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Research and Practice on Thematic Assignment Design under the Context of Reducing Burden and Increasing Efficiency

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Abstract: The middle school stage is a crucial period for cultivating students' scientific thinking and inquiry skills. This paper briefly elaborates on the optimized design of thematic assignments related to bacteria and fungi, within the educational framework of "reducing burden and increasing efficiency." Addressing the disconnect between teaching, daily life, and biotechnology, this approach significantly expands students' deeper understanding of the field of biological fermentation and lays a solid foundation for their future careers in various scientific domains.

Keywords: biological assignment design, bacteria and fungi, plant nutrient solution, kitchen waste, reducing burden and increasing efficiency

1. Introduction

The forefront of biological science is advancing rapidly, and biotechnology is constantly evolving, closely intertwined with production and daily life. In the limited classroom time and extracurricular activities, the challenge in the field of biology education is how to effectively stimulate students' interest in scientific exploration and cultivate their scientific thinking, given the constraints. This challenge also underscores the importance of cultivating scientific thinking in biology and the necessity of integrating practical inquiry into the classroom. In the current educational context of "reducing burden and increasing efficiency," the design of biological assignments should focus on optimizing the structure of student assignments, enhancing their scientific thinking and practical abilities. This approach gradually infuses core competencies of biology into the unit teaching design and the optimized assignment formats in daily teaching, especially at the middle school stage.

At the middle school level, students should learn to take a dialectical view of the impact of bacteria and fungi on humans. Harmful bacteria and fungi can cause plant diseases, but beneficial ones not only provide essential nutrients for plants but also resist pathogens. Biological control mainly utilizes biocontrol microorganisms for prevention and control. Using various biocontrol microorganisms can introduce a large number of beneficial microorganisms into the soil, which can compete with and inhibit pathogens, reduce pathogenic pressure, induce plant resistance, and promote plant growth, thereby achieving the prevention and control of soil-borne diseases [1]. On one hand, the production of plant nutrient solutions expands students' understanding beyond familiar fermented foods such as yogurt, pickles, and rice wine. On the other hand, since plant

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nutrient solutions are made from kitchen waste, students become involved in environmental conservation efforts, enhancing their sense of responsibility for protecting the environment.

2. Key Points in the Design of Middle School Biology Assignments

2.1. Diversification in Middle School Biology Assignment Design [2]

In the process of designing middle school biology assignments, teachers should effectively carry out innovative and feasible educational activities in line with the educational objectives of the new curriculum standards and the core competencies that students are expected to achieve. Diversified biology assignments should possess the following characteristics:

(1) Practicality: During assignment design, teachers should integrate the content of the current unit with real-life situations, closely connecting life and biology. This integration enhances students' learning experiences and insights by incorporating the objectives of the new curriculum reform.

(2) Practical Experience: While completing biology assignments, students delve deeply into the subject matter, exploring knowledge points in-depth. They achieve this by effectively integrating theoretical knowledge from the curriculum with hands-on practice, gaining first-hand experience.

(3) Hierarchical and Open-ended Nature: For students at Level A who have a solid grasp of core textbook knowledge, they can reinforce their foundation by employing logical thinking and scientific literacy to independently design experimental inquiry topics within a feasible scope. For Level B students, supplementary methods such as multiple-choice questions, basic fill-in-the-blanks, and contextual materials can aid in understanding foundational textbook knowledge, assisting weaker students in establishing a gradual increase in assignment complexity. Additionally, incorporating open-ended questions in assignments and allowing room for creative thinking in the classroom fosters divergent thinking and creative skills.

2.2. Utilizing Subject-based Clubs for Biology Practical Assignments

Middle school biology offers numerous opportunities for practical activities, which can supplement and extend classroom learning. However, due to limitations in time, space, and equipment, practical activities conducted during class may lack continuity [3]. Therefore, students can take full advantage of extracurricular club activities to participate in practical activities that are challenging to execute in class due to operational difficulty or limited materials. This approach ensures the integrity of practical activities. During class, participating club members can present their results and share their processes, thereby achieving the goal of cultivating scientific thinking and practical skills.

2.3. Leveraging Family Resources for Biology Practical Assignments

During vacation periods, students have ample time to complete practical assignments. They can easily access various materials needed for practical activities at home, providing opportunities for students to observe and engage in hands-on experiments that may not be feasible within the classroom setting. For instance, in the section on "Fungi," students can utilize weekend time to "observe fungi in everyday life" and "collect large fungi for observation and produce diverse spore prints." These practical activities contribute to a deeper understanding of fungal structural characteristics.

2.4. Establishing an Appropriate Assessment Mechanism for Biology Assignments to Ensure Practical Effectiveness

Assessing biology assignments should go beyond merely grading effects. It can involve peer

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assessments among students, incentive mechanisms to motivate active participation, and teacher-provided encouraging and motivating feedback. Additionally, various methods, such as showcasing outstanding student assignments in class, can be employed to establish an effective comprehensive assessment mechanism. This approach not only stimulates student enthusiasm but also ensures the timeliness of assignments, allowing students to have benchmarks in their hearts and direction in their actions.

