Underlying reasons for different learning approaches in statistics in Argentina

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Abstract

One of the main problems concerning teaching statistics at university is why students use a surface learning approach and miss the opportunity to develop statistical skills and useful knowledge for their professional careers, whereas others adopt a deep approach strategy, enabling them to critically analyze and understand course materials, build on prior knowledge and experience, and determine to what extent conclusions may be reached from a basis of evidence and reasoning. This study presents some preliminary results of an investigation carried out in Argentina to explore the relationship between some student demographic characteristics and preferences, and three learning strategies. Research was conducted in three non-statistical programs of Buenos Aires University, Argentina. We surveyed 430 students and used the ASSIST questionnaire together with a demographic questionnaire. Students had previously taken a general knowledge math test. The ASSIST questionnaire was validated for administration in Argentina. Preliminary findings showed a significant positive correlation among deep strategies, math test scores and the perceived usefulness of statistics for future work. Those students who had disliked mathematics at high school adopted a surface strategy, whereas those who had liked it adopted a strategic approach. Academic performance at the statistic course was directly related to the strategic and deep approaches and negatively to the surface approach. We also found out that those students who were considering enrolling in graduate courses showed deeper strategic approaches. Conversely, those who were not considering continuing their studies adopted a surface approach. Female students utilized a more strategic approach than male students. Finally, this questionnaire might represent a valuable tool for researching attitudes towards learning since the diagnosis and the understanding of learning factors pave the way for sound teaching strategies.

Key Words: ASSIST questionnaire, learning strategies, statistics courses.

1. Introduction

As regards our experiences as statistics university teachers at non-statistical programs, we have used different technologies enabling students to develop useful statistical knowledge and skills for their professional careers or further academic studies. The variability of the results obtained made us focus on students learning skills rather than only on teaching methodologies and techniques. Some authors have studied learning strategies used by students. Marton and Saljo (1976a,b) have identified two learning strategies clearly linked to understanding: deep and surface approach learning strategies. Students, who adopt the deep approach strategy in order to understand teaching materials, critically interact with given arguments and relate them to prior knowledge, assessing to what extent conclusions may be justified by the evidence presented. Therefore deep approaches may enhance learning retention, transfer, integration and knowledge use, resulting in better quality learning outcomes (Ramsden, 1992). On the other hand, a surface approach strategy is characterized by a lack of the students' personal commitment

in the learning process. Students focus on rote-learning without relating concepts. This strategy brings about a lack of understanding of relevant concepts and low quality learning processes. Some other studies have further analysed the test-driven influence on learning strategies and identified an additional strategy: the strategic one (Ramsden, 1979; Entwistle and Ramsden, 1983) or strategy oriented to qualification (Biggs, 1987; Bilgin, 2010). In this case, students´ interest relies on test demands. Students use any learning methodology which may increase their academic performance (Watkins, 2000). These three strategies have been assessed by the ASSIST (*Approaches and Study Skills Inventory for Students*) questionnaire developed by Tait *el al* (1998), which was validated by Pérez *et al.(*2012) in Argentina.
This paper presents some preliminary results of a study aimed at identifying some variables related to different Statistics learning strategies adopted by second-year university students of non-statistical programs.

2. The study

The sample comprised 430 students of Statistics propedeutic courses at the Agricultural Engineer and Environmental Sciences Programs -Agricultural Sciences School- and the Biological Sciences Program -Exact and Natural Sciences School- at the Buenos Aires University. In the three programs, Statistics is one of the initial courses, and in general students take it in the second year of their studies.
The ASSIST questionnaire (Tait *et al*., 1998) was used as a tool to assess student learning strategies in three levels: deep, strategic and surface. The questionnaire comprises 52 statements and students´ responses to them indicate their level of agreement with them, assessed through a 5-point Likert scale – with 1 = disagreement and 5 = agreement. Statements are combined into 13 subscales which are then grouped in three main scales (4 subscales for surface and deep approaches, and 5 for the strategic approach). Student total scores were obtained through summing up the responses to the four statements of the subscale.
In the first class, Agricultural Sciences School students had to take an elementary Math test developed by researchers at the Psychology School of Florence University. At the end of the first half of the course –after going over descriptive statistical concepts and essential probability notions- all the students completed the ASSIST questionnaire together with a demographic survey. Students' participation in the survey was not compulsory; however, the test was taken by all the students.
A confirmatory factor analysis was used. Three latent variables corresponding to three constructs of learning strategies were used. From the analysis results, scores for the different latent variables were used to explore variables related to the different strategies. We used the DGC technique (Di Rienzo *et al*., 2002) to perform multiple comparisons of score means for univariate tests.

3. Results

Only 271 students out of 430 who answered the ASSIST questionnaire went over it completely. The gender percentage was reverted in the Agricultural Engineering and the Environmental Sciences program, showing similar values. In the former, almost 70% students were male students. This percentage corresponded to women in the Environmental Sciences Program. In the Biology Program the distribution was similar as the Environmental Sciences Program. Age distribution was similar for both genders. The general median was 21 years old (Table 1).

