Transactions on Comparative Education (2024)
Clausius Scientific Press, Canada
DOI: 10.23977/trance.2024.060415
ISSN 2523-5818 Vol. 6 Num. 4

Teaching Evaluation Method of Intelligent Labor Education for College Students Based on the Internet of Things System

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Keywords: Labor Education, Internet of Things Technology, Education System, Smart Education

Abstract: Labor education is an important part of the comprehensive development of the education system, and it is an educational activity that must be carried out by universities, middle and primary schools. In this paper, combined with the Internet of Things (IoT) technology, the evaluation method of college students' smart labor education and teaching has been studied. This paper also proposed a data fusion method. Through experimental analysis, taking college A as the experimental object, it has been learned that there were 71 students in college A who were attentively listening to the labor education courses, which accounted for 35.68%. There were 128 people doing things unrelated to labor courses in class, such as studying other subjects, reading books, playing mobile phones, etc., which accounted for 64.32%, with a large proportion. This showed that labor education courses are seriously marginalized in colleges and universities, and students do not pay attention to labor education courses. Experimental results showed that the effect of this method in the research content of the paper is effective.

1. Introduction

Advances in science and technology have facilitated people's lives. The Internet of Things is a system of interconnected computer equipment and digital machines with a universally unique identification code. It is closely related to artificial intelligence and is an important part of information technology in the new era. Most of the technology and content of the Internet of Things are expanded and extended on the basis of the Internet.

The rise of labor education is a manifestation of the progress of school education. Labor is the foundation of human development and evolution. From the school's point of view, the school's education requires students to develop in an all-round way in terms of moral, intellectual, physical, aesthetic and labour education, so that they can meet the requirements of quality education. There are many scholars who analyze labor education, and there are many ways to use it, but few scholars analyze it from the perspective of the Internet of Things system. This paper uses the Internet of

Things technology to review the teaching process of smart labor education, investigating the evolution of research methods and the latest progress to explore some problems that students have in learning labor education courses. Thus the past experience can be summarized and the enlightenment for the future can be found, thereby promoting the continuous development of smart labor education research.

The innovation of this paper lies in the use of the Internet of Things technology and the combination of data fusion technology to carry out statistical analysis of labor education courses in colleges and universities.

2. Related Work

At present, there are many researches on the teaching of smart labor education for college students. Wu J believed that the current labor education is facing many difficulties, and finding an effective way to solve the difficulties of labor education is the top priority [1]. Campbell J found that online video-on-demand has now become part of the information consumption structure. The study took students as experimental objects, analyzing the impact of video on students [2]. Jakubik M believed that it is essential to use practical wisdom and intelligent labor to educate students in knowledge and skills [3]. Darmayenti D proposed that labor education for students should not be ignored, and designed a textbook based on religious characteristics and local wisdom, which can be applied to university classrooms [4]. Lestari A P believed that textbooks are important learning aids. From the analysis results of the existing textbooks, there was no information on labor wisdom, and the textbooks contained outdated materials [5]. However, what is more important to the education of college students is to pay attention to issues such as smart labor education for college students, and the above research does not consider the research on this issue.

At present, there are many researches on the Internet of Things system. Mabrouki J considered mechanization as a decontamination activity as it provided a dynamic and ecological response to the problem of organic waste disposal [6]. Abbas A believed that the field of Internet of Things has advanced rapidly in the past few years, which has completely changed the lives of human beings and made their daily lives more convenient [7]. Amiri-Zarandi M proposed to take advantage of the need to use a reliable mechanism to secure communications. Social IoT is a new type of communication mechanism that can ensure communication security [8]. Shen X proposed a verification scheme using IoT technology to assist data, which is usually used in the operation of transportation systems, matching the data in the system with information such as the car schedule to ensure the safe operation of the car during driving [9]. Chang G used the CFD method to study the distribution of urban pollution, aiming to use the Internet of Things technology to analyze the pollutant indicators and pollutant distribution areas in the city [10]. However, the related research only studied the application of the Internet of Things technology in other fields, but rarely studied the combination of college students' smart labor education and this technology.

3. Smart Labor Education Method for College Students under the Internet of Things System

3.1 Smart Labor Education for College Students

Labor education is a subject that enables students to establish correct labor awareness and labor values, which is one of the contents of the comprehensive development of people's morality, intellect, physics, aesthetics and labor [11]. Smart labor education refers to the labor education courses offered to college students using intelligent technology [12]. As shown in Figure 1, the relevant educational relationship diagram is shown.

