Scholar Publishing Group
Academic Journal of Environmental Biology
https://doi.org/10.38007/AJEB.2021.020102
ISSN 2789-8407 Vol. 2, Issue 1: 10-20

Experimental Teaching Design of Environmental Microbiology Based on Microalgae Culture under the Background of Big Data

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Keywords: Big Data, Microalgae Cultivation, Environmental Microbiology, Experiment Teaching

Abstract: Microalgae are potential renewable biodiesel raw materials, with the advantages of high oil yield per unit, no competition with farmland, and synergistic carbon dioxide fixation. However, microalgal biodiesel has not been widely commercialized so far, and the high cost of cultivation and recovery makes its product price less competitive with traditional petrochemical diesel. The main purpose of this paper is to study the design of experimental teaching of environmental microbiology based on the content of microalgae cultivation in the context of big data. Based on the analysis of the current situation of biology experiment teaching, this paper decides to adopt the method of design experiment teaching to carry out biology experiment teaching in high school. Experiments show that the impact of teaching on students' biological learning accounts for 31%, ranking after personal interests, which not only shows that teaching has a very important position in the factors that affect students' biological learning, but also shows that teaching is interesting, scientific, and diverse. Sex needs to be improved to further promote students' interest in biology.

1. Introduction

Biology is a natural discipline, a discipline that observes and discovers problems, in-depth exploration, summarization, and formation of theories or hypotheses. Experiments are the essence of natural subjects and the most direct way for students to experience the characteristics and ideas of subjects. When students study high school biology courses, they not only need to acquire corresponding theoretical knowledge, but also should be able to use the knowledge they have

learned to conduct corresponding relatively basic scientific research, so as to comprehend the inherent laws of biology in practice, and finally form an understanding of the objective world. rational cognition. However, the actual teaching implementation and effect of high school are not optimistic, and the reasons are many subjective and objective factors [1-2].

In a related study, Kumar et al. conducted a techno-economic evaluation of scaling up microalgae production and simultaneous treatment of dairy wastewater [3]. As expected, centrifuges and their electricity bills were the major contributors to capex and opex, respectively. HVVP was found to be one of the cost-effective and area-effective microalgal culture systems for large-scale production. Additionally, the process helps address environmental concerns. Baker et al. reported changes in courses and how they work when advanced experimental physical chemistry courses have to be transitioned from face-to-face to online teaching within a few days [4]. While some of the learning objectives of the lab courses can still be achieved in an online environment, others need to be modified to reduce educational losses. The use of videos, icebreakers, homework assignments, pre-lab quizzes, in-lab questions, and synchronous sessions help keep students engaged and maximize learning goals.

In order to change the status quo, on the basis of analyzing the current situation of biology experiment teaching, this paper decides to adopt the method of design experiment teaching to carry out high school biology experiment teaching. Based on the evaluation criteria of effective teaching, the effectiveness of the designed experimental teaching is evaluated, and it is hoped that the results of this research can provide some reference for the development of high school biology experimental teaching.

2. Design Research

2.1. Current Situation of Biology Experiment Teaching

(1) Cause of the problem

Through the retrieval of major well-known databases, it is found that a large number of investigations have been carried out on the current situation of high school biology experimental teaching from different levels all over the country [5-6]. An investigation and analysis of the class opening rate of biological experiments found that among the 35 biological experiments, only 8 experiments had a class opening rate exceeding 50%. In-depth investigation and analysis found that there were mainly the following five reasons: (1) The experiment was too difficult to (2) The high school biology course is too busy to carry out every experiment; (3) The equipment and experimental materials required for the experiment are insufficient, and the experiment cannot be carried out; (4) Some experiments cannot be opened because the experimental results are not clear; (5) It is not helpful for biology teaching and college entrance examination, and there is no need to conduct experiments.

