Teaching Knowledge Sharing in Virtual Practice Teaching

https://doi.org/10.3991/ijet.v18i04.38239

Li'e Wang, Fenshan Liu(✉)
P.E. Department, Yulin University, Yulin, China
liufenshan@yulinu.edu.cn

Abstract—Physical education, skill training and other related courses with physical exercises and experience training as the main means are suitable for teaching with virtual reality technology. Constructing teaching knowledge sharing strategy can promote the sharing of virtual practical teaching resources among students. At present, no scholars have paid attention to how to promote the exchange of ideas and experiences among students participating in virtual practical teaching, so that teaching knowledge can spread among students faster and more effectively. Therefore, this article studies the teaching knowledge sharing method of virtual practice teaching and constructs *BiLSTM-Attention* relation extraction model to recognize named entities of teaching knowledge resources in virtual practice teaching, to record the information of knowledge points involved in teaching knowledge resources, and to explore the information hidden in knowledge resources more deeply. This article constructs a knowledge sharing model of virtual practice teaching based on traditional evolutionary game, and analyzes the local stability of the model based on Jacobin Matrix. Experimental results verify the effectiveness of the model.

Keywords—virtual reality technology, practical teaching, teaching knowledge sharing

1 Introduction

In the virtual reality technology environment, the experiencer interacts with the machine through human-computer interaction, and produces various intuitive and natural real-time senses in vision, hearing and touch [1, 2]. With the development of image processing and information storage technology, virtual reality technology is more and more applied in the field of education and training, especially in physical education, skills training and other related courses with physical exercises and experience training as the main means [3–5]. Three-dimensional images produced by virtual reality technology can make students better see the teacher's behavior representation, and understand the relationship and development trend of every conception and step of teachers' teaching. The perceptibility and operability of the teaching content in the simulated environment shown to students are far beyond the range of still images given by traditional classroom teaching, and provide the teaching effect with lower investment, shorter period and higher efficiency than traditional teaching methods [6–10].

In order to make virtual practice teaching knowledge more quickly and better accepted by students, teaching knowledge resource management has attracted more attention from scholars at home and abroad [11–16]. Knowledge sharing is an important way for students to acquire knowledge and experience through practical learning. How to construct teaching knowledge sharing strategies to promote the sharing of virtual practical teaching resources among students, so as to enhance the practical teaching effect, has become a challenge in the implementation process of virtual practical teaching.

Due to the limitation of seasonal sports venues, it is a great challenge for students to adapt and maintain their sports state in non-snow season. Lin [17] applies virtual reality technology to alpine skiing course, makes an experimental study on the teaching and training effect in non-snow season, shows the advantages of virtual reality technology in alpine skiing teaching and training, and optimizes the conversion between land and snowfield in non-snow season. Liu et al. [18] shows virtual reality in classroom teaching. It is possible to improve the influence and level of college students' rock climbing. It focuses on the concept, technical characteristics, system composition and modeling of virtual reality technology, and applies this theory and technology to college rock climbing teaching to build a teaching mode based on virtual reality. The model is applied to the teaching of rock climbing in colleges and universities. The experimental group and the control group are set up to analyze the students' interest in the teaching of rock climbing. Applying virtual reality environment to physical education is a major trend in the development of physical education. Zhong and Zhu [19] adopts literature research method and experimental research method. Taking the set shot teaching in basketball teaching as an example, it's essential to use 3DMAX modeling software to build virtual situation and realize the integration of virtual teacher model, animation and scenes, and use the "limit key" function of Adobe Premiere software in the virtual reality fusion design to realize the fusion of teachers and virtual teaching situations, and create real-time, three-dimensional and interactive teaching videos. Based on VR technology, it conducts physical education teaching design and experimental analysis, which fully verifies the effectiveness of virtual reality fusion environment in physical education. Zhang and Zhang [20] aims to discuss the application of virtual reality technology in Wushu education. A virtual reality architecture based on deep learning algorithm is proposed to collect student data sets and divide them into two groups: control group and research group. Traditional teaching is provided to the control group, and VR assisted teaching based on deep learning is provided to the research group by using deep binary hash convolution neural network (DBH-CNN).

At present, the research of virtual reality technology in teaching field in China started relatively late. More studies focus on the improvement of technical support level and the construction of teaching mode and system. No scholars have paid attention to how to promote the exchange of ideas and experiences among students participating in virtual practice teaching, so as to make teaching knowledge spread among students faster and more effectively. Therefore, this article studies the teaching knowledge sharing method of virtual practice teaching. Firstly, in the second chapter, this article constructs *BiLSTM-Attention* relation extraction model to recognize named entities of teaching knowledge resources in virtual practice teaching, to record the information of knowledge points involved in teaching knowledge resources, and to explore the information hidden in knowledge resources more deeply. The third chapter constructs a knowledge sharing model of virtual practice teaching based on traditional evolutionary game. The fourth chapter analyzes the local stability of the model based on *Jacobin Matrix*. Experimental results verify the effectiveness of the model.

2 Extraction of knowledge resources relationship in virtual practice teaching

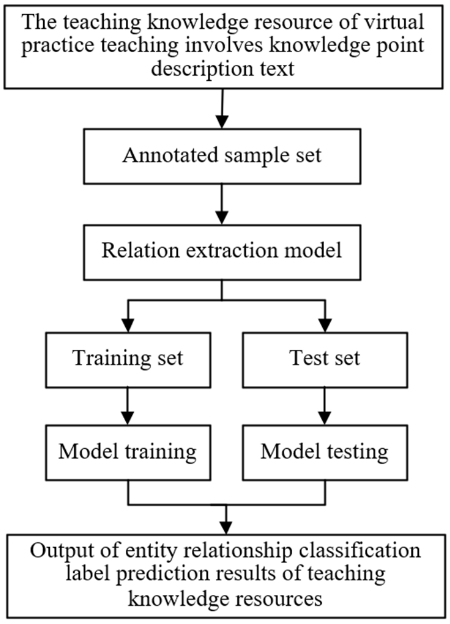

Fig. 1. Relation extraction model flow

There are mainly three kinds of teaching knowledge resources in virtual practice teaching, namely, simulated images, simulated animations, virtual experiment projects or resources provided by third-party databases. The teaching knowledge resources of virtual practice teaching are numerous and discrete, and there is no obvious connection among some knowledge resources. In order to realize the teaching knowledge sharing of virtual practice teaching, this article firstly combs the relationship among knowledge resources, and excavates the hidden connection and internal mechanism. This article constructs *BiLSTM-Attention* relation extraction model to recognize the named entity of teaching knowledge resources in virtual practice teaching, to record the information of knowledge points involved in teaching knowledge resources, and to explore the information hidden in knowledge resources more deeply. Figure 1 shows the relationship extraction model flow.

