Contemporary advanced statistical methods for the science of educational research: Principal components analysis *versus* L' analysee factorielle des correspondances

Paschalina Ntotsi, General Hospital, Agios Dimitrios, Elenis, Thessaloniki 546 34, Greece

Sofia D. Anastasiadou*, Professor, Department of Early Childhood Education, University of Western Macedonia, Frorina 53100, Greece

Selection and peer review under responsibility of Prof. Dr. Jesus Garcia Laborda, University of Alcala, Spain.

Abstract

The current paper analyses two different statistical techniques: i.e., principal components analysis (PCA) and correspondence analysis (L'analysee factorielle des correspondances) (AFC). A survey was carried out using a structured questionnaire for a sample of 135 nurses which studied in the School of Pedagogical and Technological Education (ASPETE) in Greece. Tangibility, Reliability, Responsiveness, Assurance, Empathy and Associability subscales are related to Qualitative Services ASPETE offers. These subscales were measured by 24 items, rated on a seven-point Likert scale. The study focuses on the presentation of the two main types of clustering methods, PCA and AFC. Lee and Lin's model contains a one-item scale developed to measure overall service quality and a one-item scale for customer satisfaction. The assessment of the students' satisfaction degree is evaluated based on a seven-step on the Likert scale statement, investigating the extent that the respondents are satisfied from the experience they had with the specific tertiary education organisation (CSF).

Keywords: Advanced, statistical, methods, AFC, PCA.

* ADDRESS FOR CORRESPONDENCE: **Sofia D. Anastasiadou**, Department of Early Childhood Education, University of Western Macedonia, Frorina 53100, Greece. *E-mail address*: sanastasiadou@uowm.gr / Tel.: +30-231-041-0000

1. Theoretical framework

There is considerable enlargement and employment of pattering methods in statistics although a direct comparison of multivariate methods in group/cluster identification in the field of educational research in relation to Service Quality has not yet been undertaken in the field of Research Methodology.

One hundred and thirty-five nurses who participated in the current essay studied in the School of Pedagogical and Technological Education (ASPETE) in Greece in order to be qualifying in most significant teaching methodologies and to acquire pedagogical competences and capabilities. Many of these nurses are seeking to teach in Greek secondary technological education. Others are already teachers in secondary technological education, thus they are seeking to obtain didactical and pedagogical competences in order to contribute in education quality improvement. In addition, others are teaching in continues education programmes within their hospitals. The ASPETE programme is 1 year programme.

According to Word Health Organization, there are eight Nurse Educator Core Competencies and Domains (https://www.who.int/hrh/nursing_midwifery/nurse_educator050416.pdf).

1. *Theories and Principals of adult learning:* Nurse educators possess a sound understanding of contemporary educational theories, principles and models underling the design of curricula and the value of adult education.
2. *Curriculum design and implementation:* Nurse educators demonstrate the skills and abilities to design, implement, monitor and manage curricula based on sound, contemporary educational models, principles and best evidence.
3. *Nursing practice:* Nurse educators maintain current knowledge and skills in theory and practice, based on the best evidence available.
4. *Research and evidence:* Nurse educators develop their critical inquiry and ability to conduct research and utilise finding to identify and solve educational and practice-based problems.
5. *Communication, collaboration and partnership:* Nurse educators demonstrate effective communication skills that promote collaborative teamwork and enhance partnership among health profession educational and critical practice.
6. *Ethical/legal principles and professionalism:* Nurse educators demonstrate professionalism including legal, ethical and professional values as a basis for developing nursing education policies, procedures and decision making.
7. *Monitoring and evaluation:* Nurse educators utilise a variety of strategies to monitor and evaluate nursing programmes, curricula and mastery of student learning.
8. *Management and leadership:* Nurse educators demonstrate the skills of system management and leadership to create, maintain and develop desired nursing programmes and shape the future of education institutions.

Anastasiadou (2018a) claimed that necessities posed by the society on the quality in education and the requirement of excellence are more than evident. Education, training and culture of the youth is of the highest value for people, nations, economies and cultures (Anastasiadou, 2016). Quality in education includes a multitude of issues such as satisfaction of both the internal clients (students, faculty and administration) as well as the external ones (parents and society) (Anastasiadou, 2018a). Altmann (2008) claimed that the role of professional development and advanced education is needed and it is strongly related to job satisfaction. There is considerable enlargement and employment of pattering methods in statistics although a direct comparison of multivariate methods in group/cluster identification in the field of educational research in relation to Service Quality in Tertiary education. This study tries to fulfil this gap.

