Evaluation of Mathematical Modeling Competence among Students in Application-Oriented Undergraduate Institutions: An Empirical Study of Sophomore and Junior Students

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Abstract: With the growing prominence of mathematical modeling in international mathematics education, cultivating modeling competence has become a core requirement for developing high-quality and innovative talent. However, current instruction and assessment of mathematical modeling among undergraduates still suffer from suboptimal implementation and incomplete evaluation systems. This study aims to construct a scientific evaluation framework for undergraduates' mathematical modeling competence and to examine the current status and influencing factors of sophomore and junior students in application-oriented undergraduate institutions. A multi-method evaluation approach was adopted, including a 20-item Likert-scale Mathematical Modeling Competence Questionnaire based on the five-step modeling process, as well as a three-level modeling task test (covering health management, logistics optimization, and infectious disease transmission scenarios). A total of 434 students were randomly sampled from three institutions (A, B, and C) for assessment. Results show that overall modeling competence among undergraduates is relatively low, with only 3.4% reaching a high level; abilities in formulating and testing model assumptions are particularly weak. Gender differences are not significant, but institutional level has a significant effect ($p < 0.01$). Mathematical achievement is weakly correlated with modeling competence ($r = 0.264$), whereas mathematical interest and modeling mindset are moderately correlated ($r = 0.536$ and $r = 0.331$, respectively). It is recommended to enhance the effectiveness of modeling instruction through strengthening sub-skills training, introducing authentic context-based tasks, and improving curriculum design.

Keywords: Mathematical Modeling Competence; Evaluation Research; Application-Oriented Undergraduate Institutions; Sub-Skills; Questionnaire Survey

1. Introduction

With the growing prominence of mathematics, the cultivation of mathematical modeling literacy has become a central issue and important goal in international mathematics education.[1] Curriculum reforms worldwide have identified it as a key core competency or ability.[2] At the international level, large-scale assessment programs such as PISA regard modeling as a crucial measure of mathematical literacy,[3] and the 2021 ICME14 conference further designated "mathematical modeling" as a core topic, highlighting its global significance. Mathematical modeling serves as a critical bridge connecting mathematics with the real world, and its widespread application necessitates that every citizen possess basic modeling skills. In the 21st century, amid the urgent need to cultivate innovative talent capable of undertaking national rejuvenation, along with the rapid development of information technology and artificial intelligence, mathematical modeling ability has become an indispensable core competency for high-quality innovative talent and an important reflection of innovative spirit and practical ability.[4]

However, despite the important role assigned to mathematical modeling in curriculum standards, textbooks, and teaching reforms, its implementation and assessment still face significant challenges. Practical teaching efforts often encounter difficulties, and research indicates that the outcomes of curriculum implementation are less than ideal.[5] The inherent complexity and open-ended nature of modeling activities often lead to superficial approaches in both instruction and evaluation. There is a relative lack of scientific, systematic, and accurate methods for assessing students' mathematical modeling abilities—which is precisely the foundation for targeted teaching guidance and ability enhancement. Therefore, current practices in teaching and evaluating mathematical modeling remain inadequate, calling for in-depth exploration by teachers and researchers to refine theories and guide practice, thereby truly achieving its educational goals and meeting the demands of the era for talent.

Regarding the modeling process, the five-step or seven-step models are widely accepted in China. Understanding of modeling ability generally falls into two perspectives: macro (overall proficiency) and micro (sub-abilities). Domestic research has predominantly focused on the macro level, with fewer studies at the micro level, and even fewer integrating both approaches. Methods for evaluating modeling ability can be categorized into subjective (e.g., self-report questionnaires) and objective approaches (including five main methods such as test-item analysis). Surveys indicate that the overall mathematical modeling ability of Chinese university students remains relatively low and urgently needs improvement. Based on this, our study aims to address the actual teaching of mathematical modeling for contemporary university students. Guided by the five-step process model and integrating both macro and micro perspectives, we will employ test-item evaluation methods to develop a research tool for assessing mathematical modeling ability tailored to sophomores and juniors in application-oriented undergraduate institutions.