The *BiLSTM-Attention* model constructed in this article can be divided into five layers: input layer, word embedding layer, *BiLSTM* layer, *Attention* layer and output layer. Figure 2 shows the *BiLSTM-Attention* model architecture.

Word embedding layer is used to map low-dimensional vectors of each word in the description text of knowledge points involved in teaching knowledge resources. Assuming that a sentence containing E words is represented by $R = \{a_1, a_2, a_3, \dots, a_m\}$, each word is represented by a_i, the corresponding real vector is represented by t_i, 1 at t_i, 0 at other positions, and the one-hot vector of size $|U|$ is represented by u^i. Fixed-size vocabulary is represented by U, which is a parameter to be learned. The size of the word vector layer is represented by c^θ, which is a super parameter that students need to choose. For the text sentence R described by knowledge points involved in teaching knowledge resources, firstly, the word vector matrix $Q^{qsc} \in Rc^\theta|U|$ is found to realize the word vector transformation of each word in the text sentence:

$$t_i = Q^{qsc} u^i \tag{1}$$

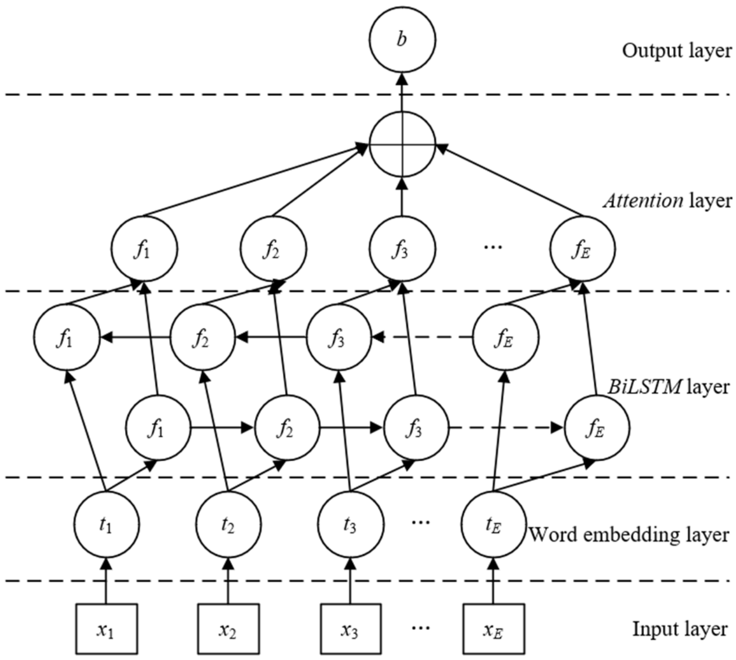

Fig. 2. *BiLSTM-Attention* model architecture

Furthermore, knowledge point description text sentences are passed to *BiLSTM* layer in the form of real number matrix $tny_r = \{t_1, t_2, t_3, \dots, t_E\}$. *BiLSTM* layer fully considers the whole information hidden in the teaching knowledge points involved in the input teaching knowledge resources, discards the unimportant features, retains the important features, and obtains richer text semantic features than one-way LSTM module in the pre-order and post-order.

The *BiLSTM* layer transmits the output vector $F = \{f_1, f_2, f_3, \dots, f_E\}$ to the *Attention* layer, which generates the weight vector corresponding to $F = \{f_1, f_2, f_3, \dots, f_E\}$, and then multiplies F with the weight vector to realize the transformation from vocabulary-level feature to sentence-level feature. Finally, the entity relationship of teaching knowledge resources is classified. Assuming that the F-word vector dimension is represented by c^Q, the transpose matrix of the parameter vector q is represented by q^E, and the sentence length is represented by E, then:

$$N = \tanh(F) \tag{2}$$

$$\beta = soft\max(q^T N) \tag{3}$$

The weighted sum of the output vectors of the *Attention* layer is the representation s of the description sentences of knowledge points involved in teaching knowledge resources:

$$s = F\beta^E \tag{4}$$

Further classify statements based on the following formula:

$$f^* = \tanh(s) \tag{5}$$

Finally, the entity relationship classification label of teaching knowledge resources is predicted based on *soft* max function of classifier:

$$\hat{b}(b|A) = soft\max(Q^{(A)}f^* + y^A) \tag{6}$$

$$\hat{b} = \arg\max \hat{o}(b|A) \tag{7}$$

Assuming that the one-hot representation of positive samples is represented by $e \in R_n$, the probability of each class is represented by $b \in R^n$, the number of classes is represented by n, and the hyper-parameter of $L2$ regularization is represented by υ, the expression of logarithmic likelihood function can be given by the following formula:

$$J(\omega) = -\frac{1}{n}\sum_{i=1}^{n} e_i \log(b_i) + \upsilon\omega_G^2 \tag{8}$$

3 Construction of knowledge sharing model in virtual practice teaching

The choice of knowledge sharing strategy in virtual practice teaching is a dynamic process. Firstly, this article constructs a knowledge sharing model of virtual practice teaching based on traditional evolutionary game, and solves the evolutionary stability strategy of the model.

