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Research Article in Scientific Thinking

A Structural Model of Physical Higher-Order Thinking Ability

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Abstract: This paper makes a qualitative analysis of the existing research and creates the hypothesis of high-order thinking ability structure model of senior high school students. 400 high school students were selected to answer the questionnaire on this basis, and exploratory factor analysis and confirmatory factor analysis were conducted on the survey results to test whether the model is reasonable. The results show that the structure of physical higher-order thinking ability in high school students includes four dimensions: "physical problem-solving ability, physical experimental exploration ability, physical critical thinking ability, and physical transfer of innovative ability", and these four dimensions are an interrelated organic whole.

Keywords: Physical higher-order thinking ability; Structural model; Exploratory factor analysis; Confirmatory factor analysis

1. Presentation of the issue

In March 2021, six departments, including the Ministry of Education, jointly issued the “Compulsory Education Quality Assessment Guidelines” (MOE of China, 2021), proposing the spirit of innovation as a key indicator for evaluating the quality of students’ academic development, and setting requirements for students' ability to integrate and analyze information, their ability to conduct independent investigations, and their awareness and ability to discover, think and solve problems. The focus of these competency requirements is that future talents need to have higher-order thinking ability, and the subject of physics, with its strong scientific and logical nature, is an important opportunity to develop students’ higher-order thinking ability. Also, how to efficiently develop students’ physical higher-order thinking ability teaching is a topic of focus for teachers and educational researchers. In this study, 400 high school students from two schools in C city of J province were selected as the research subjects with the help of literature, in an attempt to construct a structural model of high school students’ physical higher-order thinking ability from both theoretical and practical levels, which can provide theoretical reference and realistic basis for the development of high school students’ higher-order thinking ability (Ding & Chen, 2020).

2. Definition of core concepts

2.1. Higher-order thinking ability

In order to conduct an in-depth study of physical higher-order thinking ability, we must first address the question of "what is higher-order thinking ability". There is no unified definition of the concept of higher-order thinking ability, and the existing research can be divided into three main types: first, there is no clear difference between higher-order thinking and higher-order thinking ability, and the concepts of higher-order thinking and higher-order thinking ability are regarded as the same. Second, the expansion of the concept of higher-order thinking, that higher-order thinking ability is an important part of higher-order thinking. Third, based on the components of higher-order thinking ability to define, it is regarded that higher-order thinking ability includes the skills to communicate and cooperate, creative ability, practical reflection, problem solving and so on.

This study, in conjunction with existing research, defines higher-order thinking ability as the integrated ability of learners to perform mental activities at a higher cognitive level, and as the ability to use a combination of analytical, creative, and practical thinking. On this basis, this study summarizes its characteristics into five aspects: depth, flexibility, agility, originality, and criticality.

2.2. Physical higher order thinking ability

In order to successfully solve high school physics problems, only mastering physics knowledge is far from enough. It is more important to learn to use thinking methods to transfer knowledge to the problem-solving process. In addition, there are two main sources of physics knowledge in high school: the observation of life and natural phenomena as well as the induction of experiments. Both of these processes are critical to higher-order thinking (Yan, 2015). The description of "physics subject core literacy" in "General High School Physics Curriculum Standards (2017 version 2020 revised)" also emphasize the cultivation of higher-order thinking ability (MOE of China, 2020). Specifically, the core literacy of physics and physical higher-order thinking ability is complementary and indispensable. The development of students' physical higher-order thinking ability is not only to promote the physics curriculum reform, but also an important means to cultivate students' core literacy. The formation of physics higher-order thinking ability can be reflected as the higher level of cognitive activities demonstrated by learners in the process of physics problem solving, such as designing novel solutions, reflecting on and evaluating the results of solutions, etc. All these are the various higher cognitive thinking ability used in the process of successfully completing physics learning activities, such as the ability to analyze, evaluate creative ability, etc. In terms of the components of physics higher-order thinking ability, it comprehensively covers different elements of higher-order thinking ability, which includes problem solving, critical thinking, etc. Based on the above analysis, this study defines physical higher-order thinking ability as follows: physical higher-order thinking ability is based on higher-order thinking cognitive process, which refers to the comprehensive quality that learners show in higher-level cognitive activities such as physics learning and physics problem solving.