(2) Influencing factors

In the arrangement of experimental class hours, the management is more casual, there is no minimum class time requirement at the school level, and the biology teaching and research group does not uniformly set up experimental courses. The arrangement of experimental courses is entirely up to the teacher. As a result, the experimental class hours of each class are extremely uneven, and the least class has not taken a biology experimental class for three years in high school. In terms of laboratory management and the setting of laboratory personnel, in the first year of the researcher's work, the laboratory is held by teachers from other majors, and the job responsibilities mainly involve laboratory key management, school fixed asset management, etc. [7-8]. At that time,

it was extremely difficult to set up experimental courses. First, the preparation before class could not be carried out due to strict key management and the teacher's own curriculum arrangement. Second, the teachers had no motivation to carry out the experimental course. In the second year of work, the school adjusted the experimenter to a biology teacher. After that, after oral application, everyone can enter the laboratory for experimental preparation and experimental operation. However, the school did not clarify the responsibilities of the experimenter, so the pre-class preparation and after-class finishing are mainly carried out by Teachers are responsible for [9-10]. Based on interviews with other teachers in the biology group, and combined with their own work experience, the researchers concluded that the reasons for the lack of motivation of the teachers themselves to set up experimental courses are as follows: (1) The lack of class hours must catch up with the progress (2) The simulation experiment can be used instead (3) Before the experimental class Material preparation is time-consuming and labor-intensive.

From the school's arrangement of students' independent time, the regulations of subject teaching tasks, to the excessive care of experimental equipment, laboratories and other fixed assets for the sake of "safety and stop loss", all of them are obstacles to conducting experiments [11-12]. At the same time, the implementation of a teaching reform requires the cooperation of other teachers. If only a few teachers think that the experiment is important, and the values of other teachers and even the whole school are "useless for operation and useful for scores", then the teaching reform cannot be carried out. In addition, the laboratory exchanges between grassroots junior high schools and foreign schools and colleges are almost zero. It is impossible to operate laboratories and experiments well behind closed doors. Finally, the biology group needs more autonomy over the three-year subject teaching task arrangement and laboratory construction, but this may affect our exchanges with other schools in terms of test scores, so only if we improve ourselves first can we strive for more opportunities with space [13-14].

2.2. Immobilization Technology of Microalgae

Although microalgae have great application prospects in the production of bioenergy and aquaculture wastewater treatment, the recovery of microalgae is difficult due to small cells, low cell concentration, small specific gravity, and easy suspension in water, which can seriously lead to microalgae. Serious flooding, causing secondary pollution of water resources [15-16]. Several immobilization methods are compared below.

Different microalgae or wastewater are treated with different compositions, and their use in neutralization methods and transportation facilities varies. Excessive phosphate content in wastewater can lead to precipitation of calcium ions in the gel, reducing the mechanical strength of the gel. Therefore, the choice of immobilization method and carrier material is particularly important in microalgae immobilization technology. As far as the current applications are concerned, the integration method is the most used due to its strong neutralization ability and strong destructive effect on microalgae [17-18].

Table 1. Comparison of advantages and disadvantages of immobilization methods

Category	material or coupling agent	principle	Advantages and disadvantages
Adsorption	Flat porous carbon paper, porous glass, ceramics, gauze	Utilize the interaction between microalgal cells and carrier molecules	Easy to operate, but the immobilization strength is low, and the cells are easy to fall off
Embedding	Agar, alginate, cross-glycan, collagen, pectin	Embedding microalgal cells inside a porous carrier	High immobilization strength, but complicated experimental operation
cross-linking	Glutaraldehyde, Ethylenediamine, Aminosilane	Cross-linking with active groups on the surface of microalgae cells to form a network structure	The method is simple, and the cells are not easy to fall off, but the immobilization reaction is violent, and the cells are damaged.
PBR method	Source layer (glass fiber), bottom layer (printing paper, nitrocellulose membrane)	The microalgae is adsorbed on the source layer, and the bottom layer isolates the microalgae from the nutrient solution/sewage, and plays a fixed role	High immobilization efficiency and large-scale recycling application, but complex equipment and high cost

2.3. Algorithm Research

(1) Removal of pollutants

The formula for calculating the removal rate of pollutants is as follows:

$$H(\%) = \frac{Pt - P0}{P0} \tag{1}$$

H is the removal rate of pollutants (total nitrogen, total phosphorus, ammonia nitrogen, COD), in %; P0 is the pollutant concentration of the biogas slurry supernatant before flocculation, in mg/L; Pt is the biogas slurry supernatant after flocculation the concentration of pollutants in mg/L.

(2) Determination of biogas slurry decolorization rate

The biogas slurry was centrifuged at 5000 rpm, and the change in absorbance (OD475) of the supernatant before and after flocculation was measured.

