Analysis of Classroom Behavior in Vocational Education with Human-Computer Collaboration[1]

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Abstract

With the development of Chinese education informatization, the human-computer collaborative education model has been deeply developed and widely applied. The application of human-computer collaborative education model in vocational education has shown positive changes in learning atmosphere, students' status, concentration timing, interaction frequency, professional interest and career design. This paper is a collaborative pedagogical experimental study of teaching practices and analysis of data on student performance. We used the Kurt Lewin action research method and regression analysis for the pedagogical study. We construct a model of human-machine co-teaching which will have a positive impact on vocational students' learning. We measure the synergistic model suitable for vocational education reform based on student learning data. Combining the characteristics of vocational students and multiple online teaching data, we draw out a synergy criterion suitable for vocational student development and provide a basis for effective vocational education reform.

Keywords: *Human-machine collaboration, vocational education, practical teaching, action research method*

1 INTRODUCTION

In the current era of digital intelligence, along with the extensive development of human-computer co-teaching practices, a large amount of practical data has been generated from practical research. By observing and analyzing these data, we are able to understand students' learning behaviors and characteristics. This is for further in-depth research in vocational education at a later stage, and at the same time, it can provide credible references for the overall reform of education informatization [15]." Education Informatization 2.0 Action Plan" document proposes to adapt to the development of individuals in the age of intelligence. Especially with the development of smart technology, we should actively promote "Internet + education" and build a networked, digital, intelligent and personalized lifelong education system [9].

The purpose of human-machine collaboration is to make machine intelligence an expansion and extension of human intelligence [13]. American scholars D.B. Lenat and E.A. Feigenbaum proposed that computers and people can become colleagues with each other, and people and machines do various self-excellent jobs [8]. Human-machine collaborative intelligence is not the simple addition of human and machine, but a kind of human-machine fusion intelligence [14]. In CNKI, we found 24 valid articles with the theme of "human-computer synergy" + "education" or "teaching". However, only two studies were retrieved with the theme of "human-computer collaboration" + "vocational education", and there is zero cases of vocational classroom teaching practice. In this paper, we analyze the experimental data comparing human-computer collaboration in vocational education classrooms [1].

It is necessary to build a new vocational classroom that includes teachers, machines, students and other factors.The new vocational education classroom uses hybrid teaching to solve the problems of traditional education [2] For example, the classroom atmosphere is not active, students' interest in learning is not strong, teaching quality is not high, teaching effectiveness is not obvious, and teaching evaluation is not perfect, this research will promote the good development of vocational education.

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2 TEACHING PRACTICE

2.1. The basis for practice

The human-machine co-teaching resources used by the students are a basic environment built by the national government, raised by the university and funded by the partner companies. It includes hardware and software resources used in human-computer collaborative teaching practice. Hardware resources include computers, projectors, video booths, digital video recording equipment, educational robots and other digital devices. Software resources include courseware, video, audio, online courses, software standards, digital journals, databases and educational APPs used in vocational education.

The human-computer collaborative teaching application education field is divided into invisible and tangible human-computer collaborative scenarios. Invisible human-computer collaborative application scenarios include intelligent correction, assessment platforms, intelligent wearable devices, intelligent analysis platforms, intelligent analysis cameras, etc, which are applied to classroom teaching analysis [10].

The teaching practice study in this paper relies on the comparison between class 201 and class 211. One is secondary computer science majors and the course is "Information Technology". Human-computer co-teaching is used in class 201 and traditional teaching is used in class 211. The aim is to optimise online learning effect [12] and the environment for vocational teaching.

2.2. Classroom observation

2.2.1 Classroom characterization

The seven research objectives, such as learning atmosphere, student state, concentration duration, frequency of interaction [11], professional interest, and career planning [3], were improved by using human-machine collaborative vocational education. We have conducted a first-level sorting of students' representations, as shown in Table 1. The overall characteristics of students in vocational teaching are active, positive, enthusiastic, engaged and confident through teachers' guidance, inspiration and collaboration with the help of educational robots to complete the teaching and learning content.