This article sets up a series of game payment matrix parameters for the knowledge sharing model of virtual practice teaching. The parameters in the model are defined as follows: Assuming that the total amount of virtual practice teaching knowledge learned by Student 1 or Student 2 is represented by $l_i(i = 1,2)$, the Student 1 or Student 2's willingness to share knowledge in virtual practice teaching is represented by $\delta_i(i = 1,2)$, the Student 1 or Student 2's absorption ability of virtual practice teaching knowledge is represented by $x_i(i = 1,2)$, the Student 1 or Student 2's transformation ability of virtual practice teaching knowledge is represented by $\varepsilon_i(i = 1,2)$, the synergistic effect coefficient of Student 1 or Student 2 is represented by $\gamma_i(i = 1,2)$, the proportion of heterogeneous knowledge of both sides of virtual practice teaching knowledge sharing is represented by λ, the degree of trust of both sides of virtual practice teaching knowledge sharing is represented by e, the incentive coefficient of both sides of virtual practice teaching knowledge sharing is represented by μ, the cost coefficient of Student 1 or Student 2 is represented by $d_i(i = 1,2)$, and the risk of virtual practice teaching knowledge sharing of Student 1 or Student 2 is represented by $S_i(i = 1,2)$.

The knowledge sharing benefit of direct virtual practice teaching is defined as the benefit obtained by student i after absorbing the shared knowledge of student j and transforming it into their own knowledge, which is mainly affected by four aspects: l_i, δ_i, x_i *and* ε_i. Therefore, the direct benefit of active teaching knowledge sharing between Student 1 and Student 2 participating in virtual practice teaching can be expressed by $x_1\varepsilon_1\delta_2 l_2$ and $x_2\varepsilon_2\delta_1 l_1$.

If both Student 1 and Student 2 choose to share virtual practical teaching knowledge actively, they can get direct benefits and synergy benefit at the same time. Synergy benefit is defined as the knowledge value increment brought by knowledge fusion and knowledge composition difference when two students share knowledge in virtual practice teaching. It is assumed that the increment is mainly expressed by l_i, λ, e, γ_i and δ_i. Therefore, when Student 1 and Student 2 choose to actively share virtual practical teaching knowledge at the same time, Student 1 and Student 2 can get synergy benefits $\lambda e\gamma_1\delta_1 l_1$ and $\lambda e\gamma_2\delta_2 l_2$.

The incentive benefit is defined as the incentive reward for teachers when Student 1 or Student 2 choose to share virtual practical teaching knowledge actively. The benefit size depends on μ and $\delta_i l_i$, and can be expressed as $\mu\delta_1 l_1$ and $\mu\delta_2 l_2$.

When students choose virtual practice teaching knowledge sharing actively, they need to bear the related costs and risks while gaining benefits. The cost of knowledge sharing is determined by d_i and $\delta_i l_i$, which can be expressed as $d_1\delta_1 l_1$ and $d_2\delta_2 l_2$. The risk of students' active knowledge sharing in virtual practice teaching has little to do with the amount of knowledge sharing, so the risk of knowledge sharing can be expressed as S_1 and S_2.

When there is a game between any Student 1 and Student 2 who participate in the knowledge sharing of virtual practice teaching, the knowledge benefits obtained by both sides will be different under different choices and combinations of students. The following is a specific analysis of different game situations.

Situation 1: Both Student 1 and Student 2 actively share knowledge. Then, two students can get three kinds of benefits, but they have to bear the cost and risk of knowledge sharing. The benefit of Student 1 can be expressed as $F_1 = \varepsilon_1 x_1\delta_2 l_2 + \lambda e\gamma_1\delta_1 l_1 + \mu\delta_1 l_1 - d_1\delta_1 l_1 - S_1$, and that of Student 2 can be expressed as $F_2 = \varepsilon_2 x_2\delta_1 l_1 + \lambda e\gamma_2\delta_2 l_2 + \mu\delta_2 l_2 - d_2\delta_2 l_2 - S_2$.

Situation 2: If Student 1 shares actively and Student 2 shares passively, Student 1 only gets the incentive reward of teachers' teaching, and at the same time bears the cost and risk of knowledge sharing, that's, the benefit of Student 1 can be expressed as $O_1 = \mu\delta_1 l_1 - d_1\delta_1 l_1 - S_1$, and Student 2 gets the direct sharing benefit $W_2 = \varepsilon_2 x_2\delta_1 l_1$.

Situation 3: If Student 1 shares passively and Student 2 shares actively, Student 1 gets direct sharing benefit $W_1 = \varepsilon_1 x_1 \delta_2 l_2$, while Student 2 only gets the incentive reward of teachers' teaching, and at the same time bears the cost and risk of knowledge sharing, which is $O_2 = \mu\delta_2 l_2 - d_2\delta_2 l_2 - S_2$.

Situation 4: If both Student 1 and Student 2 choose to share passively, the benefits of both are 0.

4 Local stability analysis of knowledge sharing model in virtual practice teaching

It is assumed that the students participating in knowledge sharing in virtual practice teaching are composed of two different groups, i.e., Group 1 and Group 2. It is assumed that the proportions of the members of Group 1 and Group 2 who choose active sharing strategies are represented by *a* and *b* respectively, and the proportions of the corresponding two groups who choose passive sharing strategies are represented by (1−*a*) and (1−*b*) respectively. Student 1 and Student 2 are members of Group 1 and Group 2, respectively. Based on the four situations listed above, the average benefit of Student 1's actively sharing virtual practice teaching knowledge can be calculated based on the following formula:

$$T_a = bF_1 + (1-b)O_1 = b(\varepsilon_1\beta_1\delta_2 l_2 + \lambda e\gamma_1\delta_1 l_1) + (\mu - d_1)\delta_1 l_1 - S_1 \tag{9}$$

