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Evaluating Students' Attitudes Toward STEM Education: The Case of Greek Pre-Service Teachers

Lazaros Anastasiadis
University of Crete
Greece

Poulcheria Zirinoglou
Hellenic Open University
Greece

Abstract

The objective of this research paper is to assess Greek pre-service teachers' attitudes towards STEM Education through multidimensional statistical analysis. The sample consist of 130 Greek pre-services participated in the study. The study used a Scale related to respondents' feedback on teachers to implement STEM constructed by Abdullah et al. (2017) by applying a five-point Likert scale. The scale consisted of three conceptual constructs named Readiness to implement STEM from the cognitive aspect, Readiness to implement stem from the affective aspect, Readiness to implement stem from the behavioural aspect. Greek Students' General attitudes toward STEM education were evaluated by another item that rate from 1 to 100 scaling the total score. The results demonstrated that the strongest correlation was between the conceptual construct named Readiness to implement STEM from the cognitive aspect and Readiness to implement stem from the affective aspect.

In addition, the study made it evidence that the correlation between the conceptual constructs Total score related to General attitudes toward Readiness to implement STEM the conceptual construct Readiness to implement STEM from the cognitive aspect was strong.

Keywords: Attitudes, Students, Science Technology, Engineering, Mathematics, STEM

1.Introduction

Science, Technology, Engineering and Mathematics configure STEM education. Teachers claimed that STEM education has the potentiality to deliver skilled and qualified students in the epoch of globalization towards STEM Education (Wei & Maat, 2020). A comprehensible and fundamental approach to science, technology, engineering, and mathematics education or STEM education demands consideration to interdisciplinary or multidisciplinary commitment between learners (Deák et al., 2021). Mathematics, science and technology combination or cooperation is an inescapable improvement regarding teaching and learning, although this methodology involves sufficient expertise of the field aiming to integration of many courses (Deák et al., 2021). The knowledge of mathematics is evidence in every scientific domain. Moreover, the knowledge of mathematics is necessary to analyze algorithm complexity. Apparently, individuals with no mathematical background are unable to produce efficient in terms of time and space complexity (Souravlas, Katsavounis, Anastasiadou. 2020). Mathematics play an important role in science. Together science, technology, engineering, and mathematics constitute STEM, that has been widely studied in primary and secondary education level (Fernández-Cézar et al. 2020). In adding, teaching of mathematics usually operates in many areas such as Big Data applications, Cloud structures (Souravlas & Katsavounis, 2019; Souravlas, 2019), algorithms for stream processing (Souravlas, Anastasiadou & Katsavounis 2021; Souravlas & Anastasiadou, 2020; Tantaraki et al., 2020a, Tantalaki, et al., 2020b, Tantalaki, et al., 2019) and many more different applications (Tantalaki, Souravlas, & Roumeliotis, 2019; Souravlas & Roumeliotis, 2015a; Souravlas & Roumeliotis, 2015b; Souravlas & Roumeliotis, 2014a; Souravlas & Roumeliotis, 2014b; Margaris et al., 2007).

In the other way around several big data applications relate to awareness of various mathematical algorithmic functions that influence all facets of our ordinary life, education (Florou et al., 2021; Valsamidis et al., 2021). As Souravlas & Anastasiadou (2020a) and Souravlas, et al. (2020a) claimed mathematics areas relate to AI algorithms complexity, scheduling of Big Data Stream, Modeling and Simulation correlated with Cloud Computing, efficiency of AI algorithms, advance knowledge in analytics, in mathematics together with in AI, improvement programming skills and strongminded students' achievement. Students' achievement regarding learning AI algorithms, scheduling of Big Data Stream and Cloud Computing simulation is strongly associated with learners Self-Confidence in mathematics (Anastasiadou, 2009a, 2009b; Souravlas, et al., 2020a). Three major components such as achievement in computer programming courses, computers programming self-efficacy and perceived learning are considerable predictors of teachers' attitudes toward computer programming (Gurer et al., 2019). As science persists to growth, attitudes toward science appear to turn out to be even further differentiated. While several put their faith in science, others regularly discard and reject scientific evidence (Rutjens et al., 2018).

Students often have major difficulties regarding mathematical problem solving (Jeong, & González-Gómez, 2021). Negative attitudes toward mathematics are one of the major obstacle toward understanding and learning mathematics and create mostly difficulties to students' cognitive competence (Atan, & Kasmin, 2018; Petridis et al., 2017; Nicolaou, et al., 2017; Anastasiadou, 2004a, 2004b, 2004c, 2004d; Anastasiadou, Anastasiadou (2002), Chadjipadelis & Kofou 2013; Chadjipantelis & Anastasiadou, 2010), their perceptions regarding the value and the necessity of a subject, its importance both in professional life and everyday life (Anastasiadou & Papadimitriou, 2001, 2003; Anastasiadou, 2007a, Anastasiadou, 2007b; Anastasiadou, 2008a, 2008b, 2008c; Anastasiadou, 2012aq Hagan et al., 2020). Enjoyment and satisfaction has also an effect on attitudes toward mathematics (Anastasiadou, 2005a, 2005b, 2005c; Anastasiadou & Gagatsis, 2005a, 2005b; Anastasiadou & Chadjipantelis, 2008; Anastasiadou, Elia, Gagatsis, 2007; Anastasiadou & Gagatsis, 2007; Anastasiadou, Gagatsis, Elia, 2005, Draganis et al., 2013). Self-confidence and Value and Importance of Mathematics, Math anxiety as well as well gender have a serious direct effect regarding achievement in mathematics (Awaludin et al., 2015; Manalaysay, 2019; Wahid et al., 2014; Hagan et al., (2020). Brezavšˇcek, et al. (2020) showed a strong negative effect of mathematics confidence on seeming degree of math anxiety. Furthermore, they claimed that the perceived level of math anxiety has a robust negative effect on mathematics accomplishment. Fernández-Cézar et al. (2020) examine whether a STEM outreach experimentation program could possibly affect on the attitude toward mathematics and science in 5^{th} and 6^{th} grades as well as whether this potential effect of a STEM experimentation program be affected by parameters like gender, schools' type and environment as well as the teacher. They founded that the STEM program based on experimentation exerts and improvement in the attitude towards mathematics, given that it is less negative. Above and beyond this, the attitude towards school science turns out to be more positive. Though, both effects are tiny. They also found that the program neither had an impact on attitude towards mathematics nor the attitude towards school science differently for females and males. Fernández-Cézar et al. (2020) research results implied that STEM program can not have any serious effect on the students' attitude towards mathematics differently related to different schools. Moreover, the STEM program did have a different effect regarding the teacher for mathematics, but it had regarding the attitudes toward the science (Fernández-Cézar et al., 2020).

In Abdullah et al. (2017) research including 190 teachers searching their attitudes toward Readiness to implement STEM from cognitive, affective and behavioural point of view. 190 teachers' readiness related from cognitive, affective and behavioural aspects were at moderate level, although that cognitive aspect has the biggest mean value comparing to affective and behavioural aspects (Abdullah et al., 2017).

This the present study tries to capture Greek students' attitudes towards Science, Technology, Engineering and Mathematics configure STEM education. The conceptual constructs of Scale related to respondents' feedback on teachers to implement STEM constructed by Abdullah et al. (2017) are named Readiness to implement STEM from the cognitive aspect, Readiness to implement stem from the affective aspect, Readiness to implement stem from the behavioural standpoint.

2. Purpose of the study-Research Hypotheses

The objective of current study is to evaluate Greek pre-service teachers' attitudes towards STEM education through multidimensional statistical analysis. In addition, the present paper examines the following research hypotheses.

Ho1: Readiness to implement STEM from the cognitive aspect has a strong effect on General attitudes toward Readiness to implement STEM

Ho2: Readiness to implement STEM from the affective aspect has a strong effect on General attitudes toward Readiness to implement STEM

Ho3: Readiness to implement STEM from the behavioural aspect has a strong effect on General attitudes toward Readiness to implement STEM

Ho4: Readiness to implement stem from the cognitive aspect is significantly correlated with Readiness to implement STEM from the affective aspect

Ho5: Readiness to implement STEM from the cognitive aspect is significantly correlated with Readiness to implement STEM from the behavioural aspect

Ho6: Readiness to implement STEM from the affective aspect correlated with Readiness to implement STEM from the behavioural aspect

Ho7: Gender influences General attitudes toward Readiness to implement STEM

3. The instrument

The study used a 5-point response scale, higher scores then correspond to more positive attitudes, whereas 1 corresponding to strongly disagree to 5 strongly agree. The scale named was adapted from Abdullah et al. (2017) instrument exploring attitudes toward Readiness to implement STEM from cognitive, affective and behavioural point of view.

