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Attitudes and Perceptions Towards Mathematics by Greek Engineering Students at University: An Exploratory Study

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ABSTRACT

Mathematics is a constituent of the education of Engineering students. This paper reports on a study investigating the attitudes and perceptions towards mathematics of first year Engineering students. The sample consisted of 145 freshmen (80 men and 65 women) from one Greek university, derived from three Engineering departments (Mechanical, Electrical and Civil). A two-part questionnaire with satisfactory reliability in each part was completed by the participants. Data was analyzed using descriptive statistics, correlations and exploratory factor analysis. The data analysis led to nine factors which shape and mediate students' mathematical attitudes and perceptions. These factors are: Anxiety, Confidence, Learning goals, Theory of intelligence, Persistence, Approach, Learning strategies, Prior experience and General issues. Demographic variables (sex, age, learning disability and choice of study) are found to have an effect on students' attitudes and perceptions. The findings of this study need to be viewed in relation to the redesign of the Engineering Mathematics curriculum to teach effectively all students and raise their mathematical confidence and motivation.

Keywords: engineering mathematics, attitudes, perceptions, university students, learning disability

INTRODUCTION

Engineering courses require the awareness of mathematical concepts. The goal of mathematical learning for engineering students is the ability to learn and consolidate mathematical principles and skills to solve problems in their class and later in their professional career. As part of their undergraduate training, Engineering students should increase knowledge in several mathematical areas such as applied analysis, numerical analysis, potential and approximation theory, mathematical optimization, among many others (Alves et al., 2013).

A review of international surveys indicates that mathematics is a difficult subject to learn. In many countries, even in the tertiary education, there is a great concern at the large proportion of students in engineering and other fields who come to university poorly trained in mathematics (Morgan, 1990). The difficulties shown by Engineering students in basic mathematical elements, essential to successful integration in the syllabus, inevitably leads to high failure rates and withdrawal in the mathematical courses and subsequent lack of motivation (Bigotte de Almeida et al., 2012).

Another point to consider is the relations between attitudes, perceptions and students' learning outcomes. Attitudes are a complex combination of things we tend to call personality, beliefs, values, behaviors, and motivations. An attitude includes three elements: an affect (a feeling), cognition (a thought or belief), and behavior (an action) (Pickens, 2005). Perceptions are part of attitudes and specifically relate to the cognitive dimensions of attitudes (Georgas, 2005). Perceptions, as concrete ideas, coupled with a variety of emotions that arise in parallel with them, but also with expression of specific behaviour, come together with attitude (Pickens, 2005). The relation between attitudes and learning outcomes is bidirectional. Engineering students' attitude and disposition towards mathematics can affect their overall achievement in courses applying mathematical concepts and techniques (Morgan, 1990). Some researchers have found that older students and women experience higher levels of anxiety towards mathematics than younger students and men (Dew & Gallasi, 1983). Affective variables, such as anxiety and interest towards mathematics must be studied in relation to students' performance (Chaman & Callingham, 2013).

LITERATURE REVIEW

Student participation in mathematics courses is declining from secondary to tertiary education and beyond (Fullarton et al., 2003; Kennedy et al., 2014). Engineering students' academic failure in mathematics in higher education leaded in investigations of the relationship between teaching methods and how students learn (Kwan, 2017).

The factors identified as influencing the learning of mathematics can be divided into two groups: the demographic and psychosocial factors (Alves et al., 2013; Zeidmane & Rubina, 2017). As far as the demographic variables are concerned, age and gender have been found to influence students' attitudes towards mathematics but the findings are not consistent. Recent studies show that the advantage held by boys over girls in mathematics achievement and attitude has diminished remarkably over the last years and other factors are found to intervene (Chaman & Callingham, 2013).

In the psychosocial factors, we point out the personality, cognitive factors, motivation and the anxiety towards mathematics. The learning of mathematics is related to personality traits as well as cognitive factors and the latter may be considered as predictors of students' mathematical ability. Motivation is strongly connected to self-efficacy beliefs. Stronger self-efficacy beliefs of the student lead to better motivation to perform tasks (Walter & Hart, 2009).

