Exploration of Multiple Intelligence by Using Latent Class Model

Shaista Ismat[1,*] and Junaid Sagir Sidiqui[2]

[1]*Federal Urdu University of Arts Science And Tenchnology, Gulshan Campus, Karachi, Pakistan*

[2]*University of Karachi, Karachi, Pakistan*

Abstract: In this article we have tried to explore, "multiple intelligence" in the educated youth through questionnaire items by applying latent class models. A questionnaire consists of 50 questions. These questions have constructed in the light of Howard Gardner theory of multiple intelligence to explore "multiple intelligence". A survey was conducted on 399 adult students from different regions of Karachi. For statistical analysis we have selected three sets with seven variables, and one set with 4 variables each with binary response.

On these four sets up to three classes latent class models were applied. The Probability of positive response (π_{iy}) in each class were estimated by using E.M algorithm and interpreted the class as on the basis of π_{iy} values. By assessed goodness of fit latent classes/ groups were identified. Two class (two groups of people) model was found in all four data sets.

A group (class) consists of the people who think that they have strong verbal expressions abilities, effectively use language to express himself/herself theoretically and poetically, they have good ability to recognize musical pitches, tones and rhythms, we may call this class as "self competence and self esteem" as "musically talented" as "socialize" (having high interpersonal ability).

Keywords: Manifest variables, latent variable, positive response, stochastically independent, prior probability, label, likelihood, Estimation, Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC).

1. INTRODUCTION

People often comments that a particular child or individual is very intelligent or is not very intelligent. All such comments depend on ones observation on the individual performance at various tasks or attitude on different occasion, taking Interest in specific activity, attitude toward seeking for knowledge, communicative skill and similar other attributes that contribute towards his/her performance or behavior.

Howard Gardner of Harvard University has proposed "The theory of multiple intelligence" in 1983 [1]. He said intelligence is not a single attribute; people have multiple types of intelligence which grow and develop from their environmental experiences. These multiple types of intelligence named by Howard Gardner as Linguistic, Mathematical, Visual (Art Drawing Geometry), Musical thinking, Body kinetic, Interpersonal, and Intrapersonal. More recently he added naturalistic into the list and suggested that there may be other possibilities including spiritual and existential.

The multiple intelligence is not being directly measurable, but can be measured through battery of tests and the individual scores are used as an indirect measure of intelligence. In this article we have tried to explore, multiple intelligence through questionnaire by using Latent Variable models. The questions in the questionnaire are treated as observable variables (manifest variables) and have generated in the light of Howard Gardner theory of multiple intelligence.

In 1904 the psychologist Spearman [2] introduced Latent variable models to study the different mental ability. Statistical methods based on Latent variable models (LVM) play an important role in the analysis of multivariate data, its need in all the sciences but especially in psychology and other Social sciences. LVM condense the many variables into a smaller number of indices and they extract information contained in the multivariate data it is a powerful tool for analyzing high dimension data to identifying patterns in data. Latent variables are obtained on the basis of assumption that manifest variable are mutually independent when observed in the present of latent variable.

Bartholomew (1987) [3] was classified latent variable models by combination of type of latent and manifest variables. According to Bartholomew classification, when Latent variable and manifest variable both are metrical, apply Factor Analysis, when Latent variables are Categorical and manifest variables are metrical use Latent Profile Mixture Analysis, when

*Address corresponding to this author at the Federal Urdu University of Arts Science And Tenchnology, Gulshan Campus, Karachi, Pakistan; E-mail: ismat_shaista@yahoo.com

ISSN: 1814-8085 / E-ISSN: 1927-5129/12

Latent variables are metrical and manifest variable are Categorical, use Latent Trait Analysis, when both variables are Categorical then apply Latent Class Analysis (Latent structure).

For factor analysis see Bartholomew (1987), for latent trait analysis see Jansen and Roskam (1986) [4] for structural equation modeling see Marcouledes and Schumacker (2001) [5].

The tool in this study have used for analyzing Intelligence factor is latent class analysis (LCA).

LCA have preferred because the data on which this study is based on categorical and binary responses.

