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Research on mode and system of individualized safety education

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Abstract

Human unsafe behaviors, which resulted from lack of (or ineffective) safety education to those people who had unsafe behaviors, existed in every mining accident. This article started with the unsafe behaviors of people in mining accidents. It analyzed that the cause of unsafe behaviors is that people receiving unpractical safety education. That was behaved in three aspects: safety education was equated to safety training wrongly; lectures were viewed as the only safety education mode; test papers were made as the pedagogues' only assessment criteria. This article proposed that the goal of safety education is to make the pedagogues raise safety consciousness, grasp safety knowledge, master safety skills and have the corresponding education contents and methods; that it would be more necessary to carry out ISE (Individualized Safety Education) according to the difference of the pedagogues' knowledge, culture, seniority, classification of their jobs, etc.; that education effects should be reflected on the pedagogues' abilities to deal with safety emergencies. This article also conducted intensive research and development of computer system that was used for executing ISE.

Keywords: safety education; safety training; unsafe behaviors; individuation; system

1. Introduction

Among the causes of coal mine accidents, human unsafe behaviors account for a large proportion. Meanwhile, personal feature is the most important factor leading to unsafe behaviors, so carrying out individual safety training appears to be necessary. With the advent of information age, digital learning has become an irresistible trend. The use of computer is very important but also the most effective technique measures to implement individual training [1].

2. Main factors of unsafe behaviors II

2.1. Research on unsafe behaviors

Generally speaking, human unsafe behavior is the behavior which caused accidents or may cause accidents, they are the direct cause of the accident. By the statistics of original domestic coal mine accidents in 2009 to2010, Table 1 shows the analysis results.

There are 140 coal mine gas accidents happened from 2009 to 2010 in China, including the gas explosion, coal and gas outburst, gas poisoning and suffocation. The hardware in Table 1 is the factor leading to the gas accident and related to equipment environment, which leads to 25 gas accidents account for17.85% of the total number; While software means the factors related to human unsafe behaviors, which leads to115 gas accidents account for 82.14%. Thus, more than 80% of the

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gas accidents are caused by human unsafe behavior. Therefore, it is significant to understand the constituent elements of unsafe behaviors and then control the generation.

Table 1. Analysis of coal mine gas accidents causes in China during 2009-2010

Hardware	Quantity of gas accidents resulting from hardware	Software	Quantity of gas accidents resulting from software
Technology and design defects	4	No rules or not perfect	19
Equipment, facilities, tools defective	5	Do not understand the rules	24
Missing or defective safety equipment	7	Intentionally violating the operating rules, labor discipline	23
Poor Production environment	6	Safety management confusion	33
Poor personal protective equipment	3	Mechanical and electrical management confusion	16
Hardware, leading to the total number of gas from the accident	25	Software led to the total number of gas from the accident	115
the ratio of hardware in the total number	17.85%	the ratio of software in the total number	82.14%

2.2. Analysis of unsafe behaviors

This paper uses AHP to analyze the causes of unsafe behavior factor weight. Through investigation and analysis, the structure of factor influence affecting human behavior as shown in Fig 1, The levels are labeled as follows: the target layer (X), the criteria layer (Y), indicator layer (Z) [2].

Judgment matrix to determine, primarily engaged in the evaluation of coal mine safety experts, also refer to the basic conclusions of the unsafe behavior measure derived from “Research on Unsafe behaviors in major coal mine accidents in China” to determine the relative important degree.

2.2.1. Level Y analytic hierarchy process

(1) *Establish judgment matrix R*

Judgment matrix *R* to determine the level for each factor Y (Y1-Y7) between, according to the AHP, the pair wise comparison analysis to determine the relative importance of various factors, evaluation results are as follows:

$$R=\begin{bmatrix} 1 & 1/3 & 1/3 & 1/3 & 1/5 & 1/7 & 1 \\ 3 & 1 & 1 & 1 & 1/3 & 1/5 & 3 \\ 3 & 1 & 1 & 1 & 1/3 & 1/5 & 3 \\ 3 & 1 & 1 & 1 & 1/3 & 1/5 & 3 \\ 5 & 3 & 3 & 3 & 1 & 1/3 & 5 \\ 7 & 5 & 5 & 5 & 3 & 1 & 7 \\ 1 & 1/3 & 1/3 & 1/3 & 1/5 & 1/7 & 1 \end{bmatrix} \tag{1}$$

By using mathematical tools MATLAB to calculate the maximized eigenvalue of the matrix and the corresponding eigenvectors are: 7.1610 (0.0383, 0.0933, 0.0933, 0.0933, 0.2214, 0.4221, 0.0383). The feature vector, namely the corresponding weight are shown in Table 2.

