THE STATISTICS ITEMS IN THE BRAZILIAN NATIONAL STUDENT PERFORMANCE EXAM (ENADE)

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The National Student Performance Exam is part of the Brazilian Higher Education Evaluation System and aims to assess the acquisition of competences, the development of abilities, and knowledge, which are considered essential for the student's formation. The main of this exam is to analyze students' changes and gains along their trajectory in the higher educational institution. We analyzed the items of the exam by Item Response Theory, and highlighted the items concerning statistics. We used information of 823,892 students from 48 knowledge areas selected by stratified random sampling from all Brazilian courses, from 2004 to 2006. The exam was composed of 40 questions. The statistics questions presented a higher grade of difficulty and significant differences were verified among gender and careers in Statistics items, which were the most difficult ones regardless of the areas.

INTRODUCTION

Statistics is a fundamental knowledge for the development of scientific researches, and minimally necessary if one is only interested in reading these publications, most of which show statistical results. Moreover, it is an essential instrument for any professional who may need to deal with this kind of information for their daily decision makings, both professional and personal; that is why not only academic works, but also newspapers, magazines, and television, i.e. media approaching a comprehensive range of people, make use of it. Many readers are just lay when it comes to reading graphics, tables, and other statistical information.

Due to the importance given to Statistics for the qualification of teachers and researchers of several areas of scientific knowledge the teaching Statistics in Brazil started in the first cycle of the fundamental school with reading and interpretation activities, as well as writing, within the Mathematics programme. For the second cycle, students are supposed to learn the construction of graphics and tables, as well as concepts like calculation and interpretation of arithmetical average, which are contents to be improved in the next cycle. In the fourth cycle, there are more types of graphics, concepts of sample, relative frequency, and central tendency measures. Teaching Statistics in Brazil is consolidated on graduation level, several courses contemplate disciplines in their syllabus, both in graduation and post-graduation levels, but most of them present just one discipline, usually approaching the exploratory analysis of data, notions of probability, and notions of inference.

In Brazil, there is the National Student Performance Exam (*Exame Nacional de Desempenho do Estudante*–ENADE) that is part of the National Higher Education Evaluation System and aims to assess the acquisition of competences, the development of abilities, and knowledge, which are considered essential for the university student's general and specific formation, Statistics being part of this knowledge repertoire. The main goal of this exam is to analyze students' changes and gains along their trajectory in the higher educational institution by assessing the learning potential of the first-year students and competences acquired by the last-year students. It consists of a nationally-wide assessment instrument and an obligatory syllabus component (*Ministério da Educação*–MEC, 2004, 2005).

In a general way, the ENADE proposes to assess academic abilities and professional competences, consisting of two components: General Education (*Formação Geral*–FG) and Specific Knowledge (*Conhecimento Específico*–CE). The CE targets to measure the mastering of knowledge specifically related to the careers, while the FG is common to all careers and aims to assess the general knowledge on the Brazilian and world realities and other areas of knowledge, investigating the profile of an ethical professional who is engaged with the society they live in. Since the exam was implanted in 2004, thousands of students from several careers have been submitted to it, and the analyses resulting from the assessments are available to the entire public on the website http://www.inep.gov.br/enade.

Regarding the contribution of the intelligence construct on academic performance, we analyzed the items of the exam by IRT–Item Response Theory–and highlighted the items concerning statistics in order to estimate the students' proficiency in the evaluated contents. We used three databases containing academic information of students selected by random sampling procedures from all Brazilian states and all courses. The statistical process to select the students by stratified random sampling and the compulsory characteristic of the exam assure the reliable inferences of the educational characteristics within the Brazilian population.

METHOD

The sample was composed of 140,340 undergraduate students from 13 knowledge areas who submitted to ENADE in 2004; 277,476 undergraduate students from 20 areas in 2005; and 406,076 undergraduate students from 15 areas in 2006. The students who have fulfilled 7 to 22% of the minimum course load of the course's curriculum until the initial registration date are considered first-year students, and those who have fulfilled at least 80% of the minimum course load of the curriculum are considered last-year students.

