**Supplementary Materials**

**Supplementary information** The online version contains supplementary material available at <https://github.com/Baozibudong/teachingplanByGPT4>

**Data availability** The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

**Example of the Process for Improving a Teaching Plan：**

**Unit: "Statistics"**

**Lesson: "Stratified Random Sampling"**

图示, 文本

中度可信度描述已自动生成

**Fig. 1 Construction and Evaluation of the Teaching Plan Dataset**

**Example of the Teaching Phase for Explaining New Knowledge:**

**Original Teaching Plan Generated by GPT-4 Based on Problem Chains:**

**II. Explanation of New Knowledge**

**Knowledge Point 1: What is Stratified Random Sampling?**

**[Problem Chain 4]:** Through the Pre-class Introduction, we have categorized the customer groups of a supermarket. Can this operation solve the potential issues we discussed earlier with simple random sampling?

**[Variant Question 1]:** Suppose we categorize individuals based on two dimensions: gender and age, and then randomly select a certain number of people from each category for a survey. Could this method better represent the overall customer population? What is this sampling method called?

**[Teaching Activities and Design Intentions]:** An interactive Q&A activity encourages students to think and respond to questions, guiding them to self-discover the concept of stratified random sampling. The instructional objective of this design is to help students understand that stratified random sampling is a more effective method that can better represent the entire study population.

**Knowledge Point 2: How to Conduct Stratified Random Sampling?**

**[Problem Chain 5]:** Now that we understand the basic concept of stratified random sampling, how should we proceed with it? If we categorize supermarket customers by gender and age, how many people should be sampled from each category?

**[Variant Question 1]:** Suppose we categorize male customers into age groups: 18-25, 26-35, 36-45, and over 46 years old, and female customers are categorized similarly. How many people should we sample from each category? How should we decide?

**[Teaching Activities and Design Intentions]:** A small group discussion activity encourages students to explore and understand the specific methods of stratified random sampling through discussion. This activity aims to help students comprehend the factors and steps involved in stratified random sampling, enhancing their logical reasoning and mathematical modeling skills.

**Knowledge Point 3: Advantages and Disadvantages of Stratified Random Sampling**

**[Problem Chain 6]:** Now that we know how to perform stratified random sampling, is this method always superior to simple random sampling? If so, what are its advantages? If not, what are its disadvantages?

**[Variant Question 1]:** Suppose in our supermarket survey, we find that most shoppers are middle-aged women. In this case, which method is more advantageous, stratified random sampling or simple random sampling? Why?

**[Teaching Activities and Design Intentions]:** A classroom debate activity allows students to discuss and debate the advantages and disadvantages of stratified random sampling, enhancing their logical reasoning and data analysis skills. Through this activity, students gain a deeper understanding of the strengths and weaknesses of stratified random sampling, enabling them to better select and apply the appropriate sampling method to solve practical problems.

**Teaching Process Simulated by GPT-4:**

**II. Explanation of New Knowledge**

**Teacher:** Reflecting on our previous discussion, we have categorized the supermarket's customer base. Let's consider whether this approach could address the issues we previously discussed with simple random sampling.

**Student 1 (correct response):** I think it solves some problems. By categorizing the customers based on certain characteristics, the samples drawn will be more representative.

**Teacher:** Excellent point. This categorization helps us better represent the entire customer population. Suppose we classify by gender and age, then randomly select a certain number of people from each category for our survey. What do you think, can this method better represent the overall customer base? What is this sampling method called?

**Student 2 (confused, incorrect response):** Is it called categorical sampling?

Teacher: Close! It's a special kind of sampling method called stratified random sampling. Let’s delve deeper into the concept and steps of this method. Now that we understand the basics of stratified random sampling, how should we proceed with it? If we categorize supermarket customers by gender and age, how many should we sample from each category?

**Student 3 (correct response):** I think we should sample according to the proportion of people in each category. If one category has more people, we should draw more samples; if another has fewer, we should draw fewer samples.

**Teacher:** Very good! You’re correct. Typically, we sample according to the proportion of each category, a common method in stratified random sampling. Let's try a specific example. Suppose we categorize male customers into age groups: 18-25, 26-35, 36-45, and over 46 years old, and female customers similarly. How many should we sample from each category? How do we decide?

