denied an award as the best student in mathematics in his final year in the college because of this type of selection approach.
- Use of simple randomization. Another possible way that the selection can be made is to subject all the eligible boys and girls respectively to random picking of shuffled and whapped papers. The boy and the girl that pick 'yes' become the winner pair. Much as this approach may be better than the other two we have considered above, randomization by sex category makes it rather cumbersome.

  In the second hypothetical situation, the selection approach that is commonly used is ranking to determine who takes first position in each of the arms. Much as this is widely used and may be adjudged to be fair, its shortcoming is that it lays emphasis on rank or position of students rather than on students on grade 'A', which is the basic criterion for the prize. For fairness, all grade 'A' students should be given equal opportunity to contest for the prize.

  From the three possibilities open to the college authorities as highlighted above in the first hypothetical situation, and the approach used in the second hypothetical situation, it is obvious that much as they are commonly used, there is need for yet another and even better and fairer alternative. This other alternative being advocated for in this work is the use of the Cartesian product.

4. The Cartesian Product As A Tool For Paired Selection

Let us illustrate how this can be done with the following hypothetical situation. Let the eligible boys (in the first hypothetical situation) be represented by B with members as

B = {Musa, John, Gabriel}

and let the eligible girls be represented by G with members as

G = {Mary, Joy},

then the Cartesian product (Cartesian pairs) is given by

B x G = {(Musa, Mary), (Musa, Joy), (John, Mary), (John, Joy), (Gabriel, Mary), (Gabriel, Joy)}.

After getting the Cartesian pairs B x G, label six cards (tags) **A**, **B**, **C**, **D**, **E**, **F** representing (Musa, Mary), (Musa, Joy), (John, Mary), (John, Joy), (Gabriel, Mary), (Gabriel, Joy) respectively. Notice that the resulting number of pairs is equal to the product of the cardinalities of B and G which is 3 x 2 = 6. After this, six ballot papers with one marked '**yes**' and the rest five marked '**no**' are whapped and shuffled ready for picking by six persons (not necessarily the eligible students) bearing the tags. The tag that picks '**yes**' represents the pair of boy and girl that wins the scholarship—the winner-pair.

In the second hypothetical example, suppose the set of grade 'A' students in the two arms are C and D respectively with members as

C = {Jef, peter, Andy}

D = {Agnes, Newton}, then the Cartesian pair is:

C x D ={(Jef, Agnes), (Jef, Newton), (Peter, Agnes), (Peter, Newton), (Andy, Agnes), (Andy, Newton)}.

As in the case of the first hypothetical example, these six Cartesian pairs are tagged and subjected to balloting from where the winner-pair from the two arms emerges.

The advantages of the Cartesian product in this kind of selection activity are easily noticeable. The students contesting need not be physically present. Secondly, each of the eligible boys has a fair chance of being picked along each of the eligible girls and vice versa, as in the first example. In the second example, each of the grade 'A' students in one arm has a fair chance of being picked along with each of the grade 'A' students in the other arm. This advantage confers on the Cartesian product what the authors would like to call property of associativity of the Cartesian product (PACAP).

5. Conclusion

There is no limit to which mathematics serves humanity. In fact, in any endeavour, it is either that man is aware and is reaping the full benefit of mathematics in it or he is grappling with exploring the mathematics in it or painfully, he is not aware of the mathematics in it. Unfortunately, many, including mathematics teachers belong to the category of those who painfully are not aware of mathematics in every living.

The presentation in this work is an eye opener especially to the mathematics teacher on the need to continually explore and exploit the benefit of mathematics to humanity. In this way, the learner will draw closer to mathematics with attendant generation of interest and improved and sustained performance in the subject.

6. Recommendations

Based on the submission in the foregoing paragraphs, the following recommendations are made:

1. The mathematics teacher should take up the challenge to bridge the gap currently existing between mathematics and reality by striving to create a nexus, during instruction, between every topic in mathematics and its application. Through this, the seemingly abstract image of the subject will hopefully take a new and positive turn and by extension, interest and performance in it will improve.
2. Professional educational bodies such as the Mathematical Association of Nigeria (MAN) and Science Teachers Association of Nigeria (STAN) should frequently float workshops and conferences with applications of various areas of mathematics as major theme.
3. Ministries of education in various states and other partners in education should strive to sponsor mathematics teachers to such workshops and conferences as suggested in (2) above. This needs some emphasis because experience shows that many Nigerian teachers hardly attend conferences without sponsorship.

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