3. A theoretical study of the structure of physical higher-order thinking ability

3.1. Initial structure of physical higher-order thinking ability

In order to further analyze the higher-order thinking ability of physics in depth, this study applies the qualitative research method based on the Grounded Theory to initially determine the main dimensions of the higher-order thinking ability of physics, which is mainly divided into the following steps: firstly, literatures on the structure of higher-order thinking ability is selected through CNKI, and finally 20 core literature are identified, among which 17 are CSSCI and core journal literature and 3 D. thesis, which has certain authority and reliability; secondly, using Nvivo11.0 software to code the information related to the components of higher-order thinking ability in the literature, a total of 33 tertiary nodes were extracted, and the nodes with overlap and similar meaning were summarized and integrated to form 24 secondary nodes. Afterwards, the 24 secondary nodes were summarized and integrated again to obtain 7 primary nodes, namely problem-solving ability, experimental investigation ability, critical thinking ability, transfer of innovation ability, affective factors, metacognition and others, as shown in Table 1. Finally, after statistical analysis, it was found that problem-solving ability, experimental investigation ability, critical thinking ability and transfer of innovation ability were relatively higher in number among all nodes, so these four abilities were initially taken as the first-level dimensions of physical higher-order thinking ability.

Table 1. Nodes and coding reference points at each level

Level 1 Node	Secondary Nodes	Reference Points
Problem-solving Ability (78)	Problem-solving Ability	31
	Comprehension and Analysis Ability	32
	Logical Reasoning Ability	11
	Practical Application Ability	4
Experimental Investigation Ability (47)	Reflective Thinking	12
	Communication and Collaboration Ability	4
	Decision-Making Ability	9
	Experimental Ability	10
	Investigative Capacity	12
Critical thinking Ability (43)	Critical Thinking Ability	25
	Evaluation of Discriminatory Ability	12
	Ability Challenge	6
Transfer of Innovative Ability (41)	Creative Thinking	34
	Migration Ability	5
	Seek Out Different Thinking	2
Emotional Factor (9)	Emotional Support from Others	3
	Self-regulated Learning	3
	Sense of Self-efficacy	3
Metacognition (5)	Metacognition	5
Other (3)	Perceptual-imagery Thinking	2
	Internet Thinking Ability	1

3.2. Structural revision of physical higher-order thinking ability

On this basis, in order to further reflect the characteristics of high school physics subjects and summarize the structure of scientific, specifically physics, higher-order thinking ability, we interviewed physics curriculum and pedagogy experts and front-line physics teachers, and combined the interview results with the specific requirements of the "General High School Physics Curriculum Standards (2017 Edition 2020 Revision)" for students' "core literacy levels in physics subjects"(MOE of China, 2020). The structural model of physics higher-order thinking ability was initially constructed by analyzing the specific requirements put forward in the 5 levels of "Physics Core Literacy Levels", mainly including four primary dimensions of physics problem-solving ability, physics experimental investigation ability, physics critical thinking ability and physics transfer innovation ability as well as several secondary indicators and forming an expert consultation questionnaire. Thirteen experts, including physics education experts, physics researchers, and front-line high school physics teachers, were invited to go through two rounds of Delphi revision to arrive at a formal structural model of physical higher-order thinking ability. The mean value of the judgment basis of the experts' ratings (C_α) was 0.87. The mean value of the experts' familiarity with the indicators (Cs) was 0.71. The coefficient of the experts' authority (CR) was 0.79. All three of these indicators were above 0.70, indicating the reliability of the results of this survey.

Table 2. Results of the Delphi expert consultation

		Average Value	**(Statistics) Standard Deviation**	**Coefficient of Variation**
First Level Dimension	Physical Problem-solving Ability	4.769	0.421	0.088
	Physical Experimental Investigation Ability	4.615	0.487	0.105
	Physical Critical Thinking Ability	4.615	0.625	0.135
	Physical Transfer of Innovative Ability	4.769	0.421	0.088
Secondary Indicators	Identifying and Posing Physical Problems	4.615	0.836	0.181
	Converting and Reasoning about Physical Problems	4.692	0.606	0.129
	Explaining and Reflecting on Physical Problems	4.692	0.462	0.098
	Formulating Scientific Hypotheses	4.538	0.634	0.140
	Designing Experimental Protocols	4.615	0.487	0.105
	Collecting and Processing Data	4.538	0.499	0.110
	Summarize, Reflect on Experimental Findings	4.692	0.462	0.098
	Challenge	4.692	0.462	0.098
	Judgmental Evaluation	4.538	0.634	0.140
	Transferring Physical Knowledge	4.615	0.487	0.105
	Generating New Ideas, New Program	4.692	0.462	0.098

