Application of Generative Teaching in the Course of Statistics

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Abstract. This paper explores the application of generative teaching in the course of statistics. It first introduces the current teaching situation of a university's statistics course; then it elaborates on the application of generative teaching in the statistics course, including the use of generative AI tools for statistics teaching design and specific implementation methods of generative teaching in the statistics course; finally, it verifies through experiments the positive role of generative teaching in improving students' learning effectiveness and interest, and proposes suggestions for further improving the application of generative teaching in the statistics course.

Keywords: Generative Teaching, AI, Statistics.

1 Introduction

With the continuous development of artificial intelligence technology, generative teaching, as a new teaching method, has gradually attracted attention. Generative teaching emphasizes a student-centered approach, guiding students to actively participate, autonomously explore and engage in cooperative learning, thereby cultivating students' innovation and practical abilities[1]. This paper will discuss the application of generative teaching in the statistics course, aiming to provide new ideas and methods for improving the quality of statistics teaching.

As a tool-oriented course, statistics is widely applied in both daily life and scientific research, and it is one of the essential basic skills for university students. At our university, "Statistics" is a platform course for economics and management majors, combining theory with practice. The proportion of theoretical and practical sessions is equal, with software applications fully integrated with theoretical teaching, exploring a path of "modularization" + case or project-driven teaching.

According to the statistical analysis capability training matrix, the teaching content is divided into five modules: data acquisition foundation, descriptive statistics foundation, inferential statistics foundation, advanced statistical analysis, and special topics (each major module is further divided into several small teaching modules, with the fifth module being selectively studied by different majors). Each module starts with a typical case that runs through the entire theoretical and practical teaching sessions;

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professional terms (English) and statistical formulas are introduced in the typical cases, allowing students to naturally enter the learning context, avoiding rote memorization, and addressing the foundational issues of "weak subjects" for students. Software operation practice is conducted immediately after each module's theoretical teaching, applying what they have learned on the spot. Statistical investigation and analysis practice are carried out after completing the first three modules to ensure the effective integration of theory and practice. This teaching path effectively addresses issues such as the disconnect between theory and practice, single teaching methods, and limited evaluation methods in traditional teaching models, but still needs to keep pace with the times and faces some problems, such as:

(1) Lack of sufficient industry-related practical projects, which makes it difficult to fully mobilize students' initiative to learn. Although there is content on software applications, simple software operation exercises may not be enough to cultivate students' practical application abilities. A lack of sufficient practical projects closely related to real-world problems may make it difficult for students to apply their knowledge to actual situations. In addition, during the teaching process, the course may not fully demonstrate the applications of statistics in different industries, lacking close ties with the industry, which can make it difficult for students to understand the practical value of statistics, thus reducing their interest and initiative in learning.

(2) Differences in students' software operation abilities. There are differences in students' computer foundations and software operation abilities. For beginners, complex statistical software operations can be a challenge. How to balance the needs of different students and ensure that everyone can keep up with the course progress is a problem that needs to be faced in teaching.

2 Application of Generative Teaching in the Statistics Course

Generative teaching is a teaching method based on artificial intelligence technology, with the core idea of simulating the teaching process of human teachers through computer programs, generating personalized teaching content and feedback to meet the learning needs of different students. Generative teaching can generate personalized teaching content (including teaching cases matched with specialties) and learning feedback according to students' knowledge levels, interests, and learning styles, ensuring that each student receives teaching services suitable for themselves; generative teaching emphasizes interaction between teachers and students, encouraging students to ask questions, express opinions, and share experiences, promoting the exchange and sharing of knowledge; generative teaching can automatically adjust teaching content and difficulty according to students' learning progress and feedback, making teaching more aligned with students' actual needs[2].

2.1 Using Generative AI Tools for "Statistics" Teaching Design

(1) Use generative AI tools to write the teaching objectives and learning outline for the "Statistics" course. Combined with the actual situation of the school's specialty,

add prompts for polishing, and the generated teaching objectives and outline can guide students from their perspective to clarify their direction of effort, making it easier to achieve the course's training objectives.