2. Core Concepts

2.1 Mathematical Modeling Ability

Ability generally refers to the personal psychological characteristics or personality traits required for an individual to successfully complete certain activities.[6] Mathematical ability, specifically, denotes the psychological characteristics that enable the smooth and effective execution of mathematical activities. Mathematical modeling ability refers to the comprehensive manifestation of various capabilities demonstrated by students during the process of mathematical modeling.[7] Currently, experts categorize definitions of mathematical modeling ability into macro and micro perspectives.[8]

This study defines mathematical modeling ability as: a comprehensive ability demonstrated by students in applying mathematical knowledge to solve problems of varying difficulty levels across different contexts.

2.2 Mathematical Modeling Literacy

Mathematical modeling ability is a component of mathematical modeling literacy, and research on mathematical modeling literacy holds significant reference value for understanding mathematical modeling ability. Literacy refers to a moral cultivation acquired through training and practice. Compared to “ability,” the connotation of “literacy” is broader; in addition to capability, it encompasses knowledge, emotions, attitudes, values, and other dimensions.[9] Mathematical modeling is the literacy of mathematically abstracting real-world problems, expressing issues in mathematical language, and using mathematical methods to construct models to solve problems.

3. Research Design and Process

3.1 Research Participants

In evaluating the mathematical modeling ability of university students, first-year students were excluded as they are new to university education, with underdeveloped mathematical modeling thinking and abilities, as well as limited breadth and depth of mathematical knowledge. Senior students, facing internships, job searches, and thesis writing, are unlikely to engage in the research survey with a positive attitude and thus cannot reflect the overall modeling proficiency of the student population. In contrast, sophomore and junior students, after more than a year of university-level mathematics study, have acquired fundamental mathematical knowledge and skills and are in a transitional phase. Compared to first-year and senior students, sophomores and juniors are more capable of reflecting and representing the average level of mathematical modeling ability among university students. Therefore, this study focuses on the mathematical modeling ability of sophomore and junior students, selecting them as the formal research participants. A modeling ability assessment tool tailored to sophomores and juniors was designed to evaluate their mathematical modeling ability.

To enhance the representativeness of the study, 434 students from three universities (A, B, and C) of varying academic levels were randomly selected as research participants.

3.2 Research Tools

(1)Mathematical Modeling Ability Questionnaire

To scientifically evaluate the mathematical modeling ability of university students and meet the design requirements of this study, the assessment framework of this research was developed based on a comprehensive review of existing evaluation frameworks. These include Blum's[10] sub-competency assessment for mathematical modeling, Jensen's[11] three-dimensional modeling ability assessment framework, the mathematical modeling ability assessment framework proposed by the large-scale international assessment program PISA 2012[12], Xu's[13] assessment framework for mathematical modeling ability, and the evaluation framework for mathematical modeling literacy within the context of mathematical core competencies by Yu[14] et al. The assessment framework of this study is structured as shown in Figure 1, consisting of three assessment dimensions, two assessment content areas, and two assessment tools.

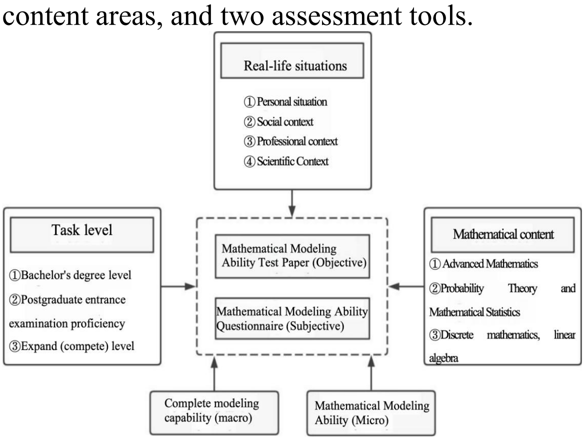


Figure 1. Mathematical Modeling Competency Assessment Framework

Based on the modeling competency assessment framework, the College Students' Mathematical Modeling Competency Questionnaire designed in this study consists of two parts: basic information and questionnaire items. The first part covers basic information, including name, gender, grade level, academic performance in mathematics, and other related details. The second part comprises the questionnaire items, which include a total of 20 questions. Each question offers five options, forming a five-point Likert scale. The questionnaire provides five choices ranging from "strongly disagree" to "strongly agree," assigned values of 1 to 5 points, respectively. Higher scores indicate that students rate their mathematical modeling competency more positively.