(1) *Consistency test*

The consistency indicators of Judgment Matrix calculation:

$$C.I. = \frac{\lambda_{max} - n}{n - 1} = \frac{7.1610 - 7}{7 - 1} = 0.027 \tag{2}$$

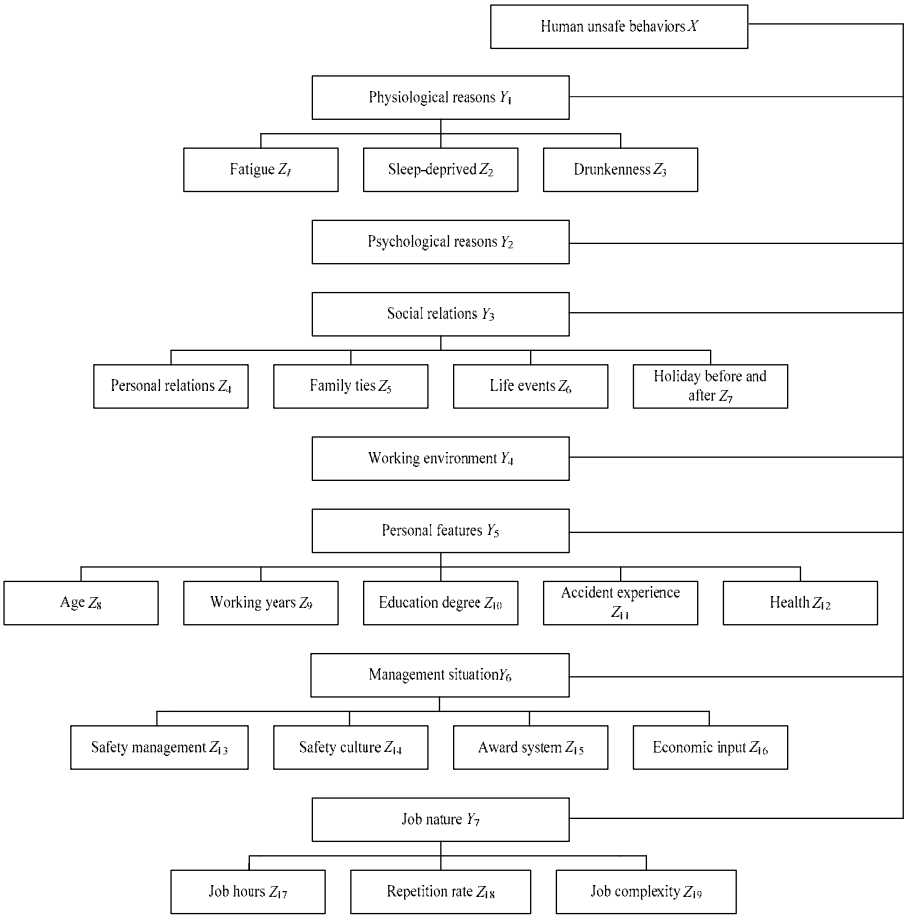

Fig. 1. Hierarchical model of affecting human unsafe behaviors.

Table 2. Weight of each factor in layer Y

Element name	Weight value
Physiological reason	0.0383
Psychological reasons	0.0933
Social relations	0.0933
Working environment	0.0933
Personal features	0.4221
Management situation	0.2214
Job nature	0.0383

Through table-look-up method to ascertain the average random consistency index *R.I.* = 1.36, then calculate the consistency ratio:

$$C.R. = \frac{C.I.}{R.I.} = 0.02 < 0.1 \tag{3}$$

So the matrix has satisfactory consistency, no further revised.

From the above analysis in the effect of human unsafe behavior factors, we know that individual characteristics accounted for the largest proportion. It included age, working years, education degree, accident experience, physical condition, now we determine the weight of each element in Y5 through the AHP (analytic hierarchy process).

2.2.2. Level Z (individual characteristics) analytic hierarchy process

As the Layer Y analytic hierarchy process, the weight of Z level analytic hierarchy process's each factor available under the individual characteristics as shown in Table 3.

Table 3. Weight of each factor in layer Z

Factor name	Weight
Age	0.0728
Working years	0.4666
Education degree	0.1939
Accident experience	0.1939
Health	0.0728

Table 3 shows that a person' age, working years, education degree, accident experience and physical condition have different effects on human unsafe behaviors. Among the factors, working years have the greatest impact, while education degree and accident experience second. Therefore, we should consider individual characteristics of workers as a starting point and implement the individualized safety training [3].

3. Design of ISE system

During the process of implement, safety education was seemed as an external force, while the pedagogues would produce an internal force through self-digestion and absorption, which made the pedagogues' safety consciousness, safety knowledge and safety skills have a qualitative change. However, how the external force action depends on training content and method [4]. So the paper starts with staffs' personal features, with the help of computer to carry out individualized training content and method.

