The Research on the Comprehensive Ability Evaluation Model of RF Electronic Technology Experiment Course

Guosheng Ma1* Jiang Wang2 Rui Dong3

1,2,3 National University of Defense Science and technology, College of electronic countermeasures, Hefei, China
*Corresponding author. Email: gsmaw@sina.com

ABSTRACT

In view of the wide range of majors involved in the electronics courses and the fact that there are many students in our college, the relevant practical training links have lacked a scientific and reasonable comprehensive ability assessment and evaluation model. This article applies the cloud model theory to the practice training assessment and evaluation of electrical courses. We aim to establish a set of fair, reasonable, scientific and standardized comprehensive ability assessment and evaluation model, which can accurately reflect the effect of practical teaching, comprehensively evaluate the level of knowledge, and ability and quality of students. Meanwhile, it help to cultivate innovative talents, promoting the comprehensive advancement of practical teaching reform.

Keywords: RF electronic technology, cloud model, cloud generator, Comprehensive ability evaluation model

1. INTRODUCTION

Experimental teaching of RF electronic technology is the key to the teaching of electronic engineering and information engineering in military colleges and universities. It is an important link to cultivate students' innovative spirit and practical ability. RF electronic technology training occupies a large proportion in the college, which involves a wide range of majors and faces many students. If can establish an objective, fair, fair and reasonable evaluation mechanism for integrated evaluation of the student practice result, it is not only beneficial to guide students to correctly treat the practice teaching, can promote the student in the teaching practice in the process of implementation of the initiative, enthusiasm, can greatly stimulate the student understanding of it's in the center position of practice teaching, and but also good for teachers to improve the practice teaching methods and means, in order to better improve the quality of teaching. Therefore, practical ability assessment is an important means to evaluate and motivate students' learning, and its rationality and fairness are especially important. In view of the difficulty of RF electronic technology course, many practical projects involved and strong comprehensiveness, it is an urgent problem to construct a set of scientific and reasonable comprehensive ability evaluation model.

2. EVALUATE THE PROBLEMS EXISTING IN THE EXPERIMENTAL COURSES OF RF ELECTRONIC TECHNOLOGY

According to many years of teaching experience found that the RF electronic technology experimental course grades are generally based on the usual experimental reports and experimental operations to determine. This evaluation model has the following problems: (1) Method is single and lack of multilevel and diversity. All the students do the same experiment according to the steps, and the evaluation result can be obtained after the experiment, which is not conducive to the improvement of teaching quality.(2)The content of the project lacks comprehensiveness and research, which is not conducive to cultivating students' application ability and innovation consciousness.(3)The lack of scientific and reasonable evaluation index system of experimental teaching makes the evaluation of experimental teaching lack of integrity in terms of items, methods and scores, which is not conducive to the integration of RF electronic technology experimental teaching content and the establishment of the curriculum system. (4) The biggest difference between practical assessment and theoretical assessment is its process management, while the existing assessment of experimental results are mostly derived from experimental results and experimental reports, unable to evaluate the experimental process, which is not conducive to the development of students' strengths and personality. 

From the perspective of comprehensive ability evaluation, it is urgent to introduce an evaluation system that can scientifically and rationally evaluate students' comprehensive practical ability.
3. GENERAL IDEA OF COMPREHENSIVE ABILITY EVALUATION OF RF ELECTRONIC TECHNOLOGY EXPERIMENT COURSE

3.1. Thinking of Comprehensive Ability Evaluation

According to the specific environment of the laboratory and the actual situation of students, we divided the evaluation of RF electronic technology experimental course into three modules, namely, experimental process, experimental operation and analysis of experimental data, as shown in Figure 1.

![Figure 1 Evaluation module distribution diagram of RF electronic technology experiment course](image)

The evaluation of the experimental process is mainly from the experimental attitude, experimental preview, experimental operational ability and the writing of experimental report and other aspects to investigate the experimental effect of students at ordinary times, this part as the usual scores; Experimental operation is mainly from the experimental design, experimental wiring, experimental debugging, troubleshooting and other aspects of independent evaluation of experimental operation; Design and analysis mainly from the circuit diagram design, circuit diagram drawing, circuit principle analysis and thinking question solution and other aspects of independent analysis ability, this part as an experimental theoretical evaluation.