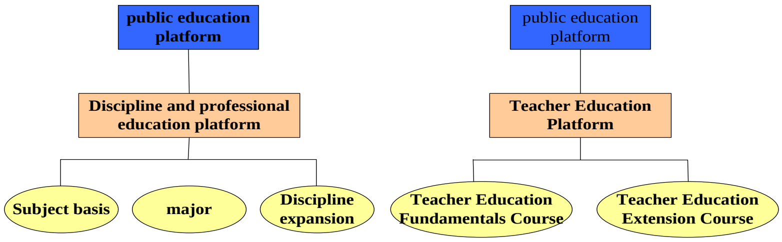


Figure 1: Structure diagram of college students' campus education curriculum

3.2 IoT System

(1) Analysis of the Internet of Things system

The IoT architecture system has been proposed for many years, and the traditional IoT system is basically designed and analyzed based on the IoT architecture [13]. As shown in Figure 2, it is a framework diagram of the Internet of Things architecture.

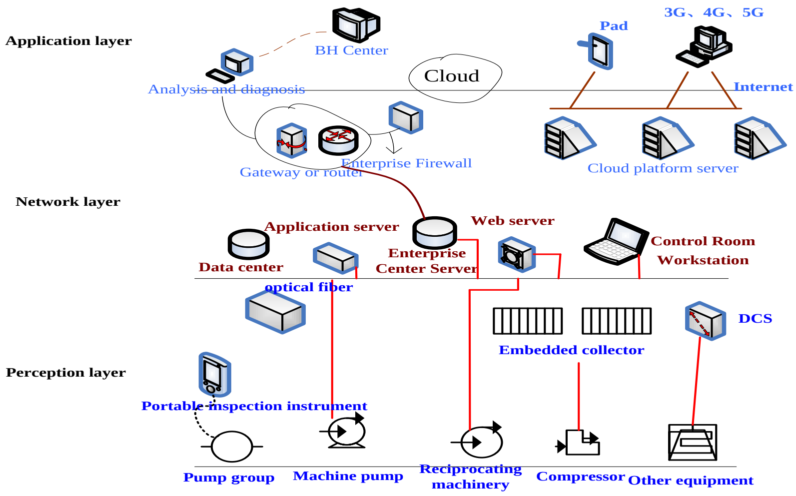


Figure 2: Framework diagram of the Internet of Things architecture

(a) Perception layer

The perception layer is the lowest part of the three-layer architecture system of the Internet of Things, and it is the data origin of the IoT system [14]. It is used to perceive object information. The perception layer is a network composed of various sensors. There are many types of sensors.

(b) Network layer

The network layer belongs to the middle layer in the three-layer architecture of the Internet of Things. It is a bridge between the perception layer and the application layer, which plays a role in linking the previous and the next [15]. There are also many communication protocols at the network layer.

(c) Application layer

The application layer is at the top of the IoT architecture system and is the performance of the application value of the IoT system [16].

(2) Data fusion processing technology based on multi-sensor

Data fusion processing technology is a new type of multidisciplinary technology, which is mainly used for comprehensive and unified processing of a large amount of data. The technology can handle a wide variety of data, with great flexibility, which can use a variety of disciplinary methods to analyze the data to produce a variety of different results [17]. Data fusion processing technology can be divided into three categories: data-level fusion, feature-level fusion, and decision-level fusion.

Data-level fusion is an initial fusion method that fuses the data information in the same type of sensor, and then combines the fused data information to extract the required information [18]. As shown in Figure 3, it is the specific process of data-level fusion.

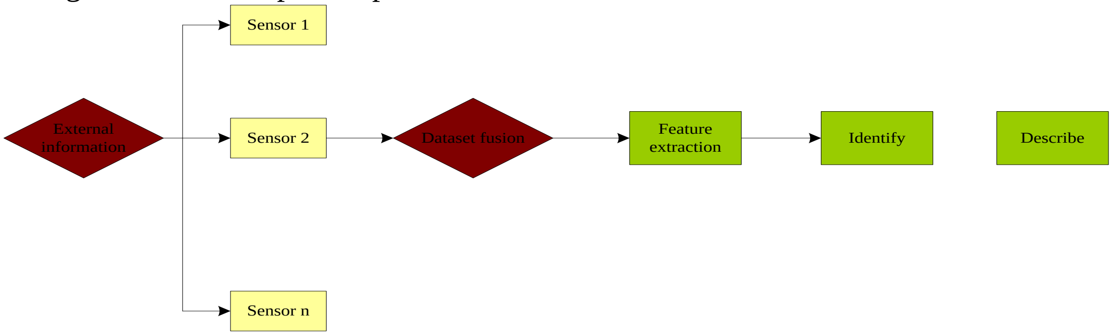


Figure 3: Specific process of data-level fusion

Feature-level fusion is an intermediate-level fusion method, which refers that each sensor first extracts a feature vector from the collected object information according to its common features. These feature vectors are then fused, and then these parameters are identified and described accurately and reasonably according to the fused feature vectors [19]. Its main advantage is that it has high flexibility and requires less communication bandwidth, but the accuracy of its fusion is not very high for this reason. As shown in Figure 4, it is the specific process of feature-level fusion.