The design of the questions in the College Students' Mathematical Modeling Competency Questionnaire is primarily based on studies by Li [15,16], Niu [17], and Koyuncu [18], among others. Considering the characteristics of the survey participants, a draft of the questionnaire was initially developed. After discussions with numerous frontline teachers and experts in related fields, adjustments were made to the expression methods and applicability of the original referenced questionnaires, resulting in a finalized version suitable for college students in China. The breakdown table of the questionnaire is shown in Table 1.

Table 1. Questionnaire Breakdown Table

	Examination dimensions	questionnaire questions
Part One	Personal Information	
	Interest in learning mathematics	1
	Complete modeling ability	2
	Mathematical Modeling Attitude	3
Part Two	Model assumption ability	4-5
	Model construction capability	6-8
	Model solving ability	9-12
	Model analysis ability	13-15
	Model checking capability	16-20

To ensure the validity of the assessment tools, a pilot test of both the test questions and the questionnaire was conducted before the formal student assessment. Experts provided revisions regarding the phrasing of certain items. For the pilot study, students from a mathematics experimental course elective class in the second year at School A were selected as participants, and the questionnaire was distributed for pilot testing. The test duration was 60 minutes. After the test, student responses were promptly evaluated. The results were largely consistent with expectations, leading to the decision to use this version of the test and questionnaire for the formal assessment.

A total of 60 copies of the College Students' Mathematical Modeling Competency Questionnaire (Pilot Version) and the College Students' Mathematical Modeling Competency

Test (Pilot Version) were distributed, and all 60 were returned, resulting in a 100% return rate. Among these, 58 were valid questionnaires, yielding an effective rate of 96.67%. The reliability of the pilot questionnaire was analyzed using SPSS, showing a Cronbach's α of 0.841, indicating high reliability and suitability for formal prediction.

This study employed AMOS statistical software to perform a confirmatory factor analysis on the pilot sample. The numbers on the connecting lines in the figure represent correlation coefficients, while the right side indicates the five sub-competencies, each corresponding to the specific areas assessed. For details, refer to Figure 2. The adjusted questionnaire showed a chi-square/degrees of freedom ratio (X^2/df) of 2.161, which is less than 3, indicating ideal model fit. The root mean square error of approximation (RMSEA) was 0.046, below 0.05, also reflecting ideal fit. Additionally, the corresponding values of CFI, IFI Delta2, and GFI were all above 0.8, suggesting good model fit. Overall, the questionnaire design is well-suited for the target population and effectively reflects students' mathematical modeling competency.

(2) Mathematical Modeling Ability Test Paper

Based on the test framework and principles, this study designed modeling tasks at three different levels (Table 2) to assess students' mathematical modeling ability levels. If a student can complete the tasks at a given level, undergo the modeling process required for tasks of that difficulty, and possess the sub-abilities necessary for each stage of the process (Table 3), it indicates that the student has reached that level.

Following the above principles, three problems were identified as the modeling test questions: a Health Management Problem, a Logistics Optimization Problem, and an Infectious Disease Transmission Problem. The item analysis for these questions is presented in Table 4.