(2) Use generative AI to automatically generate teaching content, design active learning activities, incorporate ideological and political elements, and generate tutoring materials. As mentioned earlier, a significant issue in current statistics teaching is the lack of sufficient case studies or practical projects closely related to the industry, which can also be addressed with generative AI tools. Generated cases are often based on real-life situations or actual problems, helping students better understand and grasp the application background of statistics and stimulate learning interest. At the same time, the complexity of real cases can also promote students' in-depth thinking, exercising their analytical and judgmental abilities. Case studies are usually designed for specific teaching objectives and knowledge points, helping students better understand and master relevant theories and methods[3]. By analyzing and solving problems in the cases, students can gain a deeper understanding of the concepts and principles of statistics, improving learning outcomes. The design of case studies often has a certain degree of enlightenment and guidance, igniting students' thinking sparks and promoting their active thinking and exploration. In the process of analyzing and solving cases, students need to apply their statistical knowledge and methods, continuously trying and adjusting their thinking, which helps cultivate their innovative spirit and problem-solving abilities. The teaching process of case studies is usually interactive, requiring students to actively participate in discussions and exchanges. In the process of analyzing and solving cases, students need to interact and cooperate with teachers and other classmates to jointly explore solutions to problems. This interactive teaching method helps improve students' participation and learning outcomes and also helps foster their teamwork spirit and communication skills. The teaching process of case studies has a certain degree of flexibility, which can be adjusted and modified according to students' actual situations and teaching needs. Teachers can adjust the difficulty and depth of cases in a timely manner according to students' feedback and performance to ensure the realization of teaching objectives. Meanwhile, students can also choose cases suitable for themselves for analysis and discussion based on their interests and needs.

(3) Evaluate learning outcomes based on teaching objectives to test the achievement of learning goals. Generative AI can generate simulation test questions (including fill-in-the-blank questions, multiple-choice questions, short answer questions, application questions, discussion questions, debate questions, etc.) to test students' mastery of teaching objectives. These simulation test questions can be set individually according to students' actual situations to improve the accuracy and effectiveness of the evaluation. For example, based on specific knowledge training objectives, generative AI tools can design multiple-choice questions and fill-in-the-blank questions, while for competence-oriented training objectives, application questions or practical projects can be designed, and for values-oriented training objectives, discussion questions and debate questions can be designed.

2.2 Promoting Innovation in Statistics Teaching: The Synergy of Teacher-Led Instruction and AI Support>

Undeniably, teachers hold a critical position in the field of statistics education. Their responsibilities extend beyond merely disseminating knowledge; they must also guide students in critical thinking and problem-solving. A teacher's expertise and pedagogical experience are vital for students to grasp intricate statistical concepts and methodologies. Additionally, teachers are adept at adjusting their instructional approaches in response to the varying paces and comprehension levels of students, ensuring that every individual stays on track with the curriculum. Furthermore, the utilization of artificial intelligence tools in statistics education holds great promise for significantly boosting the efficiency and quality of teaching. Teachers can effectively integrate generative AI tools into their curriculum, not only enhancing teaching effectiveness but also driving innovation in course instruction, thereby providing students with a richer, more efficient, and personalized learning experience[4].

(1) Designing Personalized Learning Experiences: Using AI tools to gain in-depth insights into students' learning styles, difficulties, and progress, we can tailor personalized learning paths for each individual student. Based on the student performance data provided by AI, we adjust the teaching content and methods in real-time to ensure that the courses are both challenging and easy to absorb.

(2) Enhancing Interactivity and Engagement: On one hand, introducing AI virtual teaching assistants to assist in answering students' questions, especially during after-school hours and self-study time, providing immediate support. On the other hand, developing AI-driven interactive learning modules, such as simulated experiments and case studies, to increase students' sense of participation and practical opportunities. ments and case studies, to increase student engagement and practical experiences.

(3) Intelligent Assessment and Continuous Feedback: Employ AI tools to automatically grade assignments and exams, especially multiple-choice and short-answer questions, to save time and focus on deeper assessments. Establish AI-supported instant feedback systems to enable students to quickly understand their learning status and make targeted improvements.

(4) Promoting Interdisciplinary Research and Application: Encourage and support students to participate in AI-assisted interdisciplinary research projects, such as utilizing big data analysis to solve practical problems, to cultivate their comprehensive application abilities and innovative thinking. Design practical-oriented teaching activities with AI tools, such as data analysis competitions, real-data set projects, and others, allowing students to learn and grow through practical operations.