The class has changed from a traditional lifeless class to active atmosphere where many students are now enthusiastic and engaged. It has changed from a teacher-led class to one where different students or teams report on the class. 90% of the students are able to keep up with the pace and content of the teacher's lectures. All students were able to listen attentively to the lecture. Students went from passive listening to active participation, and even raised their hands to actively express themselves, 76.9% of the students would often gather to discuss what they were learning and 100% of the students enjoyed the learning in groups. Students' learning time has increased from the previous 5 to 10 minutes to the current full class time. 88% of the students were able to actively participate in discussions and answer questions and the frequency and quality of classroom interaction were significantly higher than the non-human-computer co-teaching practice phenotype. Students asked more professional and comprehensive questions account for 46%, 75% of the students had a new way of thinking about their careers. They showed more enthusiasm and expectations in their professional learning. They also behaved more eagerly and positively and they often surrounded their exchanging thoughts on career topics among classmates.

Table 1: Student-level behavioral representations of human-computer co-teaching practice.

NO1. Classroom atmosphere	
Experimental class 201	Over 90% of the students participate in presentations and discussions.76.9% of students were willing to express and communicate their personal views. There are 11% of students are willing to answer the questions.
Contrast Class 211	Teachers speak students listen; students do not like to express their idea and answer the questions difficult.
NO2. Learning Status	
Experimental class 201	Students interact and ask questions with the teacher at all times; students form teams for discussion and have regular groups. Students communicate actively.
Contrast Class 211	Only 5-8% of the students love to answer questions and it is always the same few. Occasionally, 3-5% of students are inattentive and play with their mobile phones.
NO3. Concentration timescale	
Experimental class 201	90% of students maintain concentration in class for 30-45 minutes
Contrast	90% of students maintain

Class 211	concentration in class for 15-20 minutes
NO4. Frequency of interactions	
Experimental class 201	Frequency of interaction 20-30 times/session, with more than 85% of students participating.
Contrast Class 211	3-4 sessions of 2-3 people per session.
NO5. Professional thinking	
Experimental class 201	The percentage of students with professional thinking is 88%.
Contrast Class 211	The percentage of students with professional thinking is 36%.
NO6. Career planning design	
Experimental class 201	The percentage of people who have started career design is 67%.
Contrast Class 211	The percentage of people who have started to work on their career design is 12%.
NO7. 1+X vocational certificate acquisition	
Experimental class 201	85% single certificate award rate, 38% double certificate rate and 100% pass rate.
Contrast Class 211	The single certificate award rate is 26.9% and the pass rate is 30%.
NO8. Confidence Rate Survey	
Experimental class 201	67% of students feel confident about careers.
Contrast Class 211	24% of the students in the class felt confident in their careers.

The students in the human-machine collaborative practice teaching model also showed positive characteristics in aspects of career plan and course started from a series of no-questions to later on constantly seeking career advice and started to think about the content of their life plans. 97% of the students in the class showed a radical and positive change on their attitude towards.

There are 26 students in Experimental Class 201 took part in the 1+X Vocational Skills Level Certificate examination and passed with a 100% certification rate. There were also 10 students got the double certificates, with a 100% qualification rate too, including 12 elementary certificates and 10 intermediate certificates. The change on the rate, number, type and level of certificates obtained shows an overall positive trend. In contrast, 21 out of 26 students in the non-human-computer co-teaching in Experimental 211 class participated in the grade certificate assessment, with a participation rate of 80.7% and a passing rate of 26.9%. Only 7 students received certificates, 5 elementary certificates and 2 intermediate certificates, and no one enrolled in the double certificates. The classroom atmosphere, learning attitude, concentrating hours, numbers of interaction were not well.

