AFFECTIVE REACTIONS AND ATTITUDES OF THE LAST CLASS OF GREEK HIGH SCHOOL STUDENTS TOWARDS STATISTICS

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**ABSTRACT**
The purpose of the study was to capture the attitudes of the last class of Greek high school students as a result of their first exposure to instruction in statistics. This paper has examined selected non-cognitive aspects of statistics instruction, especially those related to affective reactions and attitudes towards statistics with a view to enhance prospective mathematics teachers’ knowledge of students’ attitudes.

**INTRODUCTION**

‘To make the learning of statistics less frustrating, less fearful, more effective, further attention ... should be focused on believes, attitudes, and expectations students bring into statistics classrooms’, (Gal et al, 1994).

The main aim in this research was to examine how the subject of statistics is perceived by Greek students in the final year of high school. In particular, students’ attitudes referring to their negative or positive feelings towards statistics (Affect), their perceptions about their cognitive competence in statistics (Cognitive Competence), their beliefs about the value of the course to their future personal and professional life (Value), as well as their attitudes towards the difficulty of statistics as a subject (Difficulty) were examined.

Negative affective responses to statistics are common both at the secondary and university level (Gal et al 1997, Anastasiadou 2000, Carmona 2004). In Greece, in the third grade of high school, students are taught basic elements of statistics (the concepts of: sample, relative and absolute frequency, relative and absolute cumulative frequency, various diagrams, median, average and variation and standard deviation, probability, three diagrams, tables of double entry and Venn diagrams, concept of uncertainty).

Although the first course in statistics rarely requires complicated mathematics, Greek teachers have experienced the difficulty of teaching the subject because of students’ fear of mathematics and their negatives attitudes toward statistics (Anastasiadou 2004, Bishop 2004). Students are likely to have trouble with statistics due to non-cognitive factors such as negative attitudes or beliefs towards statistics. Such factors can impede learning of
This paper examines selected non-cognitive aspects of statistics instruction, especially those related to affective reactions and attitudes towards statistics of the Greek high school students. Items that refer to students’ feelings towards statistics, their learning abilities in statistics, their perceptions regarding the value and the usefulness of this course, and finally, the difficulty of statistics as a learning subject, are all issues that were included and examined in this research with the help of implicative statistical analysis.

PARTICIPANTS- TOOLS- METHODOLOGY

The data coming from search of Survey of Attitudes toward Statistics (SATS) were collected in Greece, in Thessaloniki during the academic year 2003-04. The sample consisted of 144 high school students’ of the third class (aged 14-15) in Thessaloniki. In fact, 142 questionnaires were completed correctly in the second semester of the academic year. A total of 142 fully completed questionnaires were examined, 63 (44.4%) of which were filled by male students and 79 (55.6%) by female students. Twenty minutes of an hour were asked from the teachers in class, in order for students to fill out the questionnaires. The students filled in the questionnaires, after they were informed about the purpose of the study and were reassured about the confidentiality of their answers, and after they were given instructions about the questionnaire of the Search of Attitudes. The participation was voluntary. It was highly stressed that responses to the questionnaire will give information concerning the subject and the tuition, in order to be used by the teachers, to improve their teaching methods. It was emphasized that the questionnaire should be filled quickly, with instinctive answers.

The concepts of statistics that the students are taught in this class coexist with the notions of algebra in the book of the third class of Greek high school. Statistics is considered in the curriculum guide, as part of the mathematics course and not as a separate course. The chapter of Statistics includes the concept of a sample, the relative and absolute frequencies, the median, the average, the variation and the standard deviation. It also presents various graphical representations.

The means that was chosen for the measure of attitudes of students was the questionnaire ‘Survey of Attitudes toward Statistics’ (SATS) (Schau et al 1995). The authors of SATS developed the specific tool, in order to search the following categories of attitudes. Affect (positive and negative emotions towards statistics), Cognitive Competence (positive and negative attitudes concerning the knowledge and the abilities of a student when they refer to
statistics), Value (positive and negative attitudes towards the importance and  
the usefulness of statistics in the personal and professional life of students)  
and Difficulty (attitudes concerning the difficulty of statistics as a subject).  
The ‘Survey of Attitudes Towards Statistics’ that was provided to the  
students is a tool that measures the attitudes of students towards statistics,  
allows the application in all levels of education, constitutes a means of  
measuring positive as well as negative attitudes, and can be applied at the  
start, the duration, or the end of a semester (Schau 1992). The questionnaire  
of that tool consists of 38 items (28 items concern attitudes and 10 concern  
demographic items). Six out of 28 items are about feeling; six about  
knowledge ability, nine about value, and seven about difficulty. Half of the  
items were classified as positive and the other half as negative. In each issue  
a Likert scale of seven levels was used, extending from 1 (total disagreement)  
to 7 (total agreement).