**Student 4 (struggling with previous knowledge):** Teacher, I’m not sure how to determine the specific number of samples.

**Teacher:** No worries. We usually decide the number of samples based on the proportion of each category. For example, if male customers aged 18-25 make up 10% of all customers, we should sample 10% from this category. Everyone, try practicing this method.

**Student 5 (posing their own question):** Teacher, if a category has very few people, do we still need to sample from it?

**Teacher:** That’s an excellent question. If a category has very few people, we might need to sample all or increase the sample size to ensure representativeness. This approach ensures that all important categories are adequately represented. Now, let’s discuss the advantages and disadvantages of stratified random sampling. Do you think stratified random sampling is always better than simple random sampling?

**Student 6 (correct response):** Stratified random sampling can represent the overall population better, but it might be more complicated since it requires categorization first.

**Teacher: Well said.** The advantage of stratified random sampling is its representativeness, though it may be more complex than simple random sampling. Suppose in our supermarket survey, we find that most shoppers are middle-aged women, which method would be more advantageous in this scenario, stratified random sampling or simple random sampling? Why?

**Student 7 (correct response):** If most shoppers are middle-aged women, then simple random sampling could also represent the overall population well because the majority of the sample would be middle-aged women too.

**Teacher:** Very well! In this scenario, both simple random sampling and stratified random sampling can effectively represent the overall population. Through these discussions and debates, have you gained a deeper understanding of the advantages and disadvantages of stratified random sampling? Next, we will proceed with further exercises and consolidation.

**Teaching Reflection Generated by GPT-4:**

**II. Explanation of New Knowledge**

**Deficiency 1:** The instructional design attempts to introduce the core concepts of stratified random sampling through specific examples, yet it lacks sufficient bridging when transitioning to the actual operational methods of sampling. This deficiency may lead to difficulties for students in transitioning from theoretical understanding to practical application, particularly in grasping how many individuals should be sampled from each category.

**Deficiency 2:** Although classroom discussions and interactive Q&A sessions enhance student engagement, the teaching plan does not adequately address the needs of students with varying levels of cognitive abilities. For students who are slower in understanding concepts, the plan should provide layered questions or more detailed explanations to ensure that all students can keep pace with the lesson.

**Deficiency 3:** The explanation of new knowledge does not cover the mathematical history or cultural background related to stratified random sampling, which could enrich students' interest and deepen their understanding. For instance, introducing the historical development of this method or its application cases in modern research could be beneficial.

**Deficiency 4:** The instructional methods primarily rely on oral explanations and simple interactive activities, lacking a variety of teaching activities such as workshops simulating the actual sampling process or demonstrations using statistical software. Such activities would more vividly demonstrate the application process of stratified random sampling and enhance students' practical skills.

**Deficiency 5:** Some aspects of the question design, such as the student debate segments, do not adequately anticipate possible misunderstandings, requiring teachers to improvise responses to student errors during class. The teaching plan should incorporate more potential student responses and teacher feedback strategies to ensure continuity and effectiveness in teaching.

**Improved Teaching Plan by GPT-4:**

**II. Explanation of New Knowledge**

**Knowledge Point 1: What is Stratified Random Sampling?**

**[Context-Based Problem Chain]:**

**[Problem Chain 1]:** Suppose we have a database of supermarket customers with 20% aged 18-30, 50% aged 31-50, and 30% over 51. What potential problems might arise if we only use simple random sampling?

**[Problem Chain 2]:** To ensure each age group is adequately represented in our sample, we could divide customers into different groups by age and then sample proportionally from each group. What is this method called?

**[Problem Chain 3]:** Suppose we now categorize customers by both gender and age, sampling a fixed number of people from each category for a survey. Would this method better represent the overall customer base?

**[Trap-Based Problem Chain]:**

**[Problem Chain 4]:** If we group customers by shopping frequency (high, medium, low) and sample from each frequency group, do you think this sample design would be more representative? Why?

**[Problem Chain 5]:** What issues might arise if we divide customers into groups but do not sample proportionally from each group?