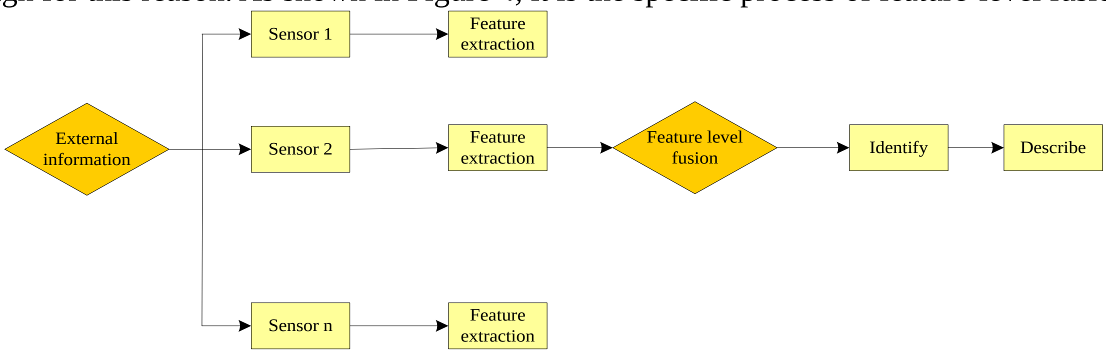


Figure 4: Specific process of feature-level fusion

Decision-level fusion is the highest-level fusion method. Each sensor first extracts a feature vector from the collected object information according to its common features. Then, pattern recognition is performed on these feature vectors, and the recognition results are classified and correlated according to certain rules. Finally, the results after the classification and correlation are unified and fused and an accurate and reasonable description is made. Decision-level fusion is application-oriented fusion, and its biggest advantages are high fault tolerance rate, small communication data capacity, and strong anti-interference ability [20]. However, at the same time, the loss of information is large and the accuracy is poor. As shown in Figure 5, it is a diagram of the decision-level fusion process.

The process of the adaptive weighted fusion algorithm is as follows. The initial values of the measurements for each sensor are obtained, and then the variance of these values is calculated. Finally, in an adaptive way, the corresponding optimal weight is obtained through the total mean square error of the initial value, and the optimal value after fusion can be obtained by multiplying the optimal weight and the initial value result, as shown in Figure 6.