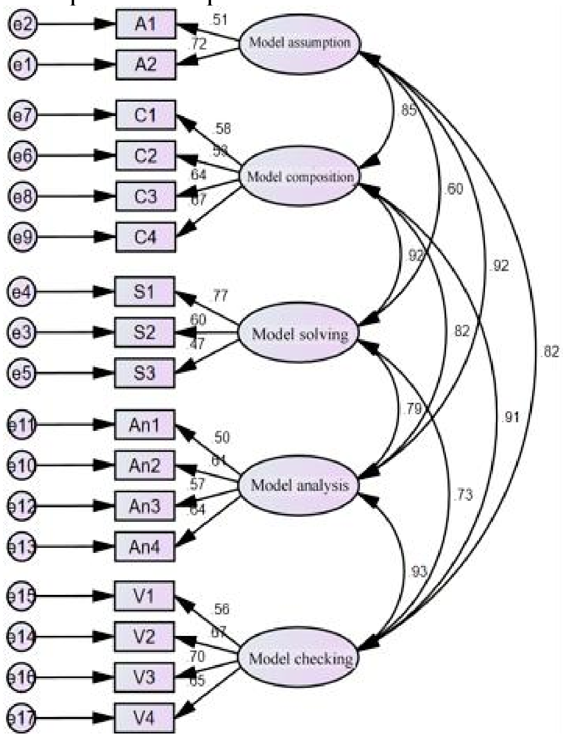


Figure 2. Diagram of the Confirmatory Factor Analysis for Mathematical Modeling Sub-Competencies

Table 2. Mathematical Modeling Ability Task Level

Level	Definition	Topic level
Level 1	In relatively simple and familiar situations, identify the standard model	Undergraduate graduation level
Level 2	In a more comprehensive context, transfer and combine the standard model to solve problems	Postgraduate entrance examination level
Level 3	In more complex situations, design and create appropriate models to solve problems	Expand (competition) level

Table 3. Sub-Capability Behavior Indicators

Possess sub-abilities	Complete the modeling steps
Model assumption ability	Students can put forward reasonable hypotheses in a given real situation, identify irrelevant variables in the question, and find the mathematical model, but they are unable to find clues related to mathematics.
Model composition ability	Students can identify a mathematical model based on assumptions and transform it into a mathematical problem, but it is merely a mathematical word problem and cannot be solved.
Model solving ability	Students can not only identify mathematical problems in real models in real-world situations, but also solve them in the mathematical world.

Model analysis ability	Students can identify appropriate mathematical models from real-life situations, accurately solve the problem in the mathematical world, and also master the applicable scope and application scenarios of the model.
Model verification capability	After going through the complete modeling process, students attempt to propose multiple solutions for comparison and verification, test the rationality of the problem-solving in real situations, and select the optimal solution.

Table 4. Analysis Table of Test Question Items

Question number	Mathematical content			Contextual dimension	Mathematical modeling Task level
	Probability Theory and Mathematical Statistics	Linear Algebra + Advanced Mathematics	Discrete mathematics + Differential equations		
1	√			Personal context	Level 1
2		√		Professional context	Level 2
3			√	Scientific context	Level 3

3.3 Data Collection

In order to conduct a more in-depth study on each student's model-building ability in the future, this study chose to use dual coding to record the specific performance of students on each modeling task. For each test question, students will receive two corresponding scores. The first one indicates that the student's correct answer level has reached the level of mathematical modeling ability, and the second number represents a diagnostic code. The types of answers provided by the majority of students were tallied.

In this study, three test tasks were encoded based on the specific performance of the students and the behavioral indicators of the preset completion steps. This study mainly analyzes whether students possess the sub-abilities of this topic at this stage. As for the specific reasons for their mistakes and the specific solutions, the coding schemes provided in this study only serve as corresponding references for subsequent strategy research and do not involve further analysis.

The research encoded the students' performance in each mathematical modeling ability test task and classified the students' modeling ability levels based on the encoding. The research classifies complete mathematical modeling ability into the zeroth category, the first category, the second category and the third category. If a student belongs to category zero, it indicates that the student's level of mathematical modeling ability is relatively low. If a student belongs to the third category, it indicates that the student's level of mathematical modeling ability is relatively high.

In this test, students' performance in each modeling task will be encoded accordingly, representing the mathematical modeling steps completed on the mathematical modeling test task at that level, reflecting the situation of each sub-ability of the students. The specific codes are shown in Table 5.

