Curriculum and Teaching Methodology (2023)
Clausius Scientific Press, Canada

DOI: 10.23977/curtm.2023.062316
ISSN 2616-2261 Vol. 6 Num. 23

Exploration of Curriculum Teaching Innovation in the Context of First-Class Curriculum Construction—Taking "Probability Theory and Mathematical Statistics" as an Example

Hongyan Wu[1,a,*]

[1]*College of Mathematics and Physics, Hulunbuir University, Hailar, Inner Mongolia, 021008, China*
[a]*wuhongyan@hlbec.edu.cn*
[*]*Corresponding author*

Keywords: First-Class Courses, Course Teaching, Probability Theory and Mathematical Statistics

Abstract: With the continuous advancement of curriculum reform, China's higher education is also gradually developing, which puts forward new requirements for cultivating talents. Probability theory and mathematical statistics, as indispensable components in mathematics education, play an important role in this process. This article elaborates on how to build a curriculum system suitable for students' lifelong learning and growth needs by reasonably classifying students and combining teaching content from the current international society's emphasis on the comprehensive development of science and technology, the support of national policies, and the school environment, and also analyzes and discusses how to apply theoretical knowledge to real life during classroom teaching to improve the practicality and efficiency of learning. Afterwards, this article also conducts an experimental test on the teaching innovation effect of the course. The test results show that the participation of these six students in introductory studies and mathematical statistics is relatively high, with the lowest being 0.8 and the highest being 0.98. This shows that student participation is relatively high after the course teaching is optimized.

1. Introduction

With the progress of society and the development of science and technology, people have a new understanding of scientific knowledge and technology levels. Therefore, during the course teaching reform and innovation process, it was found that both teachers and students need to strengthen their learning of content related to probability theory and mathematical statistics. This requires more time to be spent on educational practice to solve these problems, and attention should be paid to cultivating good subject knowledge structures, ways of thinking and innovative abilities, and improving one's own comprehensive quality to adapt to the needs of social development.

With the rapid development of society and the increase in the advancement of science and technology, human activities have become more and more complex, which has put forward higher

and more comprehensive requirements for course teaching. This article mainly expounds the concepts related to "distribution" and "probability density" in probability theory and mathematical statistics, and analyzes its application status and existing problems. This article further studies the factors that affect the achievement of expected results in mathematics education goals, including students' learning interests and abilities, as well as teachers' choices of teaching methods and methods. Finally, in response to these contents, this article puts forward corresponding suggestions from both inside and outside the classroom to promote colleges and universities to better develop China's curriculum education.

The innovation of this article lies in how to cultivate students' ability to apply mathematical knowledge to analyze and solve problems in the teaching of probability theory and mathematical statistics. This article builds a scientific and reasonable classroom teaching model by analyzing the course content and combining it with practical experience. This article is based on the theory of "fundamental principles" as the guiding ideology, and integrates mathematical knowledge and experimental skills. This requires teachers to have a solid and rich reserve of professional practical knowledge and good innovation ability. Teachers also need to have enough patience and perseverance to face every problem raised by students and handle it in a timely and effective manner.

2. Related Work

With the development of society and the increasing emphasis on science education, many scholars at home and abroad have conducted a lot of research on statistics and curriculum teaching. Adrian Celestino conducted an in-depth study of the derivation method of accumulation-accumulation relations in free probability theory, aiming to trigger the deduction of these relations from the perspective of Magnus expansion [1]. Andreas Lochbihler conducted a mechanized proof of the maximum flow and minimum cut theorem of countable networks, and applied the proof results to the field of probability theory, revealing the practical application value of this theorem in computing [2]. Aviv Adler proposed a new method to efficiently represent the probability distribution of large letters and explored how to apply it to the selection problem of information theory [3]. Zhipei Hu used probabilistic methods to conduct a detailed analysis of the stability of network sampling data systems, especially considering the uncertainty of continuous data packet loss [4]. Ming Jing proposed a new basic probability allocation method specifically used to solve conflicting data fusion problems. His research focuses on how to accurately integrate conflicting data sets to obtain precise results [5]. Nabeel Butt conducted an in-depth study of the transformation process from approximate probability model to precise probability model in dynamic portfolio decision-making theory, with the main goal of improving the accuracy of the decision-making model [6]. Paul Tappenden was rooted in the probability problem of quantum mechanics and explored the unique perspective of Everettian theory as pure wave mechanics plus collapse-free probability hypothesis [7]. Shuting Wang introduced in detail an intelligent manufacturing talent education reference training system, and discussed in depth the specific content of platform construction and course development [8]. Jacob Kelter conducted research on constructivist collaborative design and explored dual methods that combined curriculum and professional development [9]. Tiina S. Korhonen conducted an in-depth study on Finnish teachers' attitudes towards programming as a new curriculum content as recipients of educational innovations, aiming to investigate teachers' attitudes towards educational innovations and the overall picture of their implementation [10]. They start from and target practical problems, verify the accuracy of theoretical knowledge through experiments, and apply it in practice to prove its effect. The construction of research courses can cultivate students' scientific and rigorous attitude and

