Knowledge structure analysis of college physical education teachers based on latent class modeling

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Received 1 June 2014, www.cmnt.lv

Abstract

Objective To survey the intellectual structure of PE Teacher at colleges and investigate the distribution of university teachers' intellectual structure by the latent class model .Methods Questionnaire to collect information, to describe the knowledge of the distribution of the knowledge structure of university teachers and to use MPLUS software exploratory latent class analysis Results According to the latent class model, based on the knowledge structure, cognitive differentiation of PE teachers for four latent class groups and the lack of type (0.4169), respectively, for the general basic knowledge of cognition; appropriate knowledge structure and cognitive type (.2544); sports technology-driven(0.1658); knowledge structure, cognitive "smart" (0.1629). Conclusion College of Physical Education should be based on the different types of knowledge structure of targeted training to enhance the overall strength of the PE teachers, the gradual completion of the teaching of modern sports transition from sports to strengthen the theoretical knowledge to the higher capacity "smart type".

Keywords: Intellectual Structure, Latent Class Model, Colleges, PE Teachers

1 Introduction

The Latent Class Modelling (LCM) is a modelling analytical technique used to discuss latent variable, and the statistical principle of latent class analysis is established on probability distribution and log-linear model and formed through introduction of thought of factor analysis and structural equation model [1]. Just like factor model, LCM also consists of explicit variable and latent variable; the different level of explicit variable refers to different class the subject under actual measurement belongs to, and the different level of latent variable refers to different latent class obtained after estimate [2]. If we explain the relevance between measured variables by use of latent variable, the explicit variable shall meet local independence, that is, the explicit variables shall be completely independent and irrelevant [3]. The latent class analysis can be applied into ability identification, personnel classification, and problem diagnosis. The biggest difference between LCM and traditional factor analysis lies at form of variables: the continuous variable is processed in factor analysis, while the class variable is processed in LCM [4]. Although the class variable is not like continuous variable which has rich variation and can be carried out diversified statistical analysis together with countable units, the class variable has features of easy obtainment, and easy operation; for example, population variable and social variable are class variable [5]. Therefore, LCM can make up the defect that the factor analysis can't be used to process continuous variable.

People's discussion on knowledge has existed for a long time; however, the systematic research on teacher knowledge rises in recent years [6]. In foreign countries, this kind of systematic research started from 1980s. With implementation of new curriculum, people pay more and more attention to teacher knowledge, educational knowledge and other topics. Until now, the problem about teacher knowledge is still a key problem in teacher education research in the world [3]. Therefore, the discussion on the problem about what knowledge the teachers have is of great realistic significance. From the perspective of teachers' professional development, in teachers' professional development, the development of teacher knowledge is most basic and important, and the teacher knowledge structure directly influence the condition of school education; therefore, it is a core problem in contemporary curriculum reform [7]. Whether the teacher knowledge structure is reasonable directly influences the development and improvement of teachers' teaching, scientific research, and other abilities, and also influences cultivation and shaping compound modern talents [8]. The physical education is an important part of college education, and its purpose is to enhance modern college students' physical constitution and cultivate versatile talents (knowledge, ability, and quality) required in contemporary society. Since 21st century, with the development of science, technology, and educational business as well as continuous emergence of newly-developing interdisciplinary and boundary science, mutual penetration and blending between humanistic culture and science & technology, high informatization of society, and quickly-changing knowledge and information communication technology, the physical education characterized by "knowledge-based era" and "study-based era" proposes new requirement for college PE teachers' knowledge structure so as to realize "intelligent" transition from paying attention to mastering sport technique in the past to enhancing theoretical knowledge and development towards high ability at present [9].