The formula for calculating the decolorization rate is as follows:

$$D = \frac{Ct - C0}{C0} \tag{2}$$

D is the decolorization efficiency, unit %; C0 is the absorbance of the biogas slurry supernatant before flocculation; Ct is the biogas slurry after flocculation

Absorbance of the supernatant.

(3) Determination of the removal rate of suspended solids

The suspended solids removal rate determined in the experiment refers to the removal rate of suspended solids in biogas slurry by bacteria and algae flocculation.

Suspended solids concentration = total suspended solids concentration - algal cell biomass

The formula for calculating the removal rate of suspended solids is:

$$P = (W_0 - W_1) / W_0 \quad (3)$$

P is the removal rate, in %; W0 is the concentration before flocculation, in mg/L; W1 is the concentration after flocculation, in mg/L.

(4) Fitting of flocculation kinetics under optimal conditions

Chlorella MBFJNU-1 cultured in three media for 13 days was flocculated under optimal conditions, and the shake flask was sampled every 0.5h to measure the flocculation rate and pH of the medium at each time point, and the measurement time was 6h .

The relationship between flocculation time and flocculation efficiency was plotted, and the flocculation curve was fitted nonlinearly using the Hill equation model describing the binding of macromolecules and ligands in biochemistry.

Its equation can be expressed as:

$$HI = \frac{vt^n}{k^n + t^n} \quad (4)$$

t is the flocculation time, the unit is h; v is the theoretical maximum flocculation efficiency constant, the unit is %, k is the semi-flocculation time constant, which means the time required to reach 50% of the maximum flocculation efficiency, the unit is h; n is the Hill coefficient, which means the flocculation The synergy between the rate of increase and the flocculation time.

Use Oringin 9.0 software to edit the kinetic equation, fit the experimental data of flocculation, calculate the parameters of the two kinetic equations, and evaluate the fitting effect of the model according to the coefficient of determination (R2). it is good.

3. Experimental Study

3.1. Implementation Conditions

In order to complete the designed experimental teaching, the corresponding software and hardware conditions are indispensable. Now the corresponding conditions are listed as follows:

(1) Open the laboratory and establish a teaching timetable.

Design experimental teaching should provide open laboratory space for students to study and research independently. In order to allow sufficient time for students to debug equipment and configure medicines, the laboratory should be open to students during their spare time, such as lunch break, evening break, and physical activity classes. Students can complete the experiment independently according to the experimental plan determined by the interaction between teachers and students, and systematically combine experimental instruments. Through the construction of students' open laboratory and open management mechanism, the openness of the experimental process is guaranteed. The number of middle school students is large. If the laboratory is used at the same time, it will easily cause congestion, which will cause more harm than good. This requires teachers to establish a corresponding teaching schedule, and arrange the experiments throughout the semester in different time periods, so that each group can You can have your own lab time.

(2) Improve the laboratory hardware conditions and improve the laboratory management system.

In order to achieve the desired effect of the experiment, there must be sufficient experimental funds. Since most of the equipment can be reused with little damage, the initial investment is more,

and the later investment is not much. However, in terms of experimental drugs, there is indeed a situation in which the drugs cannot be used up within the shelf life, resulting in waste. Like microbiology experiments, the research objects are usually bacteria, fungi and other strains of microorganisms. The clean cultivation and preservation of microbial strains is also important, and improper handling can lead to problems such as the spread of microbial strains and the contamination of the environment by microbial waste. Failure to follow the rules and regulations can easily lead to serious consequences. In addition, the commonly used experimental equipment are high pressure steam sterilizer, stirrer, constant temperature water bath, etc. These devices are often in activation, high temperature and high pressure test modes. If you do not work according to the specifications, it is easy to cause laboratory accidents, endanger the safety of students or cause property damage. In addition, many unsuitable enzyme preparations are expensive and easy to use. If they are improperly stored or used, they will cause pollution, affect people's subsequent use, and cause great waste of scientific research funds.

The above situation will inevitably require the laboratory to have a sound experimental teaching management system, equipped with professional management personnel or trained auxiliary personnel to control the entire experimental process, such as reasonable overtime for teachers, implementation of the student rotation responsibility system, etc., to avoid accidents.

(3) According to the curriculum standards, formulate appropriate and reasonable syllabus.