pragmatic spirit, help them have good innovative qualities and the ability to solve various practical problems, and improve their comprehensive literacy and basic skill levels.

3. Method

3.1 Probability Theory

Probability theory is a discipline that studies the occurrence patterns of events and analyzes them to predict their development and changes. In teaching, teachers should make full use of students' existing knowledge and experience, as well as their psychological characteristics, to stimulate their interest in mathematical principles, methods, basic steps, etc. It can discover some important issues by observing common phenomena in daily life or learning problems related to mathematical statistics, and support the correctness of these conclusions through the verification of multiple data, guide students to define and explain probability theory, and cultivate their ability to solve practical problems and thinking logic [11-12]. In the process of learning probability theory, it first needs to understand the content of the textbook, understand its essence and development trends, and analyze it based on the requirements of the curriculum standards and the actual situation of the students. In teaching design, teachers can determine whether the course objectives, content, teaching methods, etc. meet the requirements based on society's demand for talent quality. Then, through classroom practical activities, students are allowed to participate in the study of theoretical knowledge, improve their ability to use probability theory to solve related problems and cultivate innovative consciousness. These are all inseparable from suitable teaching materials, so teachers need to conduct in-depth research and analysis of the teaching materials and make reasonable suggestions. The mathematical expression of probability theory is: assuming a random variable X, its probability density function is f(x), which satisfies the following two conditions: 1) f(x) is greater than or equal to 0; 2) the probability that the random variable falls within the interval [a, b] is equal to the integral value in this interval. The mathematical expression is:

$$P(a \Leftarrow X \Leftarrow b) = \int [a, b]\, f(x)dx \tag{1}$$

The expected value reflects the average value of a random variable. For a discrete random variable X, its expected value can be obtained by multiplying the probabilities of all possible values by the corresponding values and summing them up [13-14]. The mathematical expression is:

$$E(X) = \sum x\, P(X = x) \tag{2}$$

The expected value of a continuous random variable X can be calculated by integrating the product of its probability density function f(x) and x over the entire real range. On a certain physical quantity, specific physical factors may lead to specific results. However, this phenomenon always occurs in a random manner and cannot be predicted or follow a specific pattern. Therefore, this article treats it as an "independent variable" rather than a functional form in the traditional sense, and is used to understand and analyze the relationship between the essence, characteristics and properties of the problem.

3.2 Mathematical Statistics

By studying mathematical statistics, students can develop and improve their understanding of digital graphics, tables and other knowledge. Mathematical statistics, like other disciplines, is based on data. Therefore, it is not only a calculation method or model analysis process, but also a complex and rigorous operating system. This system has steps from simple to difficult, from low-level to

advanced. The final goal is to verify the rationality of the theory and to truly apply it in practice to improve students' mathematical application level and innovation ability. In statistics, one of the commonly used methods is point estimation [15-16]. Point estimates are designed to infer the value of a population parameter based on sample data. Maximum likelihood estimation is a method of estimating parameter values based on sample observation results. Its basic idea is to select parameter values that maximize the probability of the observed sample results. For a parameter, the maximum likelihood estimate can be expressed as:

$$L(\theta(= \prod f(x_i \mid \theta) \tag{3}$$

$f(x_i \mid \theta)$ represents the probability density function (or probability mass function) of sample observation x_i under given parameter θ. The goal of maximum likelihood estimation is to find parameter values that maximize $L(\theta)$. In teaching, if teachers can match complex and difficult-to-understand knowledge points with students' cognitive characteristics, learning efficiency will be greatly improved. Therefore, teachers should reasonably plan courses based on their professional knowledge and teaching material content to meet students' learning ability levels and development patterns. Teachers should also arrange classroom tasks according to the new curriculum standards and organize review work. In this way, teaching will be more targeted and effective [17-18].