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However, currently, there exist some problems such as more technology and less technology theory, more low educational level and less high educational level, especially some teachers' narrow theoretical knowledge and unreasonable structure in national college physical education team, which forms great contrast with modern society and modern physical education requirements and seriously influence teaching quality of college physical education [10]. The domestic research on teacher knowledge mainly focuses on following 4 aspects: firstly, it is the research on definition of teacher knowledge and research status, and this part mainly explains the research background about teacher knowledge and development trend of research on teacher knowledge; secondly, it is research on teacher knowledge structure, including discipline teacher knowledge structure; thirdly, it is research on development means of teacher knowledge; fourthly, it is research on teacher knowledge management [5]. Generally speaking, the research mainly focuses on theoretical discussion on teachers' overall knowledge structure, and there are very few empirical researches on PE teachers' knowledge structure. Therefore, to carry out survey and research on college PE teachers' knowledge structure cognition, know their knowledge structure cognition situation, and analyse the problems existing in college PE teachers' knowledge structure for convenience of optimizing and perfecting PE teachers' knowledge structure as well as providing feasible suggestions for PE teachers' professional development means is of important theoretical and realistic significance for enhancing the construction of college teaching staff.

2 Research method

2.1 SUBJECTS TESTED

This research selects PE teachers of 6 colleges (Hunan University, Hunan Agricultural University, Hunan Normal University, Central South University, Central South University of Forestry and Technology, and Hunan University of Technology) as tested group. There are totally 220 questionnaires issued and 194 effective questionnaires are returned; the effective rate is 88.18%.

2.2 RESEARCH TOOLS

This research adopts secrete questionnaire filling method; the questionnaire includes questionnaire form of basic condition and questionnaire of college PE teachers' knowledge structure. The questionnaire is designed by Xiao Huanyu and Fang Li and it consists of 7 questions, including "whether the philosophy, political economy, history of the Communist Party of China, writing, and foreign language are important to PE teachers", "whether the mathematics, and system science are important to PE teachers", "whether the anatomy, physiology, psychology of physical education, health fitness education, physical education measurement, sport statistics, biomechanics, biochemistry, and sports medicine are important to PE teachers", "whether the track and field, gymnastics, ball games, martial arts, bodybuilding exercises, and swimming are important to PE teachers", "whether the computer language and method of sport science research are important to PE teachers", "whether the education, teaching theory, and educational psychology are important to PE teachers" and "whether the physical education probability, school physical education, physical education theory, and physical exercise are important to PE teachers". This questionnaire adopts 3-point scoring method, including 1 (very important), 2 (relatively important), and 3 (not important).

2.3 MATHEMATICAL ANALYSIS THOUGHT

We assume that there are 4 explicit variables, that is, A, B, C, and D, and the level of each explicit variable is I, j, k, l(i=1,...,I ; j=1,...,J ; k=1,...,K ; l =1,...,L) respectively. The mathematic expression of LCM shall include a non-conditional probability which belongs to expression of latent class, and it is expressed to reflect 4 conditional probability of each explicit variable to composition of latent class structure so as to constitute as the most basic LCM. The expression is shown as follows:

$$\pi_{ijklt}^{ABCDX} = \sum_{t=1}^{T} \pi_t^X \pi_{it}^{\bar{A}X} \pi_{jt}^{\bar{B}X} \pi_{kt}^{\bar{C}X} \pi_{lt}^{\bar{D}X} \ . \tag{1}$$

If the variable A and B are independent and unrelated, there is expression as follows:

$$\mathrm{P}_{ij} = \mathrm{P}_i^A \mathrm{P}_j^B \ . \tag{2}$$

Wherein, π_t^x refers to latent class probability, and it shows the probability of latent variable X at the level t when the observed variable is locally independent, that is, the probability that the observed object randomly selected from sample belongs to class t. The latent class with large proportion shows that it has relatively important status in latent variables, which is similar to the percentage of explained variation in factor analysis; the sum of probability of each latent class is 1:

$$\sum_t \pi_t^x = 1.00 \ . \tag{3}$$

$\pi_{it}^{\bar{A}X}$ refers to conditional probability, which shows the probability that the individual which belongs to latent class t gives a response to level i of observed variable A. As for each latent class, because each level of latent variable is mutual independent, the sum of conditional probability of each explicit variable is 1.

$$\sum_{t=1}^{T} \pi_{it}^{\bar{A}X} = \sum_{t=1}^{T} \pi_{jt}^{\bar{B}X} = \sum_{t=1}^{T} \pi_{kt}^{\bar{C}X} = \sum_{t=1}^{T} \pi_{lt}^{\bar{D}X} = 1.00 \ . \tag{4}$$

2.3.1 Parameter estimation and model fitting

LCM often adopts maximum likelihood estimation, and the algorithm used in iterative process may include EM algorithm, and NR, etc.