More issues concerning mathematical preparatory education of statistics and  
information of general attainment are included (10 items). The analysis of  
students’ responses to these 10 items follows. A total of 142 students of the  
last grade of high school filled in the SATS questionnaire. Sixty-three  
(44.4%) of the questionnaires were filled by male students and 79 (55.6%) by  
female students. Twenty seven students (19%) say that they do not fell  
confident to master introductory statistics material, 79 (55.6 %) that they are  
very confident, and 36 (25.4%) students have neutral attitude as far as their  
confidence concerns in order to deal with introductory statistics material.  
Twenty-nine students (20.4%) mention that boys have more skills than girls,  
in opposition to 23 (16.2%) students who feel that girls are better. Ninety  
students (63.4%) believe that both boys and girls have the same skills.  
Fourteen (9.9%) of the students confess that they are not good at math, while  
83 (58.5%) believe that they are modest and 45 (31.7%) that they are good at  
math. Further, 79 (55.6%) of the students declare that they do not have much  
experience in statistics although notions of statistics appear in the  
mathematics text book from primary school, 54 (38%) that they have modest  
experience and only 9 (6.3%) that they have substantial experience in  
statistics. Finally, 34 (23.9%) of the students admit that they do not have much  
experience in computers, 71 (50%) rate their experience as modest, and  
37 (26.1%) argue that they have considerable experience in computers.

Descriptive data analysis of data was done using the SPSS 11.5 program in  
order to investigate the issues concerning mathematical preparatory education  
of statistics and information of general attainment. In order to examine  
whether students’ attitudes towards statistics (Affect, Cognitive Competence,
Value, Difficulty) are differentiated based on gender, the t-test of independents samples for every dimension of attitudes was used. Implicative analysis is used in order to analyze the data of research. The implicative analysis of Gras (1996) gives the possibility of the division of the variants of the research, of the classification of these variants and of the determination of implication between the variants or the class of variants. The resulting relations are not relations of reason, but a point of quality that allows the contention that the answer to a question which brings along the answer to another question related to the first one.

From the implicative analysis of Gras, the similarity and hierarchical trees, and the implication tree were used. In the similarity tree, the questions used in the research are grouped according to the similarity of the answer by the subjects. The hierarchical tree presents the implications existing between the variants and the classes of variants. Finally, the implication diagram shows the implicative relations existing between the variants and the classes of variants.

In the three diagrams, the lines in black color present the relations of similarity or implications at a significance level of 99%. The program CHIC, which stands for the Cohesive Hierarchical Implications Classification, is used for the analysis of data with the help of implicative statistics.

ANALYSIS OF RESULTS

SIMILARITY TREE

In the similarity tree, the collections of the variants on the basis of the conduct of the subjects of the research are presented. The similarities with a bold black color are significant at a significance level of 99%. Having as basis the similarity tree we have two groups of similarity (Diagram 1).

The first group can be appointed as a group of liking statistics. Concretely, it is constituted by two subcategories. The first subgroup \{\{(1,7),8\},(4,7)\} likes statistics and recognizes the value of the discipline. Especially it supports that statistics should be a required part of students’ professional training because statistical skills will make students more employable. Furthermore this subgroup believes that statistics formulas are easy to understand because statistics is a subject quickly learned by most people. The second subgroup \{\{(13,15),(23,24)\}\} recognizes statistics as a very useful, pleasant and easy to learn subject. This subgroup also thinks statistics equations are easy to understand.

The second group \{(6,18),\{22,28\},26\} recognizes statistics as a highly technical and complicated learning subject that requires a great deal of
discipline and involves massive computations, and argues that most people have to learn a new way of thinking in order to be able to do statistics.