3.3 Curriculum Innovation Mechanism

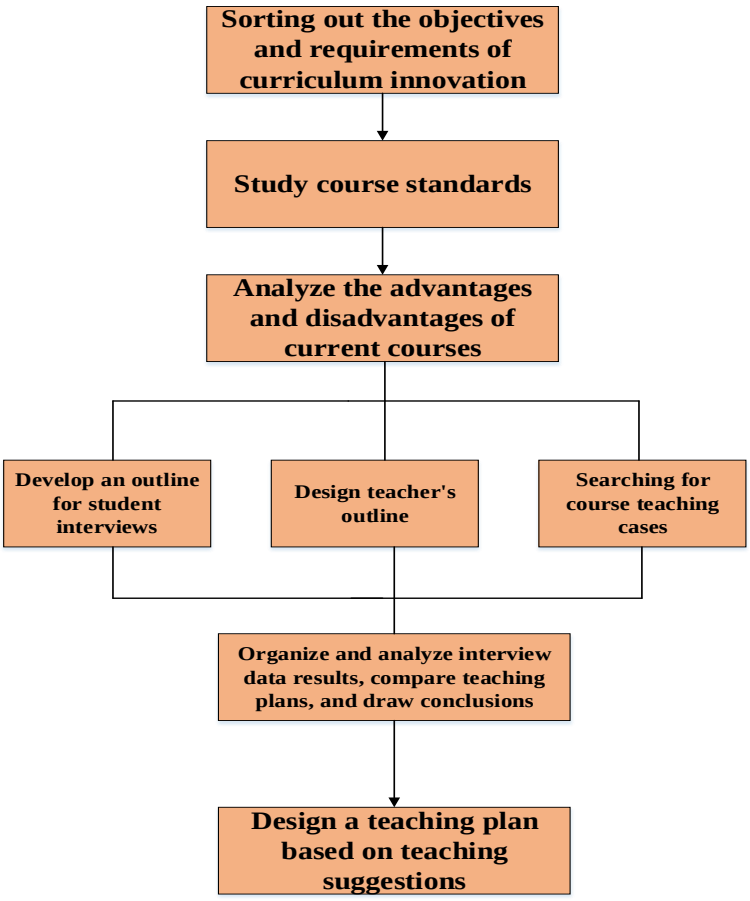

Figure 1: The process of curriculum innovation

Innovative course teaching refers to how to effectively improve and optimize teaching methods. In the classroom, teachers should integrate new curriculum reform concepts into the teaching process and provide students with more opportunities to participate in discussions and express their opinions to solve the problems they encounter in their learning, improve their problem-solving abilities and focus on integrating teaching material content with modern information technology and applying it to curriculum construction, and also use multimedia technology to enrich teaching methods and help teachers make better use of network resources, thereby effectively improving the quality of courses. The goal of curriculum teaching innovation is to cultivate students' scientific literacy and enable them to continue to grow in practice. Figure 1 is the process of curriculum innovation. It is an open and dynamic process designed to solve the difficulties students encounter in learning and cultivate their ability to think independently and solve problems.

The Chaoxing Learning Platform and the Rain Classroom platform are typical examples of course teaching innovation. Chaoxing Learning Platform is a comprehensive educational software, which is mainly used for teaching in colleges and universities to provide students with a good environment. The system adopts a "study case-driven" interactive C/S (ie B2C) model. Through detailed analysis and research on the three links of course design, pre-class preparation and production, it was found that the system had high practicability and feasibility. During the entire use process, a variety of technologies are used to realize resource sharing functions and network management platforms, etc., and can provide students with a good learning environment and improve teaching efficiency and quality. Therefore, in order to achieve the goal of continuously innovating curriculum teaching, this article designs and implements teaching plans in a targeted manner and provides personalized education based on the differences between different students [19]. For beginners, it can set different difficulty gradients to help them gradually understand the "basic principles"; for university graduate students, they need to have a deeper understanding of mathematical statistics and mathematical thinking methods to promote their interest in course learning and improve their ability to solve problems independently. Therefore, teachers should pay attention to educating students in probability knowledge and methods, and establish a teaching relationship with students as the main body and teacher-led as the supplement. The implementation of the new curriculum reform poses challenges to traditional classroom teaching, but it also brings opportunities and breakthroughs to traditional teaching models. Through innovative teaching methods and means, students' learning needs can be better met and their learning effects and interests improved. Only by constantly adapting to the pace of education reform and innovating education methods can we better cultivate a new generation of talents with comprehensive qualities and problem-solving abilities. In order to change the current situation, we should focus on good interaction and communication between teachers and students to promote curriculum teaching reform and improve learning efficiency. It is necessary to allow every student to participate in the teaching process and achieve common progress between teachers and students.