In LCM, the main indicators of evaluation model include chi-square significance testing, AIC, and BIC.

2.3.2 Latent classification

After modeling, the final step of latent class analysis is to allocate each observation value to suitable latent class to describe the posterior class property of observation value, that is, latent clustering analysis. The classification prin-

ciple is Bayesian theory, and the expression is shown as below:

$$\sum_i \pi_{it}^{\bar{A}X} = \sum_j \pi_{jt}^{\bar{B}X} = \sum_k \pi_{kt}^{\bar{C}X} = \sum_l \pi_{lt}^{\bar{D}X} = 1 \ . \quad (5)$$

2.3.3 Analysis process

The survey result is double typed in by special person by use of EpiData2.0. After data cleaning, Mplus5.1 software is adopted to carry out LCM analysis.

3 Result

3.1 BASIC SITUATION

There are totally 194 higher education teachers participating in the survey, including 142 male teachers (73.20%) and 52 female teachers (26.80%), with an average age of 37±; as for education background, there are 126 teachers (64.95%) with bachelor degree, 52 teachers (26.80%) with master degree, and 16 teachers (8.25%) with doctoral degree. As for professional title, there are 112 teaching assistants and lecturers (57.73%) and 82 associate professors and professors (42.27%).

3.2 BASIC DESCRIPTION ON COLLEGE PE TEACHERS' KNOWLEDGE STRUCTURE

Xiao Huanyu and Fang Li has carried out research on which kind of knowledge PE teachers need in early time and they think that the college PE teachers' knowledge structure shall include 3 levels (7 aspects) of content: the 1st level is general basic knowledge (politics and social science theory, natural science knowledge), and the feature is extensive; the 2nd level is professional knowledge (theoretical knowledge about body science, theoretical knowledge about professional sports, and theory of applied scientific research), and the feature is deep, wide, and new; the 3rd level is theory of education discipline (education theory and physical education theory). Xiao Huanyu and Fang Li think that the 1st level is the foundation of structure, and also the foundation for PE teachers to form teaching ability and other abilities as well as carry out ideological and moral teaching on students; the 2nd level is the center of structure and it restricts PE teachers' ability in teaching, training, scientific research, and health care; the 3rd level is the key point of structure, and it determines PE teachers' teaching ability.

The questionnaire in this research carries out survey and analysis from above 7 aspects, and the basic statistical description of items can be seen in Table 1. According to Table 1, it can be known that many college PE teachers think that the item 1 and 2 is not important, and the proportion is up to 54.8% and 49.7% respectively; however, many PE teachers think that the item 3, 4, 5, 6, and 7 is important, and the proportion is 91.4%, 93.9%, 84.3%, 79.7%, and 62.9% respectively.

TABLE 1 Basic description on college PE teachers' knowledge structure

Survey indicator	Very important		Relatively important		Not important	
	n	%	n	%	n	%
Philosophy, political economy, history of the Communist Party of China, writing, and foreign language	32	16.2%	57	28.9%	108	54.8%
Mathematics, and system science	35	17.8%	64	32.5%	98	49.7%
Anatomy, physiology, psychology of physical education, health fitness education, physical education measurement, sport statistics, biomechanics, biochemistry, and sports medicine	180	91.4%	11	5.6%	6	3.0%
Track and field, gymnastics, ball games, martial arts, bodybuilding exercises, and swimming	185	93.9%	8	4.1%	4	2.0%
Computer language and method of sport science research	166	84.3%	3	1.5%	28	14.2%
Education, teaching theory, and educational psychology	157	79.7%	7	3.6%	33	16.8%
Physical education probability, school physical education, physical education theory, and physical exercise	124	62.9%	27	13.7%	46	23.4%

3.3 LCM ANALYSIS

3.3.1 Exploratory LCM

This paper makes use of LCM to carry out exploratory analysis. Table 2 lists the adaptive indicator for 8 kinds (from 1-8) of models with different classes in latent class classification. According to analysis result on 8 models enumerated in Table 2, it is able to see that the log likelihood (LL) of model adaptation decreases and the degree of freedom gradually decreases with more and more number of classes.