In order to meet the needs of different types of students, it is necessary to prepare multiple experimental topics. Different topics have different experimental contents, different experimental systems, and different requirements. Students can choose freely according to their own situation. The main content should be the content that has been learned or is currently learning, so as not to make students feel unable to start, use their imagination to design a scientific and feasible experimental plan, and complete or test it by themselves. Students are curious and active in thinking. In the process of completing designed experiments, situations that teachers cannot imagine may occur at any time, which puts forward higher requirements for experimental instructors.

3.2. Students' Knowledge Mastery

Students should have a solid grasp of the following areas:

(1) The setting of the control group and the experimental group.

The students set up four plates at each sampling place, and placed them at 37 ℃ for a period of time. If no colonies grew, it proved that there was no foreign bacteria infection, and they inoculated the filtered membranes on four plates. in a tablet. In addition, they also set up a medium to cultivate the bacteria in the air, as a way to control their own plates to see whether there is contamination by foreign bacteria.

(2) The basic operation of preparing culture medium.

The students wrote the steps of making the medium and the formula of the medium in the lab report. After a certain mass of substances are weighed, they are dissolved in distilled water, and then placed in a high-pressure steam sterilizer for sterilization. Take it out after sterilization, and pour the plate when the temperature drops to 50 degrees Celsius (that is, it is not hot and the medium can still flow).

(3) Precautions for aseptic operation.

Regarding aseptic operation, the students listed almost all the precautions in the experimental protocol, such as tools for holding water samples should be sterilized before use, operators should sterilize their hands before inoculation, metal utensils such as tweezers, beakers, cones Glassware

such as bottles should be sterilized by dry heat sterilization before use, the ultra-clean workbench should be irradiated with ultraviolet rays for 30 minutes, and the filter membrane should also be sterilized by boiling disinfection.

(4) The basic operation of using the filter membrane.

The students listed on the third page how to use the filter during filtration, and downloaded the relevant diagram from the Internet to guide them inoculating the filter on the solid medium. This shows that they can already use the search tools in their hands and the relevant literature they have read to assist the experimental design, and use modern methods to print pictures to guide their operations more intuitively.

(5) Arrangement of experimental time.

The students wrote the approximate time of each experimental step in detail in the experimental report, and gave the approximate experimental time arrangement on the last page of the experimental design. For example, the experimental protocol reads: "If sampling outside the school, it should be carried out on Sunday, and preferably on Monday, and the filter should be applied (on the medium). It is expected that two to three mediums will take one to two One class is required for filtration and sticking of filter membranes, and another class is required for disinfection and sterilization."

4. Experiment Analysis

4.1. Investigation on the Effect of the Application of Biological Micro-Course Teaching

Regarding the effect of the teaching method of biological micro-course teaching on the teaching effect, the author also adopts the questionnaire survey method. But there are only two questions to ask.

(1) Do you think the biology teacher has a role in improving your interest in biology learning? How do you think it compares to other factors that affect your biology? (Consider several factors from society, schools, teachers, teaching materials and personal interests)

(2) Under the conditions of the new curriculum reform, under the influence of the teacher's teaching, how much do you like biology? (level of refinement: like very much, like, dislike, dislike very much)

The results of the data survey on teaching effectiveness are interpreted as follows.

4.2. Analysis of the Survey Effect

Table 2. Factors affecting student biology

Factor	Proportion
Society	5%
School	3%
Teacher	35%
Teaching material	25%
Personal interest	32%