Table 1: Scale

Scale	
Conceptual Construct	Item
Readiness to implement stem from the cognitive aspect	
	Read_Gog Asp1: I understand the objectives of implementing STEM education drawn up in the curriculum
	Read_Gog Asp2: I understand the teacher role in implementing STEM education at school
	Read_Gog Asp3: I understand the planned STEM education curriculum
	Read_Gog Asp4: I understand the STEM education curriculum that will be developed
	Read_Gog Asp5: I understand the scope of the planned STEM education curriculum
	Read_Gog Asp6: I implement the STEM teaching approach in my teaching and learning which involves applying STEM practices to solve problems in the context of daily life
	Read_Gog Asp7: I am responsible in ensuring that my students are able to explore their surroundings by solving problems that are related to the real world in the effort to install STEM practices
	I am responsible in ensuring that my students are able to explore their surrounding by solving
	Read_Gog Asp8: I need to discuss with other mathematics teachers to further improve my teaching quality of STEM education using multimodal learning
	Read_Gog Asp9: I am responsible for ensuring that the process of Teaching & Learning STEM education that is student centered is able to produce meaningful learning experience

	Read_Gog Asp10: I am responsible for ensuring that the process of Teaching & Learning STEM education that is student centered is able to produce a fun learning experience Read_Gog Asp11: I need to spend a lot of time searching for effective ideas before implementing Teaching & Learning of STEM education integration in the classroom Read_Gog Asp12: I refer to the STEM education module to ensure that I have a clear understanding in the implementation of this approach according to the procedures and requirements on Greek educational system
Readiness to implement stem from the affective aspect	
	Read_Aff Asp1: I enjoy implementing STEM education approach in Teaching & Learning in the classroom Read_Aff Asp2: I am happy with the implementation of STEM education approach as it is able to help me identify students; strengths Read_Aff Asp3: I am happy with the implementation of STEM education approach as it is able to help me identify students; weakness Read_Aff Asp4: I am satisfied with the implementation of STEM education approach as it is able to increase my two-way communication with students Read_Aff Asp5: I feel at ease for being able to implement the STEM Education approach in a way that is systematic and organised Read_Aff Asp6: I am excited with the implementation of STEM education approach in classrooms as it enables me to understand students; grasp of knowledge Read_Aff Asp7: I do not feel burdened by the many elements contained in STEM education that need to be related to the realword context Read_Aff Asp8: I do not feel disappointed with the implementation of STEM education approach although it makes it harder for me to finnish teaching the syllabus Read_Aff Asp9: approach in the classroom The differences in the students' level of mastery do not make it difficult for me to implement STEM education Read_Aff Asp10: I do not find difficulties in implementing STEM education Read_Aff Asp11: I do not feel pressured with the increased work burden
Readiness to implement stem from the behavioural aspect	
	Read_Beh Asp1: I follow the schedule set by Greek Educational System in applying STEM education approach. Read_Beh Asp2: STEM education allows me to conduct activities by preparing materials that are able to attract the attention of students in the classroom based on their capabilities Read_Beh Asp3: I am prepared to attend STEM education enhancement courses to enhance my skills Read_Beh Asp4: I am prepared to attend STEM education enhancement courses to enhance my knowledge Read_Beh Asp5: I always analyse students' achievement in STEM education for further actions Read_Beh Asp6: I have to work overtime to monitor students' progress in the classroom Read_Beh Asp7: I do not find difficulties in controlling students during the Teaching & Learning of STEM education in the classroom Read_Beh Asp8: I have enough time to implement STEM education although I need to cover many syllabuses Read_Beh Asp9: I do rigorous preparations before implementing STEM education approach in the classroom Read_Beh Asp10: I am confident in implementing STEM education approach in the classroom

4.Profiles of the respondents

The demographic profiles include the following characteristics of the despondences' gender, age and year of education. The demographic profiles shown in Table 3 is based on frequency and relative frequency distributions. The sample comprised of 130 interviewees of whom 91 (70%) were men and 39 (30%) were women (Table 2).

Table 2: Demographic data of the sample (N = 168)

Variables	Classes	N=130	%
Gender	Male	91	70
	Female	39	30

5. Results

Below (Table 3) the results related the internal consistency or reliability of the instrument, and its conceptual constructs are described. The reliability of the Scale related to Readiness to implement STEM from cognitive, affective and behavioural point of view was related to items 1 to 33 was estimated by Cronbach alpha coefficient (a) (Cronbach, 1984).

The Cronbach' alpha coefficient is calculated to measure the reliability of the three conceptual constructs, i.e. Readiness to implement STEM from cognitive aspect, Readiness to implement STEM from affective aspect and Readiness to implement STEM from behavioural aspect (Table 2). Cronbach' alpha coefficient equals to 0.912 verified the reliability of the Readiness to implement STEM scale of pre-service teachers towards Readiness to implement STEM from affective aspect and Readiness to implement STEM from behavioural aspect. In additions Cronbach' alpha coefficient was above the cutoff point of 0.70 for all the dimensions of Readiness to implement STEM scale (Anastasiadou, et al., 2014b; Anastasiadou et al., 2016a; Anastasiadou et al., 2016b; Anastasiadou & Giossi, 2014; 2018a, 2018b; Anastasiadou & Karakos, 2011; Anastasiadou, 2014; Anastasiadou, 2016; Anastasiadou, 2018a, 2018b, 2018c, 2018d) (Table 3).

The value of Cronbach's α coefficient for this instrument related to General attitudes toward Readiness to implement STEM was equal to 0.912 and it is a very high value in terms of internal consistency (Anastasiadis, 2020; Anastasiadis & Christoforidis, 2019; Anastasiadou, 2006; Anastasiadou, 2007c; Anastasiadou, 2008d; Anastasiadou, 2009c; Anastasiadou et al., 2010b; Anastasiadou, 2011; Anastasiadou, 2012a, 2012b, 2012c, 2012d, 2012e, 2012f) (Table 3).

The value of Cronbach's α coefficient for General attitudes toward Readiness to implement stem from the cognitive aspect, conceptual construct was equal to 0.851 and it is a very high value in terms of internal consistency (Anastasiadou & Anastasiadis, 2011; Anastasiadou & Anastasiadis, 2019; Anastasiadou, et al., 2010a; Anastasiadou, et al., 2010b; Anastasiadou, et al., 2013; Anastasiadou & Pappa, 2009; Anastasiadou & Pappa, 2019; Anastasiadou & Taraza, 2020a; Anastasiadou & Taraza, 2020b; Anastasiadou & Tiliakou, 2014, 2015, 2016a, 2016b) (Table 3).

The value of Cronbach's α coefficient for Readiness to implement stem from the affective aspect conceptual construct was equal to 0.907 and it is a very high value in terms of internal consistency (Panistides & Anastasiadou, 2015; Patrali et al., 2012; Souravlas & Anastasiadou, 2020; Souravlas, et al., 2020; Thapa et al., 2016; Theodoridou, et al., 2014; Anastasiadou et al., 2013; Cohen, et al., 1988; Florou, et al., 2015; Fotiadis & Anastasiadou, 2018a,2018b; Florou & Anastasiadou 2013; Kapetanopoulou et al., 2021; Kofou, & Anastasiadou, 2013; Ntotsi, & Anastasiadou, 2019a, 2019b) (Table 3).

The value of Cronbach's α coefficient for Readiness to implement stem from the behavioural aspect conceptual construct was equal to 0.823 and it is a very high value in terms of internal consistency (Anastasiadou et al., 2007, Anastasiadou et al., 2014; Anastasiadou & Draganis, 2014; Anastasiadou, et al., 2014a; Anastasiadou & Kofou, 2013a, 2013b; Anastasiadou & Loukas, 2009; Anastasiadou & Panitsides, 2014; Anastasiadou et al., 2015; Gkolia et al., 2007; Papademetriou et al., 2022; Anastasiadou, 2013a,2013b,2013c, 2013d; Anastasiadou, Florou, 2013; Batiou & Anastasiadou, 2015) (Table 3).

Table 3: **Cronbach's Alpha**

Dimensions	Cronbach's Alpha
General attitudes toward Readiness to implement STEM	0.912
Readiness to implement STEM from the cognitive aspect	0.851
Readiness to implement stem from the affective aspect	0.907
Readiness to implement stem from the behavioural aspect	0.823

The following table presents the mean value (M) and the Standard Deviation (SD) of each item and each conceptual construct of General attitudes toward Readiness to implement STEM scale (Table 4). Among the dimensions, the highest mean level of perceptions was 3.8109 (SD=0.59704) for Readiness to implement STEM from the cognitive aspect conceptual construct following by Readiness to implement stem from the affective aspect conceptual construct 3.5545 (SD=0.74870) following by the Readiness to implement stem from the behavioural 3.1615 (SD=0.43764) that was the lowest mean level (Table 4).