The examination is composed of 40 questions divided in two parts: the first part is common to all areas and the second part is specific to each area. The first part is composed of 10 questions with the objective of rating knowledge considered essential in the general formation (FG) of any higher education student; the second part is composed of 30 specific questions (CE), and aim to verify the student's mastery of the subject matter, rating the learning potential of the first-year students and the competencies the last-year students have developed along their trajectory in the higher learning institute. The questions may be open-ended or multiple-choice, both in the common part and in the specific part.

Some questions in both components, FG and GE, asked in the years 2004 to 2006, were elaborated upon statistical concepts and representations, demanding the professional of the present days to be acquainted with this tool. However, it is relevant to stress that the ENADE does not focus on measuring isolated abilities, so that the analyses present in the official reports did not have as a target the students' performance in Statistics, which is the object of interest of this study.

In this study were considered only students that complete one or both parts of the examination (FG and/or CE). We are considered 135,631 students in the year 2004 (Table 1); 270,385 in 2005 (Table 2); 395,833 in 2006 (Table 3).

RESULTS

In the year 2004, two multiple-choice questions (FG06 and FG08) demanded statistical concepts. The question FG06 addresses the context of population growth and requires reasoning on randomness, only 21.1% of students responded correctly this question. The question FG08 discusses the topic of digital inclusion, and the evolution of the number of computers connected to the Internet in Latin American countries, in the period between 2000 and 2004, having your content represented in table and graph. Of the total students, 23.9% responded the correct alternative, while 70% chose the same incorrect alternative. The results indicated that these questions were very difficult all the knowledge areas, as seen the Table 1.

The results obtained in 2004, as seen in Table 1 reveal significant differences of performance by gender in: General Formation component in the Physiotherapy, Medicine and Veterinary Medicine areas; Specific Formation component in the Pharmacy, Dentistry, and Social Service areas; statistical question FG06 in all areas except in the Social Service area.

Among all the areas, medicine was the one that always had the highest grade, independent of the component. This is due to the fact that medicine has a high candidate/vacancy relation, leading to a more competitive admissions process and, therefore, a high level is demanded from the candidates (Brito, 2009).

Table 1. *Descriptive statistics of the students performance by knowledge area - ENADE/2004*

Knowledge Area	Number of students		Correct answer in Statistics questions (%)		Raw score mean	
	N	%	FG06	FG08	General	Specific
Agronomy	6,061	4.5	20.6*	29.0*	42.8	48.8
Physical Education	26,843	19.8	18.8	23.8*	39.8	44.9
Nursery	20,623	15.2	19.2	19.9*	42.2	41.7
Pharmacy	13,989	10.3	21.4	24.7*	44.1	36.3*
Physiotherapy	21,889	16.1	19.3	20.7*	42.7*	35.8
Speech Therapy	3,258	2.4	19.2	20.0*	42.5	69.0
Medicine	8,124	6.0	39.7*	41.5*	61.7*	50.4
Veterinary Medicine	5,657	4.2	23.4	27.4*	44.7*	39.0
Nutrition	9,865	7.3	18.9*	19.6*	41.7	48.1
Dentistry	7,819	5.8	22.8*	23.5*	47.6	46.2*
Social Service	7,190	5.3	18.0	22.0	41.2	33.8*
Occupational Therapy	1,819	1.3	21.6	19.5	42.5	59.0
Zootechnology	2,494	1.8	21.0	30.7*	43.2	57.8
Total	135,631	100.0	21.0*	23.8*	43.6*	43.1*

* There is a significant performance difference between male and female students (α=0,05)

In the years 2005 (Table 2), there was no multiple-choice question that depends on statistical concepts. In the General Formation the grades of the students are very close and low. The best result is engineering - Group V, but in general students did not present good grades. The most of the courses had significant performance differences by gender.