Table 5. Classification and Coding Table of Mathematical Modeling Ability Levels

Coding	0	1	2	3	4	5
Model assumption ability	×	√	√	√	√	√
Model composition ability	×	×	√	√	√	√
Model solving ability	×	×	×	√	√	√
Model analysis ability	×	×	×	×	√	√
Model verification capability	×	×	×	×	×	√

Note: √ indicates that the student has the mold-making ability required for this test question; "×" indicates that the student does not possess the mold-making ability required for this test question.

4. Statistics and Analysis of Mathematical Modeling Ability Assessment Results

4.1 Overall Distribution

According to the research framework and the analysis of students' modeling ability performance based on the coding table of the test papers, students' mathematical modeling ability is divided into four distinct levels from high to low: Level Zero, Level I, Level II, and Level III. Based on the scores of the test questions and the evaluation criteria for mathematical modeling ability levels, the distribution of complete modeling ability levels among 382 university students was statistically analyzed. The proportions of each category are shown in Figure 3.

The data indicate that 22.0% of the students were unable to reach Step 4 in any of the modeling test tasks, placing their mathematical modeling ability at Level Zero. Additionally, 47.9% of the students were able to reach Step 4 in the modeling test task with a preset difficulty of Level I, specifically the "Health Management Problem." Approximately 26.7% of the students demonstrated mathematical modeling ability at Level II, meaning they were able to reach Step 4 in the "Logistics Optimization Problem." Only 3.4% of the students reached Level III, achieving Step 4 in the "Infectious Disease Transmission Problem."

These findings suggest that the majority of students possess a complete modeling ability at a medium to low level. University students generally perform poorly in mathematical modeling activities, and their mathematical modeling ability still requires improvement.

Furthermore, according to the survey questionnaire, students were asked to rate their ability to perform complete mathematical modeling on a scale of 1 to 5, where 1 indicated "strongly disagree," 2 "disagree," 3 "uncertain," 4 "agree," and 5 "strongly agree." The self-assessment of students' complete modeling ability is shown in Figure 4. Overall, nearly 70% of the students rated their complete modeling ability at a medium to low level. Students' self-efficacy in complete modeling ability is relatively low.

Figure 3. Shows the Complete Distribution Map of Modeling Capability Levels

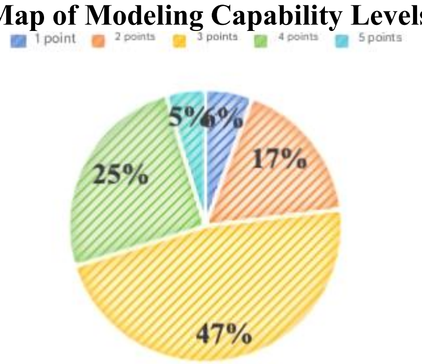


Figure 4. Distribution Map of Self-Evaluation of Complete Modeling Ability

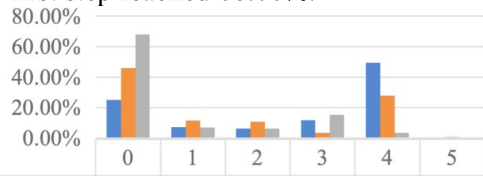
A correlation analysis conducted using SPSS revealed a statistically significant correlation between students' self-assessment and their objectively tested "complete modeling ability." Both the subjective self-evaluations and the objective assessments indicate that the mathematical modeling ability of students is at a relatively low level.

4.2 Analysis of the Performance across Five Sub-Abilities

To gain a more intuitive understanding of students' specific performance in the mathematical modeling sub-abilities, this study charted their overall performance on the sub-abilities across the three modeling test tasks. The sub-abilities corresponding to the scores are referenced in Coding Table 6. The characteristics of the performance in these mathematical modeling sub-abilities are now analyzed and summarized below:

According to Figure 5, observing the similarities in student performance across the three modeling tasks, the score distributions for the three questions are largely consistent. A significant number of students scored either 0 points or 4 points. This indicates that many students were unable to proceed to the next modeling step due to deficiencies in the sub-abilities of “model assumption” and “model testing”.

Regarding the differences in student performance across the three tasks, students exhibited certain variations in their performance on different problems. Specifically, 25.13% of students failed to complete any modeling step on the task with Level One difficulty due to insufficient ability in making model assumptions. In contrast, on the task with Level Three difficulty, the percentage of students who stalled at the first step reached 68.06%.