2.2.2 Classroom Analysis

We used the four components (planning, action, observation and reflection) and six stages of the action research method to develop collaborative human-machine teaching practices, as shown in Figure 1. We recorded, summarized, sorted and analyzed students' classroom learning behavior. We observed students' learning behavior in the classroom, and analysis of finished products referring to various changes in students' expressions, attitudes and emotions in the collaborative practice classroom. We use classroom behavior data and quality assessment results to draw inferences about a human-computer collaboration model that is appropriate for vocational students learning. It is the human-machine co-teaching solution that is suitable for the development of vocational education.

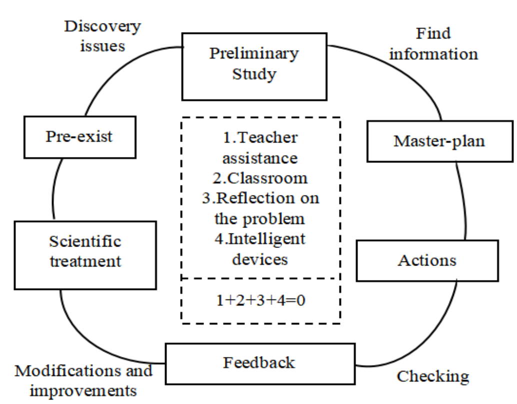

Figure 1: Human-machine collaborative classroom action research method

The six stages of the action are used to develop a collaborative human-machine approach to teaching and learning. This starts with a "pre-diagnosis" through teacher and students work together to identify the problem, to find relevant information and to carry out preliminary research on the project. The team of the students designs a specific action plan. The implementation of the 'action' is the key to the all teaching practice and is characterized by implementation, evaluation and correction at the same time.

We need to pay attention to the feedback from each step and make sure that it is feasible before moving on to the next step. The aim of each step is to solve the problem and to serve the overall objective. The final environment is the scientific processing of the data and information from the study. The teaching link can be adjusted at any time in terms of the programmers. The participation, involvement and motivation of all students in the project is guaranteed. The actions, such as the diagnostic, formative and summative evaluations, are throughout the teaching process of action research method.

3 DATA ANALYSIS

3.1 Information on behavior

Human-machine collaborative and non-collaborative experimental teaching activities are based on blended learning and the collection of multiple online teaching data, they rely on secondary vocational schools [6]. The data were analyzed by taking the behavioral indicator models of the six learning behaviors from the experiment and the results of the secondary teaching quality assessment.

The research was last four-month from September to December in 2021. We collect the learning-related behavior data generated by the learners on the smart platform and smart devices, as shown in Figure 2, which included hours of watching video materials, the number of project tasks completed, the number of interactive responses, the total number of to express their opinions, the number of questions asked in classroom and the overall score. The data shows that the new human-machine collaborative teaching is significantly more effective than the non-collaborative classroom.

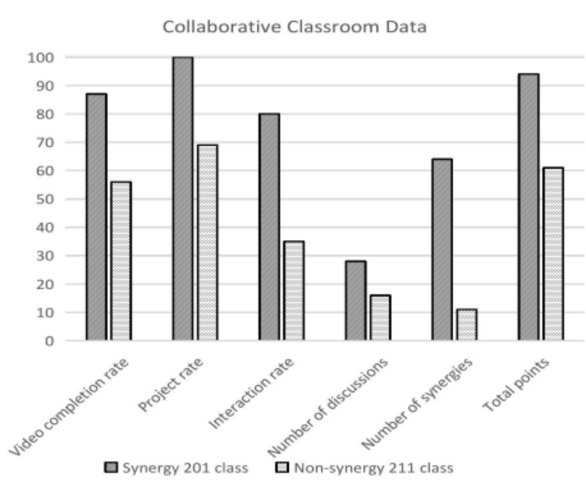

Figure 2: Online classroom data and secondary quality assessment statistics.