Latent class analysis (Lazarsfeld &Henry 1968) [6] is a powerful tool for identifying subgroups in mixed sample; it is designed for analysis of multivariate categorical data for binary (0, 1) response variables and polytomous response variables. Latent class analysis is used for analyzes the association among manifest (observable) qualitative variables and try to explore unobserved nominal variables whose values represent, different independent subpopulations. This model assumes that a heterogeneous population from which the sample are taken can be partitioned in a restricted number of homogeneous subpopulations, the latent classes. In psychology subjects are human individual and these individual respondents belong to one of these subpopulations /classes, and respondents belonging to the same class share with each other the same set of response probabilities for the manifest variables. Furthermore, within each latent class the responses to different manifest variables are supposed to be stochastically independent. Clogg (1981) [7] interpreting latent classes for different social classes, LCA is well suited to many health applications where one wishes to identify disease subtypes or diagnostic Subcategories. Anderson and Hinde used educational research data by clustering teachers into distinct teaching style. Hagenaars (1990) [8] has used categorical data analysis with discrete latent variables.

During the whole of 1990's a revised care in the utilization of latent class tool for cluster analysis. The different labels that are used to calling LC cluster models are by: Vermunt and Magidson (2000, 2002) [9]. The generalized linear latent and mixed modeling (GLLAMM) model is applied to U.S sample of the program for international student assessment (PISA) 2000 to investigate the relationship between the school level latent variable "teacher excellence" and their student level latent variable "reading ability" each measured by multiple ordinal indicator (Rabe-Hesketh *et.al* 2007) [10], Mavridis and Moustaki (2009) [11] propose maximum likelihood estimation method for modeling multivariate longitudinal ordinal variables. Giorgio (*et al.* 2010) [12] classifies disability in people of central region of Italy aged 65 or more through latent variable modeling. Demirhan (2011) [13] using women's liberation data set for latent class analysis with error of measurement with log linear models.

In the present article our main aim is to identify the number of intelligence groups in educated youth on the basis of Howard Gardner theory and this is done by applying latent class model on the subdivided items of the questions (which we have developed).

2. LATENT CLASS MODEL

A model for cross-classified contingency tables that seeks to explain associations among variables in terms of conditional independence given a latent classification (Clogg and Goodman 1984) [14]. The model is further explained below.

Notations and Model Definitions

Suppose we have p categorical manifest variables, $X = (x_1,x_2,x_3, - - - - x_p)'$ where x_i denotes the response to ith question from the questionnaire. Also suppose that there is a single categorical latent variable Y with K levels (y = 1, 2, 3, 4,……, K), here K is unknown and indicate the number of latent groups /classes that may exits, let the prior probability that a randomly chosen individuals (respondent) from the population belongs to the y^{th} latent class is denoted by

$$P(Y=y) = h(y) = \eta_y \quad (1.1)$$

Since the $\eta_y s$ are the unknown prior probabilities of the class association and they must fulfill the restriction

$$\sum_{y=1}^{k} h(y) = \sum_{y=1}^{k} \eta_{y=1} \quad (1.2)$$

The general assumption required to apply the model is that

The dependence among the variables of X vector is not direct but it's due to latent variables. That is observing the manifest variable under a latent class makes these variable independent. And for some numbers of latent class k, the independence among the

Xs not achieved significantly, we should add one or more latent class. This is often spoking as the assumptions (axioms) of conditional or local independence.

Under the assumption of local independence the conditional density of X given Y Can be written as

$$\mathrm{g}\,(\mathrm{x}/\mathrm{y}) = \prod_{i=1}^{p} g_i\,(x_i / y) \tag{1.3}$$

This is the important property of latent variable model and the derivation of maximum likelihood solution equations is performed. On the basis of the assumption, the density function for the manifest variable can be written as,

$$f(\mathrm{x}) = \sum_{y=1}^{k} h(y) \prod_{i=1}^{p} gi(x_i / y) \tag{1.4}$$

Or

$$f(\mathrm{x}) = \sum_{y=1}^{K} \eta_y \prod_{i=1}^{P} gi(x_i / y) \tag{1.5}$$

In this paper we considered only binary manifest variables and a single latent variable, the conditional density, $g_i(x_i / y)$, will have a Bernoulli distribution

$$g_i(x_i / y) = \pi_{iy}^{xi}(1-\pi_{iy})^{1-xi} \qquad (xi = 0 \; or \; 1; i = 1,2,\ldots,p)$$