As can be seen from Table 2, the mean values of the expert panel's ratings of the modified indicators of all levels of physical higher-order thinking ability are greater than 4.5, the standard deviation is less than 1, and the coefficient of variation is less than 0.2, indicating that the experts' opinions are less divergent and basically unanimous, and the importance of each indicator is highly recognized, thus stopping a new round of Delphi method questionnaire distribution. After two rounds of Delphi method questionnaires, an appropriate structural model of physical higher-order thinking ability was constructed, mainly including 4 primary dimensions and 11 secondary indicators, and the requirements related to each secondary indicator are shown in the following figure.

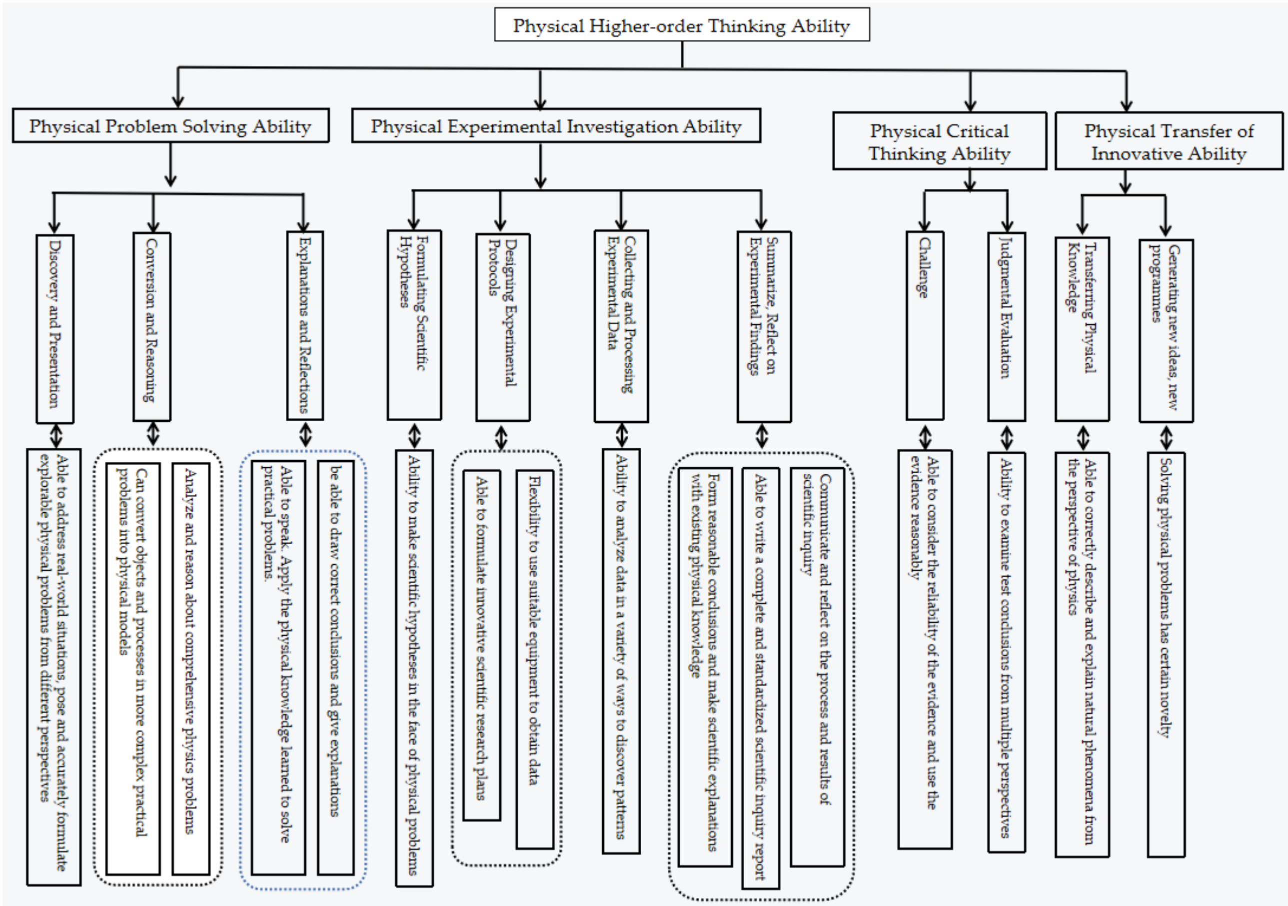

Figure 1. Structural Model of Physical Higher Order Thinking Ability

For physical problem-solving ability, Newell, a cognitive psychologist, argues that problem solving is the process of applying acquired rules and knowledge to new contextual problems, thus he views problem solving as a way of processing information (Wilson, 2000). Stenberg *et al.* propose that problem solving is the process of overcoming the difficulties faced in order to obtain a solution and achieve a goal, which cannot be achieved without the use of knowledge as well as creativity (Sternberg & Lubart, 1996). The journey of problem solving is broadly divided into five stages: first, problem discovery, i.e., being able to identify and formulate problems in complex situations; second, analyzing the problem, i.e., understanding the nature of the problem and collecting and organizing known information; third, solving the problem, i.e., integrating and using known information to propose a solution; fourth, examining and evaluating the solution, i.e., implementing the solution and reflecting on it to improve it; and finally, communicating the solution. In summary, the physics problem-solving ability covered in this study refers to the ability of students to understand and master the basic knowledge of physical concepts and laws, and to apply them flexibly when dealing with new physical problem situations. It requires students to be able to find and propose problems based on specific situations, to convert the valid information in the problems into physical quantities, to reason and analyze according to the known conditions, and to use the knowledge learned comprehensively to solve physical problems.

The physical experimental investigation ability, summarized by the Compulsory Education Physics Curriculum Standard, includes the ability to conjecture and hypothesis, design experiments, collect data, draw conclusions, reflect and evaluate as physics experimental investigation ability (Peng, 2011). Zhang Hui based on the existing research proposed that experimental inquiry ability refers to the comprehensive ability used by junior high school students in the process of physics learning when they go through the process of