In order to attract the attention of students, teachers can carry out colorful and interesting learning activities. Teachers should also pay attention to subjects or course content that are relevant to life or that can arouse students' interest, so that they can become educational materials that are full of vitality, can mobilize people's positive emotional factors, and stimulate students' thinking ability and imagination. In course teaching, teachers should take students as the main body and let students become the main body of learning. Teachers should start from multiple angles to stimulate and mobilize the enthusiasm of every student to participate in classroom activities, combine probability and mathematical statistics for analysis and discussion, or use multimedia technology to play videos or animated shorts related to mathematical knowledge points, rules, etc. for everyone to enjoy and watch. Doing so can not only improve the teaching effect, but also allow students to participate in learning more actively. It also allows teachers to have a deeper understanding of the

course content. In course teaching, the teacher's role is to guide and inspire, allowing students to independently explore and solve problems. Therefore, under the traditional examination-oriented education model, the past "cramming" teaching methods and methods must be changed. With the advancement of the times, people have higher and higher requirements for knowledge ability and comprehensive quality, and the setting of various courses is also constantly expanding to meet the needs of different groups of people. In order to promote teaching quality and improve students' learning efficiency, the teacher-led educational thinking must be transformed [20]. The innovative mechanism of course teaching mainly includes three elements: teacher leadership, student subject and social environment, which play a decisive role in course content. In the classroom, heuristics, discussion methods and other methods should be used to stimulate students' interest in learning, guide students to have thinking collisions through questions, let them actively participate in the problem-solving process, and cultivate their innovative consciousness and practical ability. Teachers can also provide targeted guidance and explanations based on the syllabus and teaching materials and the characteristics of specific subjects to make knowledge points clearer.

4. Results and Discussion

4.1 Survey on the Effectiveness of Curriculum Innovation

Table 1: Survey sample

Sample number	Grade	Gender
001	Freshman year	Male
002	Freshman year	Female
003	Junior year	Male
004	Junior year	Female
005	Sophomore year	Male
006	Senior year	Female

After investigation and research, it was found that students' learning interest, classroom participation, and teachers' requirements for cultivating talents had significantly improved during course teaching.

1) Designing survey objectives: The purpose of this survey is to investigate students' learning attitudes, curriculum knowledge and abilities, analyze the results and formulate corresponding teaching strategies to improve classroom efficiency. This article uses a questionnaire survey method to understand different students' interest in probability theory and the different teaching methods used in the new curriculum reform, so as to improve their professional quality.

2) Selecting the survey method: In order to better understand students' learning status of the "Probability Theory and Mathematical Statistics" course content, this article designs questions about the selection of survey methods and survey objects in the questionnaire. The method used is frequency analysis method, which uses indicators such as frequency and number of times to reflect students' mastery of the course knowledge and their interest in the professional courses they have studied this semester.

3) Selecting survey samples: Based on the actual situation, this article selects representative survey samples. In order to ensure the representativeness and reliability of the survey objects, this article randomly selects some qualified students with certain experimental experience and teaching experience as samples in the questionnaire. For the course "Probability Theory and Mathematical Statistics", this article first selects 6 students to fill in the questionnaire and asks them to have a brief understanding of the content they learned and to ask questions. Finally, the teacher summarizes and evaluates each person's answers. The results from the questionnaire show that most

students believe that the answers to the course meet the teaching requirements and can meet the course standards. The following is the sample data table 1 of this experimental investigation.