Thus (1. 5) can be expressed.

$$f(x) = \sum_{y=1}^{k} \eta_y \prod_{i=1}^{p} \pi_{iy}^{xi}(1-\pi_{iy})^{1-xi} \tag{1.6}$$

The maximum likelihood estimator for posterior probability that an individual with response vector x belong to class y is thus:

$$h(y / x) = \eta_y \prod_{i=1}^{p} \pi_{iy}^{xi}(1-\pi_{iy})^{1-xi} / f(x) \quad (\mathrm{y} = 1,2.....\mathrm{K}) \tag{1.7}$$

$$\eta_y = \sum_{h=1}^{n} h(y / x_h) / \mathrm{n} \qquad (\mathrm{y} = 1,2.....\mathrm{K}) \tag{1.8}$$

The maximum likelihood estimator for probability of the positive response on variable x by a respondent in class y is

$$\pi_{iy} = \sum_{h=1}^{n} x_{ih} h(y / x) / n n_y \text{ (i=1,2,.....p; y=1,2,...K)} \tag{1.9}$$

The eqs. (1.7), (1.8) and (1.9) are used for parameter estimation for latent class model in section 4.

3. THE DATA SETS

After going through the questionnaires constructed by Walter McKenzie (1999) [15] and Maya Angelou (2007) [16], which were based on Gardener theory, we have set a new questionnaire and translated it in Urdu. The data were derived from a survey of 399 adult students (age between 16 and 26) from different parts of Karachi Region we have selected institute randomly and then gallup survey method is used for picking the student. The questionnaire includes 50 items (questions) based on Gardener's criteria of intelligence as discussed earlier. The respondents were the students from private and government institutions, from intermediate to post graduate level. For statistical analysis, we have selected four sub-sets, (set: 1, 3, 4) consists of seven variables each and set 2 has four variables. Two and three latent class models are fitted to each of these data sets. For each model we have estimated the probability of the positive response "Yes" given the latent class (π_{iy}), the conditional probability of the membership of individual to a class given the responses $h(y/x_h)$ and the size of latent class are estimated (η_y), we have used four methods for judging the goodness of fit of the models, Chi square, likelihood ratio, Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). (Computations were carried out by the packages, SPSS, MINITAB, EXCELL and R, Linza and Levis (2007), poLCA) [17].

4. STATISTICAL ANALYSIS

Set 1: In this section questions related to exploring to read, to speak, to write, to analyze problem logically, to carry out mathematical operations, to hold himself/herself in verbal arguments or debates, and have specific examples to support himself/herself with general point of views are considered. The questions are coded as below.

X_1: I read everything book, magazine, newspapers even product labels. (Y/N)

X_2: I easily express myself orally. (Y/N)

X_3: I easily express myself in writing i.e. I am good writer. (Y/N)

X_4: I can hold my own in verbal arguments or debates. (Y/N)

X_5: I enjoy working with numbers and can do mental calculation. (Y/N)

X_6: I am interested in new scientific advances. (Y/N)

X_7: I can find specific examples to support a general point of view. (Y/N)

Parameter estimates for the fit of one class model are

$\pi_{11} = 0.869$ $\pi_{12} = 0.721$ $\pi_{13} = 0.614$ $\pi_{14} = 0.671$ $\pi_{15} = 0.756$ $\pi_{16} = 0.741$ $\pi_{17} = 0.724$

The parameter estimates of one class model have large probability of response "yes" on all items. This indicates that respondent mostly tends to agree with statements.

Results and Discussion for Set 1

The fit of "one class model" have large probability of "yes" answer on all seven items, indicate that most people think that they have strong ability to use language and achieve certain goals. The values all measures of judging goodness of fit are very large see (Table **3**), shows that the fitting of one class model is not appropriate.

A fit of two class model, one group which consists of 81% of the respondent (Table **1**) have large probability of "yes" answer on all seven items, indicates that this group (class) consist of the respondent who think that they have strong ability to read, write and verbally express themselves, to analyze problems logically, carry out mathematical operations. We may say that this class represents a group of people with high self competence and self esteem.