scientific inquiry to discover the physical laws and principles behind (Zhang, 2017). In summary, the physics experimental inquiry ability proposed in this study refers to the ability of students to put forward scientific hypotheses in the process of physics experiments and investigations, and to be able to flexibly select appropriate physics experimental equipment, design operable experimental solutions, collect and process relevant experimental data, summarize, analyze and reflect on research findings, and verify scientific hypotheses.

For physical critical thinking ability, Dewey saw critical thinking as a careful and sustained examination of an act, a proposal, or a belief and the knowledge that underpins it and the possible consequences (Dewey, 1933). Ennis sees critical thinking as rational reflective thinking with an eye to decide what can be believed and what can be done (Ennis, 1993). Mayfield believes that critical thinking is reflected in the individual's conscious process of observing, analyzing, understanding, and evaluating based on pre-existing standards (Mayfield, 2001). In summary, this study argues that critical thinking ability in physics mainly require students to be able to not only examine the physics knowledge and ideas in books critically during the physics learning process, but also to be able to synthetically analyze and evaluate multiple solutions, identify their strengths and weaknesses, and select the best solution from them when solving practical physics problems.

For physical transfer innovation ability, Wang Lei proposed that transfer innovation ability refers to the ability of students to use the knowledge and methods they have learned to solve uncertain problems, construct new knowledge and explore new methods (Wang, 2016). Min Zhang proposed that transfer innovation ability refers to the ability of learners to integrate existing knowledge and information to explore and solve unfamiliar problems and develop new results in new contexts (Zhang, 2020). Hao Yong proposed that transfer innovation ability requires students to adopt multiple ways of thinking and apply the knowledge and methods learned to cope with the disciplinary literacy of life practice problem situations (Hao, 2021). In summary, this study believes that physics transfer innovation ability requires students to be able to transfer the basic knowledge of physics and the scientific method to new problem situations to achieve the analysis and solution of problems, and innovation requires students to be able to use novel and creative methods and ideas to solve physics problems and come up with new ideas.

4. An empirical study of the structure of physical higher-order thinking ability

Through the above study, the structure of physical higher-order thinking ability was tentatively determined. To verify whether the structure is scientifically sound or not, this study applied exploratory factor analysis and confirmatory factor analysis on the recovered data by using SPSS and AMOS software respectively.