	0	1	2	3	4	5
Question 1	25.13	7.33%	6.28%	11.78	49.48	
Question 2	45.81	11.52	10.73	3.40%	27.75	0.79%
Question 3	68.06	7.07%	6.28%	15.18	3.40%	

Figure 5. Shows the Total Score of the Students on the Three Modeling Test Tasks

For each problem, the percentage of students unable to proceed with the modeling process due to deficiencies in the three sub-abilities of “model formulation, model solving, and model analysis" consistently fell within the range of 6% to 16%. Therefore, it can also be observed that once students possess the model assumption ability required to approach the problem—that is, once they have taken the first step into the mathematical modeling process—the majority of them are able to achieve a "4" score, successfully solving the mathematical problem.

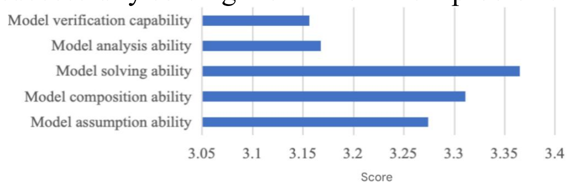


Figure 6. Shows the Scoring Chart of Students' Ability to Build Mathematical Models

Furthermore, this study utilized a questionnaire to assess students' self-efficacy regarding their sub-abilities in mathematical modeling, allowing for a subjective self-evaluation of their own capabilities. The specific results are shown in Figure 6. Overall, students' self-efficacy concerning their mathematical modeling ability and its sub-abilities was not particularly high. Among the five sub-abilities, students reported relatively higher self-efficacy in model formulation and model solving.

4.3 Analysis of Differences

(1) Analysis of Differences in Modeling Ability Levels by Gender

Research on gender differences in specific mathematical abilities such as mathematical modeling ability is relatively scarce. Figure 7 shows the distribution of mathematical modeling ability levels among students of different genders. Based on the data results, there is no significant difference in mathematical modeling ability levels between genders.

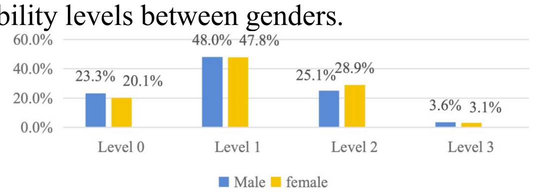
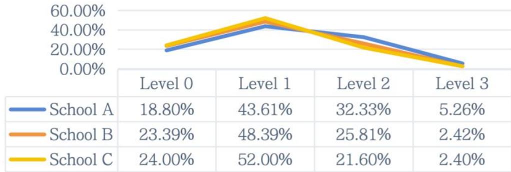


Figure 7. Distribution of Mathematical Modeling ability Levels between Male and Female Students

(2) Analysis of Differences in Modeling Ability Levels by School Tier

This study selected students from three schools (A, B, and C), randomly choosing 2-3 classes from each, to assess their mathematical modeling ability. Figure 8 shows the distribution of ability levels among students from the three schools.



	Level 0	Level 1	Level 2	Level 3
School A	18.80%	43.61%	32.33%	5.26%
School B	23.39%	48.39%	25.81%	2.42%
School C	24.00%	52.00%	21.60%	2.40%

Figure 8. Distribution of Modeling Capability Levels among Various Schools

Overall, students from the three schools exhibited a consistent trend in their modeling ability levels. Regarding the proportion of students performing at Level Zero, School A had a significantly lower percentage of students at this level compared to Schools B and C. In terms of the proportion of students reaching Level Two and Level Three, School B's percentage was slightly higher than School C's. However, 35.61% of students from School A were at these higher levels, which is noticeably higher than the proportions in Schools B and C.