Attitude towards mathematics is defined as the emotions a student associates with mathematics and how he or she behaves (Hart, 1989). Attitude formation is a result of learning, modeling other and our experiences with people or situations (Pickens, 2005). Attitude towards mathematics can interfere with future self-esteem and the relationship of the utility of mathematics in the profession of engineer [Alves et al., 2013). There is evidence suggesting that students' perceptions about mathematics are crucial in the sense of success and competence they develop (Fullarton et al., 2003).

The anxiety is another factor that influences the learning of mathematics and the academic achievement. Sometimes the mathematical anxiety is the result of low self-esteem and fear of failure. Male students suffered less anxiety dealing with mathematic problems than female and they are more confident and motivated than female students (Vitasari et al., 2010).

Several studies have been conducted to investigate the mathematical skills, attitudes and perceptions of students in engineering programmes in higher education. A pioneer study (Vitasari et al., 2010) tried to identify the possible sources of anxiety among 770 Engineering students in one Malaysian university. The findings showed that mathematics anxiety among Engineering students were manifested into five aspects, namely: (a) mathematic as difficult subject, (b) always fail in mathematics, (c) always writing down during the class, (d) anxious if don't understand, and (e) lose interest of the subject. Female students are found to be more anxious about mathematics than male students. As far as faculty effect on students' anxiety revealed that the faculty of chemical engineering and natural sources lead towards greater mathematics' anxiety.

A study by Zeidmane and Rubina (2017) investigated the causes of failures in mathematics by Engineering students at Latvia University of Agriculture. The study is based on the analysis of mathematics test results as well as on students' opinion survey. The core problem revealed by the study was not only insufficient students' background knowledge in mathematics, but also their attitude towards learning, psychological reaction against the first failure and laziness to make efforts to do additional tasks or attend tutorials. The authors underline that insufficiently developed mathematical competencies of students prevent successful acquisition of new material in mathematics. The most part of the first-year students are not ready for the studies at the university. A significant number of incoming students has the lack of background knowledge, the lack of mathematical competencies and the lack of learning, studying and organizational skills (including time management and setting priorities).

Nahari (2014) investigated the mathematical skills and attitudes of first year Engineering students. Three different samples of students from Dublin City University were involved in the study. The two samples, tested at the end of first-year engineering, scored better in the mathematics test than the sample who took the test at the start of first-year. However, no such differences were observed between their attitudes towards mathematics. An interesting finding of the study is that students in this cohort self-reported high levels of positive attitudes towards mathematics, low levels of mathematical anxiety and motivation towards achieving in this subject.

Parsons et al. (2009) tried to answer the following question: Does students' confidence in their ability in mathematics matter? Research was conducted into first year Engineering students in a university college. The majority of students were fairly confident, reported improvement in confidence during their first year at university and had positive attitudes. Better mathematically qualified students seemed to be more confident and successful in mathematics. According to a regression model, better qualifications (and the skills represented) were found to be associated with better university marks and student confidence also produced an interesting association with the marks achieved. Finally, a minority of students of this cohort was not so confident and successful, so there is room for improvement.

Flegg et al. (2012) explored the experience of 193 students as they learn first year Engineering mathematics. According to the results, students generally see the relevance of mathematics to engineering. Furthermore, they are able to see mathematics as a) a subject of study, 2) as a tool for other subjects of study, and 3) as a tool for dealing with real world problems. From the qualitative data of this research, a number of themes relevant to the design of mathematics engineering curriculum emerged. These themes are: 1) the difference in perceived importance of mathematics within different engineering majors, 2) the difficulty in seeing the relevance of mathematics to future studies, 3) importance of developing problem-solving skills 4) the relevance of formal mathematics and 5) assessment issues in engineering mathematics. This study recommends a close collaboration between mathematics and engineering departments in designing new curricula.