The average benefit of Student 1's passive sharing can be calculated by the following formula:

$$T_{1-a} = bW_1 = b\,\varepsilon_1\beta_1\delta_2 l_2 \tag{10}$$

The average benefit of Student 1's active and passive knowledge sharing in virtual practice teaching according to the probability choice of *a* and 1−*a* can be calculated by the following formula:

$$\overline{T_{a(1-a)}} = aT_a + (1-a)T_{1-a} = ab\lambda e\gamma_1\delta_1 l_1 + b\varepsilon_1\beta_1\delta_2 l_2 + (\mu - d_1)\delta_1 l_1 - aS_1 \tag{11}$$

Assuming that the proportional adjustment speed of students' active and passive knowledge sharing in virtual practice teaching is directly proportional to the average benefit of their mixed strategies, the replicator dynamic equation of Student 1 is listed below:

$$\frac{da}{de} = a\left(T_a - \overline{T_{a(1-a)}}\right) = a(1-a)[b\lambda e\gamma_1\delta_1 l_1 + (\mu - d_1)\delta_1 l_1 - S_1] \tag{12}$$

Similarly, the replicator dynamic equation of Student 2 is listed below:

$$\frac{db}{de} = b\left(T_b - \overline{T_{b(1-b)}}\right) = b(1-b)[a\lambda e\gamma_2\delta_2 l_2 + (\mu - d_2)\delta_2 l_2 - S_2] \tag{13}$$

If $da/de = 0$ and $db/de = 0$, the equilibrium points $T_1(0,0)$, $T_2(0,1)$, $T_3(1,0)$ and $T_4(1,1)$ can be obtained. When $0 < a^* < 1$ and $0 < b^* < 1$, $T_R(a^*, b^*)$ is also the equilibrium point in the evolutionary game process of students participating in knowledge sharing in virtual practice teaching. Among them,

$$a^* = \frac{S_2 + (d_2 - \mu)\delta_2 l_2}{\lambda e \gamma_2 \delta_2 l_2}, b^* = \frac{S_1 + (d_1 - \mu)\delta_1 l_1}{\lambda e \gamma_1 \delta_1 l_1} \tag{14}$$

Furthermore, this article analyzes the stability of the above five equilibrium points based on the local stability analysis method of *Jacobin Matrix*.

$$JM = \begin{pmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{pmatrix} \tag{15}$$

where,

$$x_{11} = (1 - 2a)[b\lambda e\gamma_1\delta_1 l_1 + (\mu - d_1)\delta_1 l_1 - S_1] \tag{16}$$

$$x_{12} = a\,(1 - a)\lambda e\gamma_1\delta_1 l_1 \tag{17}$$

$$x_{21} = b\,(1 - b)\,\lambda e\gamma_2\delta_2 l_2 \tag{18}$$

$$x_{22} = (1 - 2b)[a\lambda e\gamma_2\delta_2 l_2 + (\mu - d_2)\delta_2 l_2 - S_2] \tag{19}$$

The following formula gives the expressions for the determinant det JM and trace tr JM of *Jacobin Matrix*:

$$\det JM = x_{11}x_{22} - x_{12}x_{21} \tag{20}$$

$$\operatorname{tr} JM = x_{11} + x_{22}$$

When an equilibrium point in $T_1(0,0)$, $T_2(0,1)$, $T_3(1,0)$, $T_4(1,1)$, $T_R(a^*, b^*)$ satisfies $\det JM > 0$, $\operatorname{tr} JM < 0$, it is considered that the equilibrium point is in a local asymptotic stable state. The results of local stability analysis of knowledge sharing in virtual practice teaching are described in detail as follows:

Case 1: When $\mu\delta_1 l_1 < S_1 + d_1\delta_1 l_1 - \lambda e\gamma_1\delta_1 l_1$, $\mu\delta_2 l_2 < S_2 + d_2\delta_2 l_2 - \lambda e\gamma_2\delta_2 l_2$, $a^* > 1$, $b^* > 1$, there are four equilibrium points in the knowledge sharing game system, and the evolutionary equilibrium points are (0, 0). The evolution phase diagram is shown in Figure 3.

Case 2: When $\mu\delta_1 l_1 < S_1 + d_1\delta_1 l_1 - \lambda e\gamma_1\delta_1 l_1$, $\mu\delta_2 l_2 > S_2 + d_2\delta_2 l_2$, $a^* > 1$, $b^* < 0$, there are four equilibrium points in the knowledge sharing game system, and the evolutionary equilibrium point is (0, 1). The evolution phase diagram is shown in Figure 3.

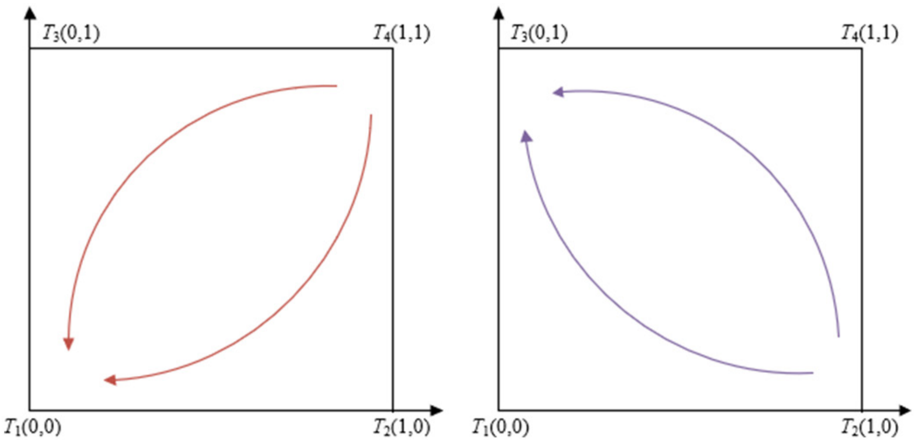

Fig. 3. Evolution phase diagram of Case 1 and Case 2

Case 3: When $\mu\delta_1 l_1 < S_1 + d_1\delta_1 l_1$, $\mu\delta_2 l_2 < S_2 + d_2\delta_2 l_2 - \lambda e\gamma_2\delta_2 l_2$, $a^* > 1$, $b^* > 1$, there are four equilibrium points in the knowledge sharing game system, and the evolutionary equilibrium point is (1, 0). The evolution phase diagram is shown in Figure 4.