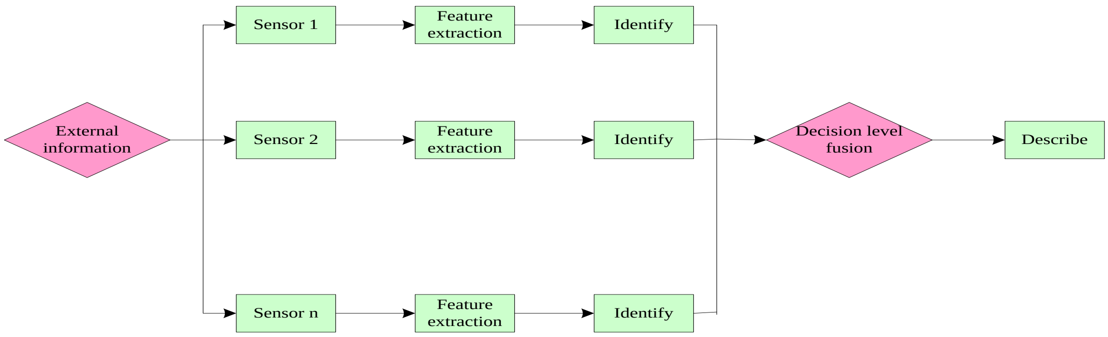


Figure 5: Decision-level fusion process diagram

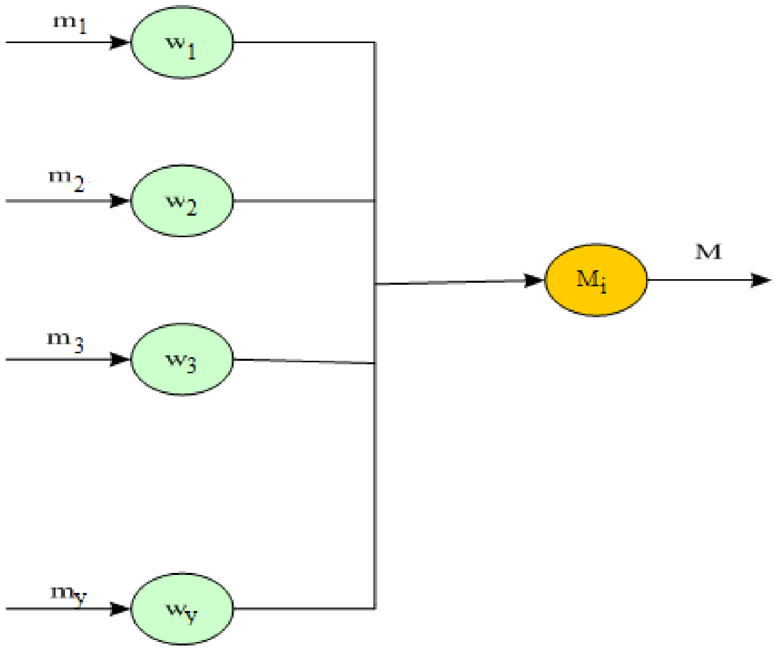


Figure 6: Adaptive weighted fusion structure diagram

It is supposed first that the measurement values of the y sensors are $M_1, M_2, M_3, \ldots, M_y$. M is the true value of the system band estimate. $\varepsilon_1^2, \varepsilon_2^2, \varepsilon_3^2, \ldots, \varepsilon_y^2$ represent the variance value of the y sensors observing the parameter to be measured respectively. These observations of the data are independent of each other and are unbiased estimates of M. The weighting factor weight of each sensor is $W_1, W_2, W_3, \ldots, W_y$. The relationship between the value of fusion result $\hat{M}$ and the weight is as Formula 1:

$$\begin{cases} \hat{M} = \sum_{i=1}^{y} W_i M_i \\ \sum_{i=1}^{y} W_i = 1 \end{cases} \tag{1}$$

The total mean squared error ε^2 is as Formula 2:

$$
\begin{aligned}
\varepsilon^2 &= E[(M-\hat{M})^2] \\
&= E[(\sum_{i=1}^{y} W_i M - \sum_{i=1}^{y} W_i M_i)^2] \\
&= E[(\sum_{i=1}^{y} W_i (M - M_i))^2] \\
M_1, M_2, M_3, \ldots, M_y &= E[\sum_{i=1}^{y} W_i^2 (M-M_i)^2 + 2\sum_{i=1, j=1}^{y} W_i W_j (M-M_i)(M-M_j)]
\end{aligned} \tag{2}
$$

Since each value is independent of each other and is an unbiased estimate of M, there is Formula 3:

$$
\begin{cases} E(M-M_i)(M-M_j) = 0 \\ i = 1,2\ldots y;\ j = 1,2\ldots y; i \neq j \end{cases} \tag{3}
$$

The total mean square error can then be written as Formula 4:

$$
\varepsilon^2 = E[\sum_{i=1}^{y} W_i^2 (M-M_i)^2] = \sum_{i=1}^{y} W_i^2 \varepsilon_i^2 \tag{4}
$$

Formula 4 is a multivariate quadratic function, so Formula 1 can be converted to Formula 5:

$$
\begin{cases} g(W_i)_{\min} = \sum_{i=1}^{y} W_i^2 \varepsilon_i^2 \\ \sum_{i=1}^{y} W_i = 1 \end{cases} \tag{5}
$$

Formula 5 can be expressed as finding the minimum value of $g(W_i)_{\min} = \sum_{i=1}^{y} W_i^2 \varepsilon_i^2$ when the condition that $\sum_{i=1}^{y} W_i = 1$ is satisfied. Using the Lagrangian method to construct the function, Formula 6 can be obtained:

$$
\begin{cases} G(W_i) = g(W_i) + \chi\varphi(W_i) \\ \varphi(W_i) = \sum_{i=1}^{y} W_i - 1 \end{cases} \tag{6}
$$

Formula 5 is put into Formula 6, and the partial derivative function of W_i is obtained respectively:

$$
\begin{cases} \dfrac{\partial G}{\partial W_1} = 2W_1\varepsilon_1^2 + \chi \\ \dfrac{\partial G}{\partial W_2} = 2W_2\varepsilon_2^2 + \chi \\ \quad\ldots \\ \dfrac{\partial G}{\partial W_y} = 2W_y\varepsilon_y^2 + \chi \end{cases} \tag{7}
$$