Table 4: ATMI Scale

	General attitudes toward Readiness to implement STEM	**Cronbach's Alpha**	**M**	**SD**
Conceptual Construct	**Item**	**.912**		
Readiness to implement STEM from the cognitive aspect		**.851**	**3.8109**	**.59704**
	Read_Gog Asp1: I understand the objectives of implementing STEM education drawn up in the curriculum		4.39	.802
	Read_Gog Asp2: I understand the teacher role in implementing STEM education at school		4.39	.792
	Read_Gog Asp3: I understand the planned STEM education curriculum		4.44	.797
	Read_Gog Asp4: I understand the STEM education curriculum that will be developed		4.20	.772
	Read_Gog Asp5: I understand the scope of the planned STEM education curriculum		3.97	.948
	Read_Gog Asp6: I implement the STEM teaching approach in my teaching and learning which involves applying STEM practices to solve problems in the context of daily life		4.42	.776
	Read_Gog Asp7: I am responsible in ensuring that my students are able to explore their surroundings by solving problems that are related to the real world in the effort to install STEM practices		4.35	.870
	I am responsible in ensuring that my students are able to explore their surrounding by solving			
	Read_Gog Asp8: I need to discuss with other mathematics teachers to further improve my teaching quality of STEM education using multimodal learning		3.12	1.118

Read_Gog Asp9: I am responsible for ensuring that the process of Teaching & Learning STEM education that is student centered is able to produce meaningful learning experience		2.78	1.365
Read_Gog Asp10: I am responsible for ensuring that the process of Teaching & Learning STEM education that is student centered is able to produce a fun learning experience		2.93	1.149
Read_Gog Asp11: I need to spend a lot of time searching for effective ideas before implementing Teaching & Learning of STEM education integration in the classroom		3.57	.998
Read_Gog Asp12: I refer to the STEM education module to ensure that I have a clear understanding in the implementation of this approach according to the procedures and requirements on Greek educational system		3.17	1.065
Readiness to implement stem from the affective aspect	**.907**	**3.5545**	**.74870**
Read_Aff Asp1: I enjoy implementing STEM education approach in Teaching & Learning in the classroom		3.12	1.111
Read_Aff Asp2: I am happy with the implementation of STEM education approach as it is able to help me identify students; strengths		3.55	1.114
Read_Aff Asp3: I am happy with the implementation of STEM education approach as it is able to help me identify students; weakness		3.320	1.022
Read_Aff Asp4: I am satisfied with the implementation of STEM education approach as it is able to increase my two-way communication with students		4.04	1.060
Read_Aff Asp5: I feel at ease for being able to implement the STEM Education approach in a way that is systematic and organised		3.97	0.923
Read_Aff Asp6: I am excited with the implementation of STEM education approach in classrooms as it enables me to understand students; grasp of knowledge		3.43	1.063
Read_Aff Asp7: I do not feel burdened by the many elements contained in STEM education that need to be related to the realword context		3.67	0.918
Read_Aff Asp8: I do not feel disappointed with the implementation of STEM education approach although it makes it harder for me to finnish teaching the syllabus		3.49	1.006
Read_Aff Asp9: approach in the classroom The differences in the students' level of mastery do not make it difficult for me to implement STEM education			
Read_Aff Asp10: I do not find difficulties in implementing STEM education		3.81	1.086
Read_Aff Asp11: I do not feel pressured with the increased work burden		3.30	1.032

Readiness to implement stem from the behavioural aspect		**.823**	**3.1615**	**.43764**
	Read_Beh Asp1: I follow the schedule set by Greek Educational System in applying STEM education approach.		3.63	.997
	Read_Beh Asp2: STEM education allows me to conduct activities by preparing materials that are able to attract the attention of students in the classroom based on their capabilities		1.52	.934
	Read_Beh Asp3: I am prepared to attend STEM education enhancement courses to enhance my skills		1.73	.994
	Read_Beh Asp4: I am prepared to attend STEM education enhancement courses to enhance my knowledge		1.47	.917
	Read_Beh Asp5: I always analyse students' achievement in STEM education for further actions		3.53	.837
	Read_Beh Asp6: I have to work overtime to monitor students' progress in the classroom		3.83	.799
	Read_Beh Asp7: I do not find difficulties in controlling students during the Teaching & Learning of STEM education in the classroom		4.15	.873
	Read_Beh Asp8: I have enough time to implement STEM education although I need to cover many syllabuses		3.91	.876
	Read_Beh Asp9: I do rigorous preparations before implementing STEM education approach in the classroom		3.94	.994
	Read_Beh Asp10: I am confident in implementing STEM education approach in the classroom		3.91	.927
Model Fit	x2/df=1.86 CFI=0.95, GFI=0.94, RMSEA=0.03, AGFI=0.90, IFI=0.95			

The following table, Table 5, presents the intercorrelations across the three conceptual constructs used in this study plus an item measures the General attitudes toward Readiness to implement STEM.An assessment of the bivariate correlations indicates that all the correlations are significant and are in the expected direction. The strongest correlation was between the conceptual constructs Readiness to implement STEM from the cognitive aspect and Readiness to implement stem from the affective aspect ($r=0.581$, $p<0.001$). The second strongest correlation was between the conceptual constructs Readiness to implement stem from the behavioural aspect and Readiness to implement STEM from the cognitive aspect ($r=0.497$, $p<0.01$) and Readiness to implement stem from the behavioural aspect and Readiness to implement STEM from the affective aspect ($r=0.497$, $p<0.01$)

As far as the correlations between Readiness to implement STEM from the cognitive aspect, Readiness to implement stem from the affective aspect and Readiness to implement stem from the behavioural aspect and General attitudes toward Readiness to implement STEM concerns that correlation analysis revealed significant correlations at a significant level of 99%.

Morespecifically, the strongest correlation was between the conceptual construct Readiness to implement STEM from the cognitive aspect and Total score related to General attitudes toward Readiness to implement STEM ($r=0.585$, $p<0.01$), the second strongest correlation was between the conceptual construct Readiness to implement stem from the affective aspect and Total score related to General attitudes toward Readiness to implement STEM ($r=0.305$, $p<0.01$), whereas the third strongest correlation was between the conceptual construct Readiness to implement stem from the behavioural aspect and Total score related to General attitudes toward Readiness to implement STEM ($r=0.295$, $p<0.01$) (Table 5).

Finally, gender has statistically insignificant correlations with Readiness to implement STEM from the cognitive aspect, Readiness to implement stem from the affective aspect but Readiness to implement stem from the behavioural aspect conceptual construct ($r=0.177$, $p<0.05$) (Table 5).

Table 5: Correlation Estimates

Correlations

		COGNITIVE	AFFECTIVE	BEHAVIOUR	GENERAL ATTITUDE	GENDER
COGNITIVE	Pearson Correlation	1				
AFFECTIVE	Pearson Correlation	,581**	1			
BEHAVIOUR	Pearson Correlation	,497**	,497**	1		
GENERAL ATTITUDE	Pearson Correlation	,585**	,305**	,295**	1	
GENDER	Pearson Correlation	,161	,115	,177*	,160	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Furthermore, the seven hypothesized effects were supported (Table 6). Thus, it is evident that the conceptual constructs Self-Confidence, Value, Enjoyment and Motivation, have a positive effect on Total score related to Greek Students' attitudes towards Mathematics.

Table 6: Hypotheses Testing

Hypotheses	Standardized estimates	p-value	Results
Ho1: Readiness to implement STEM from the cognitive aspect has a strong effect on General attitudes toward Readiness to implement STEM	.59	<0.001	Supported
Ho2: Readiness to implement STEM from the affective aspect has a strong effect on General attitudes toward Readiness to implement STEM	.56	<0.001	Supported
Ho3: Readiness to implement STEM from the behavioural aspect has a strong effect on General attitudes toward Readiness to implement STEM	.47	<0.001	Supported
Ho4: Readiness to implement stem from the cognitive aspect is significantly correlated with Readiness to implement STEM from the affective aspect	.51	<0.001	Supported
Ho5: Readiness to implement STEM from the cognitive aspect is significantly correlated with Readiness to implement STEM from the behavioural aspect	.44	<0.001	Supported
Ho6: Readiness to implement STEM from the affective aspect correlated with Readiness to implement STEM from the behavioural aspect	.52	<0.001	Supported
Ho7: Gender influences General attitudes toward Readiness to implement STEM	.32	>0.05	Not Supported

6. Conclusions

The objective of current study is to evaluate Greek pre-service teachers' attitudes towards STEM Education through multidimensional statistical analysis. The study used a Scale related to respondents' feedback on teachers/ pre-service teachers to implement STEM constructed by Abdullah et al. (2017). The scale consisted of three conceptual constructs named Readiness to implement STEM from the cognitive aspect, Readiness to implement stem from the affective aspect, Readiness to implement stem from the behavioural aspect. The structuralequation model verified the measurement model fit regarding the observed data (Model Fit x2/df=1.86 CFI=0.95, GFI=0.94, RMSEA=0.03, AGFI=0.90, IFI=0.95) ((Churchill, 1979; Cohen, et al., 1988; Fornell & Larcker, 1981; Chin, 1998; Kim, et al., 2008). Spector, 1992; Wixon, & Watson, 2001, Hair et al., 1995; Hair, et al., 2005).