4.2 Analysis of Survey Results

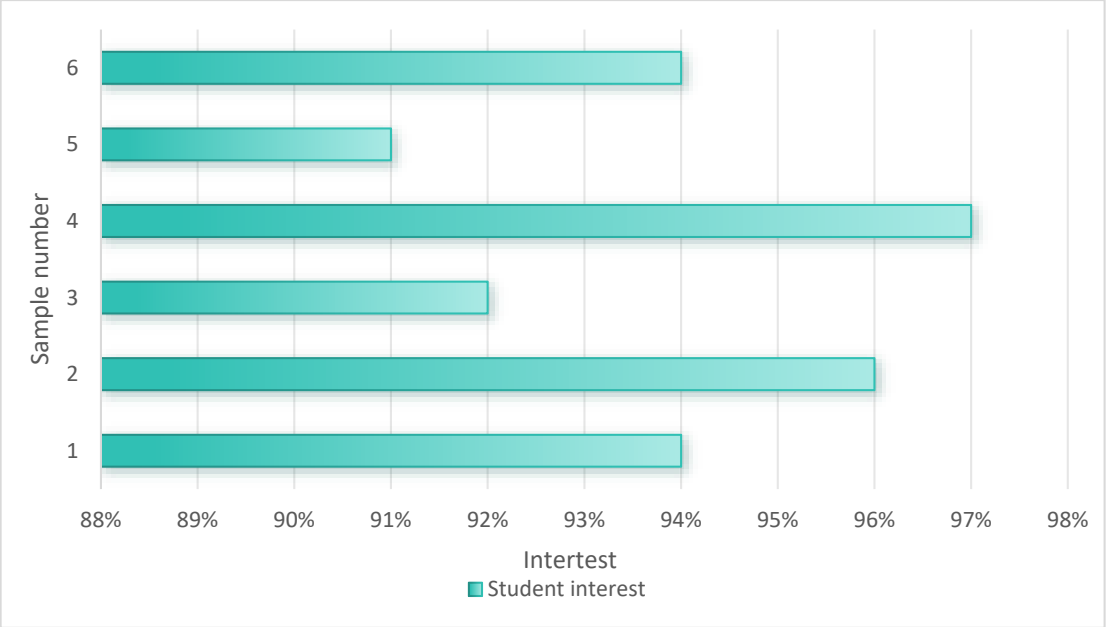

Figure 2: Student interest

The student interest test is designed to understand each student's learning situation and choice of experimental projects. By conducting a questionnaire survey, this article can analyze the degree to which students in classes at different levels have mastered the content of "Probability" and "Mathematical Statistics". During the testing process, teachers can use classroom teaching videos or other multimedia technology to determine the specific requirements of each class and whether the knowledge learned meets the expected goals. According to actual needs, this article will also adjust the class size and time arrangement, increase the amount of class hours, and consider factors such as the use of experimental equipment and instruments to ensure that each student can improve and progress accordingly. Judging from the data in Figure 2, the interest level of the six students of different grades but the same major in this test is basically maintained at above 91%. This article hopes that through such a test, it can better promote students' interest in learning and improve their motivation to learn.

In the teaching process, students' active participation and analysis and summary of knowledge points are necessary. In order to understand students' learning situation and mastery level, teachers can conduct surveys through questionnaires, interviews, etc. According to students of different levels, corresponding test questions are designed to evaluate whether they can complete tasks independently. If there are problems, appropriate adjustments need to be made based on the actual situation before continuing with teaching. For problems that cannot be solved due to lack of ability or practical experience, teachers can provide guidance and guidance. In the context of the new curriculum reform, in order to improve classroom efficiency, stimulate students' interest in learning and cultivate innovative talents, every student needs to actively participate in classroom activities. According to the test data in Figure 3, these six students have a relatively high degree of participation in introductory studies and mathematical statistics, with the lowest being 0.8 and the highest being 0.98. This shows that student participation is relatively high after the course teaching

is optimized.