It is supposed that $\frac{\partial G}{\partial W_1} = 0$ and Formula 8 can be obtained:

$$\begin{cases} 2W_1\varepsilon_1^2 + \chi = 0 \\ 2W_2\varepsilon_2^2 + \chi = 0 \\ \quad\quad \cdots \\ 2W_y\varepsilon_y^2 + \chi = 0 \end{cases} \tag{8}$$

From Formula 8, Formula 9 can be got:

$$\begin{cases} W_1 = \dfrac{1}{\varepsilon_1^2 \sum_{i=1}^{y} \dfrac{1}{\varepsilon_i^2}} \\ W_2 = \dfrac{1}{\varepsilon_2^2 \sum_{i=1}^{y} \dfrac{1}{\varepsilon_i^2}} \\ \quad\quad \cdots \\ W_y = \dfrac{1}{\varepsilon_y^2 \sum_{i=1}^{y} \dfrac{1}{\varepsilon_i^2}} \end{cases} \tag{9}$$

From Formula 9, it can be obtained that when the total mean square error ε^2 is the smallest, the optimal weight is as Formula 10:

$$W_i^* = \frac{1}{\varepsilon_i^2 \sum_{i=1}^{y} \frac{1}{\varepsilon_i^2}}, i = 1,2,3,..., y \tag{10}$$

The value of the minimum Zongjun method obtained at this time is as Formula 11:

$$\varepsilon_{\min}^2 = \frac{1}{\sum_{i=1}^{y} \frac{1}{\varepsilon_i^2}} \tag{11}$$

When the value M obtained after fusion is constant, it can be estimated according to the average value of the historical data of each sensor. The mean of the sensor measurement l times is as Formula 12:

$$\overline{m}_i(l) = \frac{1}{l} \sum_{j=1}^{l} M_j(j) \tag{12}$$

The estimated value is as Formula 13:

$$\overline{M} = \sum_{i=1}^{y} W_i \overline{M}_i(l) \tag{13}$$

The total mean squared error is as Formula 14:

$$\begin{aligned} \bar{\varepsilon}^2 &= E[(M - \overline{M})^2] \\ &= E[\sum_{i=1}^{y} W_i^2 (M - M_i(l))^2 + 2\sum_{i=1, j=1}^{y} (M + M_i(l))(M - \overline{M}_j(l))^2] \end{aligned} \tag{14}$$

It can be seen from the derivation of the above formulas that to calculate the optimal weighting factor, the variance of each sensor must be obtained first, and the value of the variance is obtained by measuring the value of each sensor. At this point, assuming that the two random sensors are i, j, the measured values are m_i, m_j respectively, and the corresponding measurement errors are e_i, e_j respectively. The true value to be estimated is M. Then Formula 15 can be got:

$$\begin{cases} m_i = M + e_i \\ m_j = M + e_j \end{cases} \tag{15}$$

In the case where e_i, e_j are zero mean stationary noise, the variance of sensor i is as Formula 16:

$$\varepsilon_i^2 = E[e_i^2] \tag{16}$$

Because e_i, e_j are uncorrelated, and the mean is zero, independent of the value of M, the covariance function of m_i, m_j can be written as Formula 17:

$$H_{ij} = E[m_i m_j] = E[M^2] \tag{17}$$

The autocovariance function of m_i is as Formula 18:

$$H_{ij} = E[m_i m_j] = E[M^2] + E[e_i^2] \tag{18}$$

Formula 17 is subtracted from Formula 18 to get Formula 19:

$$\varepsilon_i^2 = E(e_i^2) = H_{ii} - H_{ij} \tag{19}$$

Through the analysis of the above steps, the time domain estimates of H_{ii} and H_{ij} can be obtained from the measured values of each sensor, and then the variance estimate of each sensor can be obtained. The data collected by the sensor is then fused using a weighted data fusion algorithm.

4. College Students' Smart Labor Education Teaching Evaluation Experiment

4.1 Experiment Discussion of Smart Labor Education for College Students

Based on the analysis of the Internet of Things technology and data fusion technology in the previous chapter, this chapter used the Internet of Things technology and data fusion technology to study the evaluation methods of college students' smart labor education teaching. The experimental data were collected and counted using this technique. 600 students were randomly selected to conduct a questionnaire survey to understand the students' views on the school's offering of smart labor education courses.

4.2 Experiment Results of Smart Labor Education for College Students

This experiment was based on the analysis of the questionnaire results of the students in college A, and colleges B and C were used as the experimental reference groups to compare the questionnaire data of the three college students. The details are as follows.

(1) Class situation of college students' smart labor education courses

Investigating the situation of students' labor education courses can understand students' attitudes towards learning the course. The details are shown in Table 1.