Therefore, the conceptualized model that describes of teachers/ pre-service teachers to implement STEM in education. The model revealed teachers/ pre-service teachers' attitudes toward consist of conceptual constructs named Readiness to implement STEM from the cognitive aspect, Readiness to implement stem from the affective aspect, Readiness to implement stem from the behavioural aspect. The strongest correlation was between the conceptualconstruct named Readiness to implement STEM from the cognitive aspect and Readiness to implement stem from the affective aspect.

In addition, the study made it evidence that the strongest correlation between the conceptual constructs Total score related to General attitudes toward Readiness to implement STEM was the correlation was between the conceptual construct Readiness to implement STEM from the cognitive aspect and Total score related to General attitudes toward Readiness to implement STEM. However, there is great need for empirical research related to pre-service torchers' attitudes toward Readiness to implement STEM in education. The aim of STEM education could possibly be achieved by teachers and pre-service teachers' positive attitudes (Wei & Maat, 2020).

References

Abdullah, A. H., Hamzah, M. H., Hussin, R. H. S. R., Kohar, U. H. A., Rahman S. N. S. A. and J. Junaidi, J. (2017). *Teachers' readiness in implementing science, technology, engineering and mathematics (STEM) education from the cognitive, affective and behavioural aspects*, 2017 IEEE 6th International Conference on Teaching, Assessment, and Learning for Engineering (TALE), 2017, pp. 6-12, doi: 10.1109/TALE.2017.8252295.

Alevriadou, A. Anastasiadou S. & Damianidou, D. (2014). Reliability and validity of the "Reading-free Vocational Interest Inventory (R-FVII)" in adolescents and adults with intellectual disabilities. *Procedia - Social and Behavioral Sciences*. 114, 388 – 393.

Anastasiadis, L. (2020). Emotional Intelligence Influences on Consumers Consumer Behavior. *International Journal of Entrepreneurship and Innovative Competitiveness*–IJEIC, Vol2, Iss1, https://hephaestus.nup.ac.cy/bitstream/handle/11728/11527/article1.pdf?sequence=1& isAllowed=y.

Anastasiadis, L., Anastasiadou, S. & Iakovidis, G. (2016). *Malcolm Baldrige National Quality Award (MBNQA) dimensions in Greek Tertiary Education System*. 8th International Conference 'The Economies of Balkan and Eastern Europe Countries in the changed world', EBEEC 2016, Split, Croatia. KnowledgeE Publishing-the Economies of Balkan and Eastern Europe Countries in the Changed World (EBEEC) | pages 436-455.

Anastasiadis, L. & Christoforidis, C. (2019). *Evaluating citizens' actual perceptions and expectations and assessing e-Service Quality Gap in Public Sector related to e- Government Services*, International Journal of Entrepreneurship and Innovative Competitiveness–IJEIC,Vol. 1–Iss. 1.http://hephaestus.nup.ac.cy/bitstream/handle/11728/11395/Paper5.pdf?sequence=1&i sAllowed=y.

Anastasiadou, S. (2002). *Enhancing prospective teachers' knowledge of students' attitudes and representations towards statistics-the case of Greek students.* In the Journal 'Scientia Paedacogika Experimentals' XXXIX 1, pp. 103-127.

Anastasiadou, S. (2004a). *Teacher's opinions about statistics and probability.* In the journal 'Quaderni di Ricerca in Didattica', no 14. pp. 134-143. http://math.unipa.it/~grim/quaderno14.htm.

Anastasiadou, S. (2004b). *The influence of social factors on Greek mathematics teachers about statistics education,* in Gr Maridis, A. Gagatsis, K. Nikolaou eds in Castme International and Castme Europe Conference, (CASTME) Cyprus, 2004, pp. 47-58.

Anastasiadou, S. (2004c). *Perceptions-Attitudes-Conducts of the Greek Mathematicians for Statistics in Secondary Education,* D. De Bock, M. Isoda, J. A. C. Cruz, A. Gagatsis, E Simmt (eds) 10th International Congress on Mathematical Education (ICME 10) Copenhagen, Demark, pp. 61-68.

Anastasiadou, S. (2004d). *The influence of social factors on Greek mathematics teachers about statistics education,* in Gr Maridis, A. Gagatsis, K. Nikolaou eds in Castme International and Castme Europe Conference, (CASTME) Cyprus, 2004, pp. 47-58.

Anastasiadou, S. (2005a). *Survey of attitudes and beliefs toward Statistics in Greek Secondary Education.* International Conference on Mathematics Education, Svishtov, Bulgaria, pp. 125-133.

Anastasiadou, S. (2005b). *Affective reactions and attitudes of the last class of Greek high school students towards statistics,* In M Boosch (Eds) Proceedings of the Fourth Conference of the European Society for Research in Mathematics Education (CERME 4), Sant Feliu de Guíxols, Spain, 2005 in the http://cerme4.crm.es/Papers%20definitius/5/Anastasiadou%20Sofia.pdf.

Anastasiadou, S. (2005c). *How Greek Primary and Secondary school teachers perceive and evaluate statistics? A comparative study*. In A. Gagatsis, F. Spagnolo, Gr. Makridis, V. Farmaki eds, 4th Mediterranean Conference in Mathematics Education, Palermo, Italy, pp. 117-126.

Anastasiadou, S. (2005d). Analysis of compound variables concerning students' attitudes towards statistics after the first contact with the lesson of statistics. In the *journal 'Meditereeanean Journal for research in Mathematics Education'*, Vol 4 No 1, pp. 71-102.

Anastasiadou, S. (2006). *Factorial validity evaluation of a measurement through principal components analysis and implicative statistical analysis*. In D.X. Xatzidimou, K. Mpikos, P.A. Stravakou, & K.D. Xatzidimou (eds), 5th Hellenic Conference of Pedagogy Company, Thessaloniki, pp. 341-348.

Anastasiadou, S. (2007a). *Affective Responses and Attitudes of ninth grade Greek Students.* Proceedings of the 5th Mediterranean Conference in Mathematics Education, Rodes, Greece pp. 169-178.

Anastasiadou, S. (2007b). *Compartmentalization in learning process: The case study of Greek primary school pupils in statistical concepts.* In J. Novotha and H. Moraova (Eds), International Symposium Elementary Mathematics Teaching (SEMT 07), Prague, Czech Repuplic, pp. 61-68.

Anastasiadou, S. (2007c). It's the men's world: Greek males' students believe that the women's position must be home with the kids. *The International Journal of Interdisciplinary Social Sciences,* Volume 2, Issue 5, pp.123-132.

Anastasiadou, S. (2008a). *Representations and learning in statistics: a comparative study between Greek primary school students and immigrants.* Eleventh International Congress on Mathematical Education, in its eleventh edition is to be held in Monterrey, Mexico, 2008 in the http://tsg.icme11.org/document/get/195.

Anastasiadou, S. (2008b). *Greek students' ability in statistical problem solving: A multilevel statistical analysis. A conference of five cities: Nicosia, Rhodes, Bologna, Palermo, Locarno.* Research in mathematics education. Nicosia, Cyprus, pp.73-84.

Anastasiadou, S. (2008c). *The Effects of representational systems on the learning of statistics between Greek primary school students and immigrants.* Proceeding of the 5th International Mathematics Education and Society Conference (MES 5) Albufeira, Portugal, pp.167-176.

Anastasiadou, S. (2008d). Exploring Intrinsic and Extrinsic Motivation during a PhD completion with the aid of Principal Components Analysis. *The International Journal of Interdisciplinary Social Sciences,* Volume 3, Issue 2, pp. 171-178.

Anastasiadou, S. (2009a). *A structural equation model representing the hierarchical structure of translations among representations in Frequency concept*. In J. Novotha and H. Moraova (Eds), International Symposium Elementary Mathematics Teaching (SEMT 09), Prague, Czech Repuplic, pp. 57-64. http://storage.cet.ac.il/cetnews/SEMT09.PDF.

Anastasiadou, S. (2009b). *Greek students' ability in probability problem solving.* In the Sixth Conference of the European Society for Research in Mathematics Education. Proceedings of CERME 6, Lyon France © INRP 2010 <www.inrp.fr/editions/cerme6> pp. 404-412. http://ife.ens-lyon.fr/editions/editions-electroniques/cerme6/working-group-3.

Anastasiadou, S. (2009c). The effects different modes of representations in statistical problems solving: A study with third grade primary school pupils. *The International Journal of Learning,* Volume 16, Issue 4, pp.27-36.

Anastasiadou, S. (2011). Reliability and validity testing of a new scale for monitoring attitudes toward learning statistics with technology. *Acta Didactica Napocencia,* vol. 4 number 1, pp. 1-10. http://adn.teaching.ro/.

Anastasiadou, S. (2012a). Diversifications between expected and perceived attitudes toward learning statistics with technology. The *International Journal of Learning*, vol 18, Issue 3, pp.161-176

Anastasiadou, S. (2012b). Evaluating a structural equation model measuring lifelong learning and continuing education factors. The *International Journal of Knowledge, Culture and Change Management,* Volume 12, Issue 3, pp.21-34.