Case 4: When $\mu\delta_1 l_1 > S_1 + d_1\delta_1 l_1$, $\mu\delta_2 l_2 > S_2 + d_2\delta_2 l_2$, $a^* < 0$, $b^* < 0$, there are four equilibrium points in the knowledge sharing game system, and the evolutionary equilibrium points are (1, 1). The evolution phase diagram is shown in Figure 4.

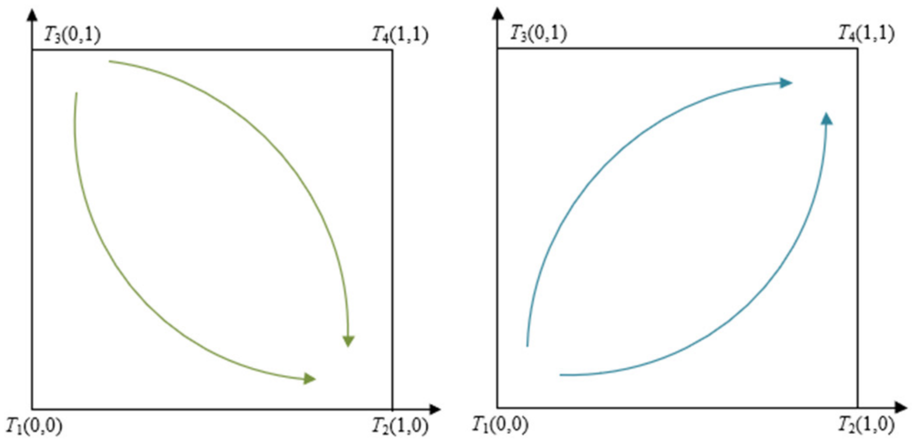

Fig. 4. Evolution phase diagram of Case 3 and Case 4

Case 5: When $S_1 + d_1\delta_1 l_1 - \lambda e\gamma_1\delta_1 l_1 < \mu\delta_1 l_1 < S_1 + d_1\delta_1 l_1$, $S_2 + d_2\delta_2 l_2 - \lambda e\gamma_2\delta_2 l_2 < \mu\delta_2 l_2 < S_2 + d_2\delta_2 l_2$, $0 < a^* < 1$, $0 < b^* < 1$, there are 5 equilibrium points in the knowledge sharing game system, and the evolutionary equilibrium points are (0, 0) or (1, 1). The evolution phase diagram is shown in Figure 5.

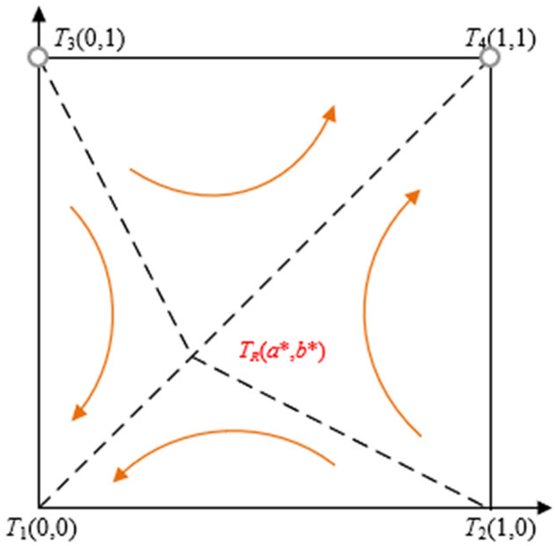

Fig. 5. Evolution phase diagram of Case 5

From the above analysis, it can be seen that the relationship among the synergy benefits of knowledge sharing, teachers' teaching incentive reward, knowledge sharing cost and knowledge sharing risk of virtual practical teaching determines the final stable state of the knowledge sharing game system. When teachers' teaching incentive reward is greater than the sum of knowledge sharing cost and risk, students tend to actively share knowledge. When the sum of synergy benefits and teachers' teaching incentive reward is less than the sum of knowledge sharing cost and risk, students tend to share knowledge passively. In particular, we can find that teachers' teaching incentive reward is important to promote students' knowledge sharing in virtual practical teaching. Only when students' teaching incentive reward is greater than the sum of knowledge sharing cost and risk, students tend to actively share knowledge.

5 Experimental results and analysis

This article takes the virtual practice teaching of sports dance major as an example to carry out experiments. The frequency of students' knowledge sharing in virtual practice teaching is often used to reflect the degree of students' acceptance of virtual practice teaching knowledge sharing in the effectiveness analysis of virtual practice teaching knowledge sharing methods. The following is a statistical analysis and comparison of the frequency of knowledge sharing between the two groups of middle school students with different knowledge capacities. The results are shown in Table 1. It can be seen from the table that students with low and high knowledge capacity share more knowledge, accounting for about 80%, indicating that students with low and high knowledge capacity have higher knowledge sharing needs. Further observing the knowledge sharing situation of students in different groups, knowledge sharing frequency change trend in the two groups of students is basically the same, indicating that the knowledge sharing development situation in the two groups of virtual practice teaching is excellent, with good development potential.

