

PERFORMANCE IN STOCHASTIC BETWEEN SECONDARY TEACHERS AND TEACHING STUDENTS: COMPARATIVE STUDY IN COSTA RICA AND MÉXICO

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The results from a study that examined the mastery in stochastic topics of a group of 111 participants –teachers and Teaching students– of two Latin American nations are shown. It was found that the level of domain is not enough to comply with the requirements of the current study programs. A high portion of participants ignore the principles of probability, do not classify variables properly, have difficulty to interpret collected data in tables and charts, and have troubles to differentiate between random and deterministic phenomena.

INTRODUCTION

The importance of the stochastic as an overall portion in the development of the modern citizen is a reality. The development of a stochastic literacy in every social aspect has been promoted for the last three decades, and the learning institutions as well as the teaching training programs have been considered as essential guidelines in the achievement of this purpose. Costa Rica and Mexico are two nations that stand out in terms of the significant adjustments made to their teaching programs and their interest in establishing academic support programs for teachers who must teach stochastic in middle school education. Both countries have also promoted the implementation of international standards to their curriculums, especially the ones made by the National Council of Teacher of Mathematics (NCTM), and the ones formulated by the Organization for Economic Co-operation and Development (OECD). The OECD is probably the organization that has influenced the most in the design, application and follow up of the standardized tests that evaluates the educational quality; in 1977 they applied for the first time the PISA test to evaluate in what measure 15 year old students were capable of applying what they have learned in reading, math and science, to similar situations than the ones they will deal with in their daily lives.

In the same way, the studies that examine problems regarding stochastic education have increased in the last two decades. More significantly, the studies related with the incorporation of stochastic subjects to the teacher-training program, the ideal mechanism for its teaching and evaluation, as well as the ones that analyze the teacher's role in these processes. Therefore, Ben-Zvi & Garfield (2004) examined the current challenges for the statistical reasoning development among students; Tintle, Topliff, Vaderstoep, Holmes & Swanson (2014) analyzed the difficulties of students to retain concepts in statistics introductory courses; Biehler, Ben-Zvi, Bakker and Makar (2013) reviewed teaching technologies and summarized what is currently known about them and its contribution to the reasoning development; Watson (2013) analyzed topics related with statistical literacy and the students reasoning, in addition he presented useful activities for teachers; Zieffler, Park, Garfield, DelMas and Bjornsdottir (2012) evaluated the attitudes, teaching practices and

teacher's assessment in statistics introductory classes; Batanero, Arteaga and Contreras (2011) considered the challenges that stochastic education is facing up in Spain due to the new policy guidelines in mandatory education and they brought up methodological recommendations to promote the stochastic reasoning development in students; in Mexico, Isunza & Guzman (2011) found a poor level of reasoning in combinatorial problems from middle school teachers.

This document shows the results of an exploratory study about the performance in elementary stochastic topics of 111 teachers in force and in training process from Costa Rica and Mexico. There was a particular interest in providing answers to the following questions: what is the level of mastery in stochastic? Which characteristics are shared in terms of mastery? And at what level is this command enough to fulfill the curricular standards required by the study programs?

METHODOLOGY

Participants.

The method used in the study was eminently quantitative. It was based on a sample of 111 participants, 33 Costa Ricans and 78 Mexicans.

Instruments and Procedure.

A test conformed by 16 items was elaborated to measure the stochastic performance in these subjects: (1) variability, (2) probability of an event, (3) random experiment, (4) graphic and tabular interpretation, (5) calculation and reading of measures, (6) probability with percentages, (7) conditional probability, (8) variable categorization, (9) individual events, and (10) Golback diagram simulation. The items classification was based on the six competition-performance levels contained in the PISA program evaluation. Subsequently the test was provided to each participant, the results were registered and a statistical analysis was made with the SPSS V.21 computer program.