We conclude that mathematical concepts and processes present various levels of difficulties for some engineering students. Previous experiences, motivation and attitude towards mathematics can affect students' achievement. Effective teaching involves

Table 1. Demographic and academic characteristics of the sample

		N	%
Sex	Men	80	55.2
	Women	65	44.8
Age	18	37	25.5
	19	19	13.1
	20	47	32.4
	21+	42	29.0
Year of study	1st	61	42.1
	2nd	6	4.1
	3rd	61	42.1
	4th	7	4.8
	5th	3	2.1
	6th or later	7	4.8
Native language	Greek	140	96.6
	Other	5	3.4
Diagnosis of specific learning difficulties	Yes	18	12.4
	No	125	86.2
	I don't know/I don't respond	2	1.4
Engineering as a first choice for study	Yes	94	64.8
	No	51	35.2
Mathematics grades at the university entrance exams (scale 0-20).	Below 10	66	45.5
	10-15	59	40.7
	16+	20	13.8
Repeating Mathematics' course	Yes	54	37.2
	No	91	62.8

more than the teaching of mathematical concepts: it also includes helping students developing interest, confidence and positive disposition towards mathematics.

Context of the Study

The present study arose as a result of the writers' concern at the mathematical competence and attitude demonstrated by Engineering students at undergraduate level in a small-size Greek university. Considering the lack of previous research in Greek higher education, the present study explores undergraduates Engineering students' attitudes and perceptions towards mathematics and their ways of coping with it. Demographic and personal variables are examined in relation to students' attitudes and ways of learning.

METHOD

Research Questions

The research conducted attempted to answer the following questions:

a) What are the attitudes and perceptions expressed by first-year Engineering students about mathematics?

b) Which is the effect of demographic variables (sex, age, year of study, math grades at university entrance, first choice of study and learning disability) on students' attitudes and perceptions?

Participants

A total of 154 students from one Greek university, derived from three Engineering departments (Mechanical, Electrical and Civil) participated in the survey. Due to incomplete data, 145 students composed the final sample. The main demographic and personal characteristics of the sample are given in **Table 1**.

Research Instrument

The research instrument employed in the study was a questionnaire which focused on the engineering students' attitudes and views about mathematics and learning. Questions were drawn from a number of sources, in order to cover all areas of interest, and more specifically, on the work of Nahari (2014), and Kashefi et al. (2012) who undertook similar studies in their countries.

The questionnaire consists of 32 questions divided in two parts (22 questions in one part concerning attitudes and perceptions and 10 questions in the second part concerning learning and study strategies), in a five-point Likert scale format. However, all questions chosen had been designed in both positive and negative formats, to counteract the problem of students marking the same response for all items (Fadali et al., 2004). The questionnaire proved to have a satisfactory reliability. The Cronbach a reliability coefficient was calculated for the factors extracted from the Principal Component Analysis of the two-part questionnaire. The Cronbach α coefficients are all satisfactory (above 0.7) apart from the Total attitude factor. In addition, factors concerning Learning Approaches to mathematics have a Cronbach of above 0.7 (see **Appendix**). Due to time constraints in the delivery of the survey, an on-line questionnaire was designed to collect data easily and efficiently.

Table 2. Factors of the Attitudes and Perceptions towards Mathematics Scale

Factors	Questions
Anxiety	**4.** I have trouble understanding anything related to mathematics
	6. I'm just not good at mathematics.
	7. I get very nervous during maths lectures.
	8. I often worry that it will be difficult for me to attend math lectures
	9. I often feel helpless when trying to solve a math problem
	10. Mathematics makes me feel uneasy and confused.
Confidence	**1.** I learn mathematics quickly.
	2. I feel confident when I do math
	3. I can get good marks in mathematics.
	5. Mathematics is for me one of the worst subjects.
	11. I usually feel at ease doing mathematics problems.
Learning goals	**14.** I can achieve everything as long as you put target.
	15. I can understand math if I believe in myself
	16. I can improve my math skills.
Theory of intelligence	**12.** You have to be smart to understand mathematics.
	13. Some people will never become good at math, no matter how hard they try.
	17. Anyone can become good at math if they work at it.
Persistence	**19.** When it comes to choosing between math problems, my preference leans towards a difficult problem.
Approach	**18.** When I learn something new in mathematics I am afraid that something I do not understand will appear
	20. When presented with a mathematical task I cannot immediately complete, I increase my efforts.
	21. When presented with a mathematical task I cannot immediately complete, I change strategy.
	22. I give up when I don't immediately find a solution to a mathematical problem