The second group in which 19%of the respondent falls and have large probability of "yes" answer on only three items reading ability(X_1), mental calculation(X_5) and scientific advances(X_6), while low probability of "yes" answer on the variable "express himself/herself orally "(X_2) "express himself/herself in writing "(X_3), "express himself/herself in verbal arguments"(X_4), indicates that, this group thinks that they are confident only about their reading ability, mental calculation, and interest in scientific advances while they not sure about their expressing skills.

Table 1: Parameter Estimates for the Fit of Two Class Model (Standard Errors in Bracket)

y	π_{1y}	π_{2y}	π_{3y}	π_{4y}	π_{5y}	π_{6y}	π_{7y}	η_y
1	0.908 (0.018)	0.845 (0.030)	0.676 (0.028)	0.779 (0.029)	0.770 (0.025)	0.770 (0.026)	0.831 (0.027)	0.807
2	0.706 (0.064)	0.202 (0.086)	0.351 (0.074)	0.217 (0.091)	0.698 (0.065)	0.619 (0.071)	0.272 (0.091)	0.1921

Table 2: Parameter Estimates for the Fit of Three Class Model (Standard Errors in Bracket)

	π_{1y}	π_{2y}	π_{3y}	π_{4y}	π_{5y}	π_{6y}	π_{7y}	η_y
1	0.668 (0.078)	0.173 (0.090)	0.294 (0.086)	0.000 (0.000)	0.670 (0.075)	0.713 (0.078)	0.2661 (0.009)	0.1382
2	0.924 (0.029)	0.964 (0.063)	0.715 (0.049)	0.786 (0.000)	0.786 (0.043)	0.980 (0.106)	1.000 (0.000)	0.3751
3	0.884 (0.031)	0.690 (0.059)	0.626 (0.048)	0.758 (0.000)	0.758 (0.041)	0.565 (0.063)	0.641 (0.000)	0.4866

Table 3: Model Assessment Criteria

	CLASS 1	CLASS 2	CLASS 3
AIC	3200.189	3106.445	3096.363
BIC	3228.112	3166.28	3188.109
G^2	252.8664	143.1227	117.0407
χ^2	602.0908	150.2502	112.5183
Estimated parameters	7	15	23
Residual d.f	120	112	104

In a three class model fit to this data (Table **2**) group two and group three both have large probability of "yes" answer on all seven items. But we have consider these two class (class 2 & 1) as same with class proportion as 86%, the reason seems to be that the second group of class two model is subdivided into two groups in three class model. It seems that 5% from the second class and 81% from the first class of re- distributed in two-class in a three class model. The other reason to consider two class models is the improvement from two to three class model is not very significant, even the G^2 for three class model is higher (see Table **3**) indicating that two class model is better fit than three class model.

Set 2: We selected the following four variables from set 1 for fitting one, two and three latent class models as for these within class probability of "Yes" response (π_{iy}) are having larger differences in the two classes see Table **1**

X_2: I easily express myself orally. (Y/N)

X_3: I easily express myself in writing i.e. I am good writer. (Y/N)

X_4: I can hold my own in verbal arguments or debates. (Y/N)

X_7: I can find specific examples to support a general point of view. (Y/N)

Parameter estimates for the fit of one class model are

$\pi_{11} = 0.721 \ \pi_{12} = 0.614 \ \ \pi_{13} = 0.671 \ \ \pi_{14} = 0.724$

Results and Discussion for Set 2

The fit of one class model show high probability of "yes" answer to all items, indicating that majority of the people think that they have strong expressing ability but the large values of all measures of judging goodness of fit shows that one class model is not a Good fit.