BIC and CAIC gradually decrease from reference model to M3 and then increase from M5. In 8 models, M4 has the lowest BIC value (1448.5547) and CAIC value (1486.5547), which shows that the model 4 is a good model.

TABLE 2 Adaptive indicators of different LCM

Model	Number of class	LL	BIC(LL)	CAIC	Npar	df	P-value
M1	T=1	-900.8322	1875.6293	1889.6293	14	183	7.3e-68
M2	T=2	-775.2076	1666.6458	1688.6458	22	175	2.5e-31
M3	T=3	-682.9565	1524.4091	1554.4091	30	167	5.7e-10
M4	T=4	-623.8965	1448.5547	1486.5547	38	159	0.076
M5	T=5	-607.0073	1457.0420	1503.0420	46	151	0.48
M6	T=6	-599.0793	1483.4516	1537.4516	54	143	0.66
M7	T=7	-591.6821	1510.9228	1572.9228	62	135	0.81
M8	T=8	-589.4092	1548.6426	1618.6426	70	127	0.75

Note: LL refers to Log Likehoods; BIC refers to Bayesian information criterion; CAIC refers to consistent Akanke's information criterion; Npar refers to number of parameter; df refers to degree of freedom.

3.3.2 Naming of latent class of teacher knowledge structure feature

Table 3 refers to the table of conditional probability and latent class probability of 7 items. According to latent class probability in Table, it can be seen that latent class 1 has the maximum proportion of 0.4169, the latent class 2 has the proportion of 0.2544, and the latent class 4 has the minimum proportion of 0.1629. Based on conditional probability, the 1st kind of subjects tested tend to answer "not important" as for item 1 and 2, and answer "very important" as for item 2, 3, 4, 5, 6, and 7. In terms of content, it is able to name the 1st kind of subjects tested as teachers with insufficient general basic knowledge cognition. The 2nd subjects tested tend to answer "relatively important" as for item 1 and 2, and answer "very important" as for item 2, 3, 4, 5, 6, and 7, thus it is able to name the 2nd subjects tested as teachers with suitable knowledge structure cognition. The 3rd kind of subjects tested tend to answer "not important" as for item 1, 2, 5, 6, 7, and answer "very important" as for item 3 and 4, thus it is able to name the 3rd kind of subjects tested as sport technology-driven teachers. The 4th kind of subjects tested tend to answer "relatively important" as for all items, thus it is able to name the 4th kind of subjects tested as teachers with "intelligent" knowledge structure cognition (Figure 1).