3.2. Detailed Rules of Comprehensive Ability Experiment Evaluation

The grades will be evaluated comprehensively in the way of "peacetime (60%) + examination (40%)\(^2\). According to the characteristics of radio frequency electronic technology experiment course and the teaching experience and teaching experience of the members of the research group for many years, a more perfect and detailed rules for the evaluation of students' achievements are summarized, striving to evaluate each student's achievements fairly, reasonably and accurately. The evaluation table of students' experimental results is shown in Table 1.\(^3\)
Table 1 Rules for the evaluation of RF electronics experimental courses

| Evaluation indicators                        | Peacetime Score 60 | Examination Score 40 |
|----------------------------------------------|---------------------|----------------------|
| The preview report is complete               | 3                   | 4                    |
| Answer questions in class                    | 3                   | 4                    |
| Proficiency level                            | 7                   | 10                   |
| Analyze problem solving ability              | 5                   | 10                   |
| Basic experimental content                   | 14                  | 10                   |
| Improve sexual selection of content          | 4                   | 10                   |
| The data are clear and the calculations accurate | 15                  | 10                   |
| Complete the extended thinking questions     | 4                   | 6                    |

The students are assessed according to the experimental preparation in each experiment course, the classroom questioning, the experimental discipline, the accuracy of practical operation, the credibility of the experimental results, the quality of the experimental report and other aspects, and are recorded. At the end of the semester and the final assessment results are combined to obtain the total results of the experimental class. It can be seen that each statistic is very complicated, and there is a certain ambiguity and uncertainty, which really increases the workload of teachers' assessment.

The final assessment of the experimental course adopts the forms of random questions and group questions for practical operation and theoretical assessment, and examines students' independent operation ability, experimental phenomenon analysis and interpretation ability and experimental summary ability. Here the practical operation is carried out in the laboratory, and the experimental theory adopts the online form, and the online evaluation results are automatically generated online, which can reduce the heavy workload of teachers, and at the same time give students a fair and just assessment results.

4. APPLICATION OF CLOUD MODEL FOR EVALUATION OF EXPERIMENTAL COURSES ON RF ELECTRONICS TECHNOLOGY

The cloud model, a concept proposed by Li Deyi, an academician of the Chinese Academy of Engineering, in 1995, is a model that deals with the uncertainty transformation between qualitative concepts and quantitative descriptions, that is, it can transform these fuzzy concepts into specific data and present them visually in cloud images. Cloud model has been successfully applied to natural language processing, data mining, decision analysis, intelligent control, image processing and other fields due to its advantages in dealing with ambiguity and randomness.[4]

The performance evaluation of RF electronic technology experiment is a multi-level and multi-objective evaluation problem, which involves a lot of contents. Many evaluation elements are fuzzy and random, so it is difficult to divide them into "neither here nor there" simply, and it is difficult to describe them accurately by traditional mathematical models. Cloud model is exactly the qualitative and quantitative exchange model proposed on the basis of traditional fuzzy mathematics and probability statistics [5]. It organically combines fuzziness and randomness, and
realizes the conversion between qualitative linguistic values and quantitative values. Therefore, we apply the cloud model theory to the evaluation of RF electronic technology experimental results, and carry out scientific statistics and evaluation of the most difficult and troublesome results in ordinary times.

4.1. Cloud Model

Cloud has three numerical characteristics, namely Expected (Ex), Entropy (En), and Super Entropy (He). Figure 2 is the digital feature diagram of cloud [6]. Where, the horizontal axis represents the range of uncertainty measurement of a certain concept, and the vertical axis represents the membership degree. The Expectation (Ex) is the expectation of the spatial distribution of cloud droplets in the field of argument, the central value of the field, and the point which can best represent this qualitative concept. Entropy (En) represents the uncertainty and fuzziness of cloud droplet distribution. Super Entropy (He), the entropy of entropy. The higher the super entropy, the greater the uncertainty of the model and the greater the thickness of the cloud. These three numerical features combine fuzziness and randomness, vividly display the shape of clouds, and complete the mutual mapping between qualitative and quantitative [6].