**[Teaching Activities and Design Intentions]:**

**Activity:** Interactive Q&A session. By guiding students through questions and gradually leading them to understand the concept of stratified random sampling, this activity helps them grasp how this method effectively addresses the issues inherent in simple random sampling.

**Design Intention:** This activity aims to guide students through thinking about practical problems to gradually understand the concept and importance of stratified random sampling, thereby developing their logical thinking and mathematical abstraction skills.

**Knowledge Point 2: How to Conduct Stratified Random Sampling?**

**[Context-Based Problem Chain]:**

**Problem Chain 6:** Now that we understand the basic concept of stratified random sampling, how should we proceed? If we categorize supermarket customers by gender and age, how many people should we sample from each category?

**Problem Chain 7:** Suppose we divide male customers into age groups: 18-25, 26-35, 36-45, and over 46 years old, and similarly for female customers. If the supermarket has 1000 customers and the proportion of each age and gender group is as follows, how many should we sample from each category to form a 100-person sample?

**[Trap-Based Problem Chain]:**

**[Problem Chain 8]:** If we categorize male customers by employment type (full-time, part-time, student, retired) and then randomly sample from each group, do you think this categorization is reasonable? Why?

**[Problem Chain 9]:** Suppose in practice, some categories have very few customers. How should we adjust our sampling strategy?

**[Teaching Activities and Design Intentions]:**

**Activity:** Small group discussion. Students discuss in groups how to perform stratified random sampling and calculate the number of people to be sampled from each category, with the teacher guiding the discussion and providing assistance as needed.

**Design Intention:** This group discussion activity aims to foster cooperative learning and logical reasoning skills among students, enabling them to master the specific steps and methods of stratified random sampling.

**Knowledge Point 3: Advantages and Disadvantages of Stratified Random Sampling**

**[Context-Based Problem Chain]:**

**[Problem Chain 10]:** Now that we know how to perform stratified random sampling, is this method always superior to simple random sampling? If so, what are its advantages? If not, what are its disadvantages?

**[Problem Chain 11]:** Suppose in our supermarket survey, we find that most shoppers are middle-aged women. In this case, which method would be more advantageous, stratified random sampling or simple random sampling? Why?

**[Trap-Based Problem Chain]:**

**[Problem Chain 12]:** Suppose during stratified random sampling, the proportion of some customer categories changes significantly. What impact might this have on our sampling results? How can we address this issue?

**[Problem Chain 13]:** If we find it difficult to gather data from a particular stratum during the sampling process, how should we handle this to ensure the representativeness of the sample?

**[Teaching Activities and Design Intentions]:**

**Activity:** Classroom debate. Students are divided into two groups, one discussing the advantages of stratified random sampling and the other its disadvantages. After the debate, the teacher summarizes and supplements the discussion with additional information.

**Design Intention:** The debate activity aims to cultivate students' critical thinking and expressive skills, enabling them to deeply understand the strengths and weaknesses of stratified random sampling and to choose the appropriate sampling method for practical problems.

**Prompt: Simulate Classroom Process**

Now, based on the "Pre-class Introduction" phase we have just generated, please continue to role-play as a high school mathematics teacher and students of different learning levels. I will provide you with the content of different instructional phases from the high school mathematics teaching plan. The next phase is the "Explanation of New Knowledge". Please simulate and generate the teaching and learning process through teacher-student interactions according to the instructional content of this phase, the instructional objectives, the teaching priorities and challenges, and the key knowledge points of this lesson. The subsequent instructional phases include: Consolidation and Improvement, Comprehensive Exercise, and Lesson Summary.

When simulating high school students' responses, possible types of responses include: confusing concepts and giving wrong answers, giving wrong answers due to misconceptions, being unable to answer due to not learning previous knowledge points, asking their own questions, and answering correctly. Note: "students" here can represent students of different ability levels, so it is necessary to consider generating different types of responses.

The simulated teacher's speech needs to make the next teaching decision based on the instructional content of this phase and the corresponding student responses, and generate the corresponding teacher's speech.