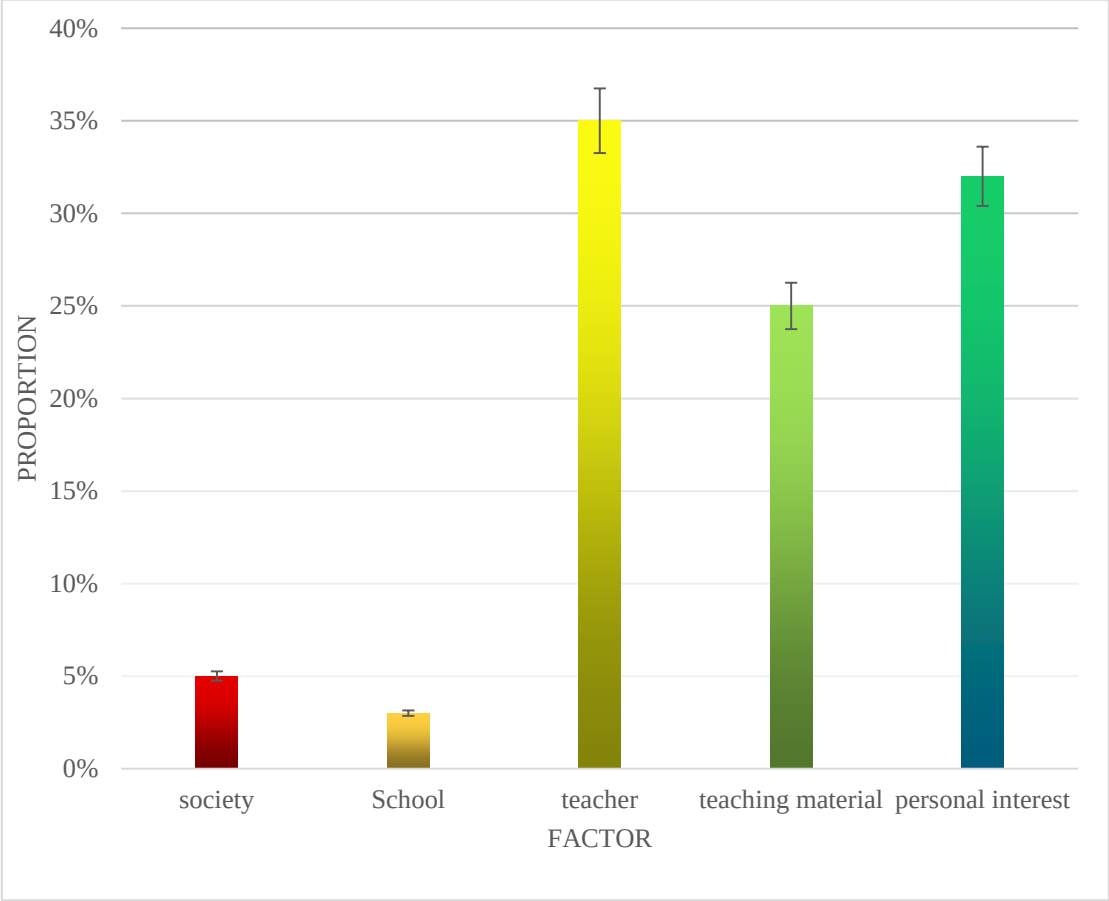

Figure 1. Analysis of factors affecting student biology

The statistics in the graph above show that, in descending order of impact on students' biological learning, they are: teacher, personal interest, teaching, society, and school. The influence of teachers is still the largest, followed by personal interests, so it is very important to improve the teaching level of teachers and stimulate students' personal interest in learning biology. The influence of teaching accounts for 31%, ranking after personal interests, which not only shows that teaching has a very important position in various factors affecting students' biological learning, but also shows that the interest, science, and diversity of teaching need to be improved to further promote Student interests in biology.

Table 3. Students' preference for biology learning

Degree	Proportion
Like it very much	4%
Like	32%
General	45%
Dislike	16%
Dislike very much	3%