2. Purpose of the article

This study analyses two different statistical techniques: i.e., principal components analysis (PCA) and L'analysee factorielle des correspondances (AFC). The main objective is to compare patterns derived from PCA and L'AFC procedures with respect to Service Quality in Tertiary Education using as a research sample 135 nurses who studied in the ASPETE in Greece viewing to be nurse educators.

3. Methods

3.1. Statistical methodologies

AFC: In the course of the research, absolute and relative frequencies were recorded for the 29 statement variables, using classic statistics methods. The 29 statement variables were then classified into three classes each, resulting in all of the data to be described by 87 classes, namely, by a logical table (0–1). By means of the categorisation of the variables, a double entry table was created for the relative and absolute frequencies with dimensions 87 × 87. This table is a Burt table and each column in this Burt table is considered as a vector with a dimension of 105. The Burt table allowed for each class and each variable to be surveyed individually and then for the classes of variables to be cross-examined.

The objective being to determine these relations employed were the $n \times n$ double entry tables, the Burt tables containing all the classes, to which variables have been divided, in their columns and lines. Consequently, each element in the Burt table exclusively depends on two variables, thus revealing the relationship that connects them. Data Analysis techniques were employed for the processing of the data, since this paper necessitated that no a priori hypotheses be made. AFC technique allows for the simultaneous statistical processing of categorised qualitative and quantitative variables (Anastasiadou, 2016; Benzecri, 1973; Karapistolis, 2015; Papadimitriou, 2007). The grouping of dominant observation groups is affected through this and thus attained is an almost universal description of the phenomenon which is expressed by the table analysed with the help of a smaller number of new complex variables-factors (Papadimitriou, 1994). The factors can assume the form of axes and form the factorial levels in pairs, which will allow the graphic representation of the variables. The contribution and cohesion of the indexes are then presented, constituting the criteria for the selection of the variables for constructing and interpreting the axes and, consequently, the factorial levels.

PCA is a method for the analysis of multivariate data, considered as constituting a part of factor Analysis. The principal objectives of PCA are: Data Reduction. PCA aims to replace highly correlated variables with a small number of correlated variables (Dafermos, 2013). Detection and establishment a structure/model. The goal of PCA is, namely, to accentuate structures or fundamental relations existing between the existing variable (Dafermos, 2013). Moreover, PCA aims to bring to light and assess latent variables, and to detect and assess latent sources of variability and co-variability in observable measurements. Patterns detection. The goal of PCA is to detect prototype correlations which may potentially determine causality relations between the examined variables (Dafermos, 2013).

3.2. Instruments

The instrument employed to measure the satisfaction getting during studies in ASPETE with respect to quality is SEVQUAL (Parasuraman, Zeithaml & Berry, 1988; Parasuraman, Zeithaml & Malhotra, 2005). According to Gronroos (1982), SEVQUAL has been the predominant method used to measure students' perceptions relating to service quality. This tool consists of 25 items referring to five different attitude sub-scales, as follows:

(a) Tangibility (e.g., Tan1: ASPETE has up-to-date and well-maintained facilities and equipment); (b) Reliability (e.g., Rel1: Services should be provided at appointed times); (c) Responsiveness (Res1: e.g., Students should be given prompt services); (d) Assurance (e.g., Ass1: Friendly and courteous personnel); (e) Empathy (e.g., Emp1: Obtain feedback from students) and (f) Accessibility (e.g., Acc1: There are adequate parking facilities).

Each item of the instrument used a five-point Likert scale that ranged from 1—Strongly Disagree to 5—Strongly Agree. The value of the Cronbach's α coefficient for this instrument in the sample of this study was 0.827. Their attitudes with regard to Loyalty Intentions to continue studies were measured by four items utilising five 5-point Likert scale questions. And, Overall Perceived Quality is measured by one 5-point Likert scale question. In addition, Customer Satisfaction is measured by one 5-point Likert scale question.