Table 4: Parameter Estimates for the Fit of Two Class Model (Standard Errors in Bracket)

y	π_{1y}	π_{2y}	π_{3y}	π_{4y}	η_y
1	0.845 (0.023)	0.671 (0.026)	0.773 (0.028)	0.820 (0.027)	0.825
2	0.135 (0.117)	0.340 (0.101)	0.188 (0.093)	0.267 (0.096)	0.174

Table 5: Parameter Estimates for the Fit of Three Class Model (Standard Errors in Bracket)

y	π_{1y}	π_{2y}	π_{3y}	π_{4y}	η_y
1	0.992 (0.000)	0.728 (0.112)	0.847 (0.000)	0.892 (0.140)	0.473
2	0.546 (0.033)	0.560 (0.044)	0.587 (0.043)	0.654 (0.043)	0.459
3	0.004 (0.057	0.165 (0.083)	0.000 (0.089)	0.010 (0.099)	0.066

Table 6: Model Assessment Criteria

	CLASS 1	CLASS 2	CLASS 3
AIC	1987.015	1903.017	1906.186
BIC	2002.971	1938.917	1962.032
G^2	102.9980	8.999	2.169
χ^2	182.0876	9.16	2.11
Estimated parameters	4	9	14
Residual d.f	11	6	1

In a fit of two class model, one group in which accounts for almost 83% of the people, have high probability of "yes" answer on all items, indicates that this group (class) consists of the people who think that they have strong verbal expressions abilities, effectively use language to express himself/herself theoretically and poetically. We may call this class as "self confident class". The second group which consists of 17% of the respondent have low probability of positive answer, indicates that second group of respondent are not sure about their expressing ability.

A three class model is also fitted to this data set. The values of AIC & BIC, instead improving have increased with little improvement in the values G^2 and $\chi 2$, number of parameter have also increased from 9 to 14. Observing estimates of π_{iy}'s are on the higher side ($\pi_{iy} > 0.5$) for class I and class II (see Table **5**)

These two classes can be considered as "one class" because it seems that one class divided into two sub classes and this "one class" may be interpreted as "Expressive group" 93 % the subject belong to this class. Only 7% of people think that they are not good in expressing themselves.

Set 3: for this set we have selected question related love of music and ability to understand, these questions are mentioned below. One, two and three classes model were fitted to this data and results are shown in table below.

X_1: I often listen to music at home and in my car. (Y/N)

X_2: I find myself tapping in time to music. (Y/N)

X_3: I can identify different musical instruments. (Y/N)

X_4: Theme music and commercial jingles often pop into my head. (Y/N)

X_5: I can t imagine life without music. (Y/N)

X_6: I often whistle or hum a tune. (Y/N)

X_7: I like a musical background when I am working. (Y/N)

Parameter estimates for the fit of one class model are

$\pi_{11} = 0.699$ $\pi_{12} = 0.516$ $\pi_{13} = 0.548$ $\pi_{14} = 0.558$ $\pi_{15} = .345$ $\pi_{16} = 0.463$ $\pi_{17} = 0.611$

Results and Discussion for Set 3

A fit of two class model shows improvement in the model assessment values as compared to 1 class model (see Table **9**), class one whose proportion is 64% consist of the people having, high probability of "yes" answer all items except question X_5, indicates that this group (class) think that they have good ability to recognize musical pitches, tones and rhythms, we may call this class as "musically talented". The second group in which consist of 36% of the people have, low

Table 7: Parameter Estimates for the Fit of Two Class Model (Standard Errors in Bracket)

	π_{1y}	π_{2y}	π_{3y}	π_{4y}	π_{5y}	π_{6y}	π_{7y}	η_y
1	0.900 (0.02)	0.771 (0.03)	0.747 (0.03)	0.741 (0.03)	0.486 (0.03)	0.655 (0.03)	0.777 (0.02)	0.639
2	0.343 (0.04)	0.064 (0.03)	0.196 (0.04)	0.235 (0.04)	0.095 (0.04)	0.123 (0.03)	0.317 (0.04)	0.360

Table 8: Parameter Estimates for the Fit of Three Class Model (Standard Errors in Bracket)

y	π_{1y}	π_{2y}	π_{3y}	π_{4y}	π_{5y}	π_{6y}	π_{7y}	η_y
1	0.968 (0.023)	0.971 (0.040)	0.895 (0.041)	0.834 (0.044)	0.613 (0.053)	0.821 (0.048)	0.863 (0.041)	0.335
2	0.109 (0.057)	0.000 (0.000)	0.084 (0.041)	0.098 (0.047)	0.000 (0.000)	0.053 (0.035)	0.178 (0.054)	0.195
3	0.752 (0.046)	0.405 (0.060)	0.493 (0.054)	0.533 (0.049)	0.298 (0.048)	0.398 (0.052)	0.611 (0.047)	0.468

Table 9: Model Assessment Criteria

	CLASS 1	CLASS 2	CLASS 3
AIC	3750.303	3329.252	3276.351
BIC	3778.226	3389.087	3368.09
G^2	637.3135	200.262	131.36
χ^2	1817,097	212.633	123.58
Estimated parameters	7	15	23
Residual d.f	120	112	104

probability of positive answer to all items, it indicates that this group think that do not have "musical talent".