**【Instructional Analysis for this Lesson】**

[Unit Name]: Sampling Methods

[Course Topic]: Stratified Random Sampling

[Instructional Objectives]:

1. Students should understand and clearly explain what "stratified random sampling" is and describe its application in data collection and research in detail. Emphasize how to use stratified sampling more effectively to obtain samples in certain situations, enhancing data analysis capabilities and mathematical abstract thinking.

2. Students need to master the specific steps and methods of stratified sampling and be able to independently design an implementation plan for stratified sampling. Understand and identify potential issues related to stratified sampling in real life or theoretical research, improving logical reasoning and mathematical modeling skills.

3. Students should be able to apply the knowledge of stratified sampling to analyze and solve practical problems. For example, in a survey study, how to design an effective sample through stratified sampling. They should not only be able to apply it but also understand and explain the results, developing intuitive imagination and mathematical computation abilities.

[Teaching Priority]: Understanding and mastering the principles and applications of "stratified random sampling", clarifying its importance in data collection and research, and proficiently using logical reasoning and mathematical modeling skills to design reasonable and effective stratified sampling plans.

[Teaching Challenge]: Effectively applying "stratified random sampling" in analyzing and solving practical problems, including sample design and result interpretation. This requires a deep understanding and proficient mastery of the knowledge of stratified random sampling, while strengthening intuitive imagination and mathematical computation abilities.

[Knowledge Points for this Lesson]: Stratified random sampling or stratified sampling, methods of stratified sampling.

**【Instructional Phase】: Explanation of New Knowledge**

Knowledge Point 1: What is Stratified Random Sampling?

[Problem Chain 4]: Through the Pre-class Introduction, we have categorized the customer groups of a supermarket. Can this operation solve the potential issues we discussed earlier with simple random sampling?

[Variant Question 1]: Suppose we categorize individuals based on two dimensions: gender and age, and then randomly select a certain number of people from each category for a survey. Could this method better represent the overall customer population? What is this sampling method called?

[Teaching Activities and Design Intentions]: An interactive Q&A activity encourages students to think and respond to questions, guiding them to self-discover the concept of stratified random sampling. The instructional objective of this design is to help students understand that stratified random sampling is a more effective method that can better represent the entire study population.

Knowledge Point 2: How to Conduct Stratified Random Sampling?

[Problem Chain 5]: Now that we understand the basic concept of stratified random sampling, how should we proceed with it? If we categorize supermarket customers by gender and age, how many people should be sampled from each category?

[Variant Question 1]: Suppose we categorize male customers into age groups: 18-25, 26-35, 36-45, and over 46 years old, and female customers are categorized similarly. How many people should we sample from each category? How should we decide?

[Teaching Activities and Design Intentions]: A small group discussion activity encourages students to explore and understand the specific methods of stratified random sampling through discussion. This activity aims to help students comprehend the factors and steps involved in stratified random sampling, enhancing their logical reasoning and mathematical modeling skills.

Knowledge Point 3: Advantages and Disadvantages of Stratified Random Sampling

[Problem Chain 6]: Now that we know how to perform stratified random sampling, is this method always superior to simple random sampling? If so, what are its advantages? If not, what are its disadvantages?

[Variant Question 1]: Suppose in our supermarket survey, we find that most shoppers are middle-aged women. In this case, which method is more advantageous, stratified random sampling or simple random sampling? Why?

[Teaching Activities and Design Intentions]: A classroom debate activity allows students to discuss and debate the advantages and disadvantages of stratified random sampling, enhancing their logical reasoning and data analysis skills. Through this activity, students gain a deeper understanding of the strengths and weaknesses of stratified random sampling, enabling them to better select and apply the appropriate sampling method to solve practical problems.

**Note:** Please describe this instructional phase's class process as detailed as possible. Do not generate responses beyond the cognitive level of high school students; they should conform to the tone of high school students.

**Note:** The teacher should avoid directly introducing the technical terms of this lesson's knowledge points before explaining them according to the teaching plan content. Once the teacher has explained these knowledge points, they can use the technical terms.

**【Teaching Process Generation Format Example】:**

【Instructional Phase】: Explanation of New Knowledge

Teacher:

Student 1:

Teacher:

Student 2:

Teacher:

Student 3:

......