3.3. Sample

Sample comprised of 135 female interviewees. With respect to the ages of participants, 12 (8.9%) of them were below 24, 39 (28.9%) of them were between 25 and 34, 11 53 (39.3%) of them were between 35 and 44, 20 (14.8%) of them were between 45 and 54 and finally, 11 (8.1%) were between 55 and 64. With respect to their family status, 58 (43%) were single, while 67 (49.6%) were married and 10 (7.4%) were separated or divorced. Regarding the education of interviewees, 81 (60%) stated that he has completed tertiary education, 42 (31.1%) hold a second degree and 12 (8.9%) hold a postgraduate diploma or doctorate. Regarding the years of experience 23 (17%) were unemployed, 42 (31.1.5) have between 0 and 10, 50 (37%) have between 11 and 20 and finally, 20 (14.8%) have between 21 and 30 years of experience. Twenty-three (17%) out of 135 respondents have not work before, 38 (28.1%) work in public hospital, 31 (23%) in private hospital and 23 had worked as nurses for a short period and now they work in secondary education.

4. Results

4.1. Principal component analysis results

Kaiser—Meyer—Olkin (KMO) Measure of the Sampling Adequacy and Bartlett's Test of Sphericity, and Measure for the suitability of the method were tested before the analysis of the factor analysis results. Both the KMO factor, equal to 0.661 and deemed very satisfactory, as it exceeds the acceptable value of 0.60, and Bartlett's Test of Sphericity (x^2 = 1,564.715, df = 435, p < 0.001) have shown that the application of the Principal Component Analysis with varimax rotation method is permitted (Kaiser, 1974).

The application of Principal Component Analysis with varimax rotation for all the variables on the basis that the characteristic root or eigenvalue criterion is over one (eigenvalue > 1), was verified for seven components. These specific factors explained 56.948% of the variance. Similarly, according to the Scree Plot criterion, the steep descending trend of eigenvalues begins after the seventh Principal Components (PC8) (Cattel, 1996). Consequently, the existence of the seven components was verified.

The first Principal Component (PC1), with an eigenvalue equal to 15.283%, interprets 4.612% of the total variance of the data, a percentage deemed satisfactory (Hair, 2005) and gathers values for variables Ass17, Ass18, Emp20, Emp21, Ass16, Emp19, Emp22 and Ass16 with very high loadings. These gathered values amount to 0.917, 0.864, 0.801, 0.733, 0.707, 0.679, 0.553 and 0.431, respectively (Table 2).

The values of the Communalities of items Ass17, Ass18, Emp20, Emp21, Ass16, Emp19, Emp22 and Ass15, take on values 0.847, 0.772, 0.684, 0.606, 0.523, 0.669, 0.478 and Ass15, exceeding the 0.40 value criterion posed as the limit for the verification of the satisfactory quality for the variables of the First Component (PC1). The First Component (PC1) is constructed and interpreted by Ass17, Ass18,

Emp20, Emp21, Ass16, Emp19, Emp22 and Ass15. The First Component (PC1) is shown to essentially be the composition of *Components Assurance and Empathy.*

The Second Component (PC2) refers to Rel7, Rel9, Rel8, Rel6 and Rel10, related to *Reliability.* This Component has an eigenvalue of 3.119 and interprets 9.461% of total data variance. The eigenvalue criterion, eigenvalue over one, verifies that the five variables/items Rel7, Rel9, Rel8, Rel6 and Rel10 which exhibit very high loadings 0.801, 0.754, −0.676, 0.574 and −0.568 correspondingly, are represented by the same conceptual construct (Table 3). The values for the Communalities of Rel7, Rel9, Rel8, Rel6 and Rel10, take on prices 0.473, 0.622, 0.612, 0.517 and 0.456, respectively, and exceed the 0.40 value criterion posed as the verification limit for the satisfactory quality of statements of Second Component (PC2) named *Reliability*.

The Third Component (PC3) (Table 2) refers to *Advocacy*, which is represented by items Adv2, Adv3 and Adv1 and exhibit high loadings of 0.902, 0.830 and 0.769, respectively, with an eigenvalue of 2.616, that interprets 7.992% of total data variance, a percentage deemed satisfactory (Hair et al., 2005), while falling under it are, in order, elements Adv2, Adv3 and Adv1. The values of the Communalities of Adv2, Adv3 and Adv1 take on prices 0.833, 0.715 and 0.649 exceeding the 0.40 value criterion posed as the limit for the verification of the satisfactory quality of Third Component (PC3). The Third Component (PC3) is essentially shown to be the *Component of Advocacy.*

The Fourth Component (PC4) (Table 2) refers to *Responsiveness,* which is represented by items Res14, Res13, Res11 and Res12 and exhibit high loadings of 0.676, 0.554, −0.472 and −0.459, respectively, with an eigenvalue of 2.168, that interprets 6.694% of total data variance, a percentage deemed satisfactory (Hair et al., 2005), while falling under it are, in order, elements Res14, Res13, Res11 and Res12. The values of the Communalities of Res14, Res13, Res11 and Res12 take on prices 0.540, 0.513, 0.694 and 0.565 exceeding the 0.40 value criterion posed as the limit for the verification of the satisfactory quality of Fourth Component (PC4). The Fourth Component (PC4) is essentially shown to be the *Component of Responsiveness.*