Figure 2 The digital characteristics of the cloud

Normal clouds are the most important cloud model. The theory of normal cloud is based on the universality of normal distribution and the universality of normal membership function. It expects the curve to be a normal curve, and defines \( y = \exp\left(-\frac{(x-\text{Ex})^2}{2(\text{En})^2}\right) \) as the expected curve of the normal cloud \((X,Y)\)[7].

The generating algorithm of normal cloud is:
- Generate a normal random number \( x_i \) with expected value Ex and standard deviation En;
- Generate a normal random number \( En_i \) with En as the expected value and He as the standard deviation;
- Calculate \( y_i = \exp\left(-\frac{(x_i-\text{Ex})^2}{2(\text{En}_i)^2}\right) \), and make \((x_i,y_i)\) as a cloud droplet, which is a concrete realization of the language value represented by the cloud in quantity, where \( x_i \) is the corresponding value of qualitative concept in the field of argument, \( y_i \) is a measure of the degree of belonging to the language value;
- Repeat the above steps until the desired number of cloud droplets is produced [8].

The model is used to implement the cloud generator. Cloud generator is a cloud-generating algorithm that can be implemented by modularized software or hardened hardware. According to its function, there are positive and negative cloud generators. Positive cloud generator is a forward and direct process, which is a mapping from qualitative concept to its quantitative representation. Cloud droplets are generated based on the digital characteristics of the cloud, where each ach cloud droplet is a concrete implementation of this concept. This is done by inputting the digital characteristics of three clouds \((\text{Ex},\text{En},\text{He})\) and the number of cloud droplets to be generated, and outputting the coordinates of each cloud droplet in the number domain, as well as the certainty that each cloud droplet represents the concept. The principle is shown in Figure 2. Negative cloud generator is the reverse process of forward cloud generator. It is a conversion model of quantitative values to qualitative concepts, which can transform a certain amount of accurate data into qualitative concepts represented by digital features \((\text{Ex},\text{En},\text{He})\). Specifically, input the cloud droplet that conforms to a specific distribution, and output the cloud model as the corresponding three digital characteristics \((\text{Ex},\text{En},\text{He})\). The principle is shown in Figure 4 [8].

4.2. Cloud Model Method for Evaluation of Experimental Courses in RF Electronics Technology

Experiment result evaluation of the radio frequency electronic technology courses many factors with the fuzziness and randomness of problem, we will cloud model theory is applied to the experiment result assessment, through the use of cloud generator implementation
experiment evaluation standard of qualitative and quantitative transformation, and the multi-factor comprehensive evaluation model of evaluation, gain the final evaluation results.

4.2.1. Determine the Weights of Evaluation Elements of the RF Electronic Technology Experimental Course

We divide the assessment rules in Table 1 into several first-level and second-level assessment elements according to the elements [9]. Here we record the peacetime assessment and the final assessment separately, especially the peacetime assessment elements are numerous, many elements are not quantitative, but fuzzy, the workload of evaluation record is very large. Such as in table 2 and table 3 have plenty of quantitative assessment elements, have a plenty of value in qualitative and fuzzy language to express a certain amount of scale, such as "evaluations operation".

Table 2 The weight of the elements of evaluation in the RF electronic technology lab course

| Primary elements | Secondary elements | Evaluation standard | Weight W |
|------------------|--------------------|---------------------|----------|
| Preview situation | The preview report is complete V11(0.5) | very complete | 0.50 |
| V1(0.1)          | Answer questions in class V12(0.5) | excellent | 0.50 |
| Experimental operation | Proficiency in content V21(0.583) | very skilled | 0.583 |
| V2(0.2)          | Analyze problem solving ability V22(0.417) | excellent | 0.417 |
| Finish the task | Basic experimental content V31(0.778) | excellent | 0.778 |
| V3(0.3)          | Improve sexual selection of content V32(0.222) | excellent | 0.222 |
| Experimental report | Finish writing on time V41(0.125) | excellent | 0.125 |
| V4(0.4)          | The data are clear and the calculations accurate V42(0.708) | very accurate | 0.708 |
|                  | Complete the extended thinking questions V43(0.167) | excellent | 0.167 |
4.2.2. Qualitative and Quantitative Conversion of Evaluation Elements and Comprehensive Evaluation Results