**Prompt:** **Generate Teaching Reflection**

Now please continue to role-play as a high school mathematics teacher. You have just finished teaching a high school mathematics lesson and have received the transcript of the teaching and learning process from the recorded video of the lesson. Based on the transcript of the lesson, reflect on the content of your designed teaching plan and the teaching process.

I will provide you with the content of different instructional phases from the high school mathematics teaching plan and the transcript of teacher-student dialogues during the lesson. The next phase is the "Explanation of New Knowledge". Please generate a teaching reflection for this phase based on the instructional plan, the teacher-student dialogue transcript, the instructional objectives, the teaching priorities and challenges, and the key knowledge points of this lesson. The subsequent instructional phases include: Consolidation and Improvement, Comprehensive Exercise, and Lesson Summary.

As a high school mathematics teacher, you need to reflect on the "Explanation of New Knowledge" phase from the following dimensions: whether the design of the problem chains reflects the definition and analysis of the core knowledge concepts of this lesson, whether the design of the problem chains considers students of different levels, whether there is knowledge beyond the scope of this lesson, whether the mathematical historical and cultural context related to the knowledge content is considered, and whether there are issues in the choice of teaching methods, strategies, and the design of teaching activities.

**【Basic Information of this Lesson】**

[Unit Name]: Sampling Methods

[Course Topic]: Stratified Random Sampling

[Instructional Objectives]:

1. Students should understand and clearly explain what "stratified random sampling" is and describe its application in data collection and research in detail. Emphasize how to use stratified sampling more effectively to obtain samples in certain situations, enhancing data analysis capabilities and mathematical abstract thinking.

2. Students need to master the specific steps and methods of stratified sampling and be able to independently design an implementation plan for stratified sampling. Understand and identify potential issues related to stratified sampling in real life or theoretical research, improving logical reasoning and mathematical modeling skills.

3. Students should be able to apply the knowledge of stratified sampling to analyze and solve practical problems. For example, in a survey study, how to design an effective sample through stratified sampling. They should not only be able to apply it but also understand and explain the results, developing intuitive imagination and mathematical computation abilities.

[Teaching Priority]: Understanding and mastering the principles and applications of "stratified random sampling", clarifying its importance in data collection and research, and proficiently using logical reasoning and mathematical modeling skills to design reasonable and effective stratified sampling plans.

[Teaching Challenge]: Effectively applying "stratified random sampling" in analyzing and solving practical problems, including sample design and result interpretation. This requires a deep understanding and proficient mastery of the knowledge of stratified random sampling, while strengthening intuitive imagination and mathematical computation abilities.

[Knowledge Points for this Lesson]: Stratified random sampling or stratified sampling, methods of stratified sampling.

**【Teaching Plan Content】: Explanation of New Knowledge**

Knowledge Point 1: What is Stratified Random Sampling?

[Problem Chain 4]: Through the Pre-class Introduction, we have categorized the customer groups of a supermarket. Can this operation solve the potential issues we discussed earlier with simple random sampling?

[Variant Question 1]: Suppose we categorize individuals based on two dimensions: gender and age, and then randomly select a certain number of people from each category for a survey. Could this method better represent the overall customer population? What is this sampling method called?

[Teaching Activities and Design Intentions]: An interactive Q&A activity encourages students to think and respond to questions, guiding them to self-discover the concept of stratified random sampling. The instructional objective of this design is to help students understand that stratified random sampling is a more effective method that can better represent the entire study population.

Knowledge Point 2: How to Conduct Stratified Random Sampling?

[Problem Chain 5]: Now that we understand the basic concept of stratified random sampling, how should we proceed with it? If we categorize supermarket customers by gender and age, how many people should be sampled from each category?

[Variant Question 1]: Suppose we categorize male customers into age groups: 18-25, 26-35, 36-45, and over 46 years old, and female customers are categorized similarly. How many people should we sample from each category? How should we decide?

[Teaching Activities and Design Intentions]: A small group discussion activity encourages students to explore and understand the specific methods of stratified random sampling through discussion. This activity aims to help students comprehend the factors and steps involved in stratified random sampling, enhancing their logical reasoning and mathematical modeling skills.