Anastasiadou, S. (2012c). Diversifications between expected and perceived attitudes toward learning statistics with technology. *The International Journal of Learning*, vol 18, Issue 3, pp.161-176.

Anastasiadou, S. (2012d). *A structural model describes Chinese tradesmen attitudes towards Greek students' consumption behaviour*. 4th International Conference The Economies of Balkan and Eastern Europe Countries in the changed world EBEEC 2012, Sofia, Bulgaria. pp. 489-501.

Anastasiadou, S. (2012e*). Reliability and validity testing of a new scale for measuring attitudes toward Chinese products.* 4th International Conference. The Economies of Balkan and Eastern Europe Countries in the changed world EBEEC 2012, Sofia, Bulgaria. pp 536-548.

Anastasiadou, S. (2012f). *A structural model describes Chinese tradesmen attitudes towards Greek students' consumption behavior*. Economic Sciences. Vol 11, Issue 2, pp. 102-111.

Anastasiadou, S. (2012g). Structural Equation Modelling in the Construction of a Structural Model of the Repercussions and Consequences in the Greek society and economy of Balkan and Eastern Europe Countries immigrants' entrance. *International Review of Applied Economic Research,* Vol.6. No.1-2, pp1-9.

Anastasiadou, S. (2013a). Evaluating a Structural Equation Model Measuring Attitudes toward Reading Books and E-books. The *International Journal of the Book,* vol 10, pp.1-10.

Anastasiadou, S. (2013b). Evaluating a structural equation model measuring lifelong learning and continuing education factors. The *International Journal of Knowledge, Culture and Change Management*. Volume 12, Issue 3, pp.21-34.

Anastasiadou, S. (2013c). Developing and Evaluating a Structural Equation Model Measuring Leadership Changes in a Lifelong Learning World. The *International Journal of Educational Organization and Leadership,* Volume 19, Issue 2, pp.1-17.

Anastasiadou, S. (2013d). *Consumer ethnocentrism: the case of Greek students*. Proceedings of the EBEEC 2013-5th International Conference 'The Economies of Balkan and Eastern Europe Countries in the changed world' EBEEC 2013. Kostadinopolis. Turkey, pp.92-97.

Anastasiadou, S. (2014). A structural equation model describes factors affecting Greek students' consumer behavior. *Procedia Economics and Finance.* Volume 9, pp. 402– 406.

Anastasiadou, S. (2015). The Roadmaps of the Total Quality Management in the Greek Education System according to Deming, Juran and Crosby in light of EFQM Model. *Procedia Economics and Finance,* vol. 33 pp. 562 – 572.

Anastasiadou, S. (2016). *Greek Tertiary Education System evaluation in respect of quality assurance dimensions according to Malcolm Baldrige Performance Excellence Model.* 8th International Conference 'The Economies of Balkan and Eastern Europe Countries in the changed world', EBEEC 2016, Split, Croatia n: Karasavvoglou A., Goić S., Polychronidou P., Delias P. (eds) Economy, Finance and Business in Southeastern and Central Europe. Springer Proceedings in Business and Economics. Springer, Cham, pp. 811-825.

Anastasiadou, S. (2018a). *Gap analysis between perceived and expected of service quality in Greek Tertiary Education.* Proceedings of EDULEARN18: 10th annual International Conference on Education and New Learning Technologies Palma de Mallorca, Spain, pp. 8373-8382. doi:10.21125/edulearn.2018.1951.

Anastasiadou, S. (2018b). Evaluating Perception, Expectation of Students/Pre-service Teachers and Service Quality Gap in Greek Tertiary Education. *KnE Social Sciences* | The Economies of the Balkan and the Eastern European Countries in the changing World (EBEEC 2018) | pages: 294–308.

Anastasiadou, S. (2018c). *Leadership according to EFQM Model in Tertiary education: The case of Greek Universities.* Proceedings of 10th International Conference The Economies of the Balkan and the Eastern European Countries in the changing world, EBEEC 2018, Warsaw, Poland, pp. 20-24.

Anastasiadou, S. (2018d). *Total quality management in Greek Tertiary Educational System: The case of Greek Universities.* Proceedings of 10th International Conference EBEEC 2018 - The Economies of the Balkan and the Eastern European Countries in the changing world, Warsaw, Poland, pp. 59-64.

Anastasiadou, S. (2019). *Comparison of contemporary advanced statistical methods regarding construct validity evaluation of TEIque-SF instrument: Statistical Implicative Analysis vs. Principal Components.* Analysis. 9ème Colloque International sur Analyse Statistique Implicative (ASI 10). Belfort – France. pp. 148-163.

Anastasiadou, S. & Anastasiadis, L. (2011). Reliability and validity testing of a new scale for monitoring attitudes toward electronics and electrical constructions subject. *International Journal of Applied Science and Technology* (IJAST), Vol 1, No 1, pp. 1- 10.

Anastasiadou S., Anastasiadis, L. Kalabouka, K. & Florou, G. (2014). Ethnocentrism, patriotism and animosity impact on freedom of competition and business activity. *WSEAS TRANSACTIONS on BUSINESS and ECONOMICS,* Vol 11, pp. 692-699.

Anastasiadou, S. & Anastasiadis, L. (2019). *Quality Assurance in Education in the Light of the Effectiveness of Transformational School Leadership*. In: Sykianakis N., Polychronidou P., Karasavvoglou A. (eds) Economic and Financial Challenges for Eastern Europe. Springer Proceedings in Business and Economics. Springer, Cham, pp. 323-344. https://doi.org/10.1007/978-3-030-12169-3_21.

Anastasiadou, S., Anastasiadis, L, Vandikas, J. & Angeletos, T. (2010a). Implicative statistical analysis and Principal Components Analysis in recording students' attitudes toward electronics and electrical constructions subject. The *International Journal of Technology, Knowledge and Society,* Volume 16, Issue 5, pp. 341-356.

Anastasiadou, S. Anastasiadis, L, Angeletos, T. & Vandikas J. (2010b). A Multidimensional Statistical Analysis of Students' Attitudes toward Physics *International Journal of Diversity in Organisations, Communities and Nations*, Volume 16, Issue 5, pp. 341-356.

Anastasiadou, S., Anastasiadis, L. Kalabouka K. & Florou G. (2014a). Ethnocentrism, patriotism and animosity impact on freedom of competition and business activity. *Wseas Transactions on Business and Economics*, Vol 11, pp. 692-699.

Anastasiadou S.D., Batiou, V. & Balkanos, E. (2014b). Occupation mobility in Greece: A completely new area. *Global Journal of Business, Economics and Management* 4(2), 73-80.

Anastasiadou S., Batiou V., Balkanos E., 2015. Occupation mobility in Greece. *Procedia Economics and Finance, Elsevier,* 19, pp. 325 – 331.

Anastasiadou, S. & Chadjipantelis, T. (2008). *The role of representations in the understanding of probabilities in tertiary education.* Eleventh International Congress on Mathematical Education, Monterrey, Mexico, 2008 in the http://tsg.icme11.org/tsg/show/14.

Anastasiadou, S., Chadjipadelis, T., Kofou, I. 2013. *Pre-school Education department to understand probability distributions.* International Symposium Elementary Mathematics Teaching (SEMT '13), Prague, Czech Republic, In Jarmila Novotná and Hana Moraová ed., pp 67-75.

Anastasiadou, S., Dimitriadou A. & Toda, E., (2013). What Makes Students Perform in PISA? Science Teachers' Beliefs. *International Journal of Humanities and Social Science.* Vol 3, Issue 1, pp.80-99.

Anastasiadou S., Eliα I. & Gagatsis A. (2007). *Le rôle des représentations dans l´apprentissage des concepts de statistique des étudiants de l´école primaire de Grèce.* In Regis Gras, Pilar Orus, Bruno Pinaud, Pablo Gregori Eds, 4nd International Conference Implicative Statistic Analysis, Castellon, Spain, pp. 135-144.

Anastasiadou, S.D, Fotiadou, X.G. & Anastasiadis, L. (2016a). Estimation of Vocational Training School (IEK) students' contentment in relation to quality of their studies. *New Trends and Issues Proceedings on Humanities & Social Sciences*, [On line].10, pp 09-18. Available from: www.prosoc.

Anastasiadou S., Florou G., 2013. *Consumer Ethnocentrism: The case of Greek students.* 3rd International Conference on Quantitative and Qualitative Methodologies, Athens, pp. 52-57.

Anastasiadou, S.D, Florou, G.S, Fotiadou, X.G. & Anastasiadis, L. (2016b). *Evaluation of the satisfaction of preservice educators of Primary Education from their work and faithfulness to their work.* New Trends and Issues Proceedings on Humanities and Social Sciences. [On line].10, pp35-41. Available from: www.prosoc.eu.