Table 1. Frequency statistics of students' knowledge sharing

Knowledge Capacity	Group 1		Group 2	
	Frequency	Percent %	Frequency	Percent %
0	55	15.11%	52	13.65%
(0,5)	35	9.62%	42	11.02%
[5,10)	42	11.54%	41	10.76%
[10,15)	26	7.14%	23	6.04%
[15,20)	26	7.14%	26	6.82%
[20,30)	19	5.22%	18	4.72%
[30,40)	38	10.44%	27	7.09%
[40,50)	42	11.54%	33	8.66%
[50,100)	41	11.26%	60	15.75%
100	40	10.99%	59	15.49%

The proportion of Student 1 and Student 2 who choose to share virtual practice teaching knowledge is 0.3, 0.6 and 0.9 respectively. Figure 6a–c verify whether the dynamic evolution of knowledge sharing behavior of Student 1 and Student 2 in virtual practice teaching is related to the stability of the knowledge sharing model of virtual practice teaching. Because the goal of the model is to maintain the stability of the model through long-term learning and adjustment of knowledge sharing selection strategies, so that all students who participate in knowledge sharing in virtual practice teaching keep a positive attitude of mutual trust, which will help the whole student group to develop towards better teaching effect. Compared with Student 2 in the actual application scenario, because of his dance learning experience, his dominant force in knowledge sharing is more obvious. In the process of virtual practice teaching, Student 2 and Student 1 carry out the docking and movement adjustment of dance design together. It is difficult for Student 1 to complete the learning task only by means of simulated images, simulated animations and virtual experiments provided by virtual reality technology, so his willingness to actively share knowledge is not high. Then, the members of Student 1 think that the learning task is relatively not difficult and his willingness to actively share knowledge is also low. The virtual practice teaching knowledge sharing system will eventually converge to 0. However, only when Student 1 and Student 2 choose to share knowledge at the same time and have a strong willingness to share knowledge, the knowledge sharing system will converge to 1, and the convergence speed will accelerate with the increase of the proportion of knowledge sharing. Moreover, in the process of virtual practice teaching, because of students' self-randomness, it is difficult to transform knowledge sharing into conscious behavior in virtual practice teaching. Only by improving the sense of team cooperation, reducing the sharing risk of students who choose virtual practice teaching knowledge sharing and ensuring their sharing benefits, can students who participate in teaching always maintain a high level of knowledge sharing emotion.

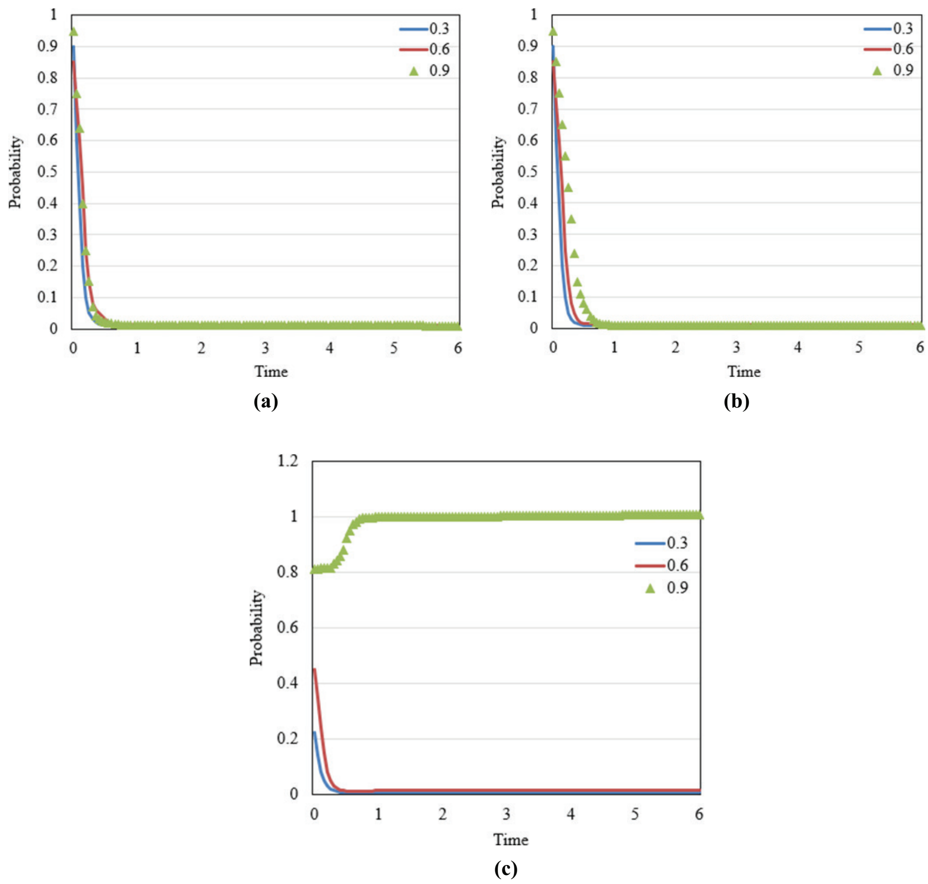

Fig. 6. The influence of the proportion of knowledge sharing on the stability of the model

Students' choice of knowledge sharing in virtual practice teaching is influenced by many factors. This article analyzes the sensitivity of each factor in order to study the interference mechanism of core elements on students' knowledge sharing strategies. The simulation results are shown in Figures 7–10. The abscissa is time, and the ordinate indicates the proportion of students choosing knowledge sharing.

Change the values of Student 1 and Student 2's knowledge sharing willingness, knowledge absorption ability, knowledge transformation ability and synergy coefficient. From the simulation results from Figures 7–10, it can be seen that when the time value is small, the slope of the curve in the graph is negative, evolving to (0, 0) and reaching stability, which shows that both Student 1 and Student 2 choose not to share knowledge in the initial stage of virtual practice teaching. When the time value increases gradually, the slopes of curves in the graph are all positive, evolving to (1, 1) and reaching stability, which means that both Student 1 and Student 2 choose to share knowledge. In this process, the evolution trend of virtual practice teaching knowledge sharing system to overall knowledge sharing is accelerated, when the values of knowledge sharing willingness, knowledge absorption ability, knowledge transformation ability and synergy coefficient decrease, the evolution speed of virtual practice teaching knowledge sharing system to the whole knowledge sharing decreases, which shows that the values of the four parameters have positive incentive effect on students' behavior of choosing virtual practice teaching knowledge sharing.