Knowledge Point 3: Advantages and Disadvantages of Stratified Random Sampling

[Problem Chain 6]: Now that we know how to perform stratified random sampling, is this method always superior to simple random sampling? If so, what are its advantages? If not, what are its disadvantages?

[Variant Question 1]: Suppose in our supermarket survey, we find that most shoppers are middle-aged women. In this case, which method is more advantageous, stratified random sampling or simple random sampling? Why?

[Teaching Activities and Design Intentions]: A classroom debate activity allows students to discuss and debate the advantages and disadvantages of stratified random sampling, enhancing their logical reasoning and data analysis skills. Through this activity, students gain a deeper understanding of the strengths and weaknesses of stratified random sampling, enabling them to better select and apply the appropriate sampling method to solve practical problems.

**【Teaching Process】: Explanation of New Knowledge**

Teacher: Reflecting on our previous discussion, we have categorized the supermarket's customer base. Let's consider whether this approach could address the issues we previously discussed with simple random sampling.

Student 1 (correct response): I think it solves some problems. By categorizing the customers based on certain characteristics, the samples drawn will be more representative.

Teacher: Excellent point. This categorization helps us better represent the entire customer population. Suppose we classify by gender and age, then randomly select a certain number of people from each category for our survey. What do you think, can this method better represent the overall customer base? What is this sampling method called?

Student 2 (confused, incorrect response): Is it called categorical sampling?

Teacher: Close! It's a special kind of sampling method called stratified random sampling. Let’s delve deeper into the concept and steps of this method. Now that we understand the basics of stratified random sampling, how should we proceed with it? If we categorize supermarket customers by gender and age, how many should we sample from each category?

Student 3 (correct response): I think we should sample according to the proportion of people in each category. If one category has more people, we should draw more samples; if another has fewer, we should draw fewer samples.

Teacher: Very good! You’re correct. Typically, we sample according to the proportion of each category, a common method in stratified random sampling. Let's try a specific example. Suppose we categorize male customers into age groups: 18-25, 26-35, 36-45, and over 46 years old, and female customers similarly. How many should we sample from each category? How do we decide?

Student 4 (struggling with previous knowledge): Teacher, I’m not sure how to determine the specific number of samples.

Teacher: No worries. We usually decide the number of samples based on the proportion of each category. For example, if male customers aged 18-25 make up 10% of all customers, we should sample 10% from this category. Everyone, try practicing this method.

Student 5 (posing their own question): Teacher, if a category has very few people, do we still need to sample from it?

Teacher: That’s an excellent question. If a category has very few people, we might need to sample all or increase the sample size to ensure representativeness. This approach ensures that all important categories are adequately represented. Now, let’s discuss the advantages and disadvantages of stratified random sampling. Do you think stratified random sampling is always better than simple random sampling?

Student 6 (correct response): Stratified random sampling can represent the overall population better, but it might be more complicated since it requires categorization first.

Teacher: Well said. The advantage of stratified random sampling is its representativeness, though it may be more complex than simple random sampling. Suppose in our supermarket survey, we find that most shoppers are middle-aged women, which method would be more advantageous in this scenario, stratified random sampling or simple random sampling? Why?

Student 7 (correct response): If most shoppers are middle-aged women, then simple random sampling could also represent the overall population well because the majority of the sample would be middle-aged women too.

Teacher: Very well! In this scenario, both simple random sampling and stratified random sampling can effectively represent the overall population. Through these discussions and debates, have you gained a deeper understanding of the advantages and disadvantages of stratified random sampling? Next, we will proceed with further exercises and consolidation.

Note: Reflect on the content design deficiencies of this instructional phase based on the teaching plan and the class process only. No more than 5 points.

Note: Do not generate or explain the next steps for improvement plans or measures.

**【Teaching Reflection Generation Format Example】**

【Reflection on the Teaching Plan】: Explanation of New Knowledge

Deficiency 1:

Deficiency 2:

Deficiency 3:

Deficiency 4:

......

【Teaching Reflection Example, for Reference Only】:

Deficiency 1: The problem chain focuses more on the classification and organization of data rather than directly addressing the core concepts of sets, such as the definitions of finite sets, infinite sets, number sets, and empty sets. This may result in students lacking clear and intuitive mathematical definitions when understanding set concepts.