Anastasiadou, S. & Gagatsis, A. (2005a). *Attitudes vers la statistique des étudiants –futurs enseignants de l'école primaire grecque.* In Regis Gras, Filippo Spagnolo, Jerome David Eds, 3nd International Conference Implicative Statistic Analysis, Palermo, Italy, pp. 109-118.

Anastasiadou, S. & Gagatsis, A. (2005b). *Believes and academic behaviors in statistics education.* In J. Novotha Eds, International Symposium Elementary Mathematics Teaching SEMT 05 Prague, pp. 59-65.

Anastasiadou, S., Gagatsis, A. (2007). *Exploring the effects of representation on the learning of statistics in Greek primary school.* In the Fifth Conference of the European Society for Research in Mathematics Education (CERME 5), Nikosia, Cyprus pp. 90-100. http://ermeweb.free.fr/CERME5b/ και http://ermeweb.free.fr/CERME%205/WG1/1_Anastasiadou.pdf.

Anastasiadou, S., Gagatsis A. & Elia, I. (2005). The relation between the perceived math ability and the feelings about mathematics and statistics. In the journal *'Scientia Paedacogika Experimentals'*, vol. 42, no 2, pp. 351-364.

Anastasiadou, S. & Giossi, S. (2018a). *Implicative Statistical Analysis vs. Confirmatory Factor Analysis in evaluation of Lifelong Learning Impact on Human Resources Development. Proceedings of CERI2018:* 12th annual International Conference on Education and New Learning Technologies, Seville (Spain) pp. 6413-6413.

Anastasiadou, S. & Giossi, S. (2018b). *A structural equation model describing the influence of lifelong learning on human resource development.* Proceedings of CERI2018: 12th annual International Conference on Education and New Learning Technologies, Seville (Spain), pp. 6368-6374.

Anastasiadou S., Draganis, A. (2014). Research on feelings of elementary school students in learning foreign languages: the case of Greek, the first and the second foreign language. *American International Journal of Contemporary Research*, Vol 4, no 4, pp. 105-111.

Anastasiadou, S. & Karakos, A. (2011). The beliefs of electrical and computer engineering students´ regarding computer programming. *The International Journal of Technology, Knowledge and Society,* Vol 7. Issue 1, pp.37-52.

Anastasiadou, S. & Kofou, I. (2013a). The Development of a Structure Equation Model, for Goal Achievement and Preparation for a Future Education Leader. *The International Journal of Educational Organization and Leadership* 19 (2): 41-55.

Anastasiadou, S. & Kofou, I. (2013b). Incorporating Web 2.0 Tools into Greek Schools. *International Journal of Technologies in Learning*, Volume 20, Issue 1, pp.11-23.

Anastasiadou S., Kyridis A., Gkolia P., Karatasos G., 2007. *Students, Politics and Politicians in Greece: trends of political apathy and devaluation of political institutions*. Proceedings of the 2007 South-European and Mediterranean Conference on Citizenship Education, pp 145-168.

Anastasiadou, S. & Loukas, D. (2009). Greek pre-service teachers' cognitive abilities in understanding the concept of frequency: A multilevel statistical analysis. *The International Journal of Learning,* Volume 16, Issue 5, pp.189-202.

Anastasiadou, S. & Panitsides, E. (2014). *And now whither..? European Union lifelong learning policy: a two-level analysis.* Proceedings of EBEEC 2014. The 6th International Conference Economies of Balkan and Eastern Europe Countries in the changed world EBEEC 2014, Nis, Serbia, pp. 42-51.

Anastasiadou, S. & Pappa, A. (2009). Structural Equation Modelling in the Construction of Structural Model of Educational Research. *The International Journal of Interdisciplinary Social Sciences,* Vol 4, Issue 5, pp.151-158.

Anastasiadou, S. & Pappa. A. (2019). *Greek pre-service teachers' perceptions, emotions and attitudes toward representations of physic concepts*. ICERI2019, the 12th annual International Conference of Education, Research and Innovation, Seville (Spain), ICERI2019, pp. 8987-8992.

Anastasiadou, S. & Papadaki, Z. (2019). Consumers' perceptions toward E-Service Quality, Perceived Value, Purchase and Loyalty Intentions. *International Journal of Entrepreneurship and Innovative Competitiveness* – IJEIC, Vol 1, Issue 1, https://hephaestus.nup.ac.cy/bitstream/handle/11728/11391/paper1.pdf?sequence=1&i sAllowed=y.

Anastasiadou, S. & Papadimitriou, I. (2001). Another way to estimate the validity of a questionnaire for measurement of attitudes towards statistics. The case of Greek students. *Learning in Mathematics and Science and Educational Technology*, Volume II, Intercollege Press, pp. 345-368.

Anasatsiadou, S. & Papadimitriou, I. (2003). *Secondary mathematics teachers' attitudes towards statistics in Greece*. 3o Mediterranean Conference in Mathematics Education, Athens, pp. 441-448.

Anastasiadou, S. & Taraza, E. (2019a). *Total Quality Management: Implementation of the Six Sigma Methodology for Improving Quality in Higher Education. ICERI2019*, the 12th annual International Conference of Education, Research and Innovation, Seville (Spain), ICERI2019, pp. 9533-9537.

Anastasiadou, S. & Taraza, E. (2019b). *Pre-service teachers' perceptions toward leadership regarding the MBVQA Model.* 11th annual International Conference on Education and New Learning Technologies, Palma de Mallorca, Spain, EDULEARN 19, pp. 533-543.

Anastasiadou, S. & Taraza, E. (2019c). The structure and paths of Malcolm Baldrige National Quality Award (MBNQA) dimensions applied in Greek Tertiary educational systems dimensions in Greek Tertiary Education System. *11th annual International Conference on Education and New Learning Technologies*, Palma de Mallorca, Spain, EDULEARN 19, pp. 455-463.

Anastasiadou, S. & Taraza, E. (2020a). Resistance to Change as an Obstacle Regarding Quality in Higher Education Institutions (HEIS*). Proceedings of of 14th annual International Technology, Education and Development Conference* (INTED2020), Valencia, Spain, pp. 396-401.

Anastasiadou, S. & Taraza, E. (2020b). *Six Sigma in Tertiary Education: A Win of Change regarding Quality Improvement in Education*, Proceedings of of 14th annual International Technology, Education and Development Conference (INTED2020), Valencia, Spain, pp. 9595-9601.

Anastasiadou, S. & Tiliakou, C. (2014). Classical Item Analysis of the Greek State of English Language Proficiency "A" Level Exam. *The International Journal of Literacies*, Volume 20, Issue 3, pp.39-53.

Anastasiadou, S. & Tiliakou, C. (2015). The Greek State Certificate in English Language Proficiency (KPG) Level A: Item difficulty, learning ability and cultural background through regression analysis. *Procedia-Social and Behavioral Sciences*, 197, 1501-1506. doi: 10.1016/j.sbspro.2015.07.101

Anastasiadou, S. & Tiliakou, C. (2016a). Investigation of the discriminating ability of the Greek State certificate of language proficiency by means of Vacor method: The case of Greek-speaking and Turkish-speaking bilingual students from the Muslim minority of Thrace. *International Journal of Learning and Teaching.* 8 (2),109-118. DOI https://doi.org/10.18844/ijlt.v8i2.517

Anastasiadou, S. & Tiliakou, C. (2016b). Evaluation of the discriminating ability of the Greek state foreign language exam (KPG) for English by means of the factorial analysis of correspondences, *International Journal of Learning and Teaching.* 8 (2), 129-140.

Anastasiadou, S. & Zirinolou, P. (2014). Reliability testing of EFQM scale: The case of Greek secondary teachers. *Procedia - Social and Behavioral Sciences*, Volume 143, pp. 990–994.

Anastasiadou, S. & Zirinoglou, P. (2015a). Teachers' attitudes toward Quality Assurance Dimensions regarding EFQM Model in Primary Education in Greece, *Procedia Economics and Finance*, vol. 33, pp. 411-431.

Anastasiadou, S. & Zirinoglou, P. (2015b). EFQM dimensions in Greek Primary Education *System. Procedia Economics and Finance*, vol 33, pp. 411 – 431.

Anastasiadou, S. & Zirinoglou, P. (2020a). Quality assessment in Greek Tertiary Education using Gap Analysis. *International Journal of Entrepreneurship and Innovative Competitiveness* – IJEIC. Vol 2, Issue 1, http://hephaestus.nup.ac.cy/handle/11728/11531.

Anastasiadou, S. & Zirinoglou, P. (2020b). Reliability and Validity Analysis of validity testing of a new scale for monitoring Students Attitudes toward Entrepreneurship Courses (SATEC). *International Journal of Entrepreneurship and Innovative Competitiveness*–IJEIC Vol 2, Issue 1, http://hephaestus.nup.ac.cy/handle/11728/11530.

Anastasiadou, S., Zirinoglou, P., Karasavoglou, A. & Florou, G. (2016c). Total Quality Management in Education: The case of Primary and Secondary Education for the implementation of the best educational policy. *Data Analysis, Bulletin* 17, 110-130.