Fitting three class model to this data show improvement in all model assessment criteria (Table **9**) class 1 whose proportion in the three class model is 3.25% is class of music lover's in this class the probability of response "Yes" (π_{iy}) to all question are high (π_{iy}>0.6). The probability of response "Yes" (π_{iy}) to all question class 2 are very low indicating almost 20% of the respondent belong class who do not have love towards music. Class 3 consists of those people who like enjoy with listening music but do not want to technically understand of music.

Set 4: In this set we considered seven variables which are concerned with intrapersonal ability. These variables are coded below. The aim is to find whether there are sub grouping in personality in term "socialize" or "loner" for this purpose up to three class model were fitted and the results are presented in the Tables (**10**, **11**, **12**).

X1: I like rough and tumble play with children.

X_2: I enjoy working with other people as part of a group.

X_3: People tend to come me for advice.

X_4: I prefer team sports such as basket ball, softball, football to individual sports such as swimming and running.

X_5: I am a social butterfly. I would much prefer to be at a party rather than home alone watching television.

X_6: I have several much closed personals friend.

X_7: have communicate well with people and can help resolve disputes

Parameter estimates for the fit of one class model are

$\pi_{11} = 0.779$ $\pi_{12} = 0.704$ $\pi_{13} = 0.568$ $\pi_{14} = 0.634$ $\pi_{15} = 0.644$ $\pi_{16} = 0.759$ $\pi_{17} = 0.711$

Table 10: Parameter Estimates for the Fit of Two Class Model (Standard Errors in Bracket)

y	π_{1y}	π_{2y}	π_{3y}	π_{4y}	π_{5y}	π_{6y}	π_{7y}	η_y
1	0.843 (0.023)	0.772 (0.026)	0.622 (0.028)	0.669 (0.027)	0.680 (0.027)	0.8018 (0.023)	0.777 (0.026)	0.876
2	0.323 (0.117)	0.223 (0.101)	0.188 (0.093)	0.382 (0.096)	0.386 (0.097)	0.4581 (0.098)	0.242 (0.105)	0.123

Table 11: Parameter Estimates for the Fit of Three Class Model (Standard Errors in Bracket)

y	π_{1y}	π_{2y}	π_{3y}	π_{4y}	π_{5y}	π_{6y}	π_{7y}	η_y
1	0.000 (0.000)	0.072 (0.112)	0.001 (0.000)	0.379 (0.140)	0.316 (0.140)	0.309 (0.128)	0.128 (0.147)	0.051
2	0.790 (0.033)	0.672 (0.044)	0.546 (0.043)	0.582 (0.043)	0.570 (0.051)	0.738 (0.037)	0.704 (0.034)	0.745
3	0.910 (0.057	0.978 (0.083)	0.791 (0.089)	0.886 (0.099)	0.995 (0.199)	0.946 (0.066)	0.884 (0.073)	0.204

Table 12: Model Assessment Criteria

	CLASS 1	CLASS 2	CLASS 3
AIC	3428.257	3364.215	3356.47
BIC	3456.180	3424.05	3448.21
G^2	228.413	148.372	124.62
χ^2	679.004	138.510	109.88
Estimated parameters	7	15	23
Residual d.f	120	112	104

Results and Discussion for Set 4

The values of AIC, BIC, $G^2$and $\chi 2$ are very large for one class model showing the fit is very poor.

Two class model seems to be weak fit, but the three class model is a good fit at α=0.05 level of significance (see Table **12**) means that the respondents are divided into three groups. Group 1 of respondent which consist of 5% of the people may termed as “loners” because π_{iy} values in this class are very low for all questions (Table **11**). Respondent belong to both class 2 and class 3 have larger probability of response “Yes” ,these two groups(classes) seem to be same, considering these two class, class 2 and class 3as one-class and may be interpreted as “socialize” (having high interpersonal ability).