Procedure

The survey was approved by the ethical committee of the university. It conducted in Greek at the end of the winter semester 2018-19 through an on-line questionnaire uploaded in the University Learning Managing System of the course *Mathematics I.* Students were informed about the research during the last class of the course and they were allowed a month to complete the survey. Participants were free to leave at any point of the survey and they were informed that their responses are anonymous and confidential. They were able to access the questionnaire and complete it from any location they chose where they had internet access on a computer. When the survey closed, the questionnaires were collected and analyzed statistically through the SPSS.

RESULTS

Steps and Method of Data Analysis

The first step in our analysis is factor analysis, a statistical method that has the purpose of finding the existence of common factors between a group of variables. With the factorial analysis we try to connect the unobserved variables (factors or components), with variables that we observe and for which we have measurements, thus achieving a grouping of the observed variables into common components. In our study, we use exploratory factor analysis with principal component analysis and we follow all the necessary criteria (Loukaidis, 2011). One of the advantages is that we have a choice in terms of the number of factors. After the factorial analysis, we have the chance to work with fewer variables since the factors are so constructed that retain the information that existed in the original variables as long as possible. The next step in our analysis is to check the hypothesis of the study in relation to the extracted factors instead of having separately each statement (question) of the questionnaire.

Factor Analysis

An exploratory factor analysis was performed to group the observed variables into factors. A Principal Component Analysis (with rectangular axis rotation) was chosen in order to have the option to choose the number of factors created. This method takes into account the total variation of the variables in a descending order.

For the first part of the questionnaire, the KMO (Keiser-Meyer-Olkin) index has a value of KMO = 0.886> 0.7. Also, the Bartlett's test of sphericity showed that there were significant correlations between the variables (p-value <0.001). As can be seen from the frequency diagram of eigenvalues, the final loading of the 22 questions in 6 factors is confirmed, since after the 6th factor there is a great change in the vertical slope of the diagram, which indicates that up to the 6th factor there is significance. As a result of the application of factor analysis to the initial set of 22 questions, the initial factorial structure of the measuring tool is confirmed by small deviations. As a result, factor analysis gave 6 factors which in total explain 68.5% of the total variability. **Table 2** shows the factors of the Attitudes and Perceptions Scale, named Anxiety, Confidence, Learning goals, Theory of Intelligence, Persistence, Approach.

For the second part of the questionnaire, the KMO (Keiser-Meyer-Olkin) index has a value of KMO = 0.772> 0.7. Also, the Bartlett's test of sphericity showed that there were significant correlations between the variables (p-value <0.001). Similarly, from the frequency diagram of eigenvalues, the final loading of the 10 questions showed significance up to the third factor since after the 3rd factor there is a great change in the vertical slope of the diagram. As a result, factor analysis gave 3 factors which in total

Table 3. Factors of the of the Learning and Studying Strategies Scale

Factors	Questions
Learning strategies	**1.** I learn mathematics by understanding logical procedures, not by memorizing rules.
	2. If I cannot solve a mathematical problem, at least I know a general method of attacking it.
	6. I apply what I learn in mathematics to real-life situation.
	7. First I think about a mathematical problem and then I plan how to solve it.
	8. I often use ICT in mathematics to help me solve math problems.
Prior experience	**3.** Mathematics is a subject which I have always enjoyed studying.
	4. I have forgotten many of the mathematical concepts that I have learned in secondary school.
	5. I have a good background in mathematics.
General issues	**9.** I have set specific goals for the study of mathematics
	10. I copy what the Professor writes on the blackboard and then I practice with examples.