Atan, M. & Kasmin, F. (2018). Assessing Mathematics' Attitude among Technical University *Students. Int. J. Acad. Res. Bus. Soc. Sci.* 7, 103–115.

Awaludin, I.S.; Ab Razak, R.; Azliana Aridi, N.; Selamat, Z. Causes of Low Mathematics Achievements in a Private University. *J. Comput. Sci. Comput. Math*. 2015, 21–26.

Batiou V., Anastasiadou S. (2015). *Greek people's attitudes toward boundary less mindset careers*. Proceedings of the EBEEC 2015-7th International Conference 'The Economies, of Balkan and Eastern Europe Countries in the changed World' EBEEC 2015 Kavala, Greece, pp 75-80.

Brezavšˇcek, A., Janja, J., Rus, G. & Žnidarši ˇc, A. (2020). Factors Influencing Mathematics Achievement of University Students of Social Sciences. *Mathematics,* 8, 2134, MDPI; doi:10.3390/math8122134.

Chin. W. W. (1998). Issues and opinion on structural equation modeling, *Mis Quarterly*, 22(1), pp 7-16.

Christodoulou, T., Gagatsis, A., Anastasiadou, S. (2017). *Enquête internationale comparative: croyances et attitudes des élèves du secondaire inférieur relatives aux erreurs en mathématiques*. Proceedings of 9ème Colloque International sur Analyse Statistique Implicative, Belfort – France, pp. 404-418.

Churchill, G.A. (1979). A paradigm for developing better measures for marketing constructs. *Journal of Marketing Research*, 16, pp 64-73.

Cohen, R.T., Monlaque, P., Nathason. L.S., & Swerdlik, M.E. (1988). *Psycholoical testing: An introduction to tests of measurement.* Mountain Viw, CA: Mayfield Publishing Company.

Chadjipantelis T., Anastasiadou S. 2010. *Pre-service teachers' understanding of probability Distributions: A Multilevel Statistical Analysis.* International Conference on the Teaching of Statistics. ICOTS 8, Ljubljanja, Slovenia 2010. http://www.stat.auckland.ac.nz/~iase/publications.php?show=icots8.

Draganis, A., Dragani, M. Anastasiadou S. (2013). *Economic crisis in Greece: Students worst nightmare.* Proceedings of the EBEEC 2013-5th International Conference. The Economies of Balkan and Eastern Europe Countries in the changed world EBEEC 2013. Kostadinopolis. Turkey, pp.1-6.

Croanbach, L.J. (1984). *Essentials of psychological testing (*4th ed.). New York: Harper & Row.

Dauphinee, T.L., Schau, C. & Stevens, J.J. (1997). Survey of attitude Toward Statistics: Factor structure and factorial invariance for female and males. *Structural Equation Modeling.* 4 (1997), pp. 129–141.

Deák, C.; Kumar, B.; Szabó,I.; Nagy, G.; Szentesi, S. Evolution of New Approaches in Pedagogy and

STEM with Inquiry-Based Learning and Post-Pandemic Scenarios. Educ. Sci. 2021, 11, 319. https://doi.org/10.3390/educsci11070319

Fernández-Cézar, R., Garrido, D. and Natalia Solano-Pinto, N. (2020). Do Science, Technology, Engineering and mathematics (STEM) Experimentation Outreach Programs Affect Attitudes towards Mathematics and Science? A Quasi-Experiment in Primary Education. *Mathematics,* 2020, 8, 1490; doi:10.3390/math8091490.

Florou, G., Anastasiadou, S., Karasavvoglou, A., Valsamidis, S, & Mandilas, A. (2015). *Greek Public Tertiary Education Departments in Agriculture*. Proceedings of the 7th International Conference on Information and Communication Technologies in Agriculture, Food and Environment (HAICTA), Kavala, Greece, pp. 471-479.

Florou G., Anastasiadou S. 2013. *Academic staff of Greek technological educational institutes.* 3rd International Conference on Quantitative and Qualitative Methodologies, Athens, pp. 52-156.

Florou, G., Anastasiadou, S., Valsamidis, S. 2021. *E-Learning and tertiary education students.* Proceedings of EDULEARN21 Conference, pp. 9796-9805.

Fornell, C. & Larcker, D. (1981). Evaluating Structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18, pp 39-50.

Fotiadis, Th., Anastasiadou S. (2018a). *Contemporary advanced statistical methods for the science of marketing: Implicative Statistical Analysis vs Principal Components Analysis.* Proceeding of the ICME 2018- 1st International Conference on Marketing and Entrepreneurship. Cyprus. http://hephaestus.nup.ac.cy/handle/11728/11393.

Fotiadis, Th., Anastasiadou S. (2018b). *Contemporary advanced statistical methods for the science of marketing: Principal Components Analysis vs Analysee Factorielle des Correspondances.* Proceeding of the ICME 2018- 1st International Conference on Marketing and Entrepreneurship. Cyprus. http://hephaestus.nup.ac.cy/handle/11728/11392.

Gkolia, P., Kyridis, A., Anastasiadou S., Vamvakidou, I. & Zagkos, C. 2007. The concepts and connotations of "homeland" as a core elements Greek national identity. Proceedings of the 2007 South-European and Mediterranean Conference on Citizenship Education, pp 225-258.

Giossi, S., Anastasiadou, S. 2014. *Human resources dimensions: an approach of Greek managers. Proceedings of EBEEC 2014.* The 6th International Conference Economies of Balkan and Eastern Europe Countries in the changed. EBBEC 2014, Nis, Serbia, pp 59-62.

Giossi, S., Anastasiadou, S., Gamanis, A. & Gamanis G. G. (2019). Tracing the concept of entrepreneurship and the role of an entrepreneur: A critical review. *International Journal of Entrepreneurship and Innovative Competitiveness* – IJEIC, Vol 1, Issue 1, https://hephaestus.nup.ac.cy/bitstream/handle/11728/11394/Paper4.pdf?sequence=1& isAllowed=y.

Gurer, M. D, Cetin, I. Top, E. (2019). *Factors Affecting Students' Attitudes toward Computer Programming Informatics in Education,* 2019, Vol. 18, No. 2, 281–296.

Hagan, I.E, Amoaddai, S. Terkwor Lawer, V & Atteh, E. (2020). Students' Perception towards Mathematics and Its Effects on Academic Performance. Asian Journal of Education and Social Studies, 8(1): 8-14, 2020; Article no. AJESS.57132, ISSN: 2581-6268.

Hair, J., Anderson, R., Tatham, R. & Black, W. (1995). Multivariate Data Analysis With Raedings, p.373. USA: Prentice-Hall International, Inc.

Hair, F.J., Black C.W., Badin, N.J., Anderson, E.R. & Tatham, R.L. (2005). *Multivariate Data Analysis.* New Joursey, Pearson Education Inc.

Jeong, J.S.; González-Gómez, D. (2021). Flipped-OCN Method in Mathematics Learning to Analyze the Attitudes of Pre-Service Teachers. *Mathematics,* 2021, 9, 607. https://doi.org/10.3390/ math9060607

Kapetanopoulou, P., Kouroutzi, A. & Anastasiadou, S. (2021). The Impact of Information Systems Implementation in the Greek Manufacturing Enterprises. *Appl. Sci.* 2021, 11(24), 11781; https://doi.org/10.3390/app112411781

Kim, D.J., Ferrin, D.L. & Rao, H.R. (2008). A trust-based consumer decision-making model in electronic commerce: The role of trust, perceived risk, and their antecedents. *Decision support systems,* 44(2), pp.544-564.

Kofou, I. & Anastasiadou S. (2013). Language and Communication Needs Analysis in Intercultural Education. *The International Journal of Diversity in Education*. Vol 12, pp.15-64.

Lee, CH, Yoon HJ. (2017). Medical big data: promise and challenges. Kidney Res Clin Pract. 2017, 36(1), pp.3–11.

Manalaysay, E.G. (2019). Gender Differences, Mathematics Anxiety, And First-Year College Students' Mathematical Achievement. *Int. J. Sci. Technol. Res*., 8, 25–29.

Margaris, A., Souravlas, S., Kotsialos, E. & Roumeliotis, M. (2007). Design and Implementation of Parallel Counterpropagation Networks using MDPI, *INFORMATICA, Volume 18, N0 1, 2007, p. 79-102.*

Nicolaou, S. Gagatsis, A., Deliyianni, E., Panaoura, A., Elia, I., Anastasiadou, S. (2017). *Tracing the beliefs and self-efficacy beliefs of undergraduate economic sciences students: the case of the representations of functions.* Proceedings of 9ème Colloque International sur Analyse Statistique Implicative. Belfort – France, pp. 461-478.

Ntotsi, P. & Anastasiadou, S. D. 2019a. Contemporary advanced statistical methods for the science of educational research: Principal components analysis versus L' analysee factorielle des correspondances. *New Trends and Issues Proceedings on Humanities and Social Sciences.* [Online]. 6(1), pp. 246–255. Available from from: www.prosoc.eu.