(5) Shifting Roles for Teachers: The role of teachers gradually shifts from traditional knowledge dissemination to facilitators and enablers of the learning process, using AI tools to provide students with more autonomous learning spaces[5]. Teachers should continually learn and adapt to new technologies, maintaining the cutting-edge relevance of their teaching content while also keeping an eye on trends in AI development to better integrate it into their instruction.

2.3 Specific Implementation Methods of Generative Teaching in the Statistics Course

(1) Case Introduction: Introduce cases related to the students' major with the help of generative AI tools. For example, for marketing majors, introduce the case of "Market Acceptance Analysis of a New Brand Product." The teacher provides background information: Describe the scenario where a brand is about to launch a new product and the brand's concern about the market acceptance of the product. Pose questions: How to evaluate the market acceptance of the new product? What data needs to be collected? How to analyze it?

(2) Data Collection: Generative teaching can guide students to design reasonable experimental schemes and questionnaires to ensure the accuracy and reliability of the data. The teacher provides simulated market research data or uses generative AI to obtain research data, including potential consumer questionnaire survey results, sales data, etc. Students collect, sort, and filter data in groups to ensure its accuracy and completeness.

(3) Statistical Software Operation: In the statistics course, software operation is an important part. The teacher introduces the basic functions and operation methods of the statistical software used (such as Excel, SPSS, etc.), especially those related to marketing data analysis. Under the guidance of the teacher, students use statistical software to process and analyze data and build models, such as drawing consumer portraits, calculating consumer satisfaction indexes, analyzing sales data, and making sales forecasts. With the help of generative AI tools, students can understand the principles and applicable conditions of various statistical models, guide them to select appropriate models for analysis. In addition, generative teaching can also provide rich cases and simulation data for students to practice and verify.

(4) Result Analysis and Discussion: Students discuss based on the analysis results, exploring how the market acceptance of the new product is and possible market strategies. The teacher encourages students to put forward their own views and hypotheses and guides them to think and discuss deeply. Students can discuss how to formulate the market promotion strategy and pricing strategy of the new product based on the data analysis results. At the same time, generative AI provides intelligent diagnosis and suggestions to help students find potential problems and improvement directions. Integration of Ideological and Political Education: Generative AI suggests that through case analysis, guide students to pay attention to social responsibility, understand the consumer needs and social impacts that enterprises should consider in product development; focus on cultivating students' critical thinking and innovation capabilities, encourage them to put forward their own insights and suggestions.

(5) Learning Feedback: Generative teaching focuses on providing timelyfeedback to students to help them understand their learning status and progress. Generative AI can analyze students' learning history and current abilities to provide personalized learning paths for each individual. For example, for students who have a weak foundation in software operation, AI can recommend more basic tutorials and practical exercises.(6)Teaching Effectiveness: Through the implementation of this case, students not only master the methods of collecting, sorting, and analyzing market re-

search data but also deepen their understanding of statistical theory through practical operations. Moreover, the generative discussion and case extension sessions can stimulate students' interest and desire for exploration, enhancing their learning enthusiasm and engagement. Additionally, students can learn about the practical application of statistics in marketing through case studies, thereby improving their problem-solving and practical abilities.

3 Experimental Verification and Results Analysis

To verify the effectiveness of generative teaching in statistics courses, we conducted a series of experiments. After completing the learning of the descriptive statistics foundation module, we selected two classes of the same grade and major, Class A (totaling 40 students) and Class B (totaling 41 students), and conducted a questionnaire survey to obtain mid-term learning feedback. After learning the inferential statistics foundation module, we conducted another questionnaire survey for Class A (where generative teaching was introduced for this module) and Class B (where traditional teaching was still used) to obtain post-learning feedback.

During the mid-term learning period (as shown in Figure 1), the two classes showed similar scores in terms of learning interest, learning initiative, and other aspects. In the later stage of learning (as shown in Figure 2), the two classes adopted different teaching methods, and the performance of Class A was significantly better than Class B. Compared to the mid-term (as shown in Table 1), Class A students who adopted generative teaching showed significant improvements in learning interest and initiative in the later stage of learning (P-value less than the significance level of 0.01). Specifically, generative teaching was able to stimulate students' learning interest and initiative, improve their learning efficiency and quality. Additionally, from the perspective of the final course report, Class A's achievements, ranging from the closeness of topic selection to the major, the overall standardization and logic of the report, to the rationality of analysis methods, were all superior to Class B. It can be seen that generative teaching can also better cultivate students' innovative and practical abilities, laying a solid foundation for future learning and work.