Table 4. Basic descriptive measures of the variables of the study

	Mean	S.D	Min	Max
Attitudes and Perceptions towards mathematics	66.4	5.8	52	83
Anxiety	13.4	5.2	6	26
Confidence	16.8	4.1	7	25
Learning goals	12.6	2.1	6	15
Theory of intelligence	6.7	2.7	3	15
Persistence	2.7	1.0	1	5
Approach	14.0	3.3	4	20
Learning and studying strategies	31.5	5.5	18	48
Learning strategies	13.3	2.4	7	20
Prior experience	9.4	2.4	5	15
General issues	8.9	2.2	3	14

explain 56% of the total variability. **Table 3** shows the factors of the Learning and Studying Strategies Scale (Learning strategies, Prior experience, General issues).

Descriptive Statistics

Table 4 presents the descriptive statistics for the factors created from the questionnaire to give a general picture of students' attitudes, perceptions and learning strategies towards mathematics. As one can see from the mean scores, students appear to self- report marginally lower than the scale average in the Anxiety factor and in the Theory of intelligence. Persistence is around the mean, and a greater than the mean score is observed in Confidence, Learning goals and Approaches. In addition, students report above average in the dimensions of Learning strategies, Prior experience and General issues. As far as the standard variation of the variables, there is a great variance in students' responses in the factors of anxiety and confidence.

Inferential Statistics

To test the effect of demographic variables on students' perceptions and strategies, the normal distribution of the factors where first checked through the Kolmogorov-Smirnov goodness-of-fit test together with the Lilliefors' test of correction. According to the results, the distributions of the variables were not normal and non-parametric statistical tests (Mann-Whitney test for two independent groups and Kruskal-Wallis test for more than two independent groups) were applied.

As far as sex is concerned, a statistically significant difference in the variable of *Prior experience* ($p<0.001$) was observed between men and women, with the women obtaining a higher mean score than the men (10.3 vs. 8.6).

With reference to age, a statistically significant difference in the variable of *Prior experience* ($p<0.001$) was observed between the age groups of 18,19, 20 and 21+. The age group of 19 years old has the greater mean score (11.1) in comparison with the other three groups (18, 20 and 21+) which have a mean score of 9.7, 7.3 and 8.3 respectively.

An interesting result of the present study is the effect of learning disability (dyslexia) on students' attitudes and perceptions towards mathematics. **Table 5** shows the relationship between learning disability and the variables of the present study. Statistically significant differences between dyslexic and non-dyslexic students are observed in 5 factors (Anxiety, Confidence, Approaches, Learning strategies, Prior experience and in the total score of the Learning and Studying Strategies dimension). This seems the most important result of the study because it is the first time that learning disability has been studied as a factor influencing Engineering students' attitudes and learning.

Table 5. Kruskal-Wallis test results for the variable of learning disability

	Diagnosis of learning disability (dyslexia)		
	Yes (N=18)	No (N=125)	
	Mean (*SD*)	**Mean (*SD*)**	***p*-value**
Attitudes and Perceptions Towards Mathematics	64.8 (5.5)	66.6 (5.9)	0.184
Anxiety	16.5 (4.3)	13.0 (5.2)	**0.006***
Confidence	14.9 (3.1)	17.1 (4.1)	**0.031***
Learning goals	12.0 (3.4)	12.7 (2.1)	0.196
Theory of intelligence	6.7 (2.9)	6.7 (2.7)	0.954
Persistence	2.7 (0.8)	2.7 (1.0)	0.900
Approach	12.0 (2.8)	14.3 (3.2)	**0.003***
Learning and studying strategies	28.5 (4.5)	32.0 (5.5)	**0.016***
Learning strategies	12.0 (2.0)	13.5 (2.4)	**0.013***
Prior experience	8.1 (1.9)	9.5 (2.4)	**0.019***
General issues	8.4 (2.1)	9.0 (2.1)	0.303