Diagram 1: Similarity Tree
The right branch of the similarity diagram (Diagram 1) expresses negative attitude of the subjects of this research. The first group of this branch admits that it feels insecurity when dealing with statistical problems. This group has two subgroups. The first subgroup \{(2,3),20\} appears to be insecure when having to deal with statistical problems, to have trouble understanding statistics because of way the students think and that’s why the students make a lot of mathematical errors. The second subgroup \{(11,14)\} includes students that get frustrated going over statistics tests in class and that are afraid of statistics.

The second group expresses negative attitudes concerning the value and the utility of statistics. It has two subgroups. The first subgroup \{\{(5,25),9\},(21,27)\} thinks that statistics is worthless because this subject is irrelevant to people’s life, it admits that it has no idea of what’s going on in statistics, and it is afraid of statistics because it finds it difficult to understand statistical concepts. The second subgroup \{(10,12),(16,19)\} does not recognize the usefulness of statistics for the typical professional because it thinks that students will not have any application for statistics in their profession. In addition it thinks that statistical thinking is not applicable in life outside a job because situations requiring the use of statistics are rarely presented in everyday life.

Hierarchical Tree
The hierarchical tree introduces the implications between the variants at a significance level of 99%. The implications with bold black color are significant to a level of 99%.

According to the hierarchical tree, there are ten groups of implicative relations (Diagram 2).

By analyzing the Hierarchical Tree, an implicative relation appears between the variants (3), (2) and (23). The variant (3) concerns the conceptual problems in understanding statistics which unfortunately are serious and
create insecurity in students when they have to do statistical problems (2), thus they make a lot of mathematical errors in statistics (23).

Diagram 2: Hierarchical Tree
From the second group of implicative relations (5,9) the negative attitude of the subjects is obvious and it is connected with the value and usefulness of statistics. These students think that statistics is worthless (5), that’s why they are totally ignorant as far as statistics is concerned. In particular the students admit that they have no idea of what’s going on in statistics (9).

The third group of implicative relations (7,8,23) is different from the previous one because it constitutes of statements which support that statistics should be a required part of basic training (7), because statistical skills will make students more employable (8). Those perceptions allow the learning of statistics (23).

The fourth group of implicative relations even if it is small expresses the rejection of the usefulness of the statistical thinking in students’ life outside their job (12) which leads to the opinion that statistics is not useful to the typical profession (10).

The next group follows (13,17,24) which is made up of statements that recognize the presence and the utility of statistics. Specifically, it recognizes that it will use statistics in everyday life (13), and this attitude leads to the belief that statistics is a subject quickly learned by most people (17), and to the persuasion that it can understand statistical equations (24).

The sixth group follows (14,11,18) and it declares that it is under stress during statistics classes (14), that leads students to get frustrated going over statistics tests in class (11) because the learning of statistics requires a great deal of discipline (18).

Change of group (seven) and change of mood. This group (15,4,1,26) which is made up of statements that declare that students enjoy taking statistics courses (15), and they believe that statistics formulas are easy to understand (4) and like statistics (1) although statistics is a highly technical subject (26).
From the eighth group of implicative relations (16,19,6), the negative attitude of the subjects is obviously connected with the value and usefulness of the complicated subject of statistics (6) in both professional and everyday life. It is highly stressed that there is no statistical application in everyday life (16) and statistics is irrelevant to professional life because there would be no application for statistics in students’ future profession (19).

In the ninth group of implicative relations (25,27,21) we have a pessimistic message concerning the understanding of the cognitive subject of statistics that according to students’ opinions is irrelevant to their life (25). This group admits that it is afraid of statistics (21), and this fear leads students to admit that they find it difficult to understand statistical concepts (27).

While ending this description of implicative relations from the last group of the hierarchical tree, we can realize that students believe that they have to learn a new way of thinking to do statistics (28), because statistics involves massive computations (22).

**IMPLICATION DIAGRAM**

The implication graph is constituted by three implicative chains (Diagram 3). The first one, which is the largest, expresses a negative attitude and consists of the variants (5 → 16 → 25,19, 12 → 10,25,19,11 3 → 20,6,2,11, 25 → 27, 27,11,2 → 21, 21,10 → 9).