Three class models seems refined form of two class model.

CONCLUSION

For the four sets of data we have fitted up to three class model. Only two class models are interpreted the reason is that the second group of class two model is subdivided into two groups in three class model. The other reason to consider two class models is the improvement from two to three Class model is not very significant, even in almost all cases the G^2 for three class model is higher making the model poorer. Consider all the four data sets and assessing a good fit to the two class model we may say that one group consist of those respondent who think that they can read books, magazine, newspaper, they express herself /himself orally, hold in verbal arguments or debates, have capacity to analyze problem logically, carry out mathematical operations, enjoy with music and commercial jingles, they like rough and tumble play with children, they enjoy working with other people, they prefer team sports such as basket ball, softball, football to individual sports such as swimming and running, they have several much closed personal friends, they communicate well with people and can help resolve disputes. One can say that this group which consist of more than 80% of the respondent who have very high and positive opinion about themselves.

The data is categorical and for categorical data Latent class analysis is one of the best method of exploring the presence of latent grouping.

RESEARCH OPENING

Factor analysis and Principle component analysis can be indirectly applied.

REFERENCES

[1] Gardner H. Frames of Mind: The Theory of Multiple Intelligences. New York 1983.

[2] Spearman C. General intelligence, objectively determine and measured. An J Psycol 1904; 15: 201-93.

[3] Bartholomew DJ. Latent Variable Models and Factor Analysis. Monograph no 40 Oxford University New York 1987.

[4] Jansen PGW, Roskam EE. Latent trait models and dichotomization of graded responses. Psychometrica 1986; 51: 69-91. http://dx.doi.org/10.1007/BF02294001

[5] Marcouledes GA, Schumacker RE. New development and Techniques In Structural equation modeling 2001.

[6] Lazarsfeld PF, Henry NW. Latent structure Analysis. New York: Houghton-Miffin 1968.

[7] Clogg CC. Latent class models for measuring. In Langeheine R, Rost J, Eds. Latent trait and latent class models. New York: Plenum 1981.

[8] Hagenars JA. Categorical Longitudinal Data-Loglinear Analysis of Panel, Trend and Cohort Data. Newbury Park: Sage 1990.

[9] Vermunt JK, Magidson J. Latent class cluster analysis. In Hagenaars JA, McCutcheon AL. Eds. Applied latent class models. Cambridge, UK: Cambridge University Press 2002; pp. 89-106. http://dx.doi.org/10.1017/CBO9780511499531.004

[10] Rabe-Hesketh S, Skrondal A, Zheng X. Multilevel structural equation modeling. In Handbook of latent variable and related models. Lee SY, Ed. Elsevier, Msterdam 2007; pp. 209-227.

[11] Mavridis I, Moustaki Irini. The forward search algorithm for detecting aberrant response patterns in factor analysis for

binary data. J Computat Graph Statist 2009; 18(4): 1016-34. ISSN 1061-8600

[12] Giorgio E, Montanari M, Ranalli G, Eusebi P. Latent variable modeling of disability people aged 65 or more journal of statistical method and applications 2010; 20(1): 49-63. Dol:10,1007/10260-010-0148-6

[13] Demirhan H. Latent Class Analysis for Models with Error of Measurement Using Log-Linear Models and An Application to Women's Liberation Data Journal of Data Science 2011; 9(2011): 43-54.

[14] Goodman LA, Clogg CC. The analysis of cross-classified data having ordered categories Harvard University Press, Cambridge, Mass 1984.

[15] Waller GN. LCA 1.1: An R Package for Exploratory Latent Class Analysis journal of the applied Psychological Measurement 2004; 28(2): 141-42.

[16] Angelou M. 2007. Multiple Intelligence Questionnaire-Teacher vision.com (Available from http://www.teachervison.fen.com/parents-and-school/intelligence/3678.html)

[17] Linzer AD, Levis. R development core Team, 2007 poLCA: Polytomous Variable Latent Class Analysis Version 1.1 2007.

Received on 14-07-2012 Accepted on 15-08-2012 Published on 02-09-2012

http://dx.doi.org/10.6000/1927-5129.2012.08.02.28