



Applied Mathematics and Nonlinear Sciences 7(1) (2022) 841-850



Applied Mathematics and Nonlinear Sciences

https://www.sciendo.com

Characteristics of Mathematical Statistics Model of Student Emotion in College Physical Education

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Submission Info

Communicated by Juan Luis García Guirao Received April 12th 2021 Accepted July 7th 2021 Available online July 27th 2021

Abstract

The influence of learning emotions on learning behaviors in college physical education is directly reflected in learning efficiency. Based on this research background, the paper applies a mathematical, statistical model to structural equation modeling of the emotional situation of students in a school's physical education curriculum. The study results found that college students have lower positive emotional attitudes towards college physical education courses. Thus, students' mood is affected by the. For this reason, we should eliminate students' resistance and fear of college physical education courses and promptly correct students' unhealthy learning emotions about college physical education courses. In this way, it helps students correct their negative feelings about college physical education courses.

Keywords: Learning mood, college physical education curriculum, structural equation, mathematical-statistical model **AMS 2010 codes:** 62J10.

1 Introduction

The current physical education curriculum, professional talent training, teaching reform research, students' learning mood, and influencing factors of college physical education curriculum have attracted many scholars' attention. Learning emotion refers to the psychological state of students' understanding of learning and emotions. It has regulatory significance for learning behavior. Therefore, how to cultivate students to form correct

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and positive learning emotions and then improve their learning behaviors and results has always been a critical concern in pedagogy [1]. Unfortunately, there are still few domestic types of research on students' emotions related to college physical education courses. The existing literature mainly focuses on studying related courses such as psychological statistics, medical statistics, and mathematics. Still, their analysis methods are mostly limited to descriptive analysis and regression analysis.

"Learning emotions" are not directly observable. Therefore, it needs to be measured by a scale. So far, there are more than ten kinds of leaves about learning emotions in college physical education courses. Foreign scholars widely adopt the SATS scale (Survey of Attitudes Toward Statistics). Schau proposed the scale in 1995, and initially, there were only 28 measurement items (SATS-28). Later the plate was added to 36 measurement items (SATS-36). This article will combine the SATS scale design questionnaire to carry out a field survey of college students in a sports college [2]. We measure their learning emotions towards college physical education courses. We build a learning emotion model based on the project packaging method and high-order factor structural equations to establish an overall understanding of college students' learning emotions in college students' college physical education courses. The thesis studies the influence path and influence intensity between college students' college physical education courses of this article are expected to play a guiding role in the teaching activities of college physical education courses.

2 Measuring tools and models

2.1 SATS scale

We use the SATS-36 scale to measure the emotions of college students in college physical education courses. The scale adopts a 7-level Likert plate (1 means "strongly disagree," 7 means "strongly agree," and so on). Thus, we use 6 dimensions, including emotion, cognitive ability, value, difficulty, interest, and effort, to measure the "emotion of college physical education courses." In addition, the research also includes the factors of "sports ability" and "expected mastery" (as shown in Table 1).

Table 1 Eight potential factors.							
Latent factor	meaning	Number of Questions	Examples of measurement questions				
emotion	Positive or negative feelings about the physical education curriculum	6	Q3: I will like sports.				
cognitive ability	Views on their ability to apply sports knowledge and skills	6	Q31: I can learn sports.				
value	Views on the value of sports knowl- edge in life and work	9	Q9: Physical education should be a necessary part of professional training.				
Difficulty	Awareness of the problem of physical education courses	7	Q6: The sports formula is easy to understand.				
interest	Interest in physical education	4	Q20: I am very interested in using sports.				
Work hard	The effort you intend to make for the physical education curriculum	4	Q14: I plan to study hard for every physical education test.				
Expected mastery	Anticipate their level of ability of sports knowledge	2	Q40: How confident are you in mastering the basics of sports?				
Physical ability	Past sports level	2	Q37: In the physical education courses you have taken before, how did you score?				

2.2 Structural equation model construction

2.2.1 Structural equation model

Structural equation modeling (SEM) is also often referred to as structural equation modeling. SEM is a statistical method to analyze the relationship between variables based on the covariance matrix of the variables. It can process latent variables and their measurement indicators at the same time. Simply put, the structural equation model can be divided into two parts: measurement model and structural model. The former describes the relationship between latent variables and measurement indicators, and the latter describes the relationship between latent variables [3]. The following measurement equation usually expresses the relationship between measurement indicators and latent variables:

$$x = \Lambda_x \xi + \delta \tag{1}$$

$$y = \Lambda_y \eta + \varepsilon \tag{2}$$

Among them x, y are the exogenous measurement index and the endogenous measurement index, respectively. ξ , η are exogenous latent variables and endogenous latent variables, respectively [4]. Λ_x is the factor loading matrix of the exogenous measurement index on the exogenous latent variable, which represents the relationship between the exogenous measurement index and the exogenous latent variable. Λ_y is the factor loading matrix of the endogenous measurement index on the endogenous latent variable, representing the relationship between the endogenous measurement index and the endogenous latent variable, representing the relationship between the endogenous measurement index and the endogenous latent variable. δ , ε are the error terms of the exogenous measurement index x and the endogenous measurement index y, respectively. The following structural equation usually represents the relationship between latent variables:

$$\eta = B\eta + \Gamma\xi + \xi \tag{3}$$

B represents the relationship between the endogenous latent variable η . Γ describes the effect of an exogenous latent variable ξ on the endogenous latent variable η . ξ is the residual term in the structural equation, representing the information that η cannot be explained in the equation.

2.2.2 High-level confirmatory factor analysis

High-order confirmatory factor analysis (HCFA) is also known as the full Y model. The core idea is to coordinate the primary factors through high-level factors, thereby simplifying the correlation between the primary factors [5]. An HCFA model only needs to be determined by the following two equations:

$$y = \Lambda_y \eta + \varepsilon \tag{4}$$

$$\eta = B\eta + \Gamma\xi + \xi \tag{5}$$

When there is a consistent high correlation between the first-order factors, high-order confirmatory factor analysis can often achieve better results.

2.2.3 Project portfolio method

The item combination method is a process of reintegrating two or more question items in the same scale and using the composite score (total score or average) as the score of the new index to analyze. For example, a scale originally had 9 question items. We can use each 3 question item to calculate its composite score to obtain 3 new indicators and then use these 3 new indicators for subsequent analysis.

Some scholars have shown that the project portfolio method can correct the non-normality of the data to a certain extent. When we reduce the number of parameters to be estimated, we can effectively avoid problems such as multicollinearity between measurement indicators, excessive error correlation, and cross-loading of measurement indicators from adversely affecting the model. Furthermore, this method can improve the fitting effect of higher-order factor models. Some scholars have proposed a two-stage simplification method that combines project portfolio and high-order factor analysis [6]. This method can significantly simplify the model and obtain the perfect goodness of fit. It is especially suitable for the situation with many model parameters.

2.2.4 The theoretical model and research hypothesis of this article

This article adopts the project portfolio method to form higher-order factors of learning emotion. This article has six potential first-order factors (emotion, cognitive ability, value, difficulty, interest, effort), as shown in Table 1. We take the arithmetic average of each factor's measured variables as the value of the element. The original six first-order factors become "explicit variables" (AFFPC, COGPC, VALPC, DIFPC, INTPC, and EFFPC) and jointly measure the "attitude "High-order factor (ATTITUDE). The "attitude" high-level factor will further affect the "expected mastery" factor (EXPMSTRY), and it will be affected by the "sports ability" factor (MATHCOMP). At the same time, "sports ability" will also directly affect the "expected mastery" (as shown in Figure 1).



Fig. 1 Theoretical model of attitude, sports ability, and expected mastery.

In theory, the more active the learning mood of university physical education courses, the easier it is to expect that one has a good grasp of statistical knowledge. The stronger the physical ability, the more confident they are in their physical fitness [7]. This also often leads to the better the expected mastery of the physical education curriculum. In addition, the stronger the physical ability, the easier it is to get a sense of accomplishment from similar courses. The easier it is for students to take a positive attitude towards university physical education courses. Therefore, this article proposes the following hypotheses:

- H1: "Attitude" positively affects "expected mastery."
- H2: "Sports ability" positively affects "expected mastery."
- H3: "Sports ability" positively affects "attitude."

3 Data analysis and model checking

3.1 Survey methods and samples

This study designed the questionnaire based on the English-Chinese version of the SATS-36 scale. The questionnaire consists of 47 items, including 36 Likert scale items and 11 background information items. The

survey subjects are all the sophomore students who participated in physical education courses in a sports college [8]. The questionnaire was issued before the first class at the beginning of the semester. After preprocessing, such as deleting wrong values, filling in missing values, and deleting outliers, we finally get data containing 1074 sample points. Among them, girls accounted for 60.99%. Thus, the composition of the sample is consistent with the actual situation of sports colleges.

3.2 Descriptive analysis

We use R software for statistical analysis. Table 2 gives the mean value of each factor. Among them, the value of each element itself is obtained by taking the mean value of its corresponding measurement item to get 1. It can be seen that the average values of the other factors except the difficulty factor are all greater than 4. That is to say, the overall emotions of the students towards the university physical education courses are positive [9]. Among them, the two factors of value and effort have the most considerable mean value. Students must recognize the importance of university physical education courses and are willing to make more extraordinary efforts. Students generally have a strong interest in university physical education courses and typically hold a more positive attitude towards their cognitive abilities. And students have positive feelings about college physical education courses. According to the calculation of the mean value of the difficulty factor, it is found that most students think college physical education courses are challenging. In addition, students also have a positive attitude towards their physical ability and expected mastery.