3.1. Design of function module

The main subsystems of individualized safety training system style are shown in Fig 2.

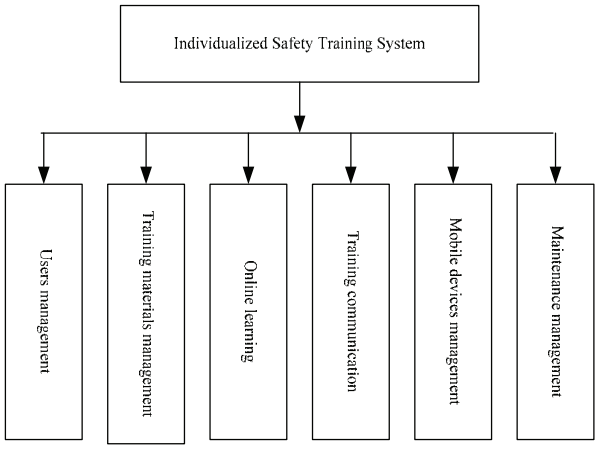

Fig. 2. Main subsystems of ISE system.

(1) Users management: the management of personal characteristics for the training personnel (including age, working years, profession, education degree, accident experience or not, etc).

(2) Training materials management: management for training plans different kinds of training, training contents, competition and examination.

(3) Online learning: After log in the system with their own user name successfully, the page will transfer the corresponding parameter to the learning page so that students with different individual characteristics will not accept identical learning interface.

(4) Training communication: Question-answering area, online communication area and BBS forum.

(5) Mobile devices management: After the release of the website, PDA or smart phone could log in system anytime and anywhere to ‘micro learning’, which can significantly improve the general staffs' interest and learning passion.

(6) Maintenance management: According to user role to distribute authority; other maintenance management systems.

3.2. Realization of the system module

A gas inspection work due, length of service 1 year, record of formal schooling junior middle school level, in good health, not experienced gas accident, this user login system after the training process as shown in Fig 3.

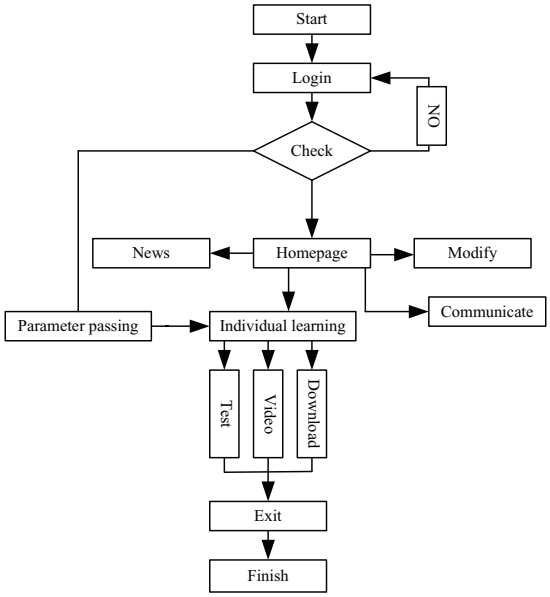

Fig. 3. Process of ISE.

First, the users to login screen, to enter your user name and password, after the system’s test and verify to make sure if the failure will need to login again; If the login successfully, The system will database table of the parameters of the Users will be passed to the value of learning home page (study.aspx) including profession, age, seniority, education, health, experience [5]. Besides accessing to information, Modifying User Personal Information and online communication, the system will show different learning interface according to the parameter value different for staffs. For example the length of service time of the employee is not long and he has no accident experience, so when playing a case video, it will produce certain impact on the visual and psychological, and the risk of such vigilance will deepen. In addition based on the risk and disposal measures appearing in the case, there will be a detailed answer in the following courseware PPT to make staffs can have deep understanding of one kind of dangerous produce source and learn to prevention and treatment method of the event. The staffs can also have tests by themselves to test their operation skills and security essentials of master degree, the system will automatically scoring , to show the students’ knowledge to each part on the basis of bar chart; Click on the links to exit and you can end this study.

4. Conclusions

The biggest feature of this system entirely based on the actual coal production and advanced concepts is easy to use. Not only the time and funds of centralized training reduce, but the training efficiency and training coverage expand. In order to stimulate the internal demands of the trainees, spark an echo in heart, weakening the unsafe acts and encourage the safe acts,

the system abandoned the past training modes such as ‘once for all’ and ‘stereotype’. The promotion and implementation of the system has a profound long-term significance to the construction of the technology process in coal mine.

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