Table 2. *Descriptive statistics of the students performance by knowledge area - ENADE/2005*

Knowledge Area	Number of students		Raw score mean	
	N	%	General	Specific
Architecture and Urbanism	6,170	2.3	68.1*	49.9
Biology	24,047	8.9	69.0*	29.7*
Social Sciences	3,318	1.2	65.7	57.6
Computer	31,907	11.8	67.1*	30.6*
Engineering - Group I	8,605	3.2	70.1*	45.6
Engineering - Group II	16,968	6.3	71.3	50.2*
Engineering - Group III	4,404	1.6	72.2	49.9
Engineering - Group IV	5,139	1.9	70.7*	48.1
Engineering - Group V	1,158	0.4	75.0*	54.5
Engineering - Group VI	6,854	2.5	71.3	48.4*
Engineering - Group VII	3,418	1.3	70.2*	46.5
Engineering - Group VIII	2,229	0.8	64.6	36.6*
Philosophy	4,212	1.6	69.7*	40.8*
Physics	3,899	1.4	71.0*	37.0*
Geography	11,089	4.1	69.0*	41.7*
History	17,352	6.4	69.4*	45.3*
Portuguese language	45,273	16.7	68.3*	36.8*
Mathematics	19,189	7.1	65.7*	28.5*
Teacher training	48,258	17.8	64.9*	46.6
Chemistry	6,896	2.6	67.9	35.9*
Total	270,385	100.0	68.0*	38.3*

* There is a significant performance difference between male and female students (α=0,05)

In the year 2006 (Table 3), there were three multiple-choice questions that depends on statistical concepts (FG01, FG06 and FG07). In the General Formation the grades of the students are very close and low. The best result is Psychology, but in general students did not present good grades. The most of the courses had significant performance differences by gender.

Table 3. Descriptive statistics of the students' performance by knowledge area - ENADE/2006

Knowledge Area	Number of students		Correct answer in Statistics questions (%)			Raw score mean	
	N	%	FG01	FG06	FG07	General	Specific
Business Administration	129,810	32.8	24.5*	55.8*	11.9*	44.5*	46.8*
Archival Science	623	0.2	31.8	65.3	12.3	54,1	52.9
Library Science	2,050	0.5	25.6	59.3	11.5	47.9	41.6
Biomedicine	5,029	1.3	25.8	63.7	14.3*	47.5*	42.4*
Accounting Science	43,903	11.1	24.6*	55.9*	13.3*	44.5*	33.6*
Economic Sciences	12,369	3.1	33.2*	65.1*	14.2*	49.1*	38.9*
Media	42,875	10.8	23.0	60.6	11.0*	46.9*	44.2*
Design	9,240	2.3	24.7	64.4	12.5*	49.1*	54.1*
Law	77,250	19.5	27.9*	59.9*	13.1*	47.8*	41.8*
Teacher preparation	22.468	5.7	19.3	45.8*	10.1*	46.7*	47.0
Music	2,995	0.8	23.2	65.0	11.3	47.8	49.8*
Psychology	23,544	5.9	24.4*	62.9*	11.4*	47.1*	54.2
Executive Secretariat	4,735	1.2	21.4	52.7	10.0	50.5*	43.9
Theater	1,731	0.4	21.9	66.3	12.0	49.6*	53.8*
Tourism	17,211	4.3	21.9	55.6	10.3*	49.9*	50.3*
Total	395,833	100.0	23.8*	55.2*	10.3*	45.2*	43.5*

* There is a significant performance difference between male and female students (α=0,05)

CONCLUSION

The statistics questions presented a higher grade of difficulty demanding greater abilities from the students to be more likely to get right answers. Significant differences were verified among gender and careers in Statistics items which were the most difficult ones regardless of the areas. Significant performance differences in the general and specific components were likewise verified among gender and careers.

The development of research and studies about intelligence, as well as tests elaborated for measuring this construct, have, in some countries, been incorporated into educational evaluation, which is reflected especially in large-scale assessments (Brito, 2009). Almeida and Primi (2004) have pointed out systematic information about the influence of age, gender, and scholar level in the student's ability, that corroborate the results observed in the present study. Other studies to this corroborate the results observed in this research (Nogueira, 2008; Vendramini, 2005, 2007; Vendramini, Silva, Dias, & Nogueira, 2007).

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