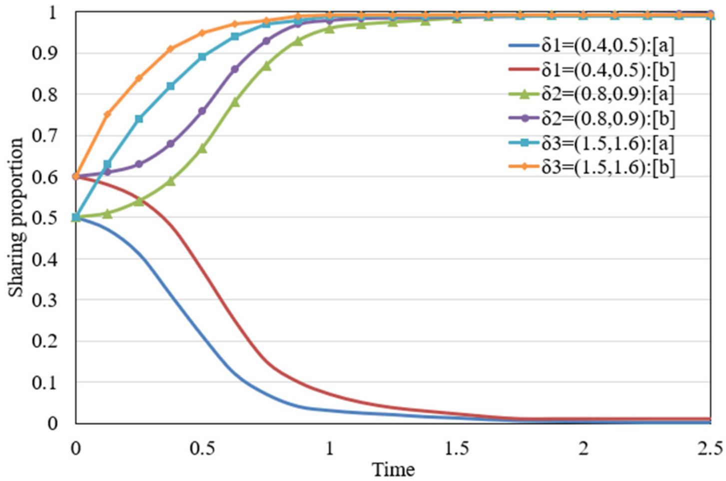

Fig. 7. Influence of willingness to share knowledge

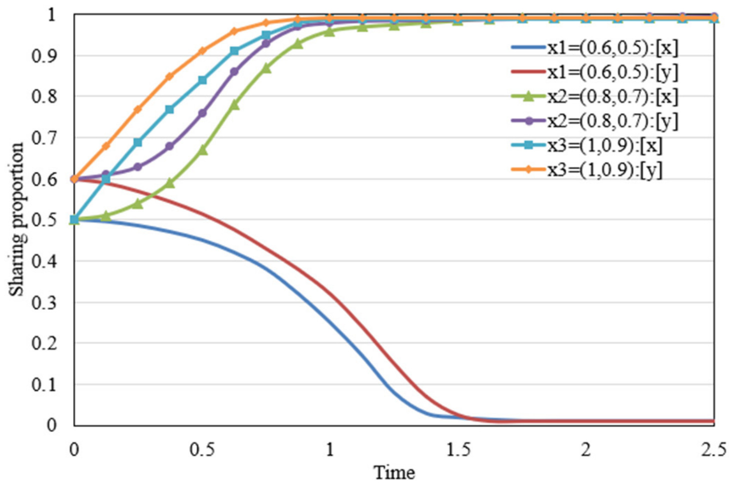

Fig. 8. Influence of knowledge absorption ability

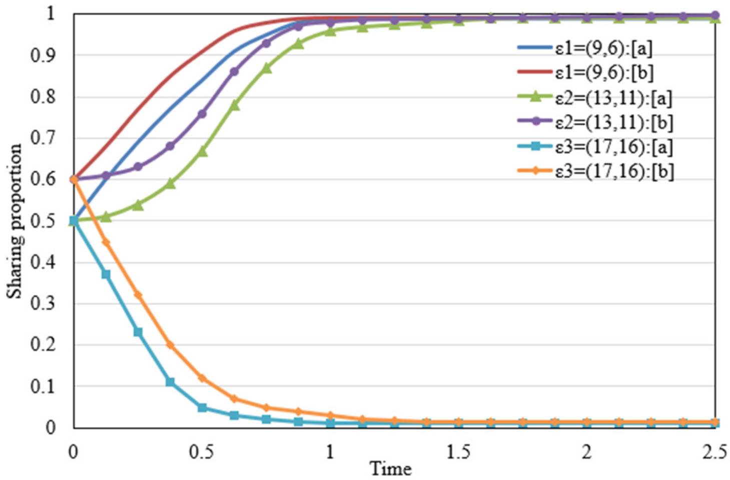

Fig. 9. Influence of knowledge transformation ability

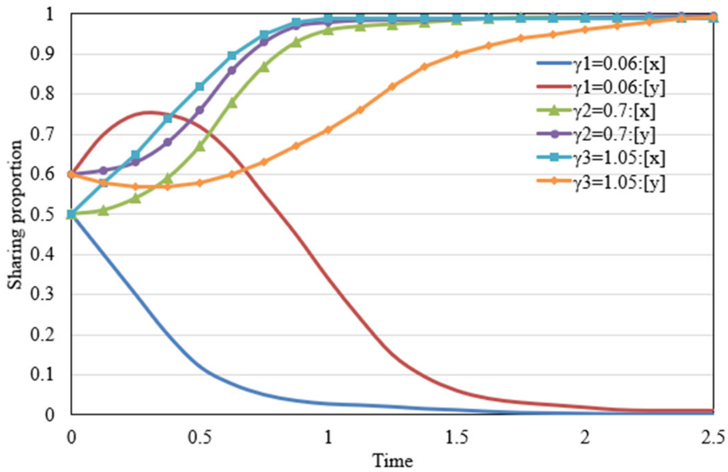

Fig. 10. Influence of synergy coefficient

6 Conclusion

This article studies the teaching knowledge sharing method of virtual practice teaching and constructs *BiLSTM-Attention* relation extraction model to recognize named entities of teaching knowledge resources in virtual practice teaching, to record the information of knowledge points involved in teaching knowledge resources, and to explore the information hidden in knowledge resources more deeply. This article constructs a knowledge sharing model of virtual practice teaching based on traditional evolutionary game, and analyzes the local stability of the model based on *Jacobin Matrix*.

Combined with experiments, the frequency of knowledge sharing between two groups of middle school students under different knowledge capacities is statistically analyzed and compared, which verifies that the development situation of virtual practice teaching knowledge sharing between the two groups is excellent. This article analyzes the influence of the proportion of knowledge sharing on the stability of the model, and verifies whether the dynamic evolution of knowledge sharing behavior in virtual practice teaching is related to the stability of the knowledge sharing model in virtual practice teaching. It carries out the sensitivity analysis of each factor and studies the interference mechanism of core elements on students' knowledge sharing strategies. It is verified that the values of knowledge sharing willingness, knowledge absorption ability, knowledge transformation ability and synergy coefficient have positive incentive effects on students' behavior of choosing virtual practice teaching knowledge sharing.

