Machine Learning Based Analysis of the Curriculum Standards and Textbooks of Middle School Biology Teaching: Case of "Curriculum Ideological and Political"

Jiazhong Liu, Hongmei Li, Huixian Zhu[✉], Huirong Li, Xin Zhang, Guofei Zhou, Dengji Lou, and Yan Chen

Institute of Biology and Environmental Engineering, Yuxi Normal University, Yuxi, People's Republic of China

{ljzh68,Hongmeili105,zhuhuixian,10942,zhx,zhouguofei,loudengji, chy}@yxnu.edu.cn

Abstract. Taking the course of biology curriculum standard and textbook analysis in middle school as an example, this paper introduces the example of introducing the dialectical relationship principle of practice and cognition into the teaching process of the first and second chapters of this course. This paper also aims to introduce similar ideological and political elements into the teaching of biology courses. This paper proposed a research method fused with machine learning. Students' feedback analysis has been performed using the machine learning classifier. Performance of the proposed method is analyzed from confusion matrix measures of Random Forest (RF) model. A detailed qualitative analysis of chapters 1 & 2 from biology textbooks has been presented with several advantages of the curriculum standards and textbook materials. The proposed RF model show 75% and 66.66% accuracy and precision, respectively. The proposed application of RF model is better than the state of the art proposed approaches. The experimental results suggest that the applications of machine learning with the teaching of biology textbooks, art of teaching and feedback from students may be undertaken in future works.

Keywords: biology curriculum standard · Textbook analysis · Curriculum ideological and political · Machine learning · Random forest · classification

1 Introduction

Research on the Curriculum Standards and Textbooks of Middle School Biology is a compulsory professional course for biology normal students in normal universities. This course deeply interprets the biology curriculum standards of middle schools in China, and studies the analysis rules and methods of biology textbooks for middle schools. It reflects the current basic education curriculum philosophy, deepens students' understanding of the biology curriculum standards formulated by the state, and deeply understands the

characteristics of the new biology curriculum textbooks [1, 2]. This helps in grasping the principles and methods of biology textbook analysis by laying a foundation for improving biology teaching design and teaching implementation capabilities. To understand the knowledge system, basic ideas and methods of biology; we need to master the basic knowledge, basic principles and skills of biology, Mastering the curriculum standards of biology makes main methods and strategies for the development of biological curriculum resources and school-based curriculum development more useful for teaching in schools; To understand the cognitive characteristics of middle school students when learning biology; they need to grasp the methods and strategies of teaching and research learning for the content of biology, scientific design of teaching objectives and teaching plans. Therefore, current research is focused on the reasonable use of teaching resources and methods to design teaching process [3].

The integration of scientific inquiry into the curriculum at schools in key phenomena in science education. It has been well-known that scientific books are accessible resources for students and teachers for the growth of public K-12 schooling worldwide [4]. A recent research is undertaken to examine the alignment between textbooks and curriculum standard. Porter's alignment model has been used to construct a two dimensional relationship between biology textbooks and curriculum standards. Results based on the Porter's alignment model indicate unsatisfactory alignment between two dimensions. This study suggested reforms in developing curriculum alignment regarding the current research on the content analysis [5].

In China, several curriculum reforms have been performed to meet the global challenges of quality education. A quality oriented curriculum (suzhi) education is aimed at producing well-rounded citizens [6]. However, this curriculum shows limitations; as an entrance examination is the sole mechanism to sort out the students for admission in middle schools. Recent science curriculum reforms have been introduced in 2017 in China. These reforms are based on tripartite framework, including the policy, programmatic and classroom curriculum [7]. However, the recent reforms in science curriculum do not meet expectations and thus need revision process in China.