Based on the above results, it can be concluded that the school a student attends has a relatively significant impact on their mathematical modeling ability. To gain a deeper understanding of this influence, an open-ended interview was conducted with Professor Z, the lead for mathematical modeling at School A, which demonstrated higher student ability levels. The in-depth interview revealed that School A is currently undergoing a reform of its mathematical modeling curriculum and has implemented a series of targeted initiatives. These include developing a mathematical experimentation course, hosting a school-level mathematical modeling competition, and implementing a mentorship system for mathematical modeling. The survey results indicate that the reform has been effective, leading to a higher level of development in students' mathematical modeling abilities. The reform model adopted by School A can serve as a reference for enhancing mathematical modeling ability in other contexts.

4.4 Correlation Analysis

To further investigate students' modeling ability, this section analyzes the correlation using mathematics academic performance and school type as independent variables, and the "total score on the three modeling tasks" as the dependent variable. As the sample size of this study exceeds 300, it is considered a large sample. Therefore, Pearson correlation analysis was chosen to examine the relationships. In

Pearson correlation analysis, a larger correlation coefficient indicates a higher degree of distinction.

To study the correlation between these two variables, students' mathematics scores were categorized and coded into five tiers: below 60, 60-70, 70-80, 80-90, and 90-100 points, which were assigned scores of 1 to 5, respectively.

A Pearson correlation analysis was conducted using SPSS to examine the relationships between the total score on the mathematical modeling ability test and mathematics academic performance, interest in mathematics, and modeling psychology. The resulting data is presented in Table 6.

Table 6. Correlation Analysis Table of Mathematics Grades, Mathematics Interest, Modeling Psychology and Mathematical Modeling Ability

	Leve
Pearson correlation of mathematics grades	.264*
Pearson correlation of mathematical interest	.536**
Model psychological Pearson correlation	.331**
Sig. (Two-tailed	.000
Number of cases	382

Note: *. At level 0.01 (two-tailed), the correlation is significant

According to Table 6, a Pearson correlation analysis of the 382 test samples reveals a correlation coefficient of 0.264 for mathematics academic performance. Since 0.1 < 0.264 < 0.3, this is defined as a weak positive correlation. In other words, at a significance level of 0.01, mathematics academic performance exhibits a weak correlation with mathematical modeling ability. This suggests that a high level of mathematical modeling ability relies on a solid foundation of mathematical knowledge, while improving modeling ability can, in turn, enhance mathematics academic performance. However, academic performance can only influence mathematical modeling ability to a certain extent. Some studies have shown that students with lower grades can still achieve good results in mathematical modeling through effort [19].

To investigate the correlation between interest in mathematics and mathematical modeling ability, this study categorized and coded students' interest in learning mathematics. Students' level of fondness for mathematics was divided into five tiers and assigned scores from 1 to 5, with higher scores indicating a stronger interest. According to Table 6, the correlation coefficient for interest in mathematics is 0.536. Since 0.5 < 0.536 < 1, this is defined as a strong positive correlation. This means that, at a significance level of 0.01, there is a strong correlation between interest in learning mathematics and mathematical modeling ability. It can be inferred that a strong interest in mathematics helps improve mathematical modeling ability, and the process of mathematical modeling allows students to appreciate the charm of mathematics, thereby further enhancing their interest.

To study the correlation between students' mathematical modeling ability and their modeling psychology, this study included questions to investigate students' psychological approach to modeling, specifically their ability to think independently and persevere without giving up easily due to difficulty. Responses were scored on a five-point Likert scale from 1 to 5. According to Table 6, the correlation coefficient for modeling psychology is 0.331, and since 0.3 < 0.331 < 0.5, this indicates a moderate positive correlation. Therefore, at a significance level of 0.01, modeling psychology is significantly correlated with mathematical modeling ability, to a moderate degree. Thus, a positive modeling psychology is conducive to improving students' mathematical modeling ability, and the positive experience gained from strong modeling skills can, in turn, foster a beneficial psychological motivation.

