Effectiveness Evaluation of Network Security Knowledge Training Based on Machine Learning

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Abstract. Due to the problem of inaccurate evaluation results of traditional methods for evaluating the effectiveness of network security knowledge training, a method for evaluating the effectiveness of network security knowledge training based on machine learning is designed. First, establish an evaluation index for the effectiveness of cybersecurity knowledge training, and then develop an evaluation standard for the effectiveness of cybersecurity knowledge training. The standard performance status is the teaching effect that employees should achieve after training. Finally, calculate the weight of each indicator to complete the evaluation of the effectiveness of cybersecurity knowledge training. The experimental comparison results show that the effectiveness evaluation method of network security knowledge training based on machine learning designed this time is more accurate than traditional methods, and has practical significance.

Keywords: Machine learning · Network security knowledge · Training effectiveness · Indicators · Weights

1 Introduction

In recent years, our country pay more and more attention to in network security knowledge training work, and the original network and the state economic and trade commission and other departments have issued a series of laws, regulations and safety production training, carry out a series of safety training is given priority to with safety publicity and education activities, to establish the occupational safety and health training center and network security knowledge training center, carried out various areas, various industries and at all levels, all kinds of safety production training, especially the business operators and managers qualification training, safety supervision inspectors work safety qualification training, new workers safety education and special operations personnel safety operation qualification training, Initially formed a certain scale of safety production training network.
Cyber security knowledge training is an important way to increase trainees’ security knowledge, improve security skills, and improve security concepts, thereby improving their security qualities, in order to prevent accidents and increase the level of intrinsic safety of human resources in enterprises. The evaluation of training effectiveness directly affects the realization of safety goals. Under the influence of the above factors, the evaluation of the effectiveness of safety training in China has been in an inefficient stage for a long time, and the employees’ unsafe behaviors are still not tangible. Although the current state has increased investment in human and material resources for the evaluation of safety training work, which has made certain achievements in China’s safety training work, because the evaluation of the effectiveness of safety training in our country is still in its infancy, it needs continuous supplement And perfect, a method for evaluating the effectiveness of network security knowledge training based on machine learning is designed. Machine learning is a multi-disciplinary and interdisciplinary discipline that involves multiple disciplines such as probability theory, statistics, approximation theory, convex analysis, and algorithm complexity theory. Specialize in how computers simulate or implement human learning behaviors to acquire new knowledge or skills and reorganize existing knowledge structures to continuously improve their performance.

2 Establishment of Evaluation Index of Network Security Knowledge Training Effect

Traditional network security knowledge training effect evaluation path is mainly divided into two categories, one is the internal training effect evaluation [1], 2 it is after the internal training will prepare the good evaluation questionnaires distributed to the trainees, let trainees to training instructors, training course content, and to evaluate training organization support, and so on and so forth, and according to the answer of the trainees, formulate improvement measures. However, the evaluation index of this method is relatively single. Aiming at the existing problem of the traditional method, the safety of the staff training effect evaluation system mainly involves three kinds of object, namely the security training management personnel, mainly be responsible for the training plan formulation and implementation of professionals, practitioners is direct embodiment of training do you have any good results, improve the work ability of employees is the ultimate goal of network security training, trainer is imparting knowledge and skills, the trainer’s personal ability and behavior directly influence on the capability and the extent of the trainees to accept. According to the different characteristics, requirements and processes of these three kinds of objects, different methods are adopted for analysis. Since the development of training plan involves many evaluation indicators, a wide range, a long periodicity of the process, and the role and importance of each step [2] are not consistent, the machine learning evaluation method is determined for evaluation as shown in the following figure (Fig. 1):
Summarize the training work of the company as required, and write the evaluation report. So as to grasp the training situation and make corresponding adjustment measures according to the evaluation report. Based on the above analysis, the evaluation index [3] is established as follows (Table 1):
### Table 1. Evaluation index of network security knowledge effect

| First-level indicators               | Secondary indicators           | Tertiary indicators                                      |
|-------------------------------------|--------------------------------|---------------------------------------------------------|
| Evaluation of training organizations| Organization support          | Attention of training opinions                           |
|                                     |                                | Notification in a timely manner                           |
|                                     |                                | Logistics assistance, complete equipment                  |
|                                     | Overall evaluation             | Expectations before training                             |
|                                     |                                | Post-training evaluation                                  |
|                                     |                                | Willing to participate again                             |
| Evaluation of training courses      | Course quality                 | Theoretical level content                                 |
|                                     |                                | Practice level content                                    |
|                                     |                                | Arrangement and logical levels of course content          |
|                                     | Curriculum, job relevance      | Training courses for work                                 |
| Trainer Evaluation                  | Personal image                 | Manner and behavior                                       |
|                                     |                                | Temperament                                               |
|                                     |                                | Personal affinity                                          |
|                                     | Sense of responsibility        | Accurate and reasonable teaching logic arrangement        |
|                                     |                                | Degree of positive response from trainees                 |
|                                     |                                | Able to arrange course content accurately and reasonably |
|                                     |                                | Preparation of teaching materials                         |
|                                     |                                | Can inspire trainees                                       |
| Trainee evaluation                  |                                | Training experience summary                               |