4.1. Questionnaire development

The questionnaire is based on the structural model of higher-order thinking ability in physics constructed in this study, and the questions are compiled based on the specific performance of each indicator, in addition to the test instruments developed by previous researchers such as Jiang Yulian and Wen Qianlan. After several revisions on this basis, the final questionnaire of "Physical Higher-Order Thinking Ability for High School Students" was developed. The questionnaire includes two parts, basic information and survey scale. The scale is designed with 22 questions, including six questions on physical problem-solving ability, eight questions on physical experimental investigation ability, four questions on physical critical thinking ability, and four questions on physical transfer innovation ability. The scale uses a six-point Likert scale, and a higher total score on the questionnaire means a higher level of higher-order thinking ability in physics.

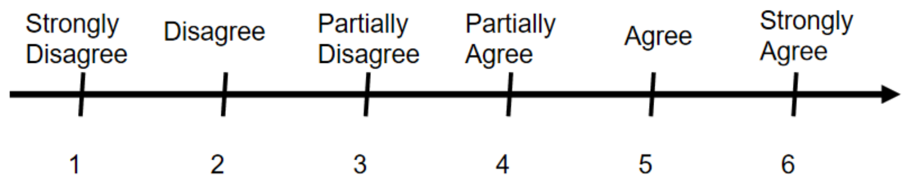

Figure 2. Six-point Likert scale rating scale

4.2. Sample

In this study, a random sample of two general public high schools of similar level in J province was selected for the survey, and the two schools are basically at the same level in terms of school size and faculty strength. Since the current senior high school students are mainly in the general revision stage, which is different from the study pattern of other senior high school students, in order to minimize the error, the scope of this survey was focused on the sophomore high school students and senior high school students. During the official survey, 400 questionnaires were distributed, and the return rate reached 99.5%. In terms of grade, 42.2% of the students in senior year and 57.8% in sophomore year; in terms of gender, 58.8% of the students were male and 41.2% were female, and overall, the sample was distributed more evenly.

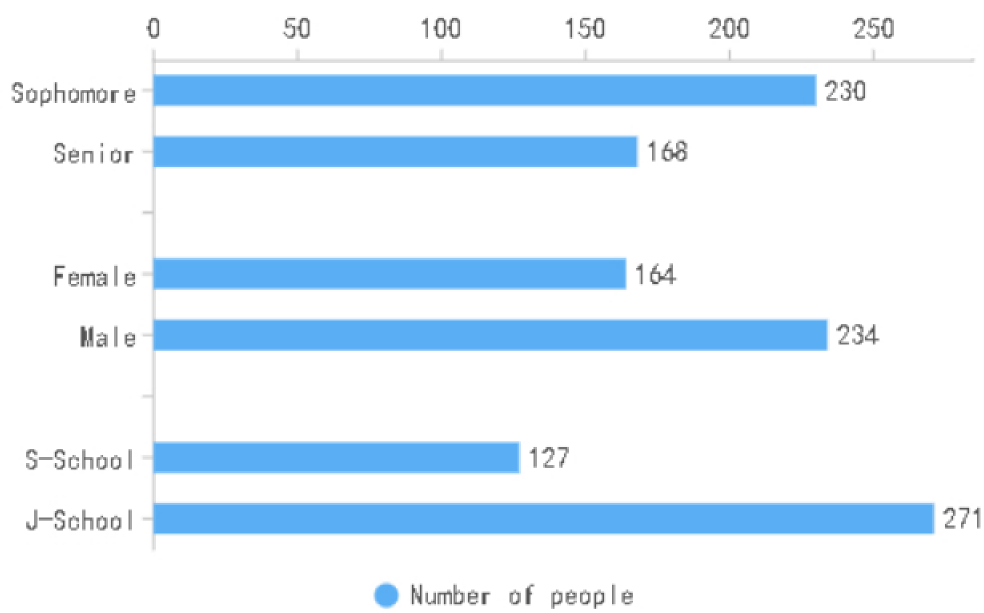

Figure 3. Sample Statistics Chart

5. Analysis of research findings

5.1. Project analysis

Item analysis is mainly to test the discriminatory degree of each question item in the scale. According to the data recovered, this study ranked their total scores from high to low, taking the first 27% as high group and the last 27% as low group, independent sample t-test was conducted on the data of both groups. According to the results, it was found that the decisive value (CR) of each item was greater than 3, and there was a significant difference between high group and low group on each question item, thus it was seen that the questionnaire items have good discrimination and differentiation for each question item.

