Exploring pre-service teachers' attitudes towards statistics: preliminary results

Aristoula Kontogianni
Department of Primary Education
University of Ioannina
desmath@gmail.com

Anastasios Emvalotis
Department of Primary Education
University of Ioannina
aemvalot@uoi.gr

In the modern era data and information overwhelm every aspect of our lives. Statistical literacy seems the only way for the effective translation of all these data and information. In this framework we conducted a research in a department of education in a university in Greece. The main goal of our study was to examine students' attitudes towards statistics before their enrollment in an introductory statistics course. Data analysis does not show a statistically significant difference between students' attitudes toward statistics as a general field by gender and students' attitudes toward statistics as a course by gender.

Introduction

It is an undeniable fact that we live in a digital era, with great consequences for our personal and social life, our working and learning habits (Artigue, 2013). In this digital era, the social media and the plethora of data are shaping our opinion through the easy access to information (Engel, 2017). According to Evans (2017), in most countries with a developed civil society statistics resembles a kind of axiom on which citizens and policy makers rely in order to take decisions or to form the public opinion. Under these circumstances statistical literacy for all the adults seems to be necessary for the fully understanding of the data and the relevant information since as a notion it is connected with the understanding of data representations and statistical arguments of others.

Although there is not unanimity about the definition of statistical literacy (Sharma, 2017) there is an overall agreement about its importance (Garfield & Ben-Zvi, 2009) and its dimension as the final goal of statistics education. Even if students do not have to perform a research with statistical data, being able to understand statistics could be assistance for them in order to assess the quality of other studies and the validity of their findings (Sharma, 2017). However, according to Gal and Ginsburg (1994) it is generally recognized that many students begin statistics courses with negative views or later develop negative feelings about the field of statistics. In addition, students who finish their statistics courses with negative attitudes it is not likely to use in their professional and personal lives or in any educational activity the statistical knowledge they had acquired (Shau & Emmioglou, 2012).

The research results about students' attitudes towards statistics at the undergraduate university level, relate their poor performance with their negative attitudes (e.g. Wise, 1985). Most students, especially in humanities' departments take either only one introductory statistics course or generally few pertinent courses. This one course or these few courses seem to be the only way to change the negative attitudes towards statistics of these students.

The main goal of our study was to examine students' attitudes before their enrollment in an introductory statistics course in a department of education. Particularly, we explored:

- students' attitudes toward statistics as a general field and its impact for their lives
- students' attitudes toward statistics as a course they have to complete as a requirement for their studies.

Our research questions were formed as follows:

- Is a statistically significant difference in students' attitudes toward statistics as a general field relative to gender?
- Is a statistically significant difference in students' attitudes toward statistics as a course relative to gender?

Method

For our study's purpose we constructed a questionnaire with 40 questions adapted from the Attitude toward Statistics scale (Wise, 1985) and the SCAS Instrument (Gal, Ginsburg & Schau, 1997). These 40 items measured on a 1 to 5-point rating scale anchored by Strongly Agree and Strongly Disagree. The questions are divided into two subscales, based on factor analytic results (Wise, 1985). Course is designed to measure students' attitudes toward the course in which they are going to be enrolled. The other is attitudes toward the field of statistics which measures students' attitudes toward the use of statistics in their lives as future teachers or more general as citizens.

The participants were 138 students who participated in convenient sampling (81% female and 19% male) in a teacher education department in Greece.

The sampling was convenient and the questionnaire was posted on e-learning platform of the course [http://survey.ptde.uoi.gr/index.php/579596?lang=el] with the request to complete it before the start of the winter semester.

Results- Data analysis

The data collected by the questionnaire were analyzed using the Statistical Package for Social Science (SPSS v.25) for Windows. Completed questionnaires were coded and data were loaded to SPSS for statistical analysis. Frequencies (Table 1), means and standard deviations were

calculated for all items. A varimax factor analysis was used to reduce the items. Correlation coefficients between the scales were used to determine their relationships with each other.