Table 6. Spearman's rho correlations between the variables (factors) of the study

	Anxiety	**Confid.**	**Learning goals**	**Theory of intel.**	**Persist.**	**Appr.**	**Learning strat.**	**Prior exper.**	**Gener. issues**
Anxiety	1	-0.692*	-0.465*	0.324*	-0.307*	-0.491*	-0.230*	-0.509*	-0.348*
Confid.		1	0.526*	-0.292*	0.353*	0.475*	0.360*	0.555*	0.501*
Learning goals			1	-0.367*	0.286*	0.378*	0.217*	0.268*	0.255*
Theory of intel.				1	-0.058	-0.241*	-0.126	-0.182**	-0.155
Persist.					1	0.256*	0.205**	0.254*	0.284
Appr.						1	0.423*	0.454*	0.469*
Learning strat.							1	0.353*	0.402*
Prior exper.								1	0.423*
Gener.									1

** Statistically significant level p=0.01*
*** Statistically significant level p=0.05*

The choice of study seems to influence the variable of *Prior experience* (p=0.006) between the two groups (students with Engineering as a first choice of study vs. students with Engineering as not a first choice of study (mean score 8.9 vs. 10.1).

Finally, a marginally statistically significant difference (p=0.025) was observed in relation to students' grade in Mathematics at the university entrance exams. The Kruskal-Wallis test showed that in the variable of *Learning Goals*, students with a grade of 10 (or less) in Mathematics have a greater mean score in the Learning Goals variable (12.4) than the other two groups (13,2, 11.9).

Correlational Analysis

Correlation analysis was performed to quantify the degree to which two variables (factors) are related. Non parametric Spearman's rho correlations are presented in **Table 6**.

DISCUSSION

This study investigates first year Engineering students' attitudes towards mathematics. The literature underlines that apart from insufficient students' background knowledge in mathematics, their attitudes, psychological reactions and fear of failure should be taken into account (Chaman & Callingham, 2013). At a first lever, the factor analysis of the two-part questionnaire used in the study revealed the following factors (dimensions), named: *Anxiety, Confidence, Learning goals, Theory of intelligence, Persistence, Approach, Learning strategies, Prior experience and General issues*. All these factors shape students' attitudes and beliefs about mathematics as well as their approaches to learning. The above factors which mediate attitudes and perceptions, affect in turn students' performance in the subject (Morgan, 1990; Nahari, 2014).

From a descriptive point of view, students, in the present study self-report almost medium level of anxiety, intelligence and persistence, and better dispotition towards confidence, learning goals and approaches. It is important that they don't feel anxiety at a discomfort level. They also value learning strategies and prior experience at an intermediate level. Their profiles cannot be directly compared with other Engineering freshmen because of the basic differences in the educational system and students' values and expectations in different countries (Chaman & Callingham, 2013).

Demographic variables are extensively studied in the present research. Sex was found to have a significant effect in the factor of *Prior experience* with women obtaining a greater score that men which means that their prior experience shape their current disposition to mathematics. A similar effect is observed with reference to age. Second year students (aged 19 years old) appeared to value more *Prior experience* in comparison to the other age groups. Engineering as a first choice of study in relation to *Prior experience* produced also a significant effect. Students whose first choice of study was other than Engineering reported more prior experience with mathematics than students who had Engineering a a first choice. This means that some Engineering students may want to study mathematics instead of engineering, and, therefore, had a better disposition and preparation in maths.

As far as students' mathematical competence in this cohort we should mention that 45.5% of the students scored 10 or less in the university entrance exams, 40.7% scored 10-15 and only 13.8% scored 16 or more. This finding is in line with with the reported tendency that many first-year students in different countries are not ready for the studies at the university (Zeidmane & Rubina, 2017; Perkin et al., 2007). However, no differences were observed in students' attitudes in relation to their grade in mathematics with the exemption of the *Learning goals* factor which is found to be mediated by the university entrance grade. The relationship between mathematical competence and attitudes towards mathematics needs to be examined in a larger sample. However, a similar finding is reported by Nahari (2014) who found a variance in students' performance on a basic mathematical test but no such difference (or variety) between attitudinal and motivational factors.