Table 3. Results of the analysis of project determination values

QUESTION MARK	DECISIVE VALUE (CR)	QUESTION MARK	DECISIVE VALUE(CR)
Q1	14.163***	Q12	12.690***
Q2	14.605***	Q13	17.249***
Q3	15.261***	Q14	13.844***
Q4	14.227***	Q15	13.135***
Q5	18.093***	Q16	12.025***
Q6	15.710***	Q17	8.753***
Q7	18.379***	Q18	15.636***
Q8	16.759***	Q19	18.029***
Q9	18.599***	Q20	17.109***
Q10	15.731***	Q21	17.510***
Q11	14.058***	Q22	19.484***

Note: * indicates $p < 0.05$, ** indicates $p < 0.01$, *** indicates $p < 0.001$.

5.2. Exploratory factor analysis

In this study, factors were extracted from all questionnaire questions based on exploratory factor analysis without differentiating variables as a way to determine whether the hypothesis of the structure of physical higher-order thinking ability constructed in this study is reasonable. First, after KMO and Bartlett's initial test, the data results reached a significant level, indicating that the questionnaire is suitable for exploratory factor analysis. Then, the factors were extracted based on principal component analysis to produce a rotated factor loading matrix. With item loading values greater than 0.5 and commonality greater than 0.3 as criteria, and with at least three observations of the common factor (Zhang, 2017), 19 items were screened out and factor analysis was performed again, at which point the results of the analysis are shown in Table 4. It can be seen that after removing the three items Q9, Q18 and Q19, the KMO value of the scale slightly decreased, and other indicators significantly decreased, and in a comprehensive view, the revised scale is more suitable for factor analysis.

Table 4. Modified KMO and Bartlett's test

KMO METRIC for SAMPLING ADEQUACY		.956
BARTLETT'S TEST SPHERICITY	APPROXIMATE CARTESIAN	4313.209
	DF	171
	SIG.	.000

Ultimately, four factors were extracted in this study, with a cumulative variance contribution of 65.754%. As can be seen from Table 5, the rotated factors loading are greater than 0.5, and the commonality is also above 0.5, indicating that the extraction of the four common factors is appropriate, and the analysis results are basically consistent with the predetermined structure of the questionnaire, indicating that the questionnaire factors are reasonably determined. The four factors in Table 5 match with the initial hypothesis of the questionnaire: factor 1 is "physical problem-solving ability" including Q1, Q2, Q3, Q4, Q5 and Q6, factor 2 is "physical experimental investigation ability" including Q7, Q8, Q10, Q11, Q12 and Q13. Q11, Q12, Q13, Q14, factor 3 is "physical critical thinking ability" including Q15, Q16, Q17, factor 4 is "transferable innovation ability in physics" including Q20, Q21, Q22.

Table 5. Results of exploratory factor analysis of the structure of physical higher-order thinking ability

ROTATION CONSTITUENT MATRIX[a]					
	ELEMENT				COMMONALITY
	1	2	3	4	
Q1	.721	.179	.296	-.022	.640
Q2	.713	.141	.210	.271	.646
Q3	.734	.113	.367	.030	.687
Q4	.666	.239	.258	.083	.573
Q5	.697	.347	.107	.149	.639
Q6	.730	.276	.136	.055	.631
Q7	.327	.736	.063	.182	.686
Q8	.448	.676	-.099	.182	.700
Q10	.429	.642	.047	.119	.613
Q11	.398	.647	.122	-.079	.598
Q12	.157	.786	.025	.196	.682
Q13	.268	.717	.168	.176	.645
Q14	.208	.683	.361	.059	.644
Q15	.291	.436	.606	-.026	.642
Q16	.231	.208	.873	.155	.884
Q17	.222	.067	.780	.194	.700
Q20	.287	.420	.095	.596	.623
Q21	.039	.435	.200	.640	.641
Q22	.251	.442	.171	.577	.620

5.3. Confirmatory factor analysis

Constructing a measurement model based on the results of relevant literature studies and exploratory factor analysis, this study further conducted a confirmatory factor analysis using AMOS 21.0 software to explore whether the structural model of physical higher-order thinking ability fits with the actual sample data collected in this study and to verify whether each indicator can be effectively used as an observed variable for each potential factor. Model corrections were made in conjunction with the results of the runs, using as the criterion, starting from the maximum value, and the revised model plot is shown in Figure 4.