3. Case Analysis of Biological Practical Assignments on Bacteria and Fungi

The textbook content for this chapter primarily includes "The Main Characteristics and Distribution of Bacteria and Fungi," "The Relationship between Bacteria and Fungi and Human Life," and "The Role of Bacteria and Fungi in Ecosystems." The textbook presents this chapter in the sequence of "macro-micro-macro," first allowing students to perceive the presence of bacteria and fungi, explore their distribution, then delve into the characteristics of bacteria and fungi in terms of morphology, structure, and reproduction. Subsequently, it focuses on the roles of bacteria and fungi in the natural world and their utilization by humans [4].

The central theme of this case is the unit design based on "Turning Kitchen Waste into Treasure." Each subsection revolves around kitchen waste, including practical activities such as comparing the natural decomposition of kitchen waste with the fermentation process involving specific bacterial strains to create plant nutrient solutions. These activities are applied to both extracurricular plant cultivation competitions and home potting activities. By cleverly adapting biotechnological knowledge related to plant nutrient solution fermentation to classroom practice, students' understanding of the broad applicability of fermentation technology in various fields is expanded.

3.1. Divergent Assignment Design in the "Distribution of Bacteria and Fungi" Section

Pre-class Assignment: Please formulate exploratory questions related to the upcoming topic, "The Distribution of Bacteria and Fungi," focusing on fruits, vegetables, or kitchen waste generated at home.

This divergent question, positioned before the classroom discussion, serves to stimulate students' thinking and assess their interest in inquiry. It also encourages students to engage in independent preparation for the upcoming lesson. The teacher can collect a variety of questions from students, selecting those that are both feasible and frequently asked to guide the in-class experimental inquiry.

Two specific questions are eventually chosen for experimentation in the laboratory:

1. Inoculating and Observing the Distribution of Bacteria and Fungi in Kitchen Waste: This experiment allows students to practice the general methods of cultivating bacteria and fungi.

2. Comparing the Quantity of Bacteria and Fungi in Fresh Vegetables and Fruits with Those That Have Decomposed Over Time: During this activity, students not only gain hands-on experience with bacterial and fungal cultivation but also gain a deeper understanding of food decay principles from a macroscopic perspective, laying a solid foundation for future chapters. In this way, students not only engage in practical experiments but also explore the microscopic world of bacterial and fungal distribution, fostering both experimental skills and a comprehensive understanding of the principles behind food decay, which serves as valuable preparation for subsequent lessons.

3.2. Homework Design for the "Fungi" Section

Assignment Content: Please collect kitchen waste or fruits and vegetables with mold spots from your surroundings during your free time. Observe the surface condition and color of the mold spots. Considering the structural characteristics of the molds you have learned about, contemplate the

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following questions:

a. The Colors of Various Mold Spots We See: What structural feature of molds determines their color, and what function does this structure serve? Why does one moldy fruit in a bag, if not promptly handled, often lead to other fruits also molding within a short period?

b. Composition of Visible Mold Mycelium: What constitutes the mycelium of the molds that we can see with the naked eye? Can it be divided into aerial mycelium and nutrient mycelium? What substances can the nutrient mycelium absorb from the food?

c. Observation of Large Fungi's Habitat: Please search for and observe the living environment of large fungi in your surroundings. Create a simple diagram outlining their structure and label their names. Consider which category of nutritional mode large fungi belong to. Collect fresh mature large fungi and create the desired spore print on A4 paper based on the different shapes of their gills. Provide students with reference procedures, such as cutting off the mushroom stem, placing the mushroom cap on the paper (preferably one with a significant color contrast to the mushroom cap), sealing it in a light-shielded place for a few days, and, after removing the mushroom, using plastic wrap or tape to preserve the spore print.

This homework assignment is designed to encourage students to actively explore and apply the knowledge they have acquired about fungi. It requires them to observe and think critically about the features and functions of molds and large fungi while conducting practical experiments.

3.3. Expansionary Homework Design on "Human Utilization of Bacteria and Fungi"

A significant portion of household waste consists of kitchen waste, and it is generated daily in every household. In reality, less than 10% of kitchen waste is composted. Given the enormous volume of kitchen waste in China, which amounts to 300-400 million tons annually, coupled with limited composting facilities and processing capacity, we must consider what actions we can take. Can we turn this waste into a valuable resource ourselves?

There are three convenient ways to make homemade organic fertilizer from kitchen waste: anaerobic composting, aerobic composting, and vermiculture. Students can research how to make compost at home and conduct experiments in groups. Additionally, a more efficient method is to ferment it into plant nutrient solution. How can this fermentation be done? What kind of fermentation culture should be used? Is there a need to add additional materials, and in what proportions? Students should establish specific questions for investigation. The teacher can guide students to form small groups in class to conduct initial experiments on specific questions. Since the experiments require continuous monitoring, they can use the time available during club activities to regularly check the fermentation progress. Other groups can utilize weekends to investigate other feasible questions.