It can be seen from Table 1 that there was little difference in the data changes of the three universities. There were 71 students in college A who were attentive to the labor education courses, accounting for 35.68%. There were 128 people doing things unrelated to labor courses in class, such as studying other subjects, reading books, playing mobile phones, etc., which accounted for 64.32%. In the control group, 66 people from college B believed that labor courses were very important, and they listened attentively in this class, accounting for 35.11%. There were 122 people who thought that labor education courses were optional so they did other things in class, accounting for 64.89%. The data of the C college was similar to the data of the A and B colleges. The above data showed that labor education courses were seriously marginalized in colleges and universities, and students and even teachers and parents did not value labor education courses.

Table 1: Statistical table of the class situation of college students' smart labor education courses

	Concentrating on lectures	Doing things unrelated to labor courses
A	71	128
B	66	122
C	80	113

(2) Students' understanding of smart labor education

"Intelligent labor" is a way of labor that relies on intelligence. Compared with traditional manual labor, most intelligent labor relies on brain power for activities. College students' cognition of smart labor can, to a certain extent, indicate the school's emphasis on this course. The survey data is shown in Figure 7.

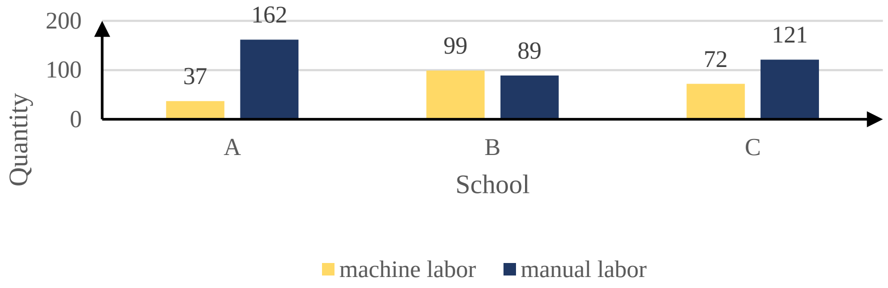


Figure 7: Students' understanding of smart labor education

It can be seen from Figure 7 that the students of the three colleges and universities had certain deviations in smart labor education. In the experimental group, 37 students from college A believed that "smart labor" was equivalent to machine labor, which did not require manual labor, accounting for 18.59%. The vast majority of people believed that "smart labor" was labor that needs to rely on people's physical strength. There were 162 people in this part, accounting for about 81.41%. In the control group, 99 students from college B believed that smart labor education was machine labor, accounting for 52.66%. 89 people thought that smart labor was manual labor, accounting for 47.34%. 72 people from college C felt that smart labor was the use of intelligent machine labor, and there was no need to waste people's physical labor for labor, which accounted for 37.31%. 121 people still felt that intelligent labor was similar to traditional manual labor, accounting for 62.69%. From the above data, it can be seen that students' cognition of smart labor was not clear enough, and the concept of labor was poor. This showed that the colleges did not pay enough attention to labor education courses, and the related supporting facilities for labor courses were not perfect.

(3) Students' understanding of the concept of labor education

In the traditional concept, people think that students' own job is to study well, who ignore the cognition of things other than study. In the traditional teaching concept, teachers, parents and students regard moral and intellectual education as the key points, while ignoring the education of students in physical, aesthetics and labour education. Table 2 is a questionnaire on students' cognition of labor education.

It can be learned from Table 2 that students in the three colleges had similar cognitions on labor education. There were 20 people in college A who believed that labor education was more important, accounting for 10.05%. 176 people felt that study was more important than labor, accounting for 88.44%. There were a small number of students who thought that both were equally important. In the statistical data of the experimental control group, 17 people in college B believed that labor education was more important than learning, and this part of the population accounted for 9.04%. 171 people thought that learning was more important. They thought that students' time was used for learning, and labor was only a dispensable existence in learning and life, which accounted for 90.96%. No student in college B considered that the two were equally important. In college C, 21 people thought that labor education was very important, accounting for 10.88%, and 167 people thought that learning was more important, accounting for 96.53%, while only 5 people felt that study and work were equally important, which accounted for 2.59%. It can be seen from the above data that the inherent concept of most students was that learning was the most important, and labor education could not match the importance of learning. However, in fact, the importance of learning and labor education was the same, with an important impact on students' future life and work.

Table 2: Questionnaire on students' cognition of labor education

	Labor education is more important.	Learning is more important.	Both are equally important.
A	20	176	3
B	17	171	0
C	21	167	5

(4) Necessity of offering labor education courses

The school offers labor education courses to help students develop good habits in labor, and hope that students can develop in an all-round way in the moral, intellectual, physical, aesthetic and labour aspects. The specific investigation situation is shown in Figure 8.