Biology is a compulsory and basic course for students adopting science group in middle and high schools as well. It has worth for students to go for medical colleges and universities and even those students adopting pharmaceutical education. However, for majority of students, the process of learning of biology is boring with several biological terms and diagrams and theorems [8]. With the addition of course thought and political processes, the situation can be averted. Several biological theorems and models have been developed hundreds of years before in history. If we add these interesting stories of scientists and their proposed theorems, we can overcome the learning issues of students in classrooms. The contribution of this paper are as follows:

1. This paper presents a comprehensive discussion of curriculum standards and biology textbooks with the help of Marxist theory.
2. This paper proposes an application of machine learning based classifier to analyze the feedback from biology class in middle schools.
3. The proposed machine learning based classifier's performance is evaluated using the accuracy and precision metrics.

The main layout of the paper is presented as follows:

Section 2 presents the materials and methods of the proposed research; Sect. 3 shows results and discussion on the proposed approach and its implementation. Section 4 concludes the results of the proposed research.

2 Materials and Methods

This section presented the proposed method to conduct the research. First, the workflow of the proposed method has been shown in the following Fig. 1. Next, we elaborate the various components of the Fig. 1 to understand the mechanism of the proposed method.

2.1 The Research Material is the Chapter Teaching Content of the Curriculum Standard and Textbook Research of Biology in Middle School

Case example method; applying the theory of Marxist basic principles to course teaching design.

Previous research and theoretical works have shown more complex means of teaching. For example; Mclaren pointed out the institutional structure, ideology and context impacts on the educational processes [9]. Further, Feminism and Marxism theories when applied to education settings bring attention to materialism and oppressions. However, these theories are still indisputable and can be used in educational settings to improve course teaching design [10]. Marxism is a popular and influential doctrine and shows impacts on different fields of education, including biology in Western countries and China. Therefore, the focused research material in this proposed work can be evaluated from users' feedback from middle schools.

Hence, we perform learner evaluation by using the self-learning algorithms. Typical examples of these algorithms include the real time analysis and feedback output etc. To measure the learners' performance, this research used the efficient machine learning
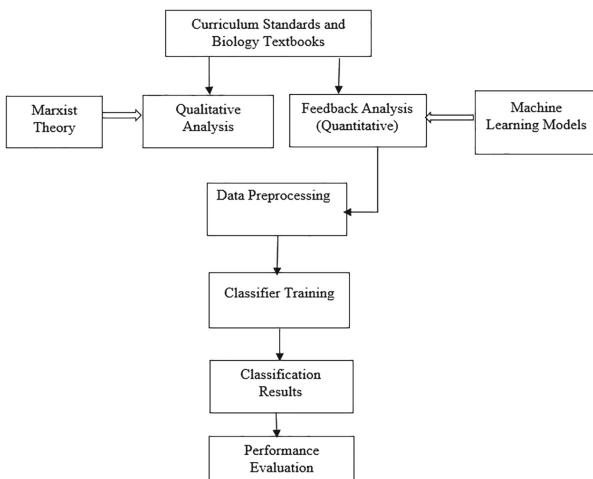

Fig. 1. Workflow of the proposed method

models. Pattern analysis of school boys learning biology in the classroom may provide better results for feedback to their biology curriculum as well as teachers. A mixed method (qualitative and quantitative) is used is this research; the first part is based on the qualitative analysis of curriculum standards applied to biology textbooks in middle schools and the second part is undertaken with the objectives of analyzing the feedback from participants who are intended users of biology textbooks in middle schools (see Fig. 1). As per given in Part 1, the application of Marxist theory have been revealed in the context of curriculum standards and biology textbooks. In the second part we propose to use asynthetic dataset concerning the teachers' capability to follow the chapters (1&2) and feedback information from a sample of 10 students have been collected and analyzed using the performance metrics in artificial intelligence as given in the following:

$$Accuracy = (TP + TN/(TN + FP + TP + FN)) \qquad (1)$$

$$Precision = TP/(TP + FP) \qquad (2)$$

Prior to performance analysis, several steps have been used as shown in the Fig. 1

Data Preprocessing
Learners' feedback information gives us some structured and unstructured extracted useful data. Data preprocessing involves cleansing data to make it ready for further processing. Data preprocessing is aimed at reducing complexity and preparing data. The data after preprocessing is fed to the machine learning classifiers. To reduce the complexity in data means better efficiency of selected classified in terms of learning time and preventing classified from overfitting [11].