Below are the specific steps for investigating one of the questions: the influence of different amounts of culture solution on the decomposition rate of kitchen waste.

Experimental Procedure: a. First, mix fermenting agent (water:sugar:molasses in a mass ratio of 10:100:1000) and ferment for two days to create the culture solution. The fermenting agent consists of beneficial bacteria suitable for plant growth. Adding sugar serves as a carbon source to activate and increase the quantity of beneficial bacteria before applying them to the decomposition of kitchen waste. b. Uniformly crush the kitchen waste using a cell disrupter, and then place equal amounts of it into wide-mouthed bottles. Add different amounts of culture solution to each bottle, mix thoroughly, cover with rubber stoppers, and store at room temperature. Ferment the mixture, thoroughly shaking it every three days for one minute. This process takes approximately 14-20 days to mature [5].

Students can explore different carbon sources (e.g., white sugar vs. brown sugar), different fermentation culture agents, and the proportion of culture solution added, as long as they adhere to

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the three main principles of the experiment. They should regularly observe the degree of kitchen waste decomposition on different fermentation days (see Figure 1) and determine the best fermentation method based on the extent of decomposition.

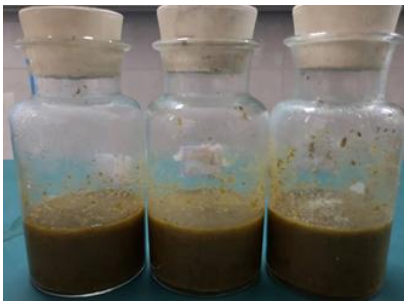

Figure 1: Plant nutrient solution after fermentation.

Adding an appropriate amount of culture solution can effectively resist the original pathogens in kitchen waste. While fermenting kitchen waste, it is transformed into fertilizer that plants can directly absorb and utilize. This plant nutrient solution not only contains beneficial bacteria to resist pathogen invasion but also provides a variety of nutrients and humic acids. Students can continue their inquiry experiments in plant cultivation using the well-fermented nutrient solution by manipulating different variables, such as studying the effect of different dilution concentrations of plant nutrient solution on plant growth.

In-Class Task Design:

Observe the beneficial microorganisms and disease-causing microorganisms inoculated in microbiological organic fertilizer. Investigate the antibacterial effects of different probiotics on disease-causing microorganisms. Calculate the diameter of the inhibition zone to assess the strength of their antibacterial effects.

3.4. Open-ended Homework Design in This Unit

Out-of-class extension assignments can effectively enhance students' ability to apply and transfer their knowledge, integrating what they have learned in class into their daily lives, influencing those around them, and maximizing the practical use of knowledge. This is the true essence of learning. Moreover, establishing appropriate assessment criteria significantly affects students' motivation to learn. It also encourages self-reflection, prompting students to adopt a positive learning attitude and fully exploit the teaching function of enhancing quality and efficiency [6]. Below is an example of one of the specific formats for out-of-class extension assignments in this thematic unit.

Assignment Instructions: Please complete a promotional flyer for the "Turning Kitchen Waste into Treasure" activity you created on your own. Inform people about the ingenious ways to recycle waste.

The content of the flyer can take various forms:

a. Inform people about several forms of kitchen waste recycling, such as making simple compost bins to turn kitchen waste into compost or creating efficient plant nutrient solutions.

b. List specific methods and procedures for people to follow.

c. Provide examples of tools and materials for reference.

Assessment Rubric for the Promotional Flyer:

A Grade: The method and steps are complete, the content title is novel and highly engaging, it sparks people's desire to try it out, the cost is low, the results are good, and it has a strong call to action.

B Grade: Multiple types of promotional materials are available, and the method and steps are

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complete. The content is practical and achieves a certain promotional effect.

C Grade: The method and steps are not very complete and need further improvement. The visuals have some promotional aspects, but the design could be enhanced.

This open-ended homework assignment encourages students to not only apply what they have learned but also share their knowledge with others in an engaging and practical manner, fostering a deeper understanding of the topic and promoting the concept of waste reduction and recycling in their communities.

4. Conclusion

Under the call of the national "Double Reduction" education policy, in terms of homework design, to break away from the traditional repetitive and mechanical homework patterns, teachers should take on the role of guides. They should consciously guide students to generate inquiry-based unit questions in the classroom, with a focus on answering questions from the students' perspective, which should be the main thread running through the course content. Therefore, the content of teachers' homework designs should truly reflect the driving, continuous, and exploratory nature of the classroom content, making homework an integral part of students' efforts to solve their own inquiry questions. Furthermore, from the students' perspective, homework that has practical significance will not be met with strong resistance. Periodic achievements in homework can make it engaging and rewarding for students. Through the process of continuous exploration, reflection, and improvement, students' core competencies are comprehensively nurtured and enhanced.

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