3.1.1 Watch the report on video

That's a total of 80 instructional videos and about 300 minutes of learning content. The students in Experiment 201 class completed an average of 75% videos of approximately 260 minutes, which accounts for 87% of the total task. The students in Experiment 211 class completed an average of 44% videos about 168 minutes, which accounts for 56% of the total task. There were 24 project tasks, all of them were completed by students in Experiment 201 class with high quality and 18 tasks were finished and 6 tasks were semi-finished in Experiment 211 class.

3.1.2 Frequency of interaction comparison

The data of the Experimental 201 class was generally higher than the 211 class, which contain the rate of question interaction, the number of questions and the level of quality. There were 20-30 interactions, in each session of the experimental 201 class close to and 80% of students participated in each question and answered aloud. The highest number of hands raised was more than 150 in one session and the situation was recorded through collaborative equipment. There were fewer interactions in Experiment 211 class, which had 12 most frequent in one session. There were 28 discussions in the experiment, class 201 participated in 26 through the human-computer synergy, with about 120-150 words answered words in each item. There were 16 discussions involved in class 211 and there were about 20-50 word responses word count average.

3.1.3 Comparison of total grades

It is helpful for students to complete their learning tasks in the human-computer co-teaching environment. The students in Class 201 asked 64 questions and the students in Class 211 asked 11 questions. There was a large difference between the two classes in the overall score, where Class 201 scored a total of 94 and Class 211 scored a total of 61.

3.2 Data Analysis

We analyze different behaviours and data on students' performance in human-computer co-teaching practices in vocational education. Correlations are drawn between the number of behaviours in human-computer co-teaching and the total student score in order to know the key factors for the learning effectiveness of vocational students to avoid isolated and ineffective learning behaviours of students. Therefore, we selected the independent and dependent variable behaviour in the data pool, including the total number of synergy for the content of the instructional video material learning ratio, number of synergy items completed, number of interactions, frequency of discussions, number of questions, overall performance score and total score. We used the logit regression study method of the regression analysis model with the intention of uncovering whether there was some correlation between human-machine collaborative behaviours and total student scores, as shown in Figure 3.

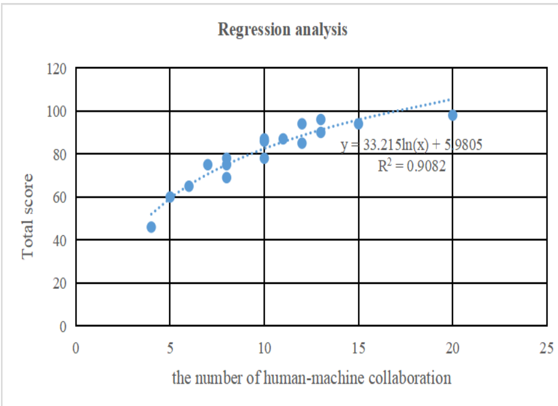

Figure3: Logistic model of human-machine co-teaching regression analysis.

Then, based on the trend of the graph, we can initially determine a positive relationship between the total score and the number of human-machine collaborations. The formula is a logarithmic regression in the middle of obtaining the total score and the number of human-machine synergies as follows

$$y = 33.215\ln(x) + 5.9805,\ R^2 = 0.9082.$$

The squared value of R is known as the 'coefficient of determination' which is used to evaluate the goodness of fit of the regression model and indicates the extent to which the independent variable (number of human-machine collaborations) explains level of the dependent variable (total score). The range of values is [0, 1]. The larger the squared value of R, the stronger it is in the effect of the independent variable on the ability of the dependent variable, the better the model fit.

4 MODEL ANALYSIS

Non-human-machine collaborative practice reduces the measurement of goal attainment to a composite grade, The richness of education is obliterated. The question of "what to teach and how to teach it" is avoided, leading to a deviation from the goal of education. The teaching practice of human-machine collaboration brings automated assessment and intelligent recommendation functions. It has three implications as follows. (1) Provide a lot of teaching resources to students. (2) It is helpful for students to learn and complete their professional homework. (3) It enables knowledge to be co-constructed and shared.