Table 2Descriptive analysis of potential factors.						
Latent factor	First-order factor/measurement item	The first-order fac- tor/mean of the measure- ment items	Latent factor			
Attitude	emotion cognitive ability value Difficulty interest Work hard	4.649 4.854 5.687 3.088 4.919 5.67	4.816			
Physical ability	Previous physical education results (Q37) Sports level (Q38)	4.28 4.224	4.252			
Expected mastery	Confidence in mastering sports knowledge (Q40) What kind of results are expected (Q44)	4.858 4.105	4.482			

3.3 Confirmatory factor analysis

3.3.1 Fitting index

We perform confirmatory factor analysis on the "attitude" factor measurement model, and the initial fitting results are given in the "initial results" row of Table 3. The standardized chi-square and each appropriate index have not reached the ideal outcome. Therefore, we need to modify the initial model: add error-related terms according to the adjustment index. The "adjusted result" row of Table 3 shows the fit of the adjusted model. The standardized chi-square value has been dramatically improved, and each fitting index meets the requirements of empirical criteria. Sports ability and expected mastery have to sound appropriate effects.

Table 4, the "Standardized Load Factor" column, gives the estimated results of the adjusted measurement model. In terms of the positive and negative coefficients, except for the difficulty factor, the other five first-

order factors have positive loading coefficients on the "attitude" high-order factors. This result indicates that the more positive learning emotions mean, the more positive emotions are, the more willing to work hard to study university physical education courses [10]. The negative loading of the difficulty factor means a more positive attitude towards university physical education courses. The more students who often accompany this result agree with the difficulty of college physical education courses.

Table 5 The initial in index of the attitude factor mea				surement model.	
Fitting effect		Initial result	Adjusted result	Rule of thumb	
	Chisq.	503.816	11.146	_	
	df.	9	3	_	
	Chisq./df.	55.98	3.715	<3	
	SRMR	0.108	0.02	<0.1	
Index	RMSEA	0.226	0.05	< 0.05	
	CFI	0.771	0.996	>0.9	
	GFI	0.846	0.997	>0.9	
	NFI	0.768	0.995	>0.9	
	IFI	0.771	0.996	>0.9	

 Table 3 The initial fit index of the "attitude" factor measurement model.

From the significance of the coefficients, all loads are significant. Except for the first-order factor of difficulty, the absolute values of the load coefficients of the other six first-order factors on the second-order factors of attitude are more significant than 0.50. Among them, philosophy has the most muscular interpretation of cognitive ability, while understanding value, emotion, interest, and effort weakened in turn.

3.3.2 Reliability and validity test

Table 5 shows the reliability and validity test of the questionnaire data. Attitude and sports ability belong to high reliability. The Cronbach alpha coefficient value of the expected mastery level is slightly lower but still acceptable. We then test the convergent validity and discriminative validity of the three factors. First, according to the study in Table 4, it is found that the load coefficients of each measurement index and its corresponding element are all significant, indicating that the questionnaire data has good convergence validity [11]. Secondly, from the average variation extraction amount (AVE) in Table 5, the sports ability factor is more significant than 0.5, and the mastery degree factor is expected to be close to 0.5. Thus, although the attitude factor is slightly lower, the overall convergence validity of the model is better. Finally, the correlation coefficient between attitude and expected mastery is somewhat higher than the \sqrt{AVE} value of the two. This result shows that the discriminative validity is slightly worse, but it is still within the acceptable range. In summary, we can consider the estimated impacts of the model to be of reference significance.

3.4 Model checking and analysis

The structural equation fitting index of the theoretical model is shown in Table 6. Except for standardized chi-square and RMSEA, all other indicators are ideal. The estimated results of the structural model are shown in Table 7. First of all, from the positive and negative path coefficients, students' learning emotions towards college physical education courses have a significant and greater positive impact on their expected mastery. The more positive the students are about college physical education courses, the better they will be expected. Sports ability has a significant and greater positive impact on the scheduled mastery and the learning mood of university physical education courses. The stronger the physical capacity, the easier it is for students to attitude towards university physical education courses [12]. Therefore, the estimation result of the model supports the hypothesis H1~H3. Secondly, from the perspective of influence path and size, the attitude has a large

Latent factor	First-order factor/measurement item	Standardized load factor
	Emotion	0.678***
	Cognitive ability	0.745***
A 44 ¹ 4 - 1	Value	0.706***
Attitude	Difficulty	-0.152***
	Interest	0.601***
	Work hard	0.524***
C	Previous physical education results (Q37)	0.917***
Sports performance	Sports level (Q38)	0.951***
Expected meetoms	Confidence in mastering statistical knowledge (Q40)	0.748***
Expected mastery	What kind of results are expected (Q44)	0.660***

 Table 4 Confirmatory factor analysis estimation results.