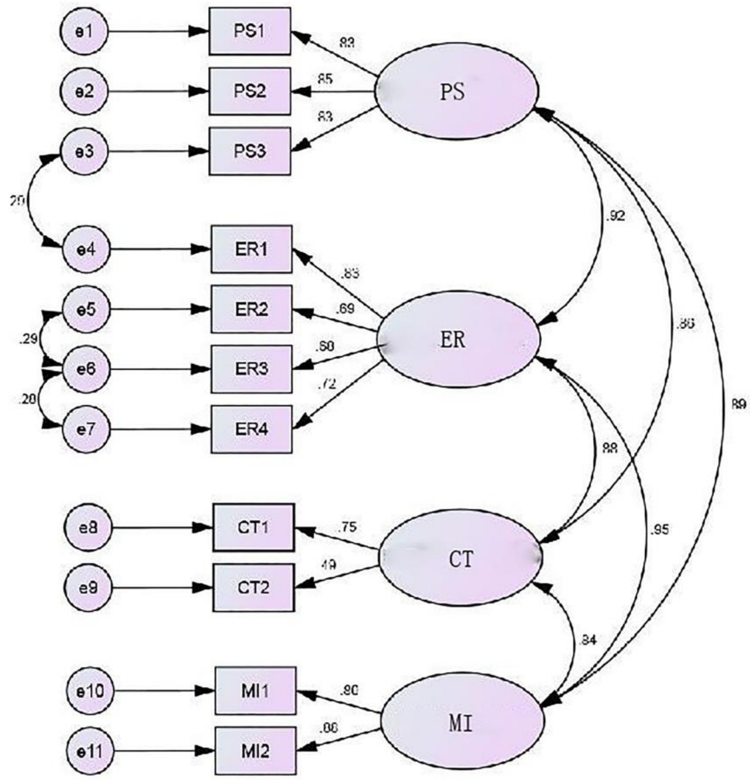

Figure 4. Measurement model of the structure of physical higher-order thinking ability

As seen in Figure 4, the four latent variables are highly positively correlated with each other, with correlation coefficients ranging from 0.84 to 0.95, and factor loading all ranging from 0.49 to 0.88, which is within the acceptable range. The results of the standardized factor loading also indicate the importance of each observed variable in the corresponding latent variable, with larger values being more important (Li, 2011). For example, the latent variable "physical problem-solving ability" has a significant impact on "finding and posing physical problems" (PS1), "transforming and reasoning about physical problems" (PS2), "solving physical problems" (PS3), and "solving physical problems" (PS4). The factor loading of the three indicators "solving physical problems" (PS3) are 0.83, 0.85, and 0.83, respectively, indicating that the observed indicator "transforming and reasoning physical problems" has the greatest influence on "physical problem-solving ability". The influence of this indicator on "physical problem-solving ability" is the greatest and most important. Likewise, the indicator "formulating scientific hypotheses" (ER1) is the most important indicator in "physics experimental investigation ability"; in "physical critical thinking ability", the indicator "questioning" (CT1) is the most important, and the indicator "generating new ideas and solutions" (MI2) is the most important in the "physical transfer of innovation ability".

From the results of the overall model fit test before and after the revision presented in Table 6, all indicators were acceptable after the revision, indicating that the structural model of higher-order thinking ability of high school students in physics proposed in this study has good extrinsic quality and good structural validity.

Table 6 Results of the overall model fit test (initial model + modified model)

STATISTICAL TEST QUANTITY		ADAPTATION STANDARDS	INITIAL MODEL FIT INDEX	INITIAL MODEL FIT JUDGEMENT	MODIFIED MODEL FIT INDEX	MODIFIED MODEL FIT JUDGMENTS
ABSOLUTE SUITABILITY INDICATOR	GFI	＞0.9	0.924	BE	0.995	BE
	AGFI	＞0.9	0.867	DENY	0.916	BE
	RMR	<0.05	0.048	BE	0.037	BE
	RMSEA	<0.08	0.097	DENY	0.068	BE
VALUE-ADDED SUITABILITY INDICATORS	NFI	＞0.9	0.936	BE	0.965	BE
	RFI	＞0.9	0.908	BE	0.945	BE
	IFI	＞0.9	0.949	BE	0.977	BE
	TLI	＞0.9	0.926	BE	0.963	BE
	CFI	＞0.9	0.949	BE	0.977	BE
PARSIMIMONY SUITABILITY INDICATOR	PGFI	＞0.5	0.532	BE	0.507	BE
	PNFI	＞0.5	0.647	BE	0.614	BE
	PCFI	＞0.5	0.655	BE	0.622	BE
	X^2 /DF	<3	4.733	DENY	2.843	BE