The Fifth Component (PC5) (Table 2) refers to Tangibility, which is represented by items Tab4, Tab5, Tab2, Tab1 and Tab3 and exhibit high loadings of −0.632, 0.589, −0.452, 0.380 and 0.284, respectively, with an eigenvalue of 1.162, that interprets 6.195% of total data variance, a percentage deemed satisfactory, but Tab3 (Hair et al., 2005), while falling under it are, in order, elements Tab4, Tab5, Tab2, Tab1 and Tab3. The values of the Communalities of Tab4, Tab5, Tab2, Tab1 and Tab3 take on prices 0.401, 0.526, 0.422, 0.579 and 0.422 exceeding the 0.40 value criterion posed as the limit for the verification of the satisfactory quality of Fifth Component (PC5). The Fifth Component (PC5) is essentially shown to be the *Tangibility.*

The Sixth Component (PC6) (Table 2) refers to *Overall Service Quality Customer, Satisfaction,* which is represented by items GPO (Overall Service Quality) and CSF (Customer Satisfaction), exhibit high loadings 0.779 and 0.474, respectively, with an eigenvalue of 1.523, that interprets 5.751% of total data variance, a percentage deemed satisfactory (Hair et al., 2005), while falling under it are, in order, elements GPO and CSF. Thus there is satisfactory quality of Sixth Component (PC6).

The values of the Communalities of GPO and CSF take on prices 0.548, and 0.422 exceeding the 0.40 value criterion posed as the limit for the verification of the satisfactory quality of Sixth Component (PC6). The Sixth Component (PC6) is essentially shown to be the *Component of Overall Service Quality Customer and Satisfaction.*

The Seventh Component (PC7) (Table 2) refers to *Accessibility,* which is represented by items Acc23, Acc24 and Acc23 and exhibit high loadings of 0.652, 0.633 and 0.358, respectively, with an eigenvalue of 1.016, that interprets 6.082% of total data variance, a percentage deemed satisfactory (Hair et al., 2005), while falling under it are, in order, elements PRC1 and PRC2. The values of the Communalities of Acc23, Acc24 and Acc23 take on prices 0.700, 0.664 and 0.284 exceeding the 0.40 value criterion

posed as the limit for the verification of the satisfactory quality of Seventh Component (PC7) but Acc23. The Seventh Component (PC7) is essentially shown to be the *Component of Accessibility.*

4.2. Analysee factorielle des correspondances results

The indexes employed to interpret the results of this particular correspondence factor analysis are the well-known indexes 'inertial' and 'contribution' (Benzecri, 1980; Papadimitriou, 2007). These indexes allow one to immediately distinguish the most important and determinative variables or objects that contribute to the creation of factorial axes. The results of this factorial analysis were interpreted with the help of inertia, which is explained by each factorial axis, of correlation and of the contribution.

The data table analysis using AFC initially produces Table 3, which presents the eigenvalues of the Burt table as well as the inertia percentages for each factorial axis. Table 1 offers the capacity to distinguish the number of the most significant factorial axes, which are the most appropriate in order to interpret the results. The inertia percentage of each factorial axis denotes the significance percentage expressed by each one.

According to the values complemented by the histogram, the significance percentage of the first factorial axis is 50.99%, while that of the second amounts to 10.20%, the third 6.25%, the fourth 5.33%, etc. The total information offered by the 12 factorial axes amounts to 95.03%, as can be seen from Table 1.

Based on cumulative frequency, the first three factorial axes interpret 67.45% of the total data variance. This percentage is deemed satisfactory to interpret the data (Karapistolis, 2015). Moving on and from Table 1 of the results of the factorial analysis of correspondences, pursuant to the aforementioned criteria that were chosen (inertia, correlation and contribution), the variables contributing to the shaping of the two first factorial axes were detected, using MAD software (Karapistolis, 2000). The aforementioned variables are deduced in compliance with two criteria, correlation (*cor ≥ 200*, criterion 2) and contribution ($Ctr \geq \dfrac{1000}{87} \approx 11.4 \approx 12$, criterion 3) (Karapistolis, 2015).