**Prompt:** **Improve Teaching Plan**

Please combine the context generated in the "Pre-class Introduction" with your analysis of the instructional content design, and the teaching plan and instructional reflection content prior to the "Explanation of New Knowledge" phase to continue improving the design of the "Explanation of New Knowledge" phase teaching plan.

The "Explanation of New Knowledge" phase can refer to the following learning activities: group discussion, guided activities, interactive Q&A, brainstorming, role-playing, experimental activities, game activities, demonstrations and presentations, field trips, classroom debates, creative activities, self-reflection, speed writing activities, story or diary writing, creating charts or models, reading aloud, knowledge competitions, cooperative learning, etc. The following teaching methods can be referenced: heuristic teaching method, cooperative learning method, situational learning method, project-based learning method, stratified teaching method, blended learning method, inquiry-based teaching method, gamified learning method, story-based teaching method, etc.

Please design detailed and specific activities for each knowledge point in the form of a detailed teaching plan, paying attention to the continuity with the "Pre-class Introduction" phase and the design of problem chains. Generate contextual problems based on the context of the Pre-class Introduction and design trap problems based on core concepts. The design of the problem chains should reflect the analysis of core concept definitions and provide possible teaching activities and design intentions after each problem.

Do not design beyond the content of the knowledge. If calculations are needed, please list mathematical formulas. Use LaTeX format in Word $ $ to represent specific formulas; do not break the line when entering formulas, and place them on the same line as the text.

**【Instructional Analysis for this Lesson】**

[Unit Name]: Sampling Methods

[Course Topic]: Stratified Random Sampling

[Instructional Objectives]:

1. Students should understand and clearly explain what "stratified random sampling" is and describe its application in data collection and research in detail. Emphasize how to use stratified sampling more effectively to obtain samples in certain situations, enhancing data analysis capabilities and mathematical abstract thinking.

2. Students need to master the specific steps and methods of stratified sampling and be able to independently design an implementation plan for stratified sampling. Understand and identify potential issues related to stratified sampling in real life or theoretical research, improving logical reasoning and mathematical modeling skills.

3. Students should be able to apply the knowledge of stratified sampling to analyze and solve practical problems. For example, in a survey study, how to design an effective sample through stratified sampling. They should not only be able to apply it but also understand and explain the results, developing intuitive imagination and mathematical computation abilities.

[Teaching Priority]: Understanding and mastering the principles and applications of "stratified random sampling", clarifying its importance in data collection and research, and proficiently using logical reasoning and mathematical modeling skills to design reasonable and effective stratified sampling plans.

[Teaching Challenge]: Effectively applying "stratified random sampling" in analyzing and solving practical problems, including sample design and result interpretation. This requires a deep understanding and proficient mastery of the knowledge of stratified random sampling, while strengthening intuitive imagination and mathematical computation abilities.

[Knowledge Points for this Lesson]: Stratified random sampling or stratified sampling, methods of stratified sampling.

**【Previous Teaching Plan】: Explanation of New Knowledge**

Knowledge Point 1: What is Stratified Random Sampling?

[Problem Chain 4]: Through the Pre-class Introduction, we have categorized the customer groups of a supermarket. Can this operation solve the potential issues we discussed earlier with simple random sampling?

[Variant Question 1]: Suppose we categorize individuals based on two dimensions: gender and age, and then randomly select a certain number of people from each category for a survey. Could this method better represent the overall customer population? What is this sampling method called?

[Teaching Activities and Design Intentions]: An interactive Q&A activity encourages students to think and respond to questions, guiding them to self-discover the concept of stratified random sampling. The instructional objective of this design is to help students understand that stratified random sampling is a more effective method that can better represent the entire study population.

Knowledge Point 2: How to Conduct Stratified Random Sampling?

[Problem Chain 5]: Now that we understand the basic concept of stratified random sampling, how should we proceed with it? If we categorize supermarket customers by gender and age, how many people should be sampled from each category?

[Variant Question 1]: Suppose we categorize male customers into age groups: 18-25, 26-35, 36-45, and over 46 years old, and female customers are categorized similarly. How many people should we sample from each category? How should we decide?