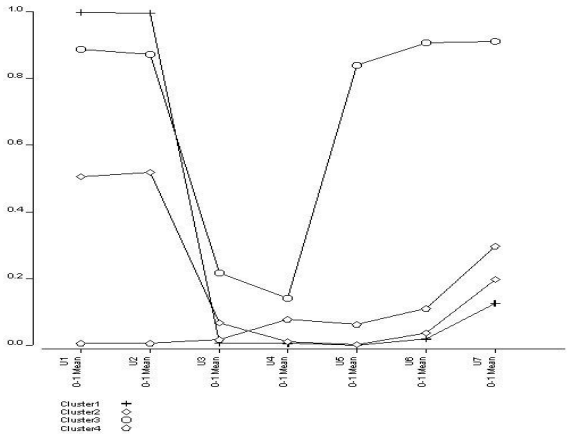

FIGURE 1 Distribution diagram of conditional probability of 4 latent classes

TABLE 3 Conditional probability and latent class probability of 7 items

Item		Conditional probability			
		Class=1	Class=2	Class=3	Class=4
Philosophy, political economy, history of the Communist Party of China, writing, and foreign language	Very important	0.0000	0.0052	0.0000	0.9891
	Relatively important	0.0044	0.9770	0.2243	0.0109
	Not important	0.9956	0.0179	0.7757	0.0000
Mathematics, and system science	Very important	0.0000	0.0051	0.0000	0.9891
	Relatively important	0.0078	0.9515	0.2547	0.0109
	Not important	0.9922	0.0434	0.7453	0.0000
Anatomy, physiology, psychology of physical education, health fitness education, physical education measurement, sport statistics, biomechanics, biochemistry, and sports medicine	Very important	0.9880	0.8926	0.7033	0.9709
	Relatively important	0.0155	0.0800	0.1591	0.0264
	Not important	0.0005	0.0274	0.1376	0.0027
Track and field, gymnastics, ball games, martial arts, bodybuilding exercises, and swimming	Very important	0.9905	0.9814	0.8015	0.8815
	Relatively important	0.0090	0.0172	0.1159	0.0814
	Not important	0.0004	0.0015	0.0827	0.0371
Computer language and method of sport science research	Very important	0.9991	0.9985	0.1342	0.9199
	Relatively important	0.0008	0.0015	0.0542	0.0339
	Not important	0.0000	0.0001	0.8115	0.0462
Education, teaching theory, and educational psychology	Very important	0.9718	0.9469	0.0654	0.8600
	Relatively important	0.0202	0.0322	0.0550	0.0601
	Not important	0.0080	0.0209	0.8796	0.0799
Physical education probability, school physical education, physical education theory, and physical exercise	Very important	0.8145	0.7238	0.0391	0.6096
	Relatively important	0.1214	0.1564	0.0976	0.1870
	Not important	0.0641	0.1198	0.8633	0.2034
Latent class probability		0.4169	0.2544	0.1658	0.1629

3.3.3 Classification of latent class of PE teachers' knowledge structure

In LCM of college PE teachers' knowledge structure, it is able to divide group into 4 latent classes. The 1st class accounts for the highest proportion (0.4169); this class of group has low conditional probability in terms of general basic knowledge and they think that the philosophy, political economy, history of the Communist Party of China, writing, and foreign language and other disciplines have low importance to college teachers; this group accounts for a large proportion and they are main group of current college teachers; the feature of this class of PE teachers is that their professional knowledge has realized firm, systematic, and profound level and mastered teaching theory well, but they are defective in getting hold of basic knowledge such as philosophy, political economy, history of the Communist Party of China, mathematics, and system science, and the possible reason is that they have insufficient self-cognition and think that they have little assistance function to PE teachers' teaching.

The 2nd class of group has a latent class probability of 0.2544. This group has a high conditional probability in terms of professional knowledge and teaching theory, but they are slightly insufficient in cognition on general basic knowledge. This class of PE teachers accounts for a large proportion; they basically meet modern social demand and can excellently complete teaching task.

The 3rd class of group has a latent class probability of 0.1685. Except for good cognition on professional knowledge, this group is insufficient in other basic knowledge and teaching theory; they purely seek for improvement of students' external level of sports technology; due to insufficient cognition on teaching theoretical knowledge, the teaching may be carried out at cross purpose.

The 4th class of group has a latent class probability of 0.1629. This group has a high cognition on 7 levels of 3 aspects, and they are high-quality PE teachers demanded in modern teaching.

The final step of latent class analysis is to assign all individuals to suitable latent class group; according to formula (3), it is able to obtain the probability that different combinations of 7 items are assigned to each latent class, as shown in Table 4.