Ntotsi, P. & Anastasiadou, S. D. 2019b. Comparison of multivariate pattering methods in group/cluster identification regarding the science of educational research: Implicative Statistical Analysis vs. L' Analysee Factorielle des Correspondances. *New Trends and Issues Proceedings on Humanities and Social Sciences*. [Online]. 6(1), pp 238–245. Available from from: www.prosoc.eu.

Nunnally, C.J. (1978). *Psychometric Theory*. New York: McGraw Hill Book Co.

Panitsides, E. & Anastasiadou S. (2015). Lifelong Learning Policy Agenda in the European Union: A bi-level analysis. *Open Review of Educational Research,* 2015 Vol. 2, No. 1, 128–142, http://dx.doi.org/10.1080/23265507.2015.1043936, Routledge.

Papadaki, Z.E. & Anastsasiadou, S.D. (2019). *Evaluating Perception, Expectation of Consumers, and Service Quality Gap in Greek Banking in a Period of Financial Crisis and Capital Controls.* In: Sykianakis N., Polychronidou P., Karasavvoglou A. (eds) Economic and Financial Challenges for Eastern Europe. Springer Proceedings in Business and Economics. Springer, Cham, pp. 67-80. https://doi.org/10.1007/978- 3-030-12169-3_5.

Patrali, K., Alevriadou, A., Petrou, M., Anastasiadou, S. & Kyridis, A. (2012). How social factors influence the understanding of the computers by kindergarten pupils. *The International Journal of Learning and Development, vol 2, No3, pp. 229-246.*

Papadimitriou, C, Anastasiadou, S., Kondeos, 2022. Papalexandris, S. (2022). COVID-19 Pandemic: The Impact of the Social Media Technology on Higher Education, *Educ. Sci. 2022, 12(4), 261;* https://doi.org/10.3390/educsci12040261.

Petridou, A., Elia, I, Gagatsis, A., Anastasiadou, S. (2017). *L' appréhension perceptive des figures géométrique*. Proceedings of 9ème Colloque International sur Analyse Statistique Implicative. Belfort – France, pp. 231-247.

Rutjens, B.T., Heine, S.J., Sutton, R.M, van Harreveld, F. (2018). Attitudes Towards Science, In James M. Olson, ed. Advances in Experimental Social Psychology, Academic Press, Volume 57, 2018, pp. 125-165, https://doi.org/10.1016/bs.aesp.2017.08.001.

Schau, C., Stevens, J., Dauphinee, T. L. & Del Vecchio, A. (1995). The development and validation of the Survey of Attitudes Toward Statistics. *Educational and Psychological Measurement*. 55. 868-875.

Souravlas, S., Anastasiadou, S. (2020a). Pipelined Dynamic Scheduling of Big Data Streams. *Applied. Sciences.* 10, 4796.

Souravlas, S., Katsavounis, S. & Anastasiadou, S. (2020b). On Modeling and Simulation of Resource Allocation Policies in Cloud Computing Using Colored Petri Nets. *Applied Sciences*. 020, 10(16), 5644; https://doi.org/10.3390/app10165644.

Souravlas, S. (2019). ProMo: A Probabilistic Model for Dynamic Load-Balanced Scheduling of Data Flows in Cloud Systems, *Electronics, Open Access Journal*, MDPI, vol.8, issue 9, September 2019.

Souravlas, S. & Anastasiadou, S. (2020). Pipelined Dynamic Scheduling of Big Data Streams, *Applied Sciences*, Open Access Journal, MDPI, 2020; 10(14):4796.

Souravlas, S, Anastasiadou, S. & Katsavounis, S. (2021). More on Pipelined Dynamic Scheduling of Big Data Streams. *Applied Sciences*, 2021; 11(1):61. https://doi.org/10.3390/app11010061

Souravlas, S. & Katsavounis, S. (2019). Scheduling Fair Resource Allocation Policies for Cloud Computing Through Flow Control, *Electronics, Open Access Journal*, MDPI, Vol.8, Issue 11, Nov. 2019.

Souravlas, S., Katsavounis, S. & Anastasiadou, S. (2020). On Modeling and Simulation of Resource Allocation Policies in Cloud Computing Using Colored Petri Nets", *Appl. Sci.* 2020, 10, 5644.

Souravlas, S. & Roumeliotis, M. (2014a). *Dynamic Load Balancing on Allto-All Personalized Communications Using the NNLB Principle*., 6th International Conference on Computational Intelligence, Communication Systems, And Networks, CICSYN2014, Tetovo, FYROM, pp. 107-112, May, 2014. (IEEE Xplore, DOI: 10.1109/CICSyN.2014.34).

Souravlas, S. & Roumeliotis, (2014b). Verification & Performance Evaluation of Parallel Pipelined Communications Using Petri Nets", UKSim-AMSS 16th International Conference on Computer Modelling and Simulation, Cambridge, UK, March 2014, pp. 399-404. (IEEE Xplore, DOI: 10.1109/CICSyN.2014.34)

Souravlas, S. & Roumeliotis, M. (2015a). Scheduling Array Redistribution With Virtual Channel Support, *Journal of Supercomputing*, Springer, Volume 71, Issue 11, pp. 4215-4234, November 2015.

Souravlas, S. & Roumeliotis, M. (2015b). Petri Net Modeling and Simulation of Pipelined Deadlock-Free Redistributions, Congent Engineering, Systems & Control Taylor and Francis Group, Volume 2, Issue 1, 2015.

Spector P.E. (1992). Summated Rating Scale Construction: An Introduction. Sage University Paper Series on Quantitative Application in the Social Sciences. Newbury Park, CA.

Tantalaki, S. Souravlas, S., Roumeliotis, M. & Katsavounis, S. (2019a). *Linear Scheduling of Big Data Streams on Multiprocessor Sets in the Cloud*, 19th IEEE/WIC/ACM. International Conference on Web Intelligence, pp. 107-115, Thessaloniki, Oct. 2019.

Tantalaki, N., Souravlas, S. & Roumeliotis, M. (2019b). Data-Driven Decision Making in Precision Agriculture: The Rise of Big Data in Agricultural Systems, *Journal of Agricultural & Food Information*, Taylor and Francis, Vol.20, Issue 4, pp 344-380, Nov. 2019.

Tantalaki, N. Souravlas, S. Roumeliotis, M. & Katsavounis, S. (2020a). Pipeline-Based Linear Scheduling of Big Data Streams in the Cloud, *IEEE Access*, vol. 8, pp. 117182-117202, 2020, doi: 10.1109/ACCESS.2020.3004612

Tantalaki, N., Souravlas, S. & Roumeliotis, M. (2020b). A review on big data real-time stream processing and its scheduling techniques, *International Journal of Parallel, Emergent and Distributed Systems*, Taylor & Francis, Vol.35, Issue 5, July 2020, pp 571-601.

Taraza, E. & Anastasiadou, S. (2019a). *Evaluation of Total Quality Management (TQM) in Greek Higher education Using advanced statistical methodologies.* ICERI2019, the 12th annual International Conference of Education, Research and Innovation will be held in Seville (Spain), ICERI2019, pp. 9450-9460.

Taraza, E. & Anastasiadou, S. (2019b). *EFQM Excellence Model in Vocational Lyceum: Reliability and Validity of EFQM* Instrument. Proceedings of 13th annual International Technology, Education and Development Conference (INTED2019), Valencia, Spain, pp. 2273-2285.

Taraza, E.I. & Anastasiadou, S.D. (2019c). Personality traits in the light of the effectiveness of transformational vocational school leadership and leaders. *New Trends and Issues Proceedings on Humanities and Social Sciences.* [Online]. 6(1), pp 184–Available from: www.prosoc.eu.

Thapa, K.B. Okalidou, A. & Anastasiadou, S. (2016). Teachers' screening estimations of speech–language impairments screening estimations of speech–language. *International Journal of Language & Communication Disorders.* Vol. 51, No. 3, 310–327.

Theodoridou, E., Alevriadou, A., Semoglou, A. & Anastasiadou, S. (2014). Investigating Memory Strategies and Motor Memory in Dyslexic and Non-dyslexic Children, *International Journal of Learner Diversity and Identities*, Volume 20, Issue 3, pp.25- 44.

Wixon, B.H & Watson, H.J. (2001). An empirical investigation of the factors affecting data warehousing. *MIS Quarterly* 25(1), pp 17-41.

Valsamidis, S., Giannoula Florou, G., Anastasiadou, S., Mandilas, A. (2021). *Educational robotics as a teaching tool of information technology in the primary education*. Proceedings of EDULEARN21 Conference, pp. 9806-9816.

Wahid, S.N.S.; Yusof, Y.; Razak, M.R. (2014). Math anxiety among students in higher education level. *Procedia Soc. Behav. Sci*. 2014, 123, 232–237.

Wong Kah Wei & Siti Mistima Maat (2020). The Attitude of Primary School Teachers towards STEM Education. TEM Journal – Volume 9, Number 3, 1243-1251.