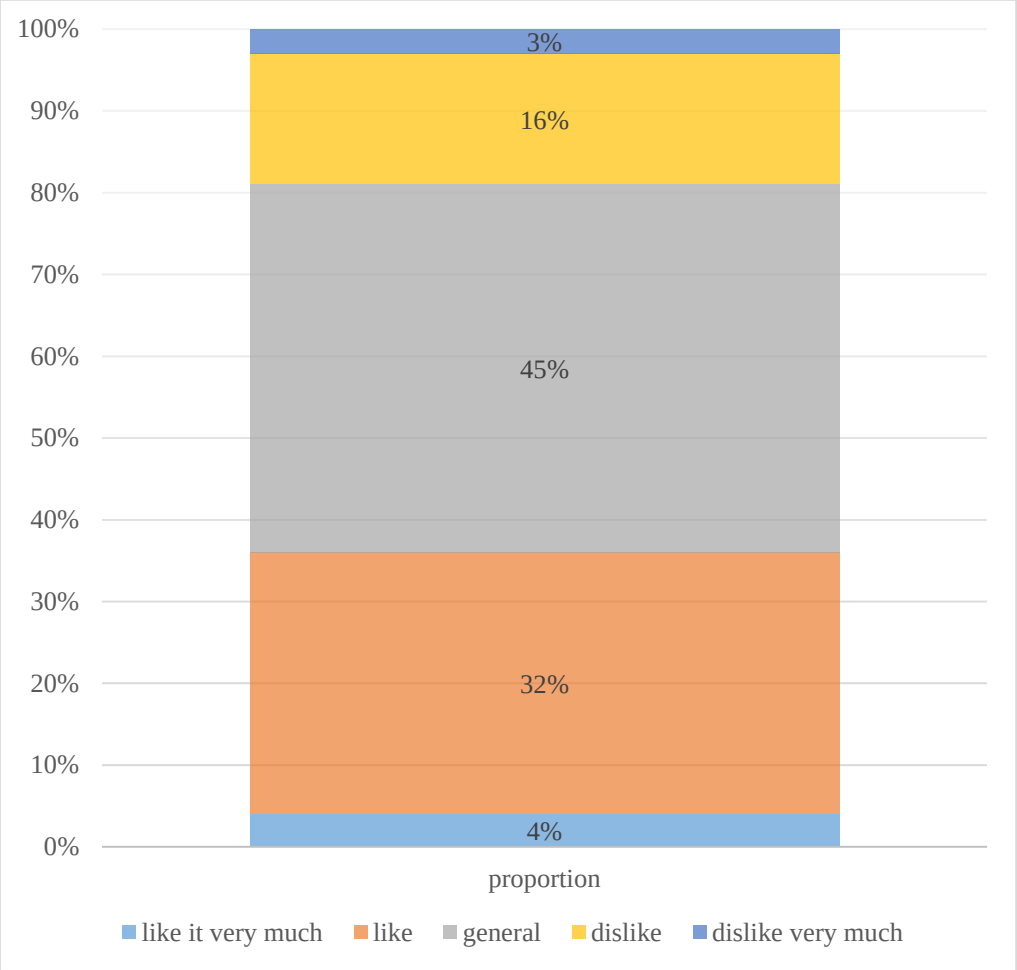

Figure 2. Analysis of students' preference for biology learning

As can be seen from the above figure, students generally do not have a high degree of preference for biological learning, and their interest in biological learning is not very strong. 46% of students chose "Fair" for their biology study.

The questionnaire can effectively help teachers understand students' interests and attitudes in learning biology, and the development direction of students' interest and willingness, so that teachers can realize the shortcomings of the current teaching mode and know the students' yearning for the new teaching mode. Therefore, a questionnaire survey based on the assisted teaching of biological micro-courses in classroom teaching is necessary.

5. Conclusion

In the implementation of biological experiment teaching courses, the teaching purpose is particularly important. The purpose of teaching is the general requirements put forward by teachers and educators to complete the teaching task. It is the basis of implementing teaching and the starting point of teaching design. All teaching steps are designed to be directed towards teaching purposes. Among the many harvesting methods based on microalgae culture, the fungal mycelial ball flocculation method for harvesting microalgae has the following two advantages: on the one hand, the mycelium ball flocculation efficiency is high, the harvesting time is short, and the solid-liquid

separation is easy, which can reduce the cost of harvesting. On the other hand, mycelium balls are widely used in the bioremediation of heavy metal wastewater and biogas slurry wastewater. The purification effect of substances.

Funding

This article is not supported by any foundation.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

[1] Ward J, Ochoa R, Eguchi A, et al. Chimeric Mouse With Humanized Liver Is an Appropriate Animal Model to Investigate Mode of Action for Porphyria-Mediated Hepatocytotoxicity:. Toxicologic Pathology, 2021, 49(7):1243-1254. https://doi.org/10.1177/01926233211027474

[2] Saleh A M, Althaqafi A . The Effect of Using Educational Games as a Tool in Teaching English Vocabulary to Arab Young Children: A Quasi-Experimental Study in a Kindergarten School in Saudi Arabia:. SAGE Open, 2021, 12(1):99-107. https://doi.org/10.1177/21582440221079806