Interpretation of the first factorial axis e_1: More specifically, based on the responses by the respondents and as follows from factor analysis, the first axis—factor e_1, with eigenvalue 0.1692577 explaining 50.99% of the total variance is constructed from classes Tab11, Ass182, Ass172, Emp201, Acc232, Emp191, Emp212, Re172, Ass162, Emp192, Emp221, Tab22, Emp202, Ass183, Ass173, Ass163, Emp213 and Emp203 (Figure 1).

More specifically, the factorial axis e_1, is constructed from those variable classes, that project a neutral attitude with respect to part of Assurance as well as a both neutral and negative attitude with respect to part of Tangibility, Assurance, Empathy and Accessibility and which are quoted on its left side and the positive attitude with respect to part of Assurance, Empathy on its right side (Figure 1).

We initially come across the respondents' views with respect to conceptual construct *Tangibility*, which support that ASPETE has not up-to-date and well-maintained facilities and equipment (Tan11) (Cor = 678, Ctr = 69).

We then come across the respondents' views with respect to conceptual construct *Assurance*. Respondents did not seem to have a crystal clear view with respect to whether the behaviour of personnel instills confidante in students/pre-service teachers (Ass182) (Cor = 973, Ctr = 144); whether Students/pre-service teachers are treated with dignity and respect (Ass172) (Cor = 966, Ctr = 137); and whether Personnel (rector and stuff) has the knowledge to answer students'/pre-service teachers' questions (Ass162) (Cor = 797, Ctr = 66) (Figure 1).

Moving forward, to the left side of the first factorial axis *e1* we came across a negative attitude to part of conceptual construct *Empathy.* The respondents supported that Opening hours of the ASPETE must not be suitable and there is 24-hour online service available (Emp201) (Cor = 626 Ctr = 65); Rector and staff do not obtain feedback from students/pre-service teachers (Emp191) (Cor = 300, Ctr = 22) as well as Rector and staff have not students'/pre-service teachers' best interest at heart (Emp221) (Cor = 398, Ctr = 23). In addition, respondents exhibited a neutral attitude with respect to whether Rector and staff have not students'/pre-service teachers' best interest at heart (Emp212) (Cor = 884, Ctr = 92) and whether opening hours of the ASPETE must be suitable and there is 24-hour online service available (Emp202) (Cor = 325, Ctr = 22); whether there was enough parking space (Acc232) (Cor = 419, Ctr = 26) and the psychical facilities is visually appealing (Tab22) (Cor = 291, Ctr = 16). Finally, respondents have did not seem to have a crystal clear view with respect to whether when a student/pre-service teacher has a problem, the ASPETE shows genuine interest in solving it (Rel72) (Cor = 527, Ctr = 34).
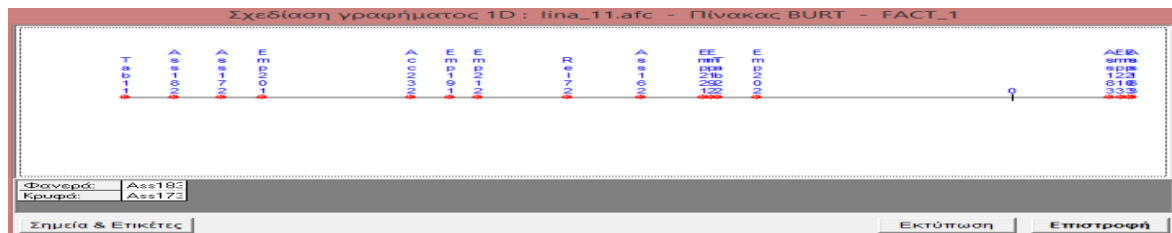

Figure 1. First factorial axis *e*₁

The variables projecting a positive attitude with respect to part of *Assurance* and part of *Empathy* are quoted to the right of the factorial axis. We initially come across the views by respondents expressing a positive attitude with respect to the conceptual construct *Assurance* and more specifically claiming that the behaviour of personnel instills confidante in students/pre-service teachers (Ass183) (Cor = 950, Ctr = 16); that students/pre-service teachers are treated with dignity and respect (Ass173) (Cor = 966, Ctr = 17) due to the fact that personnel (rector and stuff) has the knowledge to answer students'/pre-service teachers' questions (Ass163) (Cor = 797, Ctr = 21) and because Rector and staff have students'/pre-service teachers' best interest at heart (Emp213) (Cor = 757, Ctr = 20), and thus it is claimed that the opening hours of the ASPETE must be suitable, and therefore 24-hour online service must be available (Emp202) (Cor = 325, Ctr = 22).