### 3 Effective Evaluation Criteria for Network Security Knowledge Training

Standard performance status is the teaching effect that employees should achieve after training, that is, the knowledge, skills, and attitude that employees should have after training [4], which is mainly based on employee competence. It should be noted that the competency index is not the same as the training effect evaluation index. The competency index mainly refers to the performance status of the employee’s work, and the training effect evaluation index refers to the training project itself. In some aspects, there is a certain relationship between competency indicators and training effectiveness evaluation indicators. For example, training for a specific training project may be to improve a certain skill or ability of employees, but not all competencies. Evaluation needs to include both a certain skill part and other parts, such as learning situation and organizational
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improvement situation. Since there are many content evaluations of the effectiveness of cyber security knowledge training, it is understood that the performance of the excellent charging staff in the respondents’ minds on the three dimensions of knowledge, skills, and attitudes [5] has been transformed into measurable standards. After in-depth interviews, combined with the job description, the following knowledge, skills, and attitude requirements of the fee-charging staff are summarized, as shown in the following table (Table 2):

| Serial number | First dimension | Secondary dimension |
|---------------|----------------|---------------------|
| 1             | Know how       | General business knowledge |
|               |                | Industry knowledge |
|               |                | Laws and regulations |
|               |                | Civilized service requirements |
| 2             | Skill          | Communication skills |
|               |                | Learning ability |
|               |                | Special event handling capabilities |
|               |                | Emotional control |
|               |                | Computer Skills |
|               |                | Equipment operation capability |
| 3             | Attitude       | Honesty |
|               |                | Service awareness |
|               |                | Safety consciousness |
|               |                | Professionalism |

As a tool for performance improvement, training is often a short-term behavior. In other words, the effect of training on employees mainly focuses on the improvement of knowledge, skills and part of the attitude, while certain personality qualities cannot be acquired through short-term training [6]. Based on this, “resilience” was excluded from the measurement of actual performance of employees in this study.

In the decision-making of qualitative problems, AHP is an excellent method, which is based on the comparison of two evaluation objects and the construction of judgment matrix with the comparison results:

\[
A - B = \begin{bmatrix}
1 & 1/2 & 1/4 & 1/4 \\
2 & 1 & 1/2 & 1/3 \\
4 & 2 & 1 & 1/2 \\
4 & 3 & 2 & 1 \\
\end{bmatrix}
\] (1)
In the common formula (1), $A$ and $B$ respectively represent matrix elements [7]. Since the judgment matrix is the basis for determining the weights, the matrix needs to meet the requirements of consistency. Therefore, the errors and compatibility of the judgment matrix must be analyzed, which is calculated as:

$$C.R = \frac{\gamma_o}{Uf}$$

In formula (2), $C.R$ represents the consistency test result, $Uf$ represents the weight vector of the matrix, and $\gamma_o$ represents the index system containing the weight.

Then, the judgment matrix is normalized, and the calculation formula is:

$$d = \frac{r}{\sum_{i=1}^{t} t \ast m}$$

In formula (3), $d$ represents the normalized processing parameter of the index, $\sum_{i=1}^{t} t$ represents the level of the evaluation index, $m$ represents the whitening weight function of the evaluation gray class, and $r$ represents the gray evaluation coefficient.

Finally, for the consistency check of the evaluation matrix, its calculation formula is:

$$CU = \frac{\eta_c - nm}{N}$$

In formula (4), $CU$ represents the matrix consistency index, $N$ represents the maximum characteristic root of the matrix, $\eta_c$ represents the matrix element, and $nm$ is the weight coefficient of each layer of the index.

According to the above process, the calculation of the index weight [8] is completed, and the evaluation criteria for the effectiveness of network security knowledge training are determined according to the determined weight index.

## 4 Realization of Effectiveness Evaluation of Cyber Security Knowledge Training

Based on the establishment of the above-mentioned network security knowledge training effectiveness evaluation indicators and the establishment of the network security knowledge training effectiveness evaluation standards, the network security knowledge training effectiveness evaluation [9], the overall evaluation structure is shown below (Fig. 2):
In the scientific research of various fields, it is often necessary to observe a large number of variables reflecting things and collect a large number of data in order to analyze and find rules. Multi variable [9] large samples will undoubtedly provide rich information for scientific research, but to a certain extent, it also increases the workload of data collection, more importantly, it increases the complexity of problem analysis. Because there is a certain correlation between the variables, it is possible to use less comprehensive indicators to analyze all kinds of information in each variable, and the comprehensive indicators are not related to each other, that is, the information represented by each indicator does not overlap the comprehensive indicators, which not only retains the main information of the original variables, but also has some superior properties than the original variables, which makes it possible to study complex problems It is easier to grasp the main contradiction. In this way, the comprehensive indicators can be named according to professional knowledge and the unique meaning reflected by the indicators. This method is called factor analysis, and the comprehensive index representing all kinds of information is called factor or principal component. According to the purpose of factor analysis, we know that the comprehensive indicators should be less than the original variables, but the information contained should be relatively less loss, so the
relationship between each factor and the original variables can be expressed as:

\[ x = f_g + \sum_{i=1}^{e} d \]  \hspace{1cm} (5)

In formula (5), \( f_g \) represents the original variable vector, \( \sum_{i=1}^{e} d \) represents the common factor load coefficient and residual, and \( x \) represents the principal component vector.