Table 1: relevant frequencies of the items

	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
[I feel that statistics will be useful to me in my profession]	1.4	4.4	24.1	55.5	14.6
[The thought of being enrolled in a statistics course makes me nervous.]*	10.9	38.4	24.6	17.4	8.7
[A good researcher must have training in statistics.]*	1.5	5.8	7.3	46,0	39.4
[Statistics seems very mysterious to me.]*	9.4	34.1	33.3	18.1	5.1
[Most people would benefit from taking a statistics course.]*	1.4	5.1	17.4	58,0	18.1
[I have difficulty seeing how statistics relates to my field of study.]*	19.6	39.9	27.5	10.9	2.2
[I see being enrolled in a statistics course as a very unpleasant experience.]*	13,0	41.3	29.7	10.9	5.1
[I would like to continue my statistical training in an advanced course.]*	14,0	27.9	31.6	22.8	3.7
[Statistics will be useful to me in comparing the relative merits of different objects, methods, programs, etc.]*	0.7	2.9	16.9	61.8	17.6
[Statistics is not really very useful because it tells us what we already know anyway]*	26.1	56.5	13.8	3.6	0,0
[Statistical training is relevant to my performance in my field of study.]*	4.4	22.1	38.2	27.9	7.4
[I wish that I could have avoided taking my statistics course.]*	13.3	43.7	22.2	13.3	7.4
[Statistics is not a worthwhile part of my professional training.]*	26.1	57.2	12.3	2.9	1.4
[Statistics is too math oriented to be of much use to me in the future.]*	30.4	54.3	10.9	2.9	1.4
[I get upset at the thought of giving exams for a statistics course.]*	8,0	19.6	21.7	31.9	18.8
[Statistical analysis is best left to the "experts"]*	5.2	36.3	33.3	20,0	5.2
[Statistics is an inseparable aspect of scientific research.]*	0.7	0.7	18.4	50,0	30.1
[I feel intimidated when I have to deal with mathematical formulas.]*	17.6	26.5	20.6	25,0	10.3
[I am excited at the prospect of actually using statistics for my studies or for my future job]*	5.3	23.3	31.6	32.3	7.5
[Studying statistics is a waste of time]*	19.4	59,0	14.9	3.7	3,0
[My statistical training will help me better understand the research being done in my field of study.]*	1.5	8.1	22.8	53.7	14,0
[One becomes a more effective "consumer" of research findings if one has some training in statistics.]	0.7	8.1	24.4	54.8	11.9
[Training in statistics makes for a more well-rounded professional experience]*	0.7	9.6	33.1	44.1	12.5
[Statistical thinking can play a useful role in everyday my life.]*	2.9	11.7	33.6	40.9	10.9
[Dealing with large numbers makes me uneasy.]*	11.6	23.9	23.2	32.6	8.7
[I believe that statistics should be required early in one's professional training.]*	4.4	16.1	33.6	41.6	4.4
[Statistics is too complicated for me to use effectively.]*	5.1	33.1	30.9	24.3	6.6
[Statistical training is not really useful for most professionals.]*	6.6	62,0	24.1	6.6	0.7
[Statistical thinking will one day be as necessary for efficient citizenship as the ability to read and write.]*	4.4	25,0	39,0	27.9	3.7
[I often use statistical information in forming my opinions or making decisions.]**	11.3	28.6	26.3	29.3	4.5
[To be an intelligent consumer, it is necessary to know something about statistics.]**	5.2	17.9	27.6	41.8	7.5
[Because it is easy to lie with statistics, I don't trust them at all.]**	1.5	18.8	58.6	17.3	3.8
[Understanding probability and statistics is becoming increasingly important in our society, andmay become as essential as being able to add and subtract.]**	3,0	21.8	34.6	38.3	2.3
[Given the chance, I would like to learn more about probability and statistics.]**	3.7	11.1	23.7	47.4	14.1
[You must be good at mathematics to understand statistics.]**	3,0	24.4	27.4	35.6	9.6
[When someone byes a thing is preferable to ask an expert than to consulting an owner satisfaction survey in a consumer magazine]**	0,0	22.4	45.5	27.6	4.5
[I can understand almost all of the statistical terms that I encounter in newspapers or on television.]**	5.3	30.8	32.3	28.6	3,0
[I could easily explain how an opinion poll works.]**	2.2	21.6	35.8	36.6	3.7
[In the future all citizens should be statistically literate]** (adapted)	3,0	20.9	32.8	39.6	3.7
[Statistics is in fact mathematics and it shouldn't be taught as a separate lesson]**	7.4	47.1	29.4	13.2	2.9