[Teaching Activities and Design Intentions]: A small group discussion activity encourages students to explore and understand the specific methods of stratified random sampling through discussion. This activity aims to help students comprehend the factors and steps involved in stratified random sampling, enhancing their logical reasoning and mathematical modeling skills.

Knowledge Point 3: Advantages and Disadvantages of Stratified Random Sampling

[Problem Chain 6]: Now that we know how to perform stratified random sampling, is this method always superior to simple random sampling? If so, what are its advantages? If not, what are its disadvantages?

[Variant Question 1]: Suppose in our supermarket survey, we find that most shoppers are middle-aged women. In this case, which method is more advantageous, stratified random sampling or simple random sampling? Why?

[Teaching Activities and Design Intentions]: A classroom debate activity allows students to discuss and debate the advantages and disadvantages of stratified random sampling, enhancing their logical reasoning and data analysis skills. Through this activity, students gain a deeper understanding of the strengths and weaknesses of stratified random sampling, enabling them to better select and apply the appropriate sampling method to solve practical problems.

**【Teaching Reflection】: Explanation of New Knowledge**

Deficiency 1: The instructional design attempts to introduce the core concepts of stratified random sampling through specific examples, yet it lacks sufficient bridging when transitioning to the actual operational methods of sampling. This deficiency may lead to difficulties for students in transitioning from theoretical understanding to practical application, particularly in grasping how many individuals should be sampled from each category.

Deficiency 2: Although classroom discussions and interactive Q&A sessions enhance student engagement, the teaching plan does not adequately address the needs of students with varying levels of cognitive abilities. For students who are slower in understanding concepts, the plan should provide layered questions or more detailed explanations to ensure that all students can keep pace with the lesson.

Deficiency 3: The explanation of new knowledge does not cover the mathematical history or cultural background related to stratified random sampling, which could enrich students' interest and deepen their understanding. For instance, introducing the historical development of this method or its application cases in modern research could be beneficial.

Deficiency 4: The instructional methods primarily rely on oral explanations and simple interactive activities, lacking a variety of teaching activities such as workshops simulating the actual sampling process or demonstrations using statistical software. Such activities would more vividly demonstrate the application process of stratified random sampling and enhance students' practical skills.

Deficiency 5: Some aspects of the question design, such as the student debate segments, do not adequately anticipate possible misunderstandings, requiring teachers to improvise responses to student errors during class. The teaching plan should incorporate more potential student responses and teacher feedback strategies to ensure continuity and effectiveness in teaching.

Note: Before the teacher explains the knowledge points of this lesson, do not directly introduce the technical terms or definitions of the concepts of this lesson. You need to reasonably improve the content of the problem chains according to the instructional phase and the previous teaching plan. For example, before explaining what a "set" is, you should not directly mention "set" in the problem chain questions.

Note: Pay attention to the scope of the knowledge points of this lesson and avoid exceeding it. For example, if the knowledge points of this lesson do not include the content of "intersection," do not design problem chains with "intersection" content. Use LaTeX format in Word $...$ to represent specific formulas; do not break the line when entering formulas, and place them on the same line as the text. It is also preferable to include specific numerical values in the problem chain.

**【Example Format for the Improved Explanation of New Knowledge Phase】**

【Improved Teaching Plan】: Explanation of New Knowledge

Knowledge Point:

[Context-based Problem Chain]:Given that the terminal side of angle $\alpha$ passes through point $P(1,2)$, find the sine, cosine, tangent, and cotangent values of angle $\alpha$.

[Trap Variant Problem]:If the coordinates of point $P$ in Context-based Problem Chain 3 are changed to $P(a, -2a)$ (where $a > 0$), will the sine, cosine, tangent, and cotangent values of angle $\alpha$ change? Why?

[Teaching Activities and Design Intent]:

Knowledge Point:

[Context-based Problem Chain]:

1.

2.

[Trap Variant Problem]:

1.

2.

[Teaching Activities and Design Intent]:

Knowledge Point:

[Context-based Problem Chain]:

1.

2.

[Trap Variant Problem]:

1.

2.

[Teaching Activities and Design Intent]:

......