[3] Kumar A K, Sharma S, Dixit G, et al. Techno-economic analysis of microalgae production with simultaneous dairy effluent treatment using a pilot-scale High Volume V-shape pond system. Renewable energy, 2020, 145(Jan.):1620-1632. https://doi.org/10.1016/j.renene.2019.07.087

[4] Baker R M, Leonard M E, Milosavljevic B H . The Sudden Switch to Online Teaching of an Upper-Level Experimental Physical Chemistry Course: Challenges and Solutions. Journal of Chemical Education, 2020, 97(9):3097-3101. https://doi.org/10.1021/acs.jchemed.0c00776

[5] Shukla A K, Singh P, Vardhan M . An adaptive inertia weight teaching-learning-based optimization algorithm and its applications. Applied Mathematical Modelling, 2020, 77(Jan.):309-326. https://doi.org/10.1016/j.apm.2019.07.046

[6] Hencklein L C, Silva R, Campos D G, et al. Effectiveness of Clinical Simulation and Peer-Assisted Learning to Teaching About the Sexuality of People With Spinal Cord Injury. Journal of Neuroscience Nursing, 2021, 53(5):208-214.

[7] Kim D, Olson W M . Using a Transfer-Focused Writing Pedagogy to Improve Undergraduates' Lab Report Writing in Gateway Engineering Laboratory Courses. IEEE Transactions on Professional Communication, 2020, 63(1):64-84. https://doi.org/10.1109/TPC.2019.2961009

[8] Miller Z M, Zhang J D, Donald W A, et al. Gas-Phase Protonation Thermodynamics of Biological Lipids: Experiment, Theory, and Implications. Analytical Chemistry, 2020, 92(15):10365-10374. https://doi.org/10.1021/acs.analchem.0c00613

[9] Heinisch J, Lockner Y, Hopmann C . Comparison of design of experiment methods for modeling injection molding experiments using artificial neural networks. Journal of Manufacturing Processes, 2021, 61(1-4):357-368.

[10] Sonowal G, Kuppusamy K S . PhiDMA – A phishing detection model with multi-filter

approach - ScienceDirect. Journal of King Saud University - Computer and Information Sciences, 2020, 32(1):99-112. https://doi.org/10.1016/j.jksuci.2017.07.005

[11] Goossens J W, Hafermann H, Jaouen Y . Data Transmission Based on Exact Inverse Periodic Nonlinear Fourier Transform, Part II: Waveform Design and Experiment. Journal of Lightwave Technology, 2020, PP(99):1-1. https://doi.org/10.1109/JLT.2020.3013163

[12] Badizi R M, Parizad A, Askari-Paykani M, et al. Optimization of mechanical properties using D-optimal factorial design of experiment: Electromagnetic stir casting process of A357SiC nanocomposite. Transactions of Nonferrous Metals Society of China, 2020, 30(5):1183-1194.

[13] Park H, Kim M, Lee B, et al. Design and Experiment of an Anthropomorphic Robot Hand for Variable Grasping Stiffness. IEEE Access, 2021, PP(99):1-1.

[14] Dirkx N, Oomen T . Multivariable Experiment Design with Application to a Wafer Stage: a Sequential Relaxation Approach for Dealing with Element-Wise Constraints. IFAC-PapersOnLine, 2020, 53(2):8565-8570. https://doi.org/10.1016/j.ifacol.2020.12.564

[15] Ouaidat G, Cherouat A, Kouta R, et al. Numerical modeling of the mechanical behavior of proton exchange membrane fuel cell performance: Design of experiment study and optimization. International Journal of Hydrogen Energy, 2020, 45(46):25210-25226. https://doi.org/10.1016/j.ijhydene.2020.06.015

[16] Park E, Bae J, Park S, et al. Reconfiguration Solution of a Variable Topology Truss: Design and Experiment. IEEE Robotics and Automation Letters, 2020, PP(99):1-1.

[17] Kirkey A, Luber E, Cao B, et al. Optimization of the Bulk Heterojunction of All-smallmolecule Organic Photovoltaics Using Design of Experiment and Machine Learning Approaches. ACS Applied Materials And Interfaces, 2020, 12(49):54596-54607. https://doi.org/10.1021/acsami.0c14922

[18] Changade N M, Chavan M L, Jadhav S B, et al. Determination of emission uniformity of emitter in gravity fed drip irrigation system. International Agricultural Engineering Journal, 2020, 2(1):88-91.