Classifier Training
Prior to the training and testing of the RF model, we present the code and schematic diagram of the proposed RF model in this research study. First, we present the pseudo-code of the RF model in the following.

The version of pseudo-code for RF model has been presented in the Fig. 2. Based on four steps, the proposed RF model simply provides the final predicted class.

Input: testing data
1. Perform prediction and storage of each randomly decision tree from the provided dataset.
2. Perform computing of total votes from the individual class
3. Declaring the majority class as a final output class
4. Final predicted class
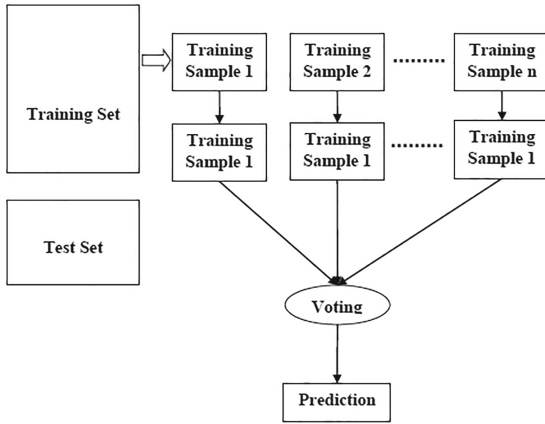
Fig. 2. Pseudo-code of the Random Forest model

Fig. 3. Working of the Random Forest classifier

The preprocessed data set is used to perform training and testing of selected classifiers (Random Forest RF) (Fig. 3). Out of the dataset, 33% proportion of dataset is selected to train the dataset and rest of 67% dataset is fed and used for testing of classifiers.

Classifier Training
Implementation of RM model is performed to achieve classification results. Confusion matrix provides a way of correct and incorrect predictions. It also informs where the RF model remained confused. In a confusion matrix, columns represent the predicted labels while rows tell us true labels. Other than accuracy and precision, confusion matrix provides error rate (ERR), specificity and sensitivity values. In the subsequent section we present the sensitivity and specificity formulas. Performance Evaluation.

The evaluation results can be used to demonstrate the accuracy and effectiveness of chosen machine learning classifiers. In order to conduct the evaluation of results, performance metrics such as accuracy, and precision have been used in this proposed research. Other than these metrics, sensitivity and specificity can be used to further show evaluation of the proposed research.

$$\text{Sensitivity} = \text{TP}/(\text{TP} + \text{FN}) \tag{3}$$

$$\text{Specificity} = \text{TN}/(\text{TN} + \text{FP}) \tag{4}$$

Sensitivity as given in Eq. (3) shows us the detection of positives while in Eq. (4) specificity represents the negatives.

3 Results and Discussion

This section presents results and their discussion on qualitative analysis of curriculum standards of biology textbooks (Part 1) and feedback analysis (Part 2). First, we provide discussion on results regarding the application of Marxist theory for two Chapters (Chapter 1 & 2) in the following.

(Part 1)
Research on the Curriculum Standards and Textbooks of Middle School Biology is a compulsory course for the majors of biological science. This course combines theory with practice, and combines the curriculum content with the flexible application of theoretical curriculum knowledge, so as to apply theory in practice and expand theory to practice.

Curriculum standards and textbook analysis are involved in the curriculum. In terms of teaching design, we should find the right starting point and introduce ideological and political elements imperceptibly, which can help students form a spirit of perseverance in scientific research and enhance their enthusiasm to participate in the class. In terms of teaching content, we should fully tap the materials that are consistent with Marx's philosophy, scientific thinking and other thoughts, and integrate them into the teaching process. In terms of teaching methods, through the introduction of ideological and political elements involved in different contents, students can practice the scientific thinking of "practice and understanding" in specific practice; Through heuristic teaching, different forms of teaching activities are carried out in teaching, such as preview before class, cooperative learning in class, summary, discussion and reflection after class, so as to fully mobilize students' enthusiasm for learning, stimulate their interest in learning, and cultivate their ability to learn independently, think independently and solve practical problems [12, 13].