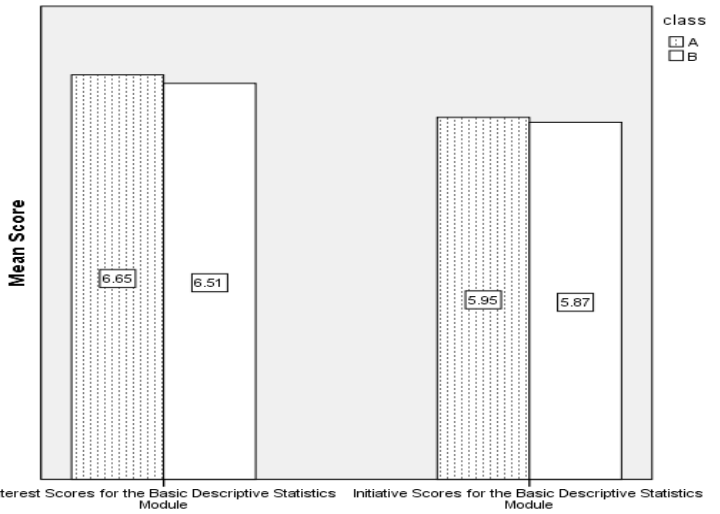

Fig. 1. Comparison of Learning Interest and Learning Initiative Scores in the Basic Module of Descriptive Statistics

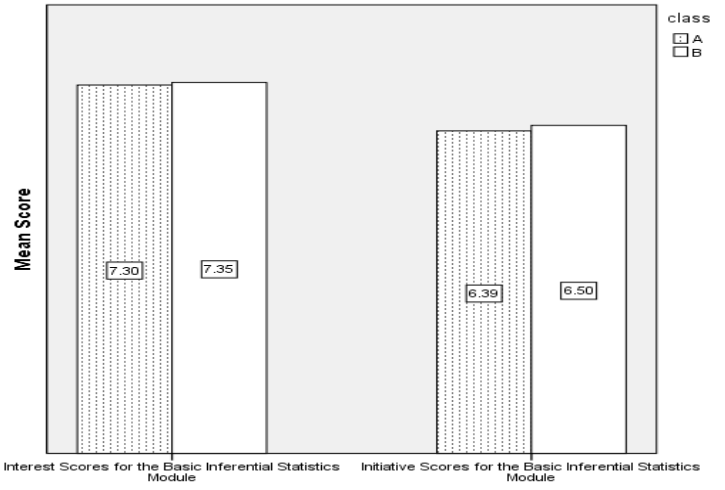

Fig. 2. Comparison of Learning Interest and Learning Initiative Scores in the Basic Module of Inferential Statistics

Table 1. Comparison of Learning Interest Scores and Learning Initiative Scores before and after Adopting Generative Teaching Methods

Paired Samples Statistics

		Mean	N	Std. Deviation	Std.Error Mean
Pair 1	Late-stage interest score	7.3000	40	1.45355	.22983
	Mid-term interest score	6.6500	40	1.65715	.26202
Pair 2	Late-stage initiative score	7.3500	40	1.49443	.23629
	Mid-term initiative score	5.9500	40	1.44914	.22913

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std.Error Mean	95% Confidence Lower	95% Confidence Upper			
Pair 1 Interest score	Late-stage - Mid-term	1.400	.761	.120	1.156	1.643	11.632	39	.000
Pair 2 Initiative score	Late-stage - Mid-term	.650	.699	.110	.426	.873	5.874	39	.000

Data Source: Course Feedback Questionnaire Survey of Class A and Class B of the International Trade Program, Grade 2021, School of Business, Beijing Institute of Technology, Zhuhai

4 Conclusion

This paper discusses the application and effect verification of generative teaching in the statistics course. The experimental results show that generative teaching plays a positive role in improving students' learning effectiveness and interest. Therefore, we suggest that generative teaching methods be widely applied in statistics courses, appropriately adjusted and optimized according to specific circumstances to enhance teaching effectiveness. We also hope that future research can further explore the application of generative teaching in other disciplines and its implementation mechanisms, injecting new vitality into the development of the education sector.

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