It can be seen from Figure 8 that the students of the three colleges had different opinions on the school's offering of labor education courses. There were 125 people in college A who agreed to offer labor education courses, accounting for 62.81%. From the questionnaire, it can be learned that the students agreed to offer labor education courses because they could do other things in the class, such as reading books, studying other subjects, writing homework, etc., which was relatively free. There were 74 people in college A who did not agree to offer labor education courses, accounting for 37.19%. In the experimental control group, 33 people from college B believed that it was necessary to set up labor education courses, accounting for 17.55%. Another part of the students was against the establishment of labor education courses, with 155 students, accounting for 82.45% of the total number. 59 people in college C agreed to offer labor education courses, accounting for 30.57%, while 134 people thought it was unnecessary to offer this course, accounting for 69.43%. It can be seen from the above data that students in major colleges and universities had almost the same idea of agreeing to offer labor education courses. They all considered that they could do other things in this course, and most of the students who opposed the establishment of this course thought that labor was taught at home by their parents, with no need to spend study time learning how to work. It can be known that the students still considered that the labor education course was an unimportant course.

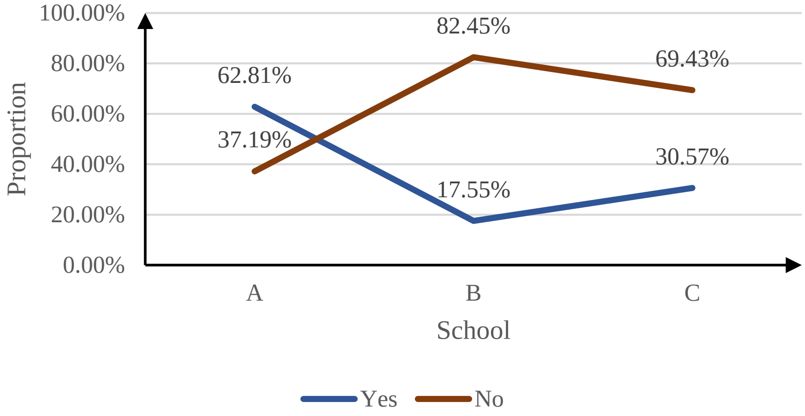


Figure 8: Necessity of offering labor education courses

(5) The situation of doing housework at home

As everyone knows, housework is also a kind of labor. Whether students do housework at home is also a manifestation of the results of school labor education. Table 3 is a questionnaire on whether students do housework at home.

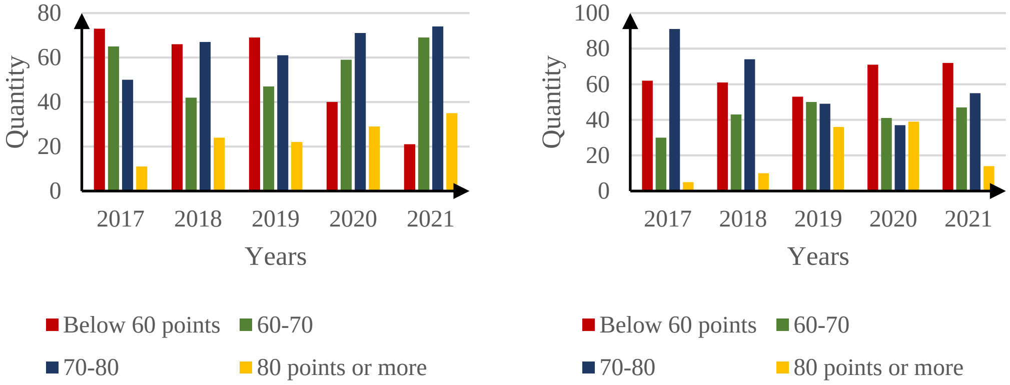
Table 3: Whether students do housework at home