5.4. Reliability and convergent validity analysis

Based on the above study, the compositional reliability (CR) and the average variance extracted (AVE) of the four latent variables were calculated to test the reliability and intrinsic convergent validity of each latent variable in the modified model. Table 7 shows that the CR of "physical critical thinking ability" is greater than 0.7 and the AVE is slightly less than 0.5, which is within the acceptable range, except that the CR of the other latent variables is greater than 0.8 and the AVE is greater than 0.5. This indicates that the overall reliability and convergent validity of the model are good, and also indicates that the model has good intrinsic quality (Guo et al., 2019).

Table 7. Reliability and convergent validity of latent variables

	PHYSICAL PROBLEM-SOLVING ABILITY	PHYSICAL EXPERIMENTAL INVESTIGATION ABILITY	PHYSICAL CRITICAL THINKING ABILITY	PHYSICAL TRANSFER OF INNOVATIVE ABILITY
CR	0.877	0.822	0.563	0.828
AVE	0.703	0.537	0.403	0.707

5.5. Correlation test analysis

The correlation test is also an important way to test the structural validity of the questionnaire. In this study, the correlation coefficient between each level of indicators of the questionnaire and its correlation coefficient with the overall physical higher-order thinking ability were analyzed by SPSS 21.0 software. According to the results, it can be found that the correlation coefficient between each level of indicators is between 0.668 and 0.790, which has a high degree of correlation. The correlation coefficients of each level indicator and the questionnaire as a whole are between 0.823 and 0.931, showing a high degree of correlation. The results show that the four first-level indicators are interrelated and influence each other, and can accurately reflect the overall test content of the questionnaire (Zhou & Lin, 2021).

Table 8. Results of Pearson correlation test for questionnaire

	PHYSICAL PROBLEM-SOLVING ABILITY	PHYSICAL EXPERIMENTAL INVESTIGATION ABILITY	PHYSICAL CRITICAL THINKING ABILITY	PHYSICAL TRANSFER OF INNOVATIVE ABILITY	PHYSICAL HIGHER-ORDER THINKING ABILITY
PHYSICAL PROBLEM-SOLVING ABILITY	1				
PHYSICAL EXPERIMENTAL INVESTIGATION ABILITY	.758**	1			
PHYSICAL CRITICAL THINKING ABILITY	.685**	.669**	1		
PHYSICAL TRANSFER OF INNOVATIVE ABILITY	.790**	.787**	.714**	1	
PHYSICAL HIGHER-ORDER THINKING ABILITY	.903**	.931**	.823**	.908**	1

6. Research findings

In this study, a theoretical model of physical higher-order thinking ability was constructed from the established results, modified by combining Delphi method consultation with expert opinions. On this basis, a corresponding test instrument was proposed to conduct item analysis, exploratory factor analysis, and confirmatory factor analysis on the recovered data. The results show that the structural model of physical higher-order thinking ability is consistent with the theoretical conception, as shown in the figure, and includes four dimensions: physical problem-solving ability, physical experimental inquiry ability, physical critical thinking ability, and physical transfer of innovation ability. Each dimension includes multiple observations. These four dimensions are not completely independent; they are an organic whole that is interrelated and interacts with each other.

Figure 5. Structure of Physical Higher-Order Thinking Ability

With the development of basic education reform, society's requirements for students' comprehensive quality and innovation ability are increasing, and educators should pay more attention to the development and evaluation of students' higher-order thinking ability in physics (Gao, 2019). In this context, it is not enough just to construct a macro-theoretical model. The development of students' higher-order thinking ability in physics at the high school level is more dependent on the physics subject curriculum. Therefore, the subsequent study will further improve the structural model of physical higher-order thinking ability with the actual situation in the physics classroom in order to enhance its scientific nature, and then provide guidance and reference for the development of students' physical higher-order thinking ability curriculum and students' core literacy in physics subject.

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