Table 1. Gender and age sample composition by Program

	Ag. Sciences	Environ. Sciences	Biology	Total
n (%)	186 (43.3%)	96 (22.3%)	148 (34.4%)	430
Female	31.7%	65.6%	69.0%	52,0%
Age (in years)				
Median	20	20	21	21
Range	18-40	18-38	18-31	18-40

The confirmatory factor analysis of the students´ responses to the ASSIST questionnaire showed that programs of both university schools (Agricultural Sciences-Exact and Natural Sciences) did not have show significant differences in surface and strategic strategies, but in deep approach strategies. Agricultural Engineering and Environmental Sciences programs had the higher scores on this scale (p-value: 0.0421).
As regards gender, females had higher scores than males in strategic scores, but no significant differences were detected by gender in the other two approaches (Table 2). A deeper analysis of the strategic approach subscale brought about that female scores in study organization, time management, learning effectiveness monitoring, and search for positive results were significantly higher than male scores (values-p < 0.05).

Table 2: Learning strategies by gender

Gender (n=430)	**Learning strategy**		
	Surface	**Strategic**	**Deep**
Female (n=224)	-0.040	0.142	0.014
Male (n=206)	0.043	-0.154	-0.015
p-value	0.302	0.0005*	0.739

The design of both Environmental Sciences and Agricultural Engineering Programs allows students to simultaneously attend five courses per semester, whereas students of the Biology Program may only take two courses by semester. In both Environmental Sciences and Agricultural Engineering Programs, there was a significant direct relationship between deep and surface strategy scores and the number of courses that students were simultaneously attending with the Statistics course.
All the students of the Biology Program stated that they would study post-graduate courses, therefore only the answers of the other student programs were analyzed. Students who were not planning to take post-graduate programs adopted a surface strategy. Conversely, those who had plans for post-graduate programs adopted deep or strategic approaches (Table 3).

Table 3: Learning strategies and post-graduate prospective studies by Agricultural Engineering and Environmental Sciences Programs.

Postgraduate (n=271)	**Learning strategy**

	Surface	**Strategic**	**Deep**
No (n=38)	0.434	-0.249	-0.267
Yes (n=233)	-0.065	0.079	0.133
p-values	0.0003*	0.0305*	0.0051*

Biology student's strategy did not differentiate by their high school preference in Math courses. On the contrary, those students of Agricultural Engineering and Environmental Sciences Programs who had liked Math at high school adopted deep and strategic approaches. Those who had disliked Math showed surface strategies.

Those students who considered that Statistics was useful for their professional careers had more significant scores in deep strategies. Biology students did not take the Math pre-test. A positive relationship was detected between the deep learning approaches and the scores obtained in the Math test (r= 0.172, p-value= 0.0093) and a significant inverse relationship between the score of the Math test and the surface approach (r= -0.148, p-value= 0.025).

Table 4 shows the relationship between the strategy adopted by students in the courses and their final achievement in the courses assessed by their accomplishment percentage assessed against course objectives and contents. Three levels of achievement were considered: below 39%; between 40% and 69%, and 70% and above. The average score significantly higher on the surface scale corresponded to students who had a level of achievement below 39%; and the lower to those students who had a level of achievement 70% or above. There were significant differences across the three levels. On the strategic scales, the three levels of achievements had significant differences. The students who accomplished less than 39% had the lowest averages and the ones who accomplished 70% or above had the highest averages. On the deep scale, students who had a level of achievement 70% or above had the highest average showing a significant difference from the other levels, among which no differences were detected.

Table 4: Learning strategies and student final condition

Final level of achievement (n=417)	**Learning Strategy**		
	Surface	**Strategic**	**Deep**
Below 39% (n=90)	0.277 a	-0.518 c	-0.199 a
From 40% to 69% (n=147)	0.037 b	-0.092 b	-0.031 a
From 70% to 100% (n=180)	-0.169 c	0.315 a	0.110 b
p-value	<0.0001	<0.0001	0.0238

As regards the comparison of strategies by university schools, only differences on the deep scale (p-value= 0.0421) were found. The Biology Program had the lowest average.

4. Some preliminary conclusions

In this study, female students showed a strategy more focused on the study organization and achievement of better outcomes, getting scores on the strategic scale significantly higher than male students. On the other scales, genders had a similar performance. This result differs from results obtained by Flood and Wilson (2008) at an Economic Sciences School, where females had better scores on the surface scale. On the other hand, Byrne *et al.* (1999, 2002), and Wickramasinghe and Samarasekera (2011) did not find any differences by gender in the learning strategies of Economic Sciences students at an Irish university and of Medicine students at Sri Lanka, respectively.

The number of courses taken simultaneously with Statistics showed a positive correlation with deep and strategic approaches in Agricultural Engineering and Environmental Sciences.

Scores of students who had liked Math at high school were positively related to the deep and strategic approach only in Agricultural Engineering and Environmental Sciences Programs. Students who would take further graduate programs showed strategic and deep approaches only in Agricultural Engineering and Environmental Sciences Programs. Those students who would not take further graduate courses had high scores on the surface approach scale. This may suggest that Statistics is considered useful for academic purposes but not for making better everyday-life or professional decisions.

As expected, students´ final academic achievement agreed with their learning strategies. There were significant differences across the three levels of achievement considered. On the strategic scales, the three levels of achievement had significant differences. The students who accomplished less than 39%, had the lowest averages and the ones who accomplished 40% or above, had the highest averages.

It would be interesting to extend this study to other countries in order to increase the variability of the demographic and cultural variables and the heterogeneity of courses and programs. Thus, the complex set of variables underlying in the adoption of learning strategies would be further explored. The knowledge of these variables may be used as a valuable input to design teaching strategies leading to sustainable statistics learning.

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