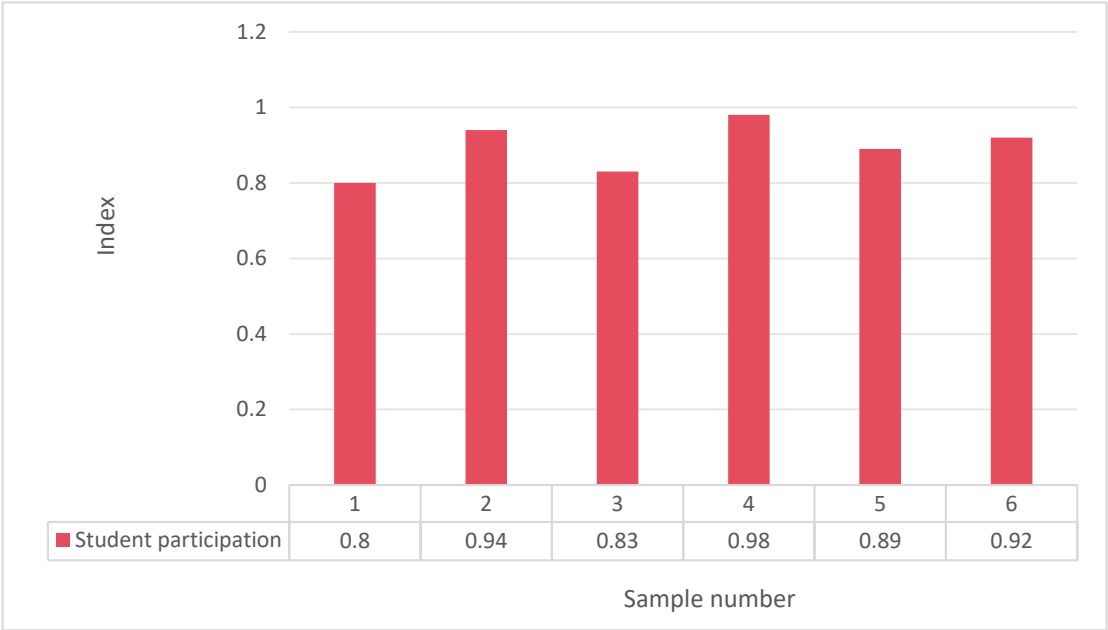

Figure 3: Student participation

5. Conclusion

With the continuous development of Chinese society and the deepening of higher education reform, new requirements have been put forward for curriculum teaching, especially in cultivating students' scientific literacy. Therefore, we must start from educational ideas and methods to explore how to carry out curriculum construction. This article takes "Probability Theory and Mathematical Statistics" as an example to study its content and characteristics; this article also discusses common problems in this topic, such as high frequency, abstract logic and difficulty in understanding, etc.; finally, this article analyzes the shortcomings of this subject and the areas that need improvement based on these situations, and proposes strategies that should be paid attention to in future development, aiming to provide help in improving the level of undergraduate teaching in China. However, the research content of this article is not comprehensive enough. It only covers some aspects and does not propose more new ideas. In teaching practice, the knowledge points of probability theory and mathematical statistics are relatively simple and easy to understand. However, due to teachers' insufficient attention to this field and lack of professional understanding, classroom efficiency is low. In addition, although students have mastered these theoretical foundations, they do not understand them deeply, have certain difficulties in learning, and the effects are not obvious enough, and they have not even achieved the expected goals. This also causes some students to lose interest, which in turn affects the quality of the course. The teaching reform of the two courses of probability theory and mathematical statistics should take students as the main body and teachers as the guide, based on teaching materials, implement the "people-oriented" teaching concept, and pay attention to the characteristics of the subject and its own characteristics. We should not only focus on the teaching of theoretical knowledge, but also pay more attention to the cultivation of practical abilities and other aspects of development to improve students' comprehensive quality. In the future, the teaching content and methods of these two courses should be further comprehensively explored to promote curriculum innovation and progress, so as to better meet society's needs for scientific literacy.

Acknowledgement

This work was supported by First-Class Undergraduate Course “Probability and Statistics” of Hulunbuir University (XXKC2022005).