A pioneer aspect of the study was the effect of learning disability (dyslexia) in students' attitudes and beliefs. Statistical differences between students diagnosed with dyslexia and students without dyslexia are observed in important dimensions such as *Anxiety, Confidence, Approach, Learning strategies and Prior experience.* Students with dyslexia seem to report more anxiety, less confidence, less effective coping strategies, less variety of learning strategies and less prior experience in relation to mathematics when compared with students with no learning disability. Learning disability seems to shape differently and mediate students' attitudes toward mathematics. It seems that students with a diagnosis of a dyslexia-type disability are at risk of failing and consequently developing negative attitude and low interest. This finding has important implications for the redesigning of first year curriculum of mathematical courses in Engineering to take account the needs of students with dyslexia type problems and other learning difficulties (Hawkes & Savage, 2000). Our study is in line with Searle and Sivalingam (2004) observation that dyslexic pupils may experience serious difficulties with tertiary mathematics, despite their effort and special arrangement at secondary education. Being aware of the nature of the dyslexic difficulties is an important first step in helping students improve mathematical competencies by remedial classes or other type of support.

The present study shed light on the relationship between attitude towards mathematics and learning goals and outcomes. Correlations between the variables reveal some interesting associations. *Anxiety* was found to correlate negatively with all variables except Theory of intelligence with which it has a positive correlation. *Confidence* is found to correlate positively with all variables, but it correlates negatively with Theory of intelligence. A same pattern is also observed for the *Learning goals* factor. *Theory of intelligence* correlate negatively which means that moves in the opposite direction of the Approach and Prior experience. *Persistence* has a positive association with Approach, Learning strategies and Prior experience factors. All these correlations show that different factors contribute in different ways to perceptions and attitudes towards mathematics. These emerging variables should be taken into account in order to change the negative or neutral disposition towards mathematics (Nahari, 2014).

LIMITATIONS

This study was exploratory in nature and, as such, has several limitations. The sample comes from only one university and one year of study, so findings cannot be generalized to other universities or students from advanced years of study. Ideally, such a study would be undertaken over a longer time period, allowing for comparisons, between quantitative and qualitative data from different years and data from different time periods. In addition, due to time constraints, it was not possible to administer a mathematical test to have an index of students' competence in mathematics.

CONCLUSIONS AND RECOMMENDATIONS

The present study attempted to portrait the profiles of freshmen engineering students in one Higher Education Institution according to their background characteristics and attitudes towards mathematics. Several psychological and cognitive factors related to anxiety, motivation and learning approaches are found to contribute largely to students' attitudes and perceptions towards mathematics. In addition, this is the first Greek study establishing a link between engineering students' attitudes and their learning outcomes. In line with the relevant literature, demographic variables as well as affective variables shape students' attitudes. Psychological reactions to failure, motivation and responsibility of studying are factors which seem to improve academic competence. Our study has several pedagogical implications for students and lectures. Students should be aware of the importance and relevance of motivational and attitudinal aspects of learning and studying. Lecturers should offer academic support, inclusive teaching practices and encouragement to weaker students and students with learning disability (dyslexia). A unified approach between mathematics and engineering courses is crucial if we like to influence how engineering students see the use of mathematics in their degrees and future careers. As Pajares (2000) states 'Efficacious teachers create classroom climates in which academic rigor and intellectual challenge are accompanied by the emotional support and encouragement necessary to meet that challenge.'

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APPENDIX

Cronbach Alphas (a) Regarding the Factors of the Study

	Cronbach's alpha
Attitudes and Perceptions Towards Mathematics	0.300
Anxiety	0.886
Confidence	0.823
Learning goals	0.797
Theory of intelligence	0.725
Persistence	0.998
Approach	0.770
Learning and studying strategies	0.757
Learning strategies	0.682
Prior experience	0.667
General issues	0.503