TABLE 4 Result of individual classification of latent class

Item							Classification probability				Classification result
No.1	No.2	No.3	No.4	No.5	No.6	No.7	Cluster1	Cluster2	Cluster3	Cluster4	
3	3	1	1	1	1	1	0.9996	0.0004	0.0001	0.0000	1
3	3	1	1	1	1	2	0.9985	0.0005	0.0010	0.0000	1
2	2	1	1	1	1	1	0.0001	0.9999	0.0000	0.0001	2
3	2	1	1	1	1	1	0.4920	0.5067	0.0012	0.0000	2
1	1	2	1	1	1	1	0.0000	0.0002	0.0000	0.9998	4
2	2	1	1	2	3	3	0.0000	0.0034	0.9965	0.0000	3

Table 4 randomly lists classification result of 6 individuals. Take the 1st individual (3311111) as an example: the probability for such individual to be assigned into the 1st latent class, the 2nd latent class, the 3rd latent class, and the 4th latent class is 0.9996, 0.0004, 0.0001, and 0.0000 respectively. The probability for such individual to be assigned into the 1st latent class; therefore, it is thought that such individual belongs to the 1st latent class group.

4 Discussion

Currently, the selection, training, and performance assessment for college teachers in China are mainly based on their basic skill knowledge and daily work performance. However, in reality, there are many people who seem excellent but have disappointing performance in actual work, and the possible reason is that they have not comprehensive knowledge structure and ignore enhancing on other aspects. The modern PE teachers shall have comprehensive knowledge structure, and the neglect of any aspect may result in decrease of teaching quality and be not good for cultivating the comprehensive talents required by modern society.

LCM analysis shows that it is able to divide college PE teachers into 4 latent groups according to knowledge structure cognition situation. Currently, the 1st latent class group (teachers with insufficient basic knowledge cognition) accounts for maximum proportion (0.4169); this group has insufficient cognition on general basic knowledge. However, as socialist professional talents, the PE teachers shall have strong entrepreneur spirit and sense of responsibility, noble sentiment and excellent quality, get hold of extensive and solid basic knowledge, and also have knowledge in philosophy, political economy, history of the Communist Party of China, foreign language, mathematics, and system science, etc.; those knowledge are the foundation for college PE teachers to form good teaching, training, and scientific research ability. The 2nd latent class group (teachers with suitable cognition on knowledge structure) and the 4th latent class group (teachers with "intelligent" knowledge structure cognition) account for a proportion of 0.2544 and 0.1658 respectively; these 2 groups have sufficient cognition on general basic knowledge, professional knowledge, and education theory and basically meet the knowledge structure requirement of modern PE teacher. The 3rd latent class group (sport technology-driven teachers) accounts for a proportion of 0.1685; PE teachers of this group purely seek for improvement of students' athletic skill and have insufficient cognition on basic knowledge and education theory; because this class of teachers lack of knowledge of education theory, they may be unable to get well hold of scientific teaching method, follow education law and law of students' psychological development for convenience of improving teaching quality and make students' mind and body obtain healthy development.

5 Conclusion and suggestions

5.1 CONCLUSIONS

This research shows that LCM divides college PE teachers into different classes of teachers who have inconsistent attitude and knowledge towards knowledge structure according to their cognition on knowledge structure, and different classes of teachers have different performances in cultivating students. The colleges and universities can adopt different enhancing measures according to their own faculty power and teachers' individual situation so as to enhance college PE teachers' overall strength and gradually complete the "intelligent" transition of modern teaching of physical education from sport technique to enhancing theoretical knowledge and development towards high ability.

5.2 SUGGESTIONS

The PE teachers shall enhance self-learning, enhance interdisciplinary awareness, and actively create conditions to obtain interdisciplinary knowledge about physical edu-

cation, and they shall especially enhance the learning on general basic knowledge (such as philosophy, political economy, virtue and culture, mathematics, writing, system science, and foreign language), for the basic knowledge is the basis for college PE teachers to form good teaching, training, and scientific research ability.

The training pattern shall be reformed for after-employment further education and training for PE teachers. It is required to distinguish different levels, and the training can be made in a targeted way according to different latent classes divided based on LCM. The education content shall start from actual demand of college physical education work in new era, combine with reform status of current physical education curriculum, highlight the features of after-employment further education, and emphasize the pertinence and effectiveness.

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