* Wise, 1985

**Gal, Ginsburg & Schau, 1997

Factor analysis and reliability

An exploratory factor analysis was first conducted on 40 items. The Kaiser–Meyer–Olkin Measure (KMO) of Sampling Adequacy was 0.889 for the exploratory factor analysis. Kaiser (1974) characterizes KMO measures in the 0.80s as good (Field 2107). Bartlett's test was significant (chi square = 2557.54, $p < .001$). The results therefore indicated that the sample was appropriate for EFA analysis with Varimax Rotation Method.

The results of the factor analysis confirmed the two-factor instrument with 35 items. All items have a loading of at least 0.30 on their priori scale and on no other scale. Five items either did not load at a value higher than 0.30 on any of the seven factors or did not form a logically coherent group, are considered redundant and removed.

The internal consistency of the items on the instrument was assessed using the Cronbach's Alpha coefficient. Cronbach's alpha is a measure of internal consistency based on item covariance (Field, 2017; Howitt and Cramer, 2017) and provides evidence that was used to support the instrument's construct validation.

Reliability coefficients also were calculated for each of the scales identified through the factor analysis. Using the individual as the unit of analysis (Table 2), scale reliability estimates ranged from 0.88 for the scale of attitudes toward field (ATF), to 0.95 for the scale of attitudes toward course (ATC) (Table 3). Thus, each scale shows an acceptable degree of internal consistency (Howitt and Cramer 2017).

Table 2. Descriptive information of each scale.

	Sample item
ATF	Statistics is too math oriented to be of much use to me in the future
	Statistics is an inseparable aspect of scientific research
	Studying statistics is a waste of time.
	Statistical thinking will one day be as necessary for efficient citizenship as the ability to read and write
ATC	The thought of being enrolled in a statistics course makes me nervous
	Statistics seems very mysterious to me
	Statistics is too complicated for me to use effectively
	My statistical training will help me better understand the research being done in my field of study
	I have difficulty seeing how statistics relates to my field of study

Gender differences

The means and standard deviations for the two factors according to gender are presented in Table 3 & Table 4. The t-test with independent samples was used in this study to determine whether there was a significant difference between the perceptions of male and female students. A significant interaction was not observed between gender and the two factors

Table 3: Independent T-Test Gender by ATF

	Gender	N	Mean	Std. Deviation	Std. Error Mean
ATC	Male	21	96,10	22,21	4,85
	Female	91	103,47	15,43	1,62

t (24) = -1.444, n.s.

Table 5: Independent T-Test Gender by ATC

	Gender	N	Mean	Std. Deviation	Std. Error Mean
ATC	Male	26	19,65	4,60	0,90
	Female	108	18,08	5,78	0,56

t (132) = 1.289, n.s.

Conclusions

Data analysis does not show a statistically significant difference between students' attitudes toward statistics as a general field by gender and students' attitudes toward statistics as a course by gender. Based on the research limitations (especially for the sample selection method), we propose similar research projects to representative samples in national populations and comparative research into similar educational systems. The positive attitude to the field of statistics and courses in statistics must be the pursuit of all educational systems if we want to optimally face the prospect of participation and democracy in a changing world.

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