The results of these experiments can also help students form a lifelong career perspective, establish new ideas and thoughts, and achieve mastery of new technologies. It also plays a very significant role in promoting precise and personalised teaching [7].

4.1 Analysis of learning methods

We started with an analysis of the students' learning objectives. They had three main study goals: "to improve their personal value", "to go on to university" and "to find a secure job". Of these, there were 54% of students chose the course because they liked it, 18% chose it because they had good career prospects, and 28% chose it with the help of their parents.

One conclusion we can draw from the above data is that most of the students are seeking to learn with the more positive subjective intention to come to school and their aim is to reap good learning outcomes for themselves in order to have a better professional foundation. An analysis of students' preferred method of learning. The result was that students preferred the teacher-led approach, accounting for 14% of the students surveyed.

The willingness of students to learn independently online or through Nails Live broadcast Learning accounts for 26% of the students surveyed. That is 60% of the students choose the offline co-teaching method of teacher and smart device. There is a clear conclusion from the questionnaire that students prefer the human-machine collaborative learning mode.

4.2 Synergy mechanism

The design of the teaching should be fit students and the research should focus on the construction of the learning framework and content system of the human-computer collaboration mechanism. The design should be close to students' lives, close to the teacher's reality and also operable. The design should be able to add hands-on sessions at any time and be flexible. The design of the teaching model should also reduce the proportion of theoretical lectures and learn to deliver the learning content through seminars, which is easy for students to understand and accept.

Human-computer co-teaching should be designed for areas and topics in which students excel and organized teaching and learning. Instructional design should also be student-centered. Teachers and students use smart devices to solve a variety of difficult problems. This is an effective way to help students find problems and solve them. The human-machine co-teaching model uses teaching objectives appropriate to the students' level and good the general processes and learning methods appropriate to vocational students' learning.

With the help of smart devices, students' self-confidence is gradually built up and motivation to learn is formed. At the same time, a collaborative platform is introduced for evaluation and guidance of coursework tasks, and a variety of collaborative mechanisms are used to promote mutual learning through debriefing presentations, back-to-back scoring, shaking, raising hands to answer, brainstorming and so on. A competitive mechanism is formed.

Faced with some students who have a weak learning base, co-teaching designs a Gamification review mechanism for these students' situations. The principles of operation take the content of this lesson to be reviewed in the lesson, with key content to be reviewed in every lesson. The review can be conducted in a gamified way which is easily accessible to students. Introduce a game punishment mechanism to allow students to feel that they are learning by playing and playing by learning. Students will really feel that the vocational classroom is fun, informative, useful and effective.

4.3 Promoting Co-Teaching Strategies

Teachers in vocational education work with a human-computer according to collaboration mechanism. They collect and analyze students' multifaceted online learning data, such as when and where students learn, smart devices they used, what they browse, their learning habits and other data on their learning traces. We provide a comprehensive analysis of student learning. There include data on the content of the student's browsing, the teacher's instructional design, the frequency of interaction in the course, the situation of the questions, the quality of the learning outcomes, the evaluation of the course instruction, the analysis of the data in the learning monitoring, the quality of the interaction and the validation of the results.

We summarized the individual learning habits of students and analyzed the learning patterns of groups. Using the multiple piles of data we have collected. We have listed the characteristics of students by grade, major, gender and ethnicity. It is helpful to personalized and precise education.

5 CONCLUSION

We need to be student-centred and balancing the relationship among teachers, students and smart teaching devices. We also need to be the first to support and help student who encountered with problems and difficulties in learning in the laboratory classroom [4]. We should continue to improve the support service system for human-machine collaboration and open the door to a smart education e-learning system [5].

We used the behavioral representations and data of vocational education students in learning. We conclude that human-machine co-teaching is a good teaching model suitable for vocational education. We will adopt this approach to vocational education more in the future in order to produce more vocational talents.

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