RESULTS AND ANALYSES

Item 1 evaluated the variability topic; only 21.6% of the participants gave accurate answers. Out of this 21.6% that succeeded, 9.01% were Costa Ricans and 12.61% were Mexicans. In regards to the probability of occurrence of an event item, 94.6% of participants provided correct answers. Item 3 investigated the way participants could identify differences between random and deterministic phenomena; the results pointed out that 71.2% of all of the participants chose the right answer, 57.5% and 76.9% for Costa Ricans and Mexicans respectively. Items 4 and 5 evaluated the performance in reading and interpretation of box plots; the results in both items were similar, less than 50% of participants answered accurately; there were not significant differences in performance according to nationality. Item 6 assessed a situation that required interpret what measure of central tendency should be used to answer a question; it was successfully resolved by 48.6% of participants, 45.5% and 50% for Costa Ricans and Mexicans respectively. Item 7 demanded reading and interpretation of tabulated data; it was found that only 14.4% of participants answered properly what they were being asked; only 21.2% were Costa Ricans and 11.53% Mexicans. Item 8 examined a problem situation that presented several affirmations related with measures of central tendency interpretation; only 39.64% selected the right answered. Item 9 required elaborate a

graphical analysis to calculate probabilities with percentages; it was determined that 73% of participants selected the right answer, 84.8% and 67.94% for Costa Ricans and Mexicans respectively. On the other hand, Item 10 evaluated performance in the conditional probability topic; it was found that only 46.85% gave correct answers and 10.81% opted not to answer, 54.55% of Costa Ricans and 43.59% of Mexicans succeeded. Item 11 showed a situation that required observe two figures and select the measure of central position that best summarized the location of the highest data concentration; this item had a level of difficulty 2 according to the PISA parameters, even though only 44.14% got it right, which allowed to determine the participants shortcomings in terms of conceptualization and measures application. Items 12, 13 and 14 were settled to examine the way in which participants accurately classified different types of variables and consequently selected the correct measure of central tendency and graphic representation. The results obtained indicated that participants are unaware of how a variable categorization affects the subsequent attribute assignment. Items 15 and 16 besides to the solved, they demanded to compile the followed procedure and justify its response. Item 15 presented a Golback Diagram in which the throwing of 100 marbles was simulated, a question was made and its supporting statement was required; 74.77% answered accurately, however not all of them justified their statement in a proper manner. Item 16, for its part, proposed a situation akin to independent events; the results pointed out that 79.28% of participants chose the right option, 13.51% the wrong one and a high 7.21% did not answered. The analysis by country brought up that 63.64% of Costa Ricans and 85.9% of Mexicans succeeded. The following table provides a summary, by thematic, total average performance of participants and average performance by country. There is an extreme concern due to the poor interpretation of tables and charts as well as the inadequate variables classification.

Topics	Items	Total accuracy %	Accuracy per country %	
			Costa Rica	México
Interpretation of tables and charts	1, 4, 5, 7, 9	38.74	40.00	38.21
Deterministic and random experiments	2 y 3	82.88	77.27	85.26
Measures of central tendency	6, 8 y 11	44.14	42.42	44.87
Probability	10	46.85	54.55	43.59
Variable classification	12, 13 y 14	39.04	57.58	31.20
Golback Diagram	15	74.77	66.67	78.21
Independence of events	16	79.28	63.64	85.90

Table 1: Global performance and per participants nationality performance according to the topics.

What is the mastery level in stochastic? Which characteristics are shared in terms of this mastery? And at what level is this command enough to fulfill the curricular standards required by the study programs? Participants performance from both nations was low. The level of mastery showed is not enough to comply with the stochastic educational standards established in study programs. A high portion of participants ignore the basic principles of probability, they don't classify variables correctly and have difficulty reading and interpreting grouped data in tables and charts. It was surprising to find that a significant high portion of participants have issues distinguishing between random and deterministic phenomena, an irreducible topic to any middle school teacher- or potential one-. There were a few differences between Costa Ricans and Mexicans performance, however they were not significant.

CONCLUSIONS AND RECOMMENDATIONS

This study examined the performance in basic stochastic topics of 111 teachers in force and in training process from Costa Rica and Mexico. The results obtained showed a low performance in most of the topics. It is recommended that educational institutions design work programs in order for teachers to be able to: (1) know statistic historic development; (2) have a better understanding of the most representative probabilistic assumptions; (3) comprehend and use the language specific to this discipline; (4) read and interpret information from tables and charts; (5) use and select different ways for data representation in a consistent manner; (6) solve stochastic problems in and out the school framework; (7) provide conclusions and recommendations that comply with the logic of work as well as the statistic analysis coverage.

It is necessary for school institutions to examine the effectiveness and forward looking of its teachers improving, updating and job training programs. This examination can be guided through the formulation of questions such as: at what level does the current graduate profile fit the academic necessities and goals in whether a national and international field? What features must include the graduate profile to be added in the study programs? How to issue training, skills and updating programs that comply with the social and scientific demand that could benefit the achievement of high quality learning?

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