	Frequently	Occasionally	Never
A	59	74	66
B	77	80	31
C	43	92	58

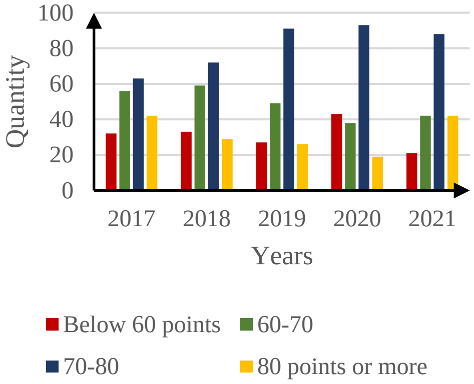
It can be seen from Table 2 that the frequency of students doing housework at home was different in the three colleges and universities. There were 59 people in college A who often did housework at home, accounting for 29.65%. There were 74 people who occasionally did housework at home, accounting for 37.19. There were also 66 people who had never done housework at home, accounting for 33.16% of the total number of people. In the experimental control group, 77 people in college B often did housework, accounting for 40.96%. 80 people did housework occasionally, accounting for 42.55%. 31 people have never done housework, accounting for 16.49%. From the 193 questionnaires returned by college C, it can be learned that 43 students often did housework, accounting for 22.28%. 92 people only occasionally performed housework, accounting for 47.67%. There were 58 people who had never done housework, accounting for 30.05%. It can be seen from the above data that most students still did housework at home, but most of them only did housework occasionally. However, there were still some students who had never done housework. Most of the parents of the students believed that the most important thing for students was to study, and they did not need the students to do housework because doing housework was a waste of time. It can be seen that parents still had traditional and inherent ideas about labor education, and they thought that labor was one of the reasons that affected students' learning.

4.3 Schemes for Improving College Students' Smart Labor Education Experiment

This paper uses this technology to study the questionnaire data of smart labor education in colleges and universities. Overall, the experimental analysis was relatively complete, but there were still some defects that need to be improved. The details are as follows. First, in the study with the A college as the research object and the other two colleges as the control group, this was a horizontal comparison. This paper did not analyze the situation of the students in college A over the years, so the results obtained were not comprehensive enough. Second, during the experiment, the selected sample size was too small, and the sample data type was relatively simple. It is recommended to increase the sample size in order to achieve the purpose of more accurate and perfect experimental data, thus improving the reliability of the experiment. As shown in Figure 9, it is a statistical graph of the scores of students in three colleges A, B, and C over the years.



(a) Statistical chart of the grades of college A students over the years
(b) Statistical chart of the grades of college B students over the years



(c) Statistical chart of the grades of C college students over the years

Figure 9: Statistics of the grades of students in three colleges and universities A, B, and C over the years

It can be seen from Figure 9 that the evaluation methods of college students' smart labor education teaching in the three colleges over the years are mainly based on a single examination form. Among them, in Figure 9(a), the data of college A generally increased with the year. The number of people in the high segment was gradually increasing, and the number of people in the lower segment was gradually decreasing. The scores of the experimental control group fluctuated greatly over the years as a whole. From Figure 9(b), it can be seen that from 2017 to 2021, the number of people in the high segment has experienced an increase and then a decrease, while the number of people in the low segment was the opposite, with the number of people first decreasing and then increasing. From the data in Figure 9(c), it can be seen that the number of people with high scores in college C was the largest in 2017, with 42 people. In 2020, the number of people continued to decline for four years, reaching the lowest value in 2020. In 2020, there were 19 people in the high segment, with a decrease of 23 people. The number increased in 2021. It can be seen from the comparison of the time line that the previous students of college A have performed relatively stable in the examination and evaluation, and there was an upward trend, indicating that college A has continuously improved the teaching quality in the teaching of smart labor education courses.

5. Discussion

This paper has studied the smart labor education course for college students from the perspective of Internet of Things technology and data fusion algorithm. First of all, the statistical analysis of students' attendance in smart labor education courses showed that labor education courses have a serious trend of marginalization in colleges and universities. Secondly, by analyzing students' understanding of smart labor, it has been learned that students thought that smart labor is machine labor or manual labor. Thirdly, students did not pay much attention to labor education courses, and most students thought that learning was more important than labor. Finally, based on the results of the questionnaire survey in this paper, it has been introduced into the Internet of Things system to refine the analysis. This paper has been devoted to the research of data fusion technology in various fields, and applied it to the research of smart labor education in colleges and universities, which was not only to expand and extend the application scope of data fusion technology, but also to make a new attempt in the research on teaching evaluation of this course in colleges and universities. Through the case study, it is shown that this paper reflects the effective role of the Internet of Things technology in the analysis of labor education teaching evaluation.

6. Conclusion

With the gradual increase of people's requirements for education, the educational pressure on schools has also gradually increased. This paper took data fusion technology as the main research method, and conducted a questionnaire survey on the students of A college affairs. Then two colleges B and C were added as the experimental control group, and the data fusion technology was used to collect and analyze the questionnaires. Through case analysis, the following conclusions have been drawn. Since colleges and universities have set up labor education courses, they should also ensure the teaching quality of the courses. Students and parents should change their minds. Labor education is also a part of school education, and what students learn is also knowledge. Therefore, it is one of the main goals of current education development to construct an education system suitable for students and a teaching evaluation method for labor education suitable for students.

Acknowledgement

This work was supported by the Guangxi Science and Technology Base and Talent Special Project under grant 2021AC19394, the National Natural Science Foundation of China under grants 62002297.

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