Course Ideological and Political Teaching Design and Content
In the process of teaching interaction, in view of the current college students' lack of social responsibility, patriotism, political sensitivity, as well as the lack of goals, self-discipline, poor teamwork and other problems, the curriculum teachers need to consciously combine the teaching content to carry out the ideological and political teaching of the curriculum, and imperceptibly improve the ideological and moral level of students.

In terms of teaching content, the theories and laws of many courses are also applicable to the rules of human society operation. The explanation can be naturally introduced based on professional knowledge to guide students to think deeply and naturally integrate the concepts of patriotism, dedication, equality, fraternity and correct outlook on life.

The ideological and political teaching of this course is designed along three main lines: first, the theoretical teaching realizes the knowledge goal and integrates the moral education viewpoints related to teaching knowledge points; the second is to achieve the goal of ability through the practical teaching, and improve teaching skills and scientific analysis ability by combining students' lectures. The third is to achieve the quality goal through the teaching process. In the teaching process, the teacher uses a rigorous working attitude to imperceptibly cultivate students to be serious and responsible, closely follow

the biology curriculum standards of middle schools, and love the students' character in the process of education.

Examples of ideological and political education in this course are as follows:

- In chapter I, middle school biology curriculum standards, at first, we must learn curriculum standards for compulsory education 2022 revision, secondary school biology 2020 revision. At the same time, we must combine elements of ideological and political, that is: Dialectical relation principle of practice and cognition.

Adhere to the view of practice first, adhere to the principle of combining theory with practice, and achieve the concrete and historical unity of theory and practice. The so-called concrete means that the subjective knowledge should be consistent with the objective practice at a certain time, place and condition. The so-called historical means that subjective knowledge should be adapted to the objective practice in a specific historical development stage. If subjective knowledge falls behind objective practice, it is easy to make the mistake of right-wing conservatism. If subjective knowledge is ahead of objective practice, it is easy to make the mistake of left leaning and rash progress.

In the teaching process, students can learn the latest curriculum standards that keep pace with the times, and also apply the principle of combining theory with practice to teaching by explaining the examples of our country's constantly revised biology curriculum standards for middle schools.

- In chapter II, an overview of biology textbooks for middle schools, at first, we must learn concept and function of textbooks, design and compilation of biology textbooks for middle schools, and history of biology textbooks for middle schools. At the same time, we must combine elements of ideological and political, that is: Strengthen system and self-confidence education.

In the chapter of "Overview of Middle School Biology Textbooks", it is pointed out that biology, as a compulsory course in middle schools, began in the late Qing Dynasty. After the founding of New China, secondary school biology education has been evolving with the development of social politics, economy and biology curriculum. Middle school biology textbooks have gone through a complex development process, from copying foreign countries in an all-round way, to independent exploration, from overall negation to overall left leaning, to putting things right and finally to comprehensively deepening reforms. This fully demonstrates the social system advantages of China's democratic centralism.

Take the prevention and control of the novel coronavirus pneumonia epidemic as an example. China was able to effectively control the COVID-19 epidemic within one month after it was discovered. This is due to the unified deployment and coordination of all forces by the Party Central Committee. The epidemic prevention measures in China have become a model highly recognized and used for reference by the international community, which fully demonstrates the advantages of the social system of China's democratic centralism, in sharp contrast to the epidemic prevention effects of the Western capitalist system. This is enough to prove the decision-making advantages of our socialist system. Students should be confident in the system of socialism with Chinese characteristics.