According to the rules of comprehensive ability evaluation of electronic technology experiment course, all levels of evaluation factors are established, and the evaluation criteria of each factor are respectively described by cloud model. This step is the key, which is related to whether the evaluation results are objective and reasonable. Here, specific cloud models are given for each evaluation element, such as the evaluation standard of "content proficiency" of the element in "experimental operation". The qualitative concept is expressed as follows in the cloud of:

| Primary elements | Secondary elements | Evaluation standard | Weight $W_i$ |
|------------------|-------------------|---------------------|--------------|
| Experimental theory $V_1 (0.35)$ | Basic operation methods and basic concepts $V_{11} (0.285)$ | 90-100 80-90 70-80 60-70 $<$ 60 | 0.285 |
| | Basic principle and usage of the instrument $V_{12} (0.715)$ | 90-100 80-90 70-80 60-70 $<$ 60 | 0.715 |
| Experimental operation $V_2 (0.65)$ | Operational capability $V_{21} (0.577)$ | 90-100 80-90 70-80 60-70 $<$ 60 | 0.577 |
| | Basic experimental contents $V_{22} (0.192)$ | 90-100 80-90 70-80 60-70 $<$ 60 | 0.192 |
| | Improved experimental content $V_{23} (0.231)$ | 90-100 80-90 70-80 60-70 $<$ 60 | 0.231 |

the quantized value of the ith element in the first-level element, while $W_i$ is the weight of the ith element in the first-level element.

5. SUMMARY

The scientific and normal comprehensive ability evaluation model can not only reflect the effect of experimental teaching accurately, but also evaluate the knowledge level, ability level and quality of students comprehensively. Meanwhile, it is conducive to cultivating innovative talents, which plays an important role in promoting the comprehensive reform of experimental teaching. Currently, there exists the wide range of specialties involved in the RF electronic technology courses of our college with the fuzziness and randomness of relevant experimental evaluation elements. In view of this, cloud model and multi-factor comprehensive evaluation model of tools are adopted to realize RF electronic technology experiment examination evaluation, which can more accurately the assessment of the specific conditions of the students' comprehensive ability completely. It is also the radio frequency electronic technology experiment course of practical training the comprehensive ability to build a scientific and reasonable evaluation model. The application of this model has a good reference value for the training and evaluation of other disciplines.
REFERENCES

[1] Xiangsong Huang et al. The exploration and practice of the reform of the examination method in the experimental teaching of analog electronic technology [J]. Experimental science and technology. 2018, 16(2), pp.82-84, 88.

[2] Chunyu Cheng et al. Exploration and Practice of simulation Electronic Technology Experimental Assessment Model Reform [J]. Laboratory Science. 2015 (4), pp.68-70.

[3] Liping Sun, Wenxiu Tang, Yizhuo Zhang. The Experiment of diversified teaching Mode in the teaching of analog Electronic Technology [J]. China's Out-of-school Education. 2013(S2), pp.64-64.

[4] Guilin Chen. An Uncertainty Model for Qualitative and quantitative information Transformation - Cloud Model [J]. Computer Application Research. 2010. 27(6), pp.2006-2010.

[5] Shidong Ma et al. Target threat level assessment based on cloud model [J]. Journal of Beijing university of aeronautics and astronautics. 2010, 36(2), pp.151-153.

[6] Ye Qiong, et al. Overview of Cloud Model and Its Application [J]. Computer Engineering and Design. 2011. 32(12), pp.4198-4201.

[7] Zhengjie Xu, Youpeng Zhang, Hongsheng Su. Application of Fuzzy Comprehensive Evaluation method based on cloud Model in risk Assessment [J]. Journal of Safety and Environment. 2014 (14), pp.69-72.

[8] Qiu Han, Junhu Zhu, Yufeng Li, et al. Exploration and Practice of the reform of experimental Teaching Assessment mode in colleges and universities [J]. Journal of Wuhan University: Science Edition. 2012 (S2), pp.207-210.

[9] Guijin Zheng, Peigang Sun, Baolin Su. Research and Practice on teaching Reform of High-frequency Electronic Technology Experimental Course [J]. Heilongjiang Science and Technology Information. 2013(27), pp.123-123.

[10] Shibin Zhang, Xiao Shan, Chang Yan et al. Research on Network User Behavior Evaluation Model based on cloud model theory [J]. Minicomputer System. 2013(10), pp.2367-2372.