5. Conclusions and Teaching Implications

The mathematical modeling ability framework for university students, constructed in this study based on the three dimensions of real-world context, mathematical content, and task level, is feasible. The assessment tools designed according to this framework can evaluate university students' mathematical modeling ability in a relatively scientific and effective manner. The results indicate that: students' complete modeling ability is generally low; model testing ability is particularly critical for the completion of modeling tasks; there are certain disparities in the development of students' sub-abilities; and most students have significant deficiencies in model assumption ability and model testing ability. Gender differences in mathematical modeling ability are minimal; the school a student attends has a considerable influence on their modeling ability. Meanwhile, students' mathematics academic performance, interest in mathematics, and modeling psychology all influence their mathematical modeling ability to some extent.

By analyzing the assessment results of students' mathematical modeling ability and conducting in-depth teacher interviews, the following three implications are drawn:

5.1 Strengthen the Training of Modeling Sub-Abilities

The survey results show that there are certain differences in the development of students' mathematical modeling sub-abilities. Teachers should fully understand the proficiency levels of students' sub-abilities. Strengthening the training of sub-abilities (especially model assumption ability) is conducive to overcoming obstacles in the mathematical modeling process and helps improve overall mathematical modeling ability. The survey found that when faced with modeling tasks of lower difficulty, one-quarter of students were unable to handle tasks across all difficulty levels. Conversely, when task difficulty increased, another segment of students struggled to relate the real-world context to the mathematical situation, finding themselves unable to begin solving the problem. The initial step into mathematical modeling is particularly challenging, primarily because students find it difficult to make reasonable assumptions and mathematize practical problems.

Therefore, in daily teaching, emphasis should be placed on guiding students to identify problems in their life and studies, and to attempt to establish connections between real-world problems and mathematical situations.

5.2 Guide Students to Participate in Modeling Tasks within Authentic Contexts

When schools organize social practice activities based on local characteristics, they should actively guide students to identify problems during these practices, accumulate material for mathematical modeling, and engage deeply in mathematical modeling activities through teacher-student collaboration.

The investigation found that students' learning interest has a significant impact on their mathematical modeling ability. Interviews revealed that School A offers a mathematical experimentation course and organizes students to participate in social practice activities. For example, teachers led students to participate in the "2025 10th 'MathorCup' University Student Mathematical Modeling Summer Camp," allowing students to genuinely appreciate mathematics in the real world, which is beneficial for improving their model assumption ability. Thus, guiding students to authentically participate in mathematical modeling tasks within real-world contexts, and integrating mathematical modeling instruction with local culture, helps accumulate problem-solving experience and is conducive to developing university students' mathematical modeling ability.

5.3 Strengthen the Development of Mathematical Modeling Curricula

The overall level of mathematical modeling ability among university students is relatively low. In mathematical modeling instruction, most teachers fail to arrange dedicated mathematical modeling courses, and those that exist often have very limited class hours. Research indicates that strengthening the development of mathematical modeling curriculum resources is a powerful guarantee for developing students' mathematical modeling ability. In daily teaching, schools should, based on their own circumstances and local and school characteristics, appropriately integrate mathematical culture into the design and development of mathematical modeling curricula. Schools can offer multiple elective courses to provide students with the necessary platform for mathematical modeling, creating learning opportunities and development space for students who have both the ability and the willingness to study mathematical modeling.

Acknowledgments

This paper was supported by the following projects:

Guangdong Province Higher Education Association “14th Five-Year Plan” Research Project for 2024 on the Evaluation of Mathematical Modeling Capabilities of Undergraduates in New Era Applied Universities (No. 24GQN35);

Guangdong Technology College 2025 first-class course construction project Economic Mathematics (II) (No.YLKC202521);

Research Project of the 2024 Annual Project by the Professional Committee on Teaching Quality Management of Private Universities under the Guangdong Higher Education Teaching Management Association: Blended Teaching Quality Evaluation for Mathematics Courses Based on Neural Networks (No.

GDZLGL2423);
Guangdong Technology College 2024 “Quality Engineering” Project: Blended Teaching Quality Evaluation for Mathematics Courses Based on Neural Networks (Project No. JXGG2024150);
Guangdong Technology University 2023 school-level science and technology project and "Innovation and Strengthening School Project" research project "Research on the Development of MPCK of Mathematics Teachers in Private Applied Undergraduate Colleges" (2023YBSK012).

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