Interpretation of the second factorial axis e2: Based on the answers given by the respondents and as follows from factor analysis, the second axis—factor *e₂*, with an eigenvalue of 0.0338931 and explaining 10.21% of total variance, is constructed from classes Res141, Res131, Emp211, Re161, Res111, Tab51, Rel91, Acc251, Re181, Rel103, Rel93, Res113, Rel63, Rel83 and Rel103 (Figure 2).

More specifically, the factorial axis *e₂*, is constructed from those variable classes, that project a negative attitude with respect to *Responsiveness, Reliability* and part of *Tangibility, Assurance* and *Empathy* conceptual constructs and which are quoted on its left side and the positive attitude with respect to part of Responsiveness and *Reliability* conceptual constructs on its right side (Figure 2).

We initially come across the respondents' views with respect to conceptual construct *Responsiveness*, which support that ASPETE personnel/staff is too busy to respond to students/pre-service teachers' requests (Res141) (Cor = 667, Ctr = 35) and is not always willing to help students/pre-service teachers/pre-service teachers (Res131) (Cor = 279, Ctr = 60). In addition, respondents on this side of axis *e₂* supported that and students/pre-service teachers are not been given prompt services (Res111) (Cor = 476, Ctr = 69). Thus, it is concluded that conceptual construct *Responsiveness appears* in its negative dimension. Moreover to the left of the second factorial axis *e₂*, one finds those respondents who claimed that Rector and staff haven't students'/pre-service teachers' best interest at

heart (Emp211) (Cor = 277, Ctr = 49); Services are not provided at appointed time (Tab51) (Cor = 456, Ctr = 58) and ASPETE' services provided are not affordable charges (Acc251) (Cor = 320, Ctr = 31).

We then come across the respondents' views with respect to conceptual construct and *Reliability*. It supports that ASPETE' services are not reliable and they not carried out right the first time (Rel61) (Cor = 635, Ctr = 86); ASPETE does not provide services once promised to do (Rel91) (Cor = 456, Ctr = 90); rector and staff are not both professional and competent (Rel81) (Cor = 390, Ctr = 42); ASPETE does not maintain accurate records for students/pre-service teachers (Rel101) (Cor = 501, Ctr = 60).
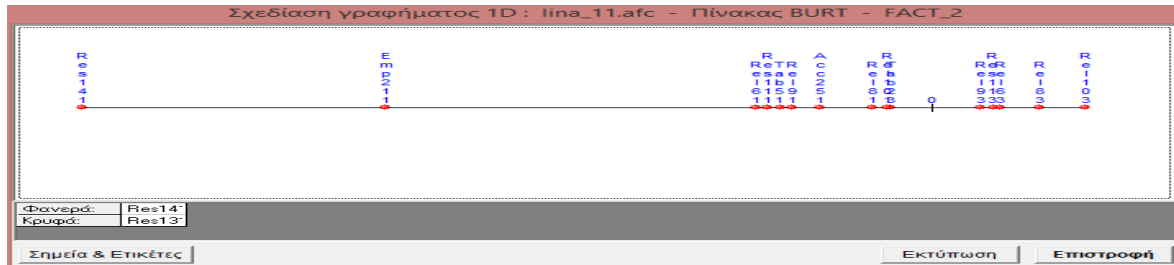

Figure 2. Second factorial axis e_2

The variables projecting a positive attitude with respect to part of *Responsiveness* and part of *Reliability* are quoted to the right of the factorial axis. We initially come across the views by respondents expressing a positive attitude with respect to the conceptual construct *Reliability* and more specifically claiming that ASPETE provides services once promised to do (Rel93) (Cor = 336, Ctr = 20); Rel63: ASPETE' services are reliable and carried out right the first time (Rel63) (Cor = 641, Ctr = 37); Rector and staff are both professional and competent (Rel83) (Cor = 337, Ctr = 22) and ASPETE maintains accurate records for students/pre-service teachers (Rel103) (Cor = 368, Ctr = 14). In addition, variable that is quoted on its right side express views with respect to the conceptual construct *Responsiveness*. Respondents claimed that students/pre-service teachers should be given prompt services (Res113) (Cor = 461, Ctr = 29).