Teaching methods and means:

- In terms of teaching content, this course divides the teaching content into knowledge modules, designs self-study topics and discussion topics according to the modules, requires students to carry out group discussions after class, and puts forward reports or plans in class. In order to cultivate students' ability to master knowledge, we need to expand knowledge, think independently, and solve problems, so as to imperceptibly enhance their confidence, discover and cultivate interest, and form the new era college students' character of optimism, self-confidence, truth-seeking, pragmatic, and proactive.

- In terms of course teaching process, the course is designed according to students' independent learning and discussion, teachers' random questions and key explanations, and classroom online testing. In terms of teaching space, the classroom and network are integrated in an all-round way and switched at any time according to teaching needs. For teaching methods, multiple tools such as traditional teaching materials, multimedia, mobile social software and online examination software are comprehensively used for three-dimensional teaching. After class, difficulties, hot spots, online discussion and online independent learning are supplemented. In the process of learning and discussion, the students' team cooperation ability, oral expression ability and thinking ability were trained.

- In terms of teaching means and methods, this course adopts the combination of lecture based teaching and autonomous learning based teaching to enable students to acquire the ability to solve practical problems through the knowledge internalization process of autonomous learning on the basis of mastering theoretical knowledge.

- In the aspect of classroom teaching, this course successively sets up teachers to teach, raise questions, and students to consult materials and feedback. They also require to expand knowledge through the independent learning, exercise students' self-study ability and independent thinking ability, cultivate students' interest in professional research, and feel the power of knowledge and the fun of knowledge seeking through learning and thinking.

- In terms of course assessment, this course has increased the proportion of usual scores and enriched the classroom assessment forms; In addition to the previous classroom attendance, questions and discussions, online classroom testing is added as a means to test students' classroom learning effect and learning ability, so as to achieve a comprehensive assessment of the whole learning process and students' comprehensive quality. The assessment system emphasizes honesty and strengthens the concept of time. Many absenteeism will also fail. Therefore, setting flexible scores can encourage students to learn actively and make progress

(Part 2)

This part is focused on results and their discussion on students' feedback data and their analysis using the RF as a machine learning classifier.

Table 1 shows us the sample of a fewer test dataset with the actual labels and predicted labels. The proposed RF model made correct prediction for feedback 1, 3 and 4. As shown in Table 1; the proposed model did not handle the negation feature and thus resulted in a positive prediction. Our proposed research predicted students' feedback as positive or

Table 1. Student feedback of learning Biology textbooks using Curriculum Standards

Sr. No.	Student Feedback text	Actual Label	Predicted Label
1	Usefulness of biology textbooks	Positive	Positive
2	Curriculum standards highly focus on ideology and politics	Negative	Positive
3	Biology textbooks have practical outcomes	Positive	Positive
4	Curriculum standards do not make biology textbooks interesting	Negative	Negative

negative. Based on the prediction results, a confusion matrix was formulated to further elaborate the results.

From Table 2 the confusion matrix results, accuracy and precision scores can be determined using Eq. (1) and (2) respectively. Accuracy score attained in this research is 75% and precision score is 66.66% that indicate the effectiveness of the proposed application of RF classifier. From confusion matrix measures, it has been known that majority of users of biology textbooks have shown their acknowledgement for the usage of curriculum standards in middle schools. This has been proven by the accuracy and precision metric results as earlier explained in this study. The following figure is showing us the accuracy comparison results from another study.

Table 2. Confusion matrix results from Random Forest classifier

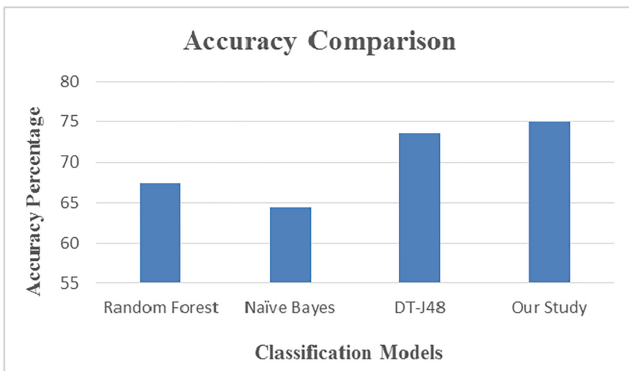| N = 04	Predicted No.	Predicted Yes	
Actual No	TN = 1	FP = 01	2
Actual Yes	FN = 0	TP = 02	2
	1	3	