In this chain we observe that students declare that statistics is worthless (5) because statistical conclusions are rarely applicable in everyday life (16), statistics is irrelevant to their life (25) and there will be no application for statistics in their future profession (19). Moreover the chain (12 → 10,25,19,11) can show that the students believe that statistical thinking is not applicable in life outside their job (12) which leads to the conclusions that statistics is not useful to the typical professional (10). Statistics is irrelevant to students’ life (25), and there will be no application for statistics in their future profession (19). Those perceptions make students frustrated when going over statistics tests in class (11).

Diagram 3: Implication diagram
Furthermore, the chain (3 → 20, 6, 2, 11) shows that the students consider their way of thinking as a serious obstacle in understanding statistics (3), thus they make many mathematical errors in statistics (20). They also consider statistics as a complicated subject (6), a subject that makes them feel frustrated with tests in class (11). The implications 25 → 27 show that students who think that statistics is irrelevant to life (25) have difficulty in understanding statistical concepts (27).

The implications 27, 11, 2 → 21 make it clear that students’ difficulties in understanding statistics concepts (27), make them feel frustrated with tests in class (11), feel insecure when dealing with statistical problems (2), and have fear towards statistics (21). In the last part of the first chain (21, 10 → 9) the students that fear statistics (21) and think that statistics is not useful to the typical professional (10), are students totally ignorant about statistics (9).

The second chain (28, 14 → 22) shows that students’ perception that statistical understanding forces most people to learn a new way of thinking to deal with this discipline and the stress they feel during statistics classes, are both connected with the fact that statistics involves massive computations.

The third chain (15, 7 → 8, 7 → 1, 4, 8, 14, 24, 13, 17 → 23) shows that the joy of taking statistics courses (15) and the perception that statistics should be a required part of professional training (7) lead to the certainty that statistical skills make students more employable (8). Further, there are implications (7 → 1, 4) which concern the necessity of teaching statistics during basic training (7) and this is because the students like statistics (1) and find statistics formulas easy to understand (4).

In the same chain (8, 14, 24, 13, 17 → 23) we observe that students believe that statistical skills can make them more employable (8) and thus they like the subject (1), they have all the required capacities to understand the formulas (4) and the equations (24), because statistics is a subject that is quickly learned by most people (17), and is used in everyday life. Those feelings make students confident that they can learn statistics (23).

The t-test showed that there is only a statistically significant difference between male and female students concerning the positive and negative feelings towards statistics (Affect) (Affect: t=2.379, df=150, p<0.05). This result is similar with (Roberts et al. 1982, Auzmendi 1991, Zeidner 1981) results.

The t-test showed that there is no statistically difference of the male and female students concerning the Cognitive Competence, Value and Difficulty factors towards statistics (Cognitive Competence: t=2.881, df=140, p>0.05, Value: t=-1.751, df=140, p>0.05, Difficulty: t=2.456, df=150, p>0.05).
CONCLUSIONS

Having as basis the results of the research, three basic groups of students were distinguished. The first group consists of students who face negatively the course; the second group of students who consider necessary the change of their way of thinking in order to do statistics, and the third one of students that perceives statistics positively.

The first group appears as a negative group towards statistics. This group has students who do not value statistics; on the contrary, they find it absolutely useless both in professional and personal life. Further, negative feelings about statistics such as insecurity, stress and fear lead them to have a low self-esteem concerning their learning capacities. This fact demonstrates a common observation about human attitudes and behavior; if students do not do certain activities well, they tend to feel more negatively about them. Students who feel relatively more inept in applying their knowledge and skills to statistics also feel relatively more negative toward statistics. These attitudes make students think that are totally confused and ignorant as far as the subject is concerned. Thus, we can support that there is a strong relationship between Cognitive Competence and Affect.

For the second group of students, their current way of thinking comes up as a major obstacle in understanding of statistics, and a source of anxiety about statistics, which they consider a subject that entails massive computations. This relation between Cognitive Competence and Affect and Difficulty factors also determines students’ attitudes towards statistics.

The third group, which is positively inclined towards statistics, stresses the importance and utility of teaching of statistics in the third grade of Greek high school, considering how much the capability in doing statistics is valued in the professional fields. Concretely, this group is disposed positively to the knowledge that statistics offers as science object and to the capacities that will offer to the young members for people upon entrance in society. Moreover students in this group have confidence concerning their learning capacities. This relation between Value and Affects factors indicate that students who feel positively about statistics also tend to value statistics, a fact that is also a common observation about human attitudes and behavior.

REFERENCES