Based on this, the comprehensive evaluation value is calculated, and the control of the safety training process is only good. Generally, more efforts need to be made at all levels to further improve the control level of each process. When there are several implementation schemes participating in the evaluation jointly, the company also can be ranked and selected according to their comprehensive evaluation value, and its calculation formula is:

\[ F = \frac{o}{D} \cdot jk \]  \hspace{1cm} (6)

In formula (6), \( F \) represents the weight vector of each criterion layer, \( D \) represents the comprehensive evaluation value, \( o \) represents the influence parameter, and \( jk \) represents the degree of correlation between the indicators.

According to the above process, combined with the above indicator system to establish an evaluation hierarchy, as shown below (Fig. 3):

Based on the above, a comprehensive evaluation is carried out to achieve scientific decision-making, continuously improve the business level of managers in safety training, and then improve the training effect of enterprises, reduce the occurrence of accidents, and enhance the overall safety level of the enterprise.

5 Experimental Comparison

In order to verify the effectiveness of the evaluation method of network security knowledge training based on machine learning designed this time, an experiment was conducted, and the traditional method was compared with the design method to compare the accuracy of the two methods.

5.1 Experimental Scheme

This project training is for 5 website personnel of a company. A total of 27 applicants applied for project training, of which 24 are eligible for registration. Therefore, this study evaluated 24 trainees. Specifically, one day after training for each training course, the course is assessed by taking a test of the course, the results are recorded in the registration form, and the training center evaluates the enthusiasm of the trainees. The center distributed behavior-level questionnaires to 24 trainees, and recovered 24 valid questionnaires, with a questionnaire recovery rate of 100%, and the supervisors of the operation department evaluated the behaviors of trainees in each department after training. Among the valid samples, 11 were male (46%), 13 were female (54%), the average
age was 29 years, the average working age was 6 years, 63.3% had a college degree or below, and undergraduates and above accounted for 26.7%. Sort out data from 24 valid questionnaires. After the training, the trainees were asked to solve the problem of network attack. In the experiment, each port of the target server was requested to connect in turn, and then some open ports were found. At this time, cyclic neural network is used to learn the process. After learning, the neural network will be able to predict whether the next operation is normal access or network attack according to the characteristics of the current data. The scanning target is as follows (Fig. 4):
After the training of the experimental personnel, the above network security events are solved, and the data captured by the server is as follows (Fig. 5):

Then evaluate the effectiveness of network security knowledge training. There are many data contents involved in the evaluation process. An experimental platform is established for this purpose, as shown in the following figure (Fig. 6):

The experiment was carried out with the above platform, and the specific experimental results are shown as follows.
5.2 Analysis of Experimental Results

The comparison between the traditional evaluation method and the design evaluation method is shown in the following figure (Fig. 7):

Analysis of the above comparison results shows that the accuracy of the design method in the training effect evaluation is high, up to 98%, while the accuracy of the traditional method in the training effect is poor, up to 50%. In the five experiments, the accuracy of the traditional method in the training effect is lower than the design method, because the design method can fully analyze the evaluation of network security knowledge Standard, as well as the corresponding index weight, thus ensuring a higher evaluation accuracy. Therefore, through the above experiments, it can be proved that the design method has practical application significance and higher evaluation accuracy than the traditional method.
6 Concluding Remarks

How to objectively and effectively establish the training effect evaluation index system to evaluate the enterprise training effect, so as to diagnose and modify the enterprise training program, and then improve the effectiveness of the training program, and promote the healthy development of the enterprise, is an urgent problem to be solved by the enterprise, is also worth the attention of the academic community. The traditional evaluation method is of low accuracy, so a new evaluation method of network security knowledge training based on machine learning is designed, and the effectiveness of this method is proved. To sum up, the method of this study has the following characteristics: applying performance technology to the evaluation system of enterprise training effect. Previous studies on the evaluation system of enterprise training effect by scholars mostly focus on simple problem analysis or overview, but lack systematic and targeted analysis. This article applies machine learning to the diagnosis of training effect evaluation problems, making the problems more obvious and the causes more targeted. The method of fusion of quantitative and qualitative analysis is used for research. Quantitative analysis and qualitative analysis are softened together, making the index construction process more standardized. With a certain degree of reliability. Even so, this study still has certain limitations: in the selection of evaluation indicators, this study uses as much independence, efficiency and operability as possible; for result-level indicators, vehicle toll revenue and employee turnover rate They will be affected by many factors, and the changes may not only be caused by training, but also by other factors. However, although the changes in this research indicator take this into account, in the evaluation of the examples, the influence of other factors cannot be controlled.
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