Fig. 4. Accuracy comparison

Comparison of the performance metric results show that accuracy (75%) is greater than the Naïve Bayes (64.40%), Random Forest (67.40%), and DTJ48 (73.6%). As shown in Fig. 4, it is understood that our proposed classification model is better in classifying the feedback score from students.

The proposed approach although shows the fusion of Marxist theory and machine learning for hybrid analysis, but it has a few limitations. The accuracy and precision percentages attained from this research are low so far and can be improved by increasing the number of samples of feedback data from participants. This study presents the classification problem from the collected feedback of students. Henceforth, several advanced deep learning model can be trained to yield results with better accuracy and precision. Furthermore, the accuracy and precision results of classifiers can be compared to identify most suitable models. Hence, more classification models can be used to verify the correct prediction.

4 Conclusions

On March 25, 2022, the Ministry of Education issued a document:

In order to implement the spirit of the 18th and 19th National Congress of the Communist Party of China, implement the deployment of the National Education Conference, comprehensively implement the fundamental task of building morality and cultivating people, and further deepen the curriculum reforms, the newly revised compulsory education curriculum plan and 16 curriculum standards such as Chinese are printed and distributed to you, and will be implemented in the autumn semester of 2022.

All localities should plan and systematically promote the implementation of the compulsory education curriculum plan and curriculum standards (2022edition). Organize and carry out training in a planned and step-by-step manner, strengthen the research and exchange of curriculum reform ideas and general reform requirements in various forms, and achieve full coverage of principals, teachers, teaching and research personnel, and educational administrators. To strengthen the management and guidance of curriculum implementation, it is suggested to formulate provincial compulsory education curriculum implementation measures and report to the Ministry of Education, and specify the work requirements for school curriculum implementation. We should vigorously promote teaching reforms, which change the way of education, and effectively improve the quality of education. It can strengthen the guarantee of conditions to ensure the effective implementation of the curriculum.

To implement these requirements, we need to revise and improve the compulsory education curriculum plan and curriculum standards, and also need to reform the contents and methods of teaching and learning. Second, in 2011, China has achieved the full popularization of compulsory education. The demand for education has shifted from "learning" to "learning well". The development of education has put forward new requirements and challenges for talent cultivation. We must deepen curriculum reform and strengthen the construction of compulsory education curriculum. Third, the current compulsory education curriculum plan and curriculum standards were formulated and promulgated in 2001 and 2011 respectively, which played an important role in guiding and promoting education and teaching reforms. However, there are still some areas that

are not compatible with the new situation and new requirements, which must be revised and improved. The teacher first introduces the curriculum standards to the students, then shows the new version of the curriculum standards to the students, and introduces the ideological and political content of scientific thinking of "the dialectical relationship principle of practice and cognition", so that the students can fully realize that everything needs to practice the "dialectical relationship principle of practice and cognition".

This course is appropriately integrated with the ideological and political cases of the course in teaching, which enriches the classroom teaching content and achieves good teaching results. Students generally reflect that they have mastered the ability to solve practical problems through the study of the course "Analysis of Middle School Biology Curriculum Standards and Textbooks", and their learning results have improved significantly. They agree with the teachers' ideological and political attempts in the course of "Analysis of Middle School Biology Curriculum Standards and Textbooks". This research showed innovation in fusing the curriculum standards and textbooks of biology teaching with the machine learning to analyze the feedback from biology classmates in China. Machine learning results have shown a new era of applying artificial intelligence (AI) on students' feedback regarding the curriculum standards.

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