



Italian University Students' Achievement in Statistics: The Role of Attitudes and Approaches to Learning.

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Abstract

The aim of the present study was to investigate students' achievement in introductory statistics courses taking into account the relationships between learning approaches and attitudes toward statistics (including the self-confidence in learning statistics component). This research is part of a larger multinational study on learning approaches in statistics which includes students from Australia, Argentina, Finland, Turkey and Vietnam. It was hypothesised that attitudes toward statistics influenced the learning approaches that students adopt, which in turn affected achievement. Students were administered measures assessing their attitudes and learning approaches (i.e., deep, surface and strategic). Achievement was assessed considering students' final grades and the number of exam failures. To analyse these data, a structural equation model (SEM) was applied. The results attested that attitudes toward statistics had an effect on the learning approaches. Additionally, we found that surface, deep and strategic approaches predicted achievement. Findings suggest the need to foster positive attitudes toward statistics in order to promote a learning approach (deep or strategic) which helps in achieving higher grades and avoiding failures.

Keywords: learning approaches; achievement; attitudes; SEM.

1. Introduction

Learning approaches (Biggs, 2003; Entwistle, 1991; Marton & Saljo, 1976a, 1976b; Ramsden, 2003; Rhem, 1995) are one of the most widely used frameworks for understanding how students go about learning in their higher education. They are defined as *deep*, *surface*, and *strategic*. A deep approach to learning is characterized by a personal commitment to learning and an interest in the subject. Students adopting this approach aim to understand the topics, they engage critically with the arguments put forward, relate them to their prior knowledge, and evaluate whether conclusions are justified by the evidence. Consequently, deep learning leads to higher quality learning outcomes. In contrast, a surface approach is characterized by a lack of personal engagement in the learning process. As such, students focus on rote-learning, they tend to study the topics in an unrelated manner, and they are constrained by the specific task. This approach often leads to misunderstanding of important concepts and, as a consequence, to poor learning outcomes. Finally, the strategic approach refers primarily to adopting learning strategies (including time management and planning) tailored on the assessment demands. Students adopting this approach focus on finding the strategies that fit the specific course requirements in order to maximize their chances of academic success.

The impact of learning approaches on achievement has not been investigated referring specifically to statistics. Thus, the present paper aimed at addressing this issue starting from the following assumptions. Approaches to learning are not intrinsic characteristics of students (Lucas & Mladenovic, 2004; Ramsden, 2003) but they are sensitive to the environment in which the learning occurs and are affected by students' perceptions of the learning situation (Rhem, 1995). Thus, it turns to be very interesting to investigate the learning approaches that students adopt inside the statistics learning environment. Indeed, all over the world and in many university programs students that have to pass compulsory statistics exams are for the most part students progressing towards degrees other than

statistics (and sometimes quite different from it, such as psychology, health sciences, educational science degrees). As such, they fail to understand the significance and benefit of statistics for their own academic and professional life. More broadly speaking, these students are more likely to have a negative attitudes toward statistics, i.e., they do not like statistics, are not interested in statistics, believe that statistics is difficult to learn, or aren't willing to put in the effort needed to learn statistics (Schau, Miller & Petocz, 2012). For all these reasons, to gain a better understanding of university students' learning approaches to statistics could provide new insights in investigating factors impacting on statistics learning in higher education, and in improving the learning and teaching of statistics.

The aim of the present study was to investigate students' achievement in introductory statistics courses taking into account the relationships between learning approaches and attitudes toward statistics (including the self-confidence in dealing with the discipline). We hypothesized that attitudes toward statistics influenced the learning approaches that students adopt, and then approaches affected achievement (Figure 1). This research is part of a larger multinational study on learning approaches in statistics which includes students from Australia, Argentina, Finland, Turkey and Vietnam (Chiesi et al., 2013, 2015).

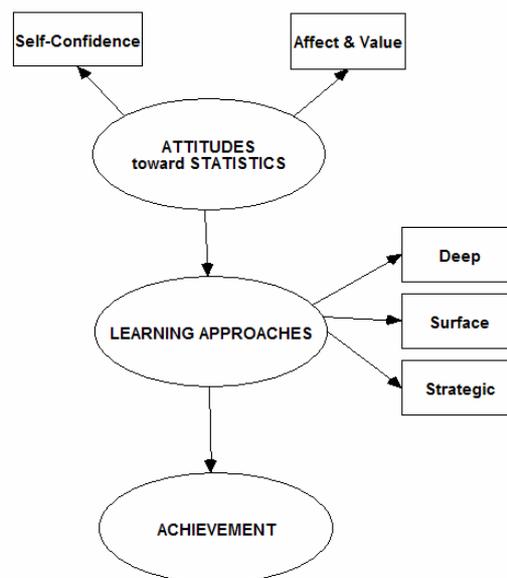


Figure 1. Model on the relationships of attitudes and learning approaches on achievement in Statistics.

2. Method

2.1. Participants

Data were collected from 172 psychology students enrolled in an undergraduate introductory statistics course at the University of Florence in Italy. The course was scheduled to take place over 10 weeks, at 6 hours per week (for a total amount of 60 hours). It covered the usual introductory topics of descriptive and inferential statistics, and their application in psychological research. During each class some theoretical issues were introduced followed by practical examples and exercises. Students were requested to solve exercises by paper-and-pencil procedure, and no computer package was used. Participants' age ranged from 18 to 62 with a mean age of 20.7 years ($SD = 4.0$), and most of the participants were women (82.6%). This percentage reflects the gender distribution of the population of

psychology students in Italy. All students participated on a voluntary basis after they were given information about the general aim of the investigation (i.e., collecting information in order to improve students' statistics achievement).