7 References

[1] Latif, S., Tarner, H., Beck, F. (2021). Talking realities: Audio guides in virtual reality visualizations. IEEE Computer Graphics and Applications, 42(1): 73–83. https://doi.org/10.1109/MCG.2021.3058129

[2] Liu, Z.H., Lyu, J., Zhao, H.L., Liu, J. (2020). Prediction of graphic interaction time of virtual reality system based on improved Fitts' law. Traitement du Signal, 37(2): 227–234. https://doi.org/10.18280/ts.370208

[3] Peng, L., Yen, Y., Siswanto, I. (2020). Virtual reality teaching material-virtual reality game with education. In Journal of Physics: Conference Series, 1456: 012039. https://doi.org/10.1088/1742-6596/1456/1/012039

[4] Wang, Y. (2020). Application of virtual reality technique in the construction of modular teaching resources. International Journal of Emerging Technologies in Learning, 15(10): 126–139. https://doi.org/10.3991/ijet.v15i10.14129

[5] Georgieva-Tsaneva, G., Serbezova, I. (2020). Virtual reality and serious games using in distance learning in medicine in Bulgaria. International Journal of Emerging Technologies in Learning, 15(19): 223–230. https://doi.org/10.3991/ijet.v15i19.15753

[6] Liu, S., Liu, Y., Cao, X. (2020). Application of virtual reality technology in the experiment teaching of tourism destination crisis management. In Innovative Computing, pp. 1305–1315. https://doi.org/10.1007/978-981-15-5959-4_160

[7] Zhang, Y., Chen, J., Miao, D., Zhang, C. (2018). Design and analysis of an interactive MOOC teaching system based on virtual reality. International Journal of Emerging Technologies in Learning, 13(7): 111–123. https://doi.org/10.3991/ijet.v13i07.8790

[8] Halabi, O. (2020). Immersive virtual reality to enforce teaching in engineering education. Multimedia Tools and Applications, 79(3): 2987–3004. https://doi.org/10.1007/s11042-019-08214-8

[9] Mikulowski, D., Pilski, M. (2017). Ontological support for teaching the blind students spatial orientation using virtual sound reality. In Interactive Mobile Communication, Technologies and Learning, Thessaloniki, Greece, pp. 309–316. https://doi.org/10.1007/978-3-319-75175-7_32

[10] Alves, F.C., Diniz, M.M., Rodrigues, A., Monteiro, D.C. (2018). Teaching platonic polyhedrons through augmented reality and virtual reality. In Proceedings of the 17th Brazilian Symposium on Human Factors in Computing Systems, New York, United States, pp. 1–4. https://doi.org/10.1145/3274192.3274243

[11] Zhang, J., Zhou, Y. (2020). Study on interactive teaching laboratory based on virtual reality. International Journal of Continuing Engineering Education and Life Long Learning, 30(3): 313–326. https://doi.org/10.1504/IJCEELL.2020.108543
[12] Septinaningrum, Hakam, K.A., Setiawan, W., Agustin, M. (2022). Developing of augmented reality media containing Grebeg Pancasila for character learning in elementary school. Ingénierie des Systèmes d'Information, 27(2): 243–253. https://doi.org/10.18280/isi.270208
[13] Philippe, S., Souchet, A.D., Lameras, P., Petridis, P., Caporal, J., Coldeboeuf, G., Duzan, H. (2020). Multimodal teaching, learning and training in virtual reality: A review and case study. Virtual Reality & Intelligent Hardware, 2(5): 421–442. https://doi.org/10.1016/j.vrih.2020.07.008
[14] Wang, F. (2018). Computer distance virtual experiment teaching application based on virtual reality technology. International Journal of Emerging Technologies in Learning, 13(4): 83–94. https://doi.org/10.3991/ijet.v13i04.8472
[15] Pu, Y., Yang, Y. (2022). Application of virtual reality technology in martial arts situational teaching. Mobile Information Systems, 2022: 6497310. https://doi.org/10.1155/2022/6497310
[16] Kumar, A., Saudagar, A.K.J., AlKhathami, M., Alsamani, B., Hasanat, M.H.A., Khan, M.B., Kumar, A., Singh, K.U. (2022). AIAVRT: 5.0 transformation in medical education with next generation AI-3D animation and VR integrated computer graphics imagery. Traitement du Signal, 39(5): 1823–1832. https://doi.org/10.18280/ts.390542
[17] Lin, J. (2022). Classroom teaching design of alpine skiing based on virtual reality technology. Mathematical Problems in Engineering, 2022: 5721790. https://doi.org/10.1155/2022/5721790
[18] Liu, M., Liu, Z., Zhang, S., Yang, W. (2022). Application of virtual reality for teaching rock climbing in colleges using big data. Mobile Information Systems, 2022: 6531823. https://doi.org/10.1155/2022/6531823
[19] Zhong, Z., Zhu, X. (2022). Application analysis of virtual reality integration environment based on VR technology in physical education teaching. In 2022 2nd International Conference on Information Technology and Contemporary Sports (TCS), Guangzhou, China, pp. 76–81. https://doi.org/10.1109/TCS56119.2022.9918720
[20] Zhang, H., Zhang, L. (2022). Investigation on the use of virtual reality in the flipped teaching of martial arts Taijiquan based on deep learning and big data analytics. Journal of Sensors, 2022: 3921842. https://doi.org/10.1155/2022/3921842

8 Authors

Li'e Wang, graduated from Xi'an Institute of Physical Education and obtained a master's degree. Now she works in the Institute of Physical Education of Yulin University. Her main research direction is sports education and training. Email: fengshan0627@163.com

Fenshan Liu, graduated from Xi'an Institute of Physical Education and obtained a master's degree. Now he works in the Institute of Physical Education of Yulin University. His main research direction is sports education and training. Email: liufenshan@yulinu.edu.cn

Article submitted 2022-11-17. Resubmitted 2023-01-15. Final acceptance 2023-01-19. Final version published as submitted by the authors.