Note: *** means p <0.001.

Table 5 Reliability and validity test indicators.

Latent factor	Cronbach α coefficient	AVE	\sqrt{AVE}	Correlation coefficient			
				Attitude	Expected mastery	Physical ability	
attitude	0.739	0.362	0.602	1	0.789	0.434	
Expected mastery	0.624	0.498	0.705	0.789	1	0.81	
Physical ability	0.931	0.872	0.934	0.434	0.81	0	

and significant favorable influence on the degree of expectation mastery. Sports ability, directly and indirectly, affects the degree of expected knowledge through two paths. Its direct effect is 0.577, the indirect impact is 0.234 (0.434×0.539), and the total product is 0.810. This result shows more remarkable than the influence of attitude on the expected degree of mastery. This indicates that the students' existing physical level is an essential factor in their judgment of the predicted mastery degree. The degree of influence of this factor is greater than the impact of students' subjective attitudes towards college physical education courses.

Table 6	Fitting index of structural equation model.

Fitting effect	Index								
1 10019 011000	Chisq.	df.	Chisq./df.	SRMR	RMSEA	CFI	GFI	NFI	IFI
Value	245.15	26	9.429	0.06	0.089	0.957	0.957	0.953	0.957
Rule of thumb	_	_	<3 or <5	<0.1	< 0.05	>0.9	>0.9	>0.9	>0.9

4 Related Suggestions

1) With the development of data science, university physical education courses have become compulsory courses for finance and economics majors. Through this survey, it can be seen that most of the students have favorable emotions towards the study of university physical education courses and recognize the value of statistical knowledge [13]. Students have a strong interest in learning physical education and are willing to make

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path	Standardized path coefficient	test result
Attitude ß Sports Ability	0.434***	H1 established
Expected mastery β sports ability	0.577***	H2 established
Expected mastery ß attitude	0.539***	H3 established

 Table 7 Estimation results of the structural equation model.

Note: *** means p <0.001.

more extraordinary efforts. They hold a positive attitude towards their cognitive abilities and expect to achieve better results. At the same time, it is undeniable that most physical education students think that college physical education courses are demanding, which may be related to the thinking mode and reasoning ability involved in the learning process. Therefore, the teaching process should focus on the students' cognition of the difficulty of college physical education courses. We need to adopt appropriate teaching methods to make it easier and to eliminate students' fear of college physical education courses as much as possible.

2) When students recognize the value of university physical education courses and have more positive emotions for studying university physical education courses, students will have the stronger motivation and a more positive attitude to research university physical education courses. At the same time, when students are more affirmed of their cognitive abilities and are more willing to work hard, it also means that students have a more positive attitude towards studying university physical education courses. Therefore, in the teaching process, teachers should emphasize to students the application value of physical fitness in real life and realize the importance of sports knowledge [14]. At the same time, teachers should adopt vivid teaching methods to mobilize students' interest in learning and enhance students' positive attitudes towards their cognitive abilities. In this way, teachers can encourage students to learn sports knowledge with a more positive attitude.

3) Students' learning emotions towards college physical education courses positively influence their expected mastery. When students have a more positive attitude towards the study of university physical education courses, the more interested they are in university physical education courses, the more willing they are to make efforts—more excellent results.

4) Students' physical quality significantly positively affects their learning mood of university physical education courses and their expected mastery of university physical education courses. The higher the student's material quality, the easier it is to obtain a sense of accomplishment from the study of physical education courses and then have a more superior sense of superiority in the face of college physical education courses [15]. The student's physical fitness will also directly affect the student's expected mastery. The stronger the physical ability, the more students will hope to achieve good university physical education courses.

5) Past physical exercise learning experience affects students' expectations of college physical education courses. Therefore, on the one hand, teachers need to correct students' emotions about physical education as soon as possible, and help them gain a sense of accomplishment from physical education learning will help cultivate students' positive emotions for college physical education courses. However, on the other hand, teachers only can students improve their opposing expectations of college physical education courses.

5 Conclusion

Combined with the SATS-36 scale, we conducted a field investigation on the learning mood of college physical education courses of college students in a sports college in China. We use the project-based packaging method and the high-order factor method to construct a structural equation model about learning mood, sports level, and expected mastery. According to our research, the overall attitude of students towards college physical education courses are considered problematic. Students' attitudes towards college physical education courses are mainly reflected in five dimensions: emotion, cognitive

ability, value, interest, and effort. Students' learning emotions towards college physical education courses have a strong positive influence on their expected mastery. In addition, a student's physical fitness level can directly or indirectly affect their expected knowledge of college physical education courses.

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