2.3. Measure and Procedure

At the beginning of the course the Italian version (Chiesi & Primi, 2009) of the *Survey of Attitudes Toward Statistics* (SATS, Schau et al., 1995) was administered to provide a multidimensional measure of attitude that includes the perception of statistics in itself and as part of the degree program, as well as affective and cognitive components. Additionally, to measure specifically students' self-confidence in statistics the Italian version (Chiesi, Primi & Galli, 2007) of the *Current Statistics Self-Efficacy scale* (CSSE, Finney & Schraw, 2003) was employed.

A revised version of the *Approaches and Study Skills Inventory for Students* (ASSIST, Tait et al., 1998) developed in a previous study (Chiesi et al., 2014) was administered toward the middle of the course. It contains 32 statements, and respondents indicate the degree of their agreement with each statement using a five-point Likert scale where 1 = disagree and 5 = agree. The statements are combined into 8 subscales of four statements each which are then further grouped into the three main scales: Deep (Seeking Meaning, Relating Ideas, Use of Evidence), Strategic (Organized Studying, Time Management), Surface (Lack of Purpose, Unrelated Memorizing, Syllabus-Boundness).

Finally, achievement was assessed considering students' final grades and the number of exam failures. Final grade was assigned through a written task (problems and open-ended questions) constructed by instructors, and an oral exam. Sometimes students were unsuccessful in the final examination and some of them needed several attempts to pass. Thus, the number of failed attempts was recorded as indicator of the performance.

3. Results and Discussion

To analyse these data, a structural equation model (SEM) was applied. Analyses were conducted with AMOS 5.0 (Arbuckle, 2003) using maximum likelihood estimation on the variance-covariance matrix since Skewness and Kurtosis indices of all the observed variables ranged inside the values of -1 and 1 revealing that the departures from normality were acceptable and that cannot be expected to lead to appreciable distortions (Marcoulides & Hershberger, 1997). Several fit indices were used to assess model fit as suggested by Schumaker and Lomax (1996). Goodness-of-fit statistics reported are χ^2 /degrees of freedom ratios, the comparative fit index (CFI), the Tucker-Lewis index (TLI), and the root mean of square error of approximation (RMSEA).

Prior to conducting the analyses, we looked at missing values in the data. For each item, we computed the percentage of missing responses, and we tested if missing data occurred completely at random (MCAR). Minimal data were missing across all variables. For each item, missing values remained at or below 0.2% of the total cases in the sample, and no case had more than five missing responses. Since Little's (1988) chi-square test attested that data were missing completely at random, we used an expectation maximization (EM) algorithm to impute the missing data (see Scheffer, 2002). Both Little's test and the EM algorithm are implemented in SPSS 20.0.

The hypothesized model showed a good fit ($\chi^2(12) = 16.57, p = .17, \chi^2/df = 1.38, CFI = .97, TLI = .95, RMSEA = .047$). For the measurement model, each of the subscales loaded strongly and significantly on the hypothesised factor (factor loadings ranged from .24 to .87). For the structural model, positive relations* were found between Attitudes and Learning Approaches (.37), and Learning Approaches and Achievement (.53).

* To fix the metric of the Learning approaches variable the Deep scale was used.

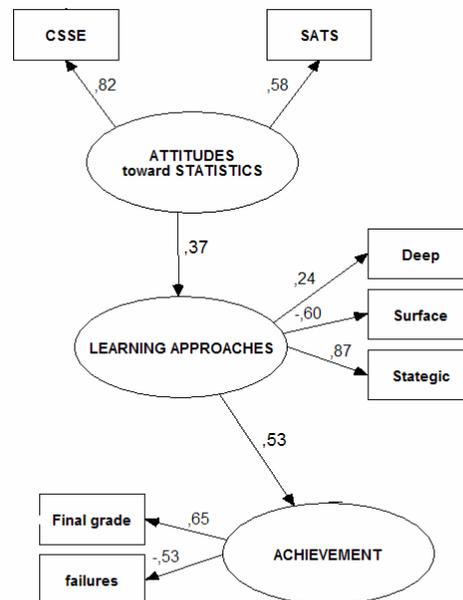


Figure 2. Model on the relationships of attitudes and learning approaches on achievement in Statistics with standardized parameters (paths are all significant at the .05 level or lower).

The results attested that attitudes toward statistics had an effect on the learning approaches. That is, more positive attitudes toward statistics (including higher self-confidence in own ability to deal with the discipline) are linked to higher deep and strategic approaches, and lower surface approach. Additionally, we found that surface, deep and strategic approaches predicted achievement. As expected, lower the surface approach and higher the deep and strategic ones, higher the achievement and lower the likelihood to encounter failures.

5. Conclusions

Findings suggest the need to foster positive attitudes toward statistics in order to promote learning approaches (deep or strategic) which helps in achieving higher grades and avoiding failures. Indeed, results showed that attitudes toward statistics (self-confidence, positive or negative feelings, value ascribed to statistics) affect the way in which students move towards the discipline. If they believe that they could not master the topics, they perceive the subject as difficult and worthless, and they experience negative feelings, they are more likely to adopt a surface approach in learning. That is, students focus on rote-learning, study the topics in an unrelated manner, and misunderstand important concepts. As a consequence, they get poor learning outcomes.

Some pedagogical issues can be derived from this finding suggesting that attitude toward statistics should be the focus of planning interventions to help students in choosing the right approach to the discipline. Given that cognitive and non-cognitive factors appear to be interrelated in achievement, intervention strategies should be aimed at supporting change not only in competence but also in perceived competence, perceived difficulty and utility of the subject, and feelings towards it.

Future research should aim to test the effectiveness of pedagogical techniques directed in enhancing attitudes and to assess the related effects on learning approaches and performance.

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