References

[1] Adrian Celestino, Kurusch Ebrahimi-Fard, Frédéric Patras, Daniel Perales. Cumulant-Cumulant Relations in Free Probability Theory from Magnus' Expansion. Found. Comput. Math. 22(3): 733-755 (2022).
[2] Andreas Lochbihler. A Mechanized Proof of the Max-Flow Min-Cut Theorem for Countable Networks with Applications to Probability Theory. J. Autom. Reason. 66(4): 585-610 (2022).
[3] Aviv Adler, Jennifer Tang, Yury Polyanskiy. Efficient Representation of Large-Alphabet Probability Distributions. IEEE J. Sel. Areas Inf. Theory 3(4): 651-663 (2022).
[4] Zhipei Hu, Rongni Yang, Xutao Li, Yongkang Su. A Probability Theory Approach to Stability Analysis of Networked Sampled-Data Systems with Consecutive Packet Dropouts. IEEE Trans. Circuits Syst. II Express Briefs 69(2): 429-433 (2022).
[5] Ming Jing, Yongchuan Tang. A new base basic probability assignment approach for conflict data fusion in the evidence theory. Appl. Intell. 51(2): 1056-1068 (2021).
[6] Nabeel Butt. From approximate to exact probability models in dynamic portfolio decision theory. J. Oper. Res. Soc. 72(2): 268-280 (2021).
[7] Paul Tappenden. Everettian theory as pure wave mechanics plus a no-collapse probability postulate. Synth. 198(7): 6375-6402 (2021).
[8] Shuting Wang, Jie Meng, Yuanlong Xie, Liquan Jiang, Han Ding, Xinyu Shao. Reference training system for intelligent manufacturing talent education: platform construction and curriculum development. J. Intell. Manuf. 34(3): 1125-1164 (2023).
[9] Jacob Kelter, Amanda Peel, Connor Bain, Gabriella Anton, Sugat Dabholkar, Michael S. Horn, Uri Wilensky. Constructionist co-design: A dual approach to curriculum and professional development. Br. J. Educ. Technol. 52(3): 1043-1059 (2021).
[10] Tiina S. Korhonen, Laura Salo, Noora L. Laakso, Aino Seitamaa, Kati Sormunen, Minna Kukkonen, Heidi Forsström. Finnish teachers as adopters of educational innovation: perceptions of programming as a new part of the curriculum. Comput. Sci. Educ. 33(1): 94-116 (2023).
[11] Sri Untari, Meidi Saputra, Muhammad Taufiqurrahman. Website-Based Government Learning Development: An Innovation for Learning in the Implementation of Life-Based Curriculum. Int. J. Interact. Mob. Technol. 16(24): 143-153 (2022).
[12] Yanyan Chang, Wei Zhang, Hao Wang, Yanyan Liu. Fast Blind Recognition of BCH Code Based on Spectral Analysis and Probability Statistics. IEEE Commun. Lett. 25(10): 3170-3174 (2021).
[13] Kingsley Anthony Reeves, Victor M. Hernández-Gantes, Grisselle Centeno, Carolina Gushi Nurnberg. Game - Constructivist Exercises to Enhance Teaching of Probability and Statistics for Engineers. INFORMS Trans. Educ. 22(1): 55-64 (2021).
[14] Mohd Rashid Mohd Saad, Simah Mamat, Riyan Hidayat, Abdul Jalil Othman. Integrating Technology-Based Instruction and Mathematical Modelling for STEAM-Based Language Learning: A Sociocultural and Self-Determination Theory Perspective. Int. J. Interact. Mob. Technol. 17(14): 55-80 (2023).
[15] Rafael Correa, Marco A. López, Pedro Pérez-Aros. Optimality Conditions in DC-Constrained Mathematical Programming Problems. J. Optim. Theory Appl. 198(3): 1191-1225 (2023).
[16] Anamaya Vyas, Arsh Parnami, Manas Ranjan Prusty. Graph theory-based mathematical modeling and analysis to predict a football dream team. Knowl. Inf. Syst. 65(4): 1523-1547 (2023).
[17] Adrian N. Bishop, Pierre Del Moral. On the mathematical theory of ensemble (linear-Gaussian) Kalman-Bucy filtering. Math. Control. Signals Syst. 35(4): 835-903 (2023).
[18] Jacek Blazewicz, Benjamin Moseley, Erwin Pesch, Denis Trystram, Guochuan Zhang. Mathematical challenges in scheduling theory. J. Sched. 26(6): 519-521 (2023).
[19] Da Kang, M. Prabhu, Ramyar Rzgar Ahmed, Zhuo Zhang, Atul Kumar Sahu. Digital-IIoTs spheres approach toward public development: an exploiting fuzzy-grey mathematical modeling of IIoTs spheres. Grey Syst. Theory Appl. 12(2): 389-416 (2022).
[20] Panos M. Pardalos, Michael Yu. Khachay, Yuri Kochetov. Special Issue: 18th International conference on mathematical optimization theory and operations research (MOTOR 2019). J. Glob. Optim. 83(3): 403-404 (2022).