Interpretation of the second factorial axis e_3: Based on the answers given by the respondents and as follows from factor analysis, the third axis—factor e_3, with an eigenvalue of 0.0207523 and explaining 6.25% of total variance, is constructed from classes Adv21, Adv11, Adv31, Adv13, Adv23 and Adv33 (Figure 3). More specifically, the factorial axis e_3, is constructed from those variable classes, that project a negative attitude with respect to *Advocacy* and which are quoted on its left side and the positive attitude with respect to the same conceptual construct*, Advocacy,* on its right side (Figure 3).
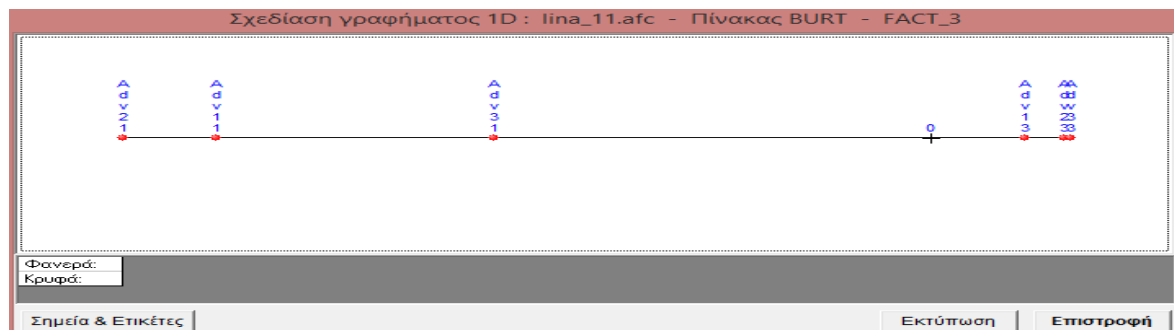

Figure 3. Second factorial axis e_3

We initially come across the respondents' views with respect to conceptual construct *Advocacy*, which support that neither they have not recommend ASPETE to others (Adv21), (Cor = 581, Ctr = 122) nor they have not said positive things about the ASPETE to others (Adv11) (Cor = 454, Ctr = 86). Additionally, the respondents claimed that they have not encouraged friends and family to use the

ASPETE services (Adv31) (Cor = 356, Ctr = 60). We then come across the respondents' positive views with respect to conceptual construct *Advocacy*. It supports that have said positive things about the ASPETE to others Adv13, (Cor = 417, Ctr = 18) and they have recommended ASPETE to others (Adv23) (Cor = 588, Ctr = 35). Furthermore, they claimed that they have encouraged friends and family to use the ASPETE services (Adv33) (Cor = 486, Ctr = 33).

It is, therefore, relatively easy to draw the conclusion that in the third factorial axis e_3 and to its left one comes across those variable classes expressed by a group of respondents that project a negative attitude with respect to *Advocacy,* while variable classes quoted to the right of the first factorial axis that represent a group of respondents who have a positive attitude with respect to construct *Advocacy*.

5. Conclusions and discussion

The current study presents two different statistical techniques: i.e., the PCA and the AFC (Anastasiadou, 2018b). The main objective is to compare the outcomes derived from AFC, PCA procedures with respect to Consumer Behaviour and specifically with respect to ASPETE quality services. The two methods operate complementary, each one accentuating a different dimension for the interpretation of data, the interpretation of which would not have been determinative without the import of Education Scientists. AFC application unveils factors, independent per couple between them, which are created from the synthesis of groups of the initial variables, simplifying the process for probing the relations between the variables and thus offering a full and more complex image of the phenomenon under examination. The factors can assume the form of axes and form factorial levels in pairs, which will then allow for the graphic representation of the variables. AFC is a method where no a priori hypothesis is made.

PCA is an unsupervised pattern recognition method. It is based on the principle that there is no a priori information about the membership of the sample examined. PCA falls under this category, since the Principal Components are not known beforehand, but ensue from the application of the method (Anastasiadou, 2018a). Principal Components are hierarchically calculated (Anastasiadou, 2018a). The application of PCA creates patterns for SERVQUAL scale and made it evident that the specific scale constitutes five diminution' scale containing the constructs *Assurance* and *Empathy* (one single construct), *Reliability, Responsiveness, Tangibility* and *Accessibility*. *Overall Service Quality Customer* and *Satisfaction* is another single dimension as well as the conceptual construct named *Advocacy.*

More specifically, PCA application resulted to seven components. These results made evidence that conceptual constructs, namely, *Assurance* and *Empathy* load on one fact and constitute one construct which is the First Component (PC1) in this study. The Second Component (PC2) was resulted as a unique conceptual construct known as *Reliability*. The Fourth Component (PC4) was essentially shown to be the Component of *Responsiveness.* The Fifth Component (PC5) was essentially shown to be the *Tangibility.* The Seventh Component (PC7) was essentially shown to be the *Component of Accessibility. All the previous components represent SERVQUAL conceptual constructs.*

The Sixth Component (PC6) is essentially shown to be the *Component of Overall Service Quality Customer* and *Satisfaction.* This component indicated that there is not any connection between the SERVQUAL conceptual constructs and respondents' perceptions related to Overall Service Quality Customer and Satisfaction. Furthermore the Third Component (PC3) is essentially shown to be the Component of *Advocacy.*

SERVQUAL scale is a multidimensional and hierarchical scale by Parasuraman et al. (1988; 1990) consists of six constructs*: Tangibility, Reliability, Responsiveness, Assurance, Empathy, and Associability*. The application of AFC made it evident that *Reliability, Responsiveness, Assurance, Empathy* constructs are shaped attitudes. *Tangibility* and *Associability* conceptual constructs are weak playing in shaping attitudes and there are seem to be unimportant because none of their dimensions

play a role to respondents mind. Component of Overall Service Quality, respondents Satisfaction is totally insignificant due to the fact that its classes do not appear constitute to any of the three factorial axes after the application of AFC because they couldn't fulfil the three criteria of the specific statistical method. Finally, the conceptual construct known as *Advocacy* or *Word of Mouth Intentions* seem to differentiate respondents with negative attitudes from those with positive.

The application of AFC based on the three criteria, inertia (criterion 1) correlation (*C*or, criterion 2) and contribution ($Ctr2$, criterion 3) reveal the latent dimension of respondents psychological attributes towards services that ASPETE offers.

References

Altmann, T. (2008). *Nurses' attitudes towards continuing formal education: a comparison by level of education and geography* (Doctoral dissertation). Duquesne University, Pittsburgh, PA. Retrieved from http://ddc.duq.edu/etd/16

Anastasiadou, S. (2016). *Evaluation of the implementation of TQM principles in tertiary education using the EFQM excellence model–research in educational departments of Greek universities* (Published Master's thesis). Greek Open University, Patra, Greece.

Anastasiadou, S. (2018a). *Gap analysis between perceived and expected of service quality in Greek tertiary education.* Proceedings of EDULEARN18 Conference, Palma, Spain, pp. 8373–8382.

Anastasiadou, S. (2018b). *Comparison of multivariate methods in group/cluster identification* (Published Master's thesis). Faculty of Medicine, University of Thessaly, Volos, Greece.

Bauer, R. (1967). Consumer behavior as risk taking. In: D. Cox (Ed.), *Risk taking and information handling in consumer behavior*. Cambridge, MA: Harvard University Press.

Benzecri, J. P. (1973). *Analyse des Donnees*. Paris, France.

Benzecri, J. P. (1980). *Pratique de l'Analyse des donnees T. 2: analyse des correspondances, expose elementaire.* Paris, France: Dunod.

Cattel, R. B. (1966). The scree test for the number of factors. *Multivariate Behavioral Research, 1*, 245–275.

Dafermos, B. (2013). *Factor analysis*, Thessaloniki, Greece: Ziti.

Davis, F. 1989. Perceived usefulness, perceived ease of use and user acceptance of information technology. *MIS Quarterly, 1*, 319–340.

Drosos, B. (2004). *Statistical analysis linguistics information* (PhD thesis). University of Macedonia, Thessaloniki, Greece.

Karapistolis, D. (2000). *Data analysis software MAD*. Thessaloniki, Greece: Altitzi Eds.

Karapistolis, D. (2015). *Multivariate satistical analysis.* Thessaloniki, Greece: Altitzi Eds.

Papadimitriou, I. (2007). *Data analysis*. Athens, Greece: Tipothito Eds.

Parasuraman, A., Zeithaml, V. A. & Berry, L. L. (1985). A conceptual model of service quality and its implications for future research. *Journal of Marketing, 49*(4), 41–50.

Parasuraman, A., Zeithaml, V. A. & Berry, L. L. (1988). SERVQUUAL: a multi-item scale for measuring consumer perceptions of service quality. *Journal of Retailing, 64*(1), 12–40.

Parasuraman, A., Zeithaml, V. A. & Malhotra, A. (2005). E-S-Dual: a multiple-item scale for assessing electronic service